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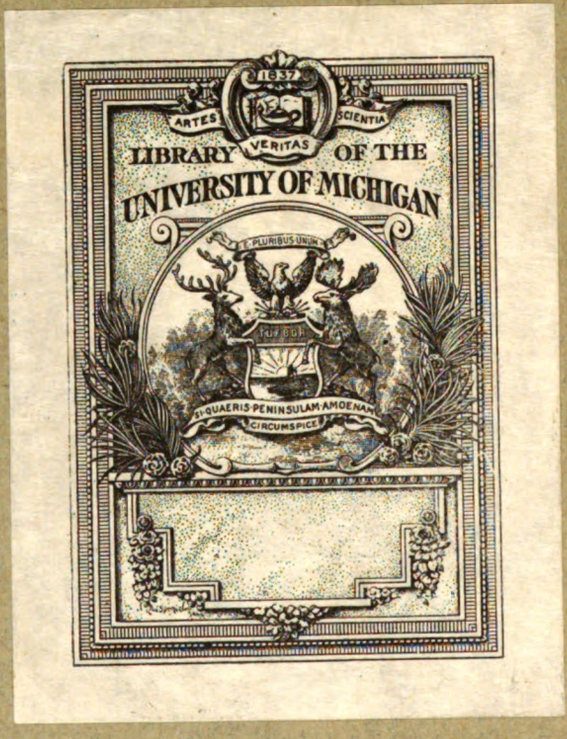

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THE

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NOTES.

Royal Institution.—A general monthly meeting of the members of the Royal Institution was held on Monday last, Sir James Crichton-Browne, treasurer and vice-president, in the chair. Mr. G. Jamieson, C.M.G., Dr. S. Shore Nightingale, Mr. W. Stone, Mr. H. S. Stoneham, and Mr. E. Turk were elected members.

Electric Power in Norway.—With reference to the notices which appeared towards the end of last year respecting a Norwegian law regulating the sale of real property, it is now reported by his Majesty's Legation at Christiania that a Government proposal restricting leases or sales of electric power to foreigners was recently passed by the Storthing, and subsequently ratified by the Council of State. The law takes effect at once. His Majesty's Legation remark that, in order to keep the control of electric power produced by waterfalls in the hands of the Government, an addition has been made to the temporary Act of June 12, 1906, which has been extended for a period of one year—viz., to April 1, 1908. The provisions of the supplementary Act are that the regulations contained in the temporary Act regarding the right of acquisition and working of mines, waterfalls, and forests shall also apply to the acquisition of the right to electric power produced by water power in larger quantities than 250 h.p.

The Institution Wiring Rules.—We have received a proof of the cover of the reprint of the revised wiring rules, which contains lists of the insurance offices who have adopted the rules, and of the supply authorities who accept them as standard practice and recommend their use. All the principal fire offices are included in the lists, and among the electric supply authorities who accept the wiring rules as standard practice and recommend their use we notice the following companies: Brompton and Kensington Electricity Supply, Chelsea Electricity Supply, County of London Electric Supply, Kensington and Knightsbridge Electric Lighting, London Electric Supply Corporation, Notting Hill Electric Lighting, St. James's and Pall Mall, South London Electric Supply Corporation, South Metropolitan Electric Light and Power, Westminster Electric Supply Corporation, Edmundson's Electricity Supply Corporation, Urban Electric Supply, Bournemouth and Poole Electricity Supply, Cambridge Electric Supply, Cork Electric Tramways and Lighting, Harrow Electric Light and Power, Isle of Wight Electric Light and Power, Midland Electric Corporation for Power Distribution, Midland Electric Light and Power, National Electric Supply, Northampton Electric Light and Power, Northwich Electric Supply, Oxford Electric, Pontypool Electric Light and Power, Prescot and District Lighting, Reading Electric Supply, Scarborough Electric Supply, Uxbridge and District Electric Supply, Windermere and District Electricity Supply, and the Incorporated Municipal Electrical Association.

Publications Received.—"The Electric Tramcar Handbook," by Mr. W. A. Agnew (London: H. A. Alabaster, Gatehouse, and Co., 4, Ludgate-hill, E.C. 2s. 6d. net). The fourth edition of the handbook, revised and enlarged, has just been published. The additions made relate to the new Westinghouse controller, which is described with diagram of connections; the latest type of Raworth's regenerative controller, described also with diagram; and some additional types of trucks are illustrated, and a Union "time-meter" described.—The "Arclight Metric Table," showing the metrical and decimal equivalents to feet and inches, has just been published by the Arclight Printing Depôt, Colchester.—There has come to hand the *Journal* of the Western Society of Engineers, Chicago (vol. xii., No. 2), which contains the following among other contributions: "Practical Pyrometry," by Mr. R. S. Whipple; "Vibrations in Passenger Trains from High-Speed Electric Lighting Engines," by Mr. F. W. Huels; and "Direct-Current Compensators for Balancing Electric Circuits," by Mr. H. M. Biebel.—The June issue of the *Journal* of the Franklin Institute (Philadelphia) contains an article by Dr. Lee de Forest on "Recent Developments in Wireless Telegraphy."—We have received an advance copy of the Great Eastern Railway Company's handbook, "Summer Holidays," issued in convenient pocket size. Prominence has been given to some less-known districts in East Anglia, and to the country between the Cromer coast and the Norfolk Broads. The facsimile water-colour and pen-and-ink illustrations have been made a special feature.—Mr. Alfred Hands has sent us a reprint of his paper, "The Protection of Buildings from Lightning,' which he read before the School of Military Engineering, Chatham, on Dec. 6, 1906.

Engineering at the Universities.—It is a welcome sign of the times that the older universities—Oxford and Cambridge—are devoting much greater attention to the cultivation of scientific studies than at any other period, and are identifying these studies with the great industries of the country. At Oxford a statute will be brought forward in October next for establishing a professorship of engineering science, for which a sum of not less than £800 per annum, inclusive of a fellowship, has been guaranteed for five years. It is proposed that the professor shall lecture and give laboratory, but not workshop, instruction, and he will have charge of any engineering laboratory that may be assigned him by the university. He will be elected for a period of five years, and will be eligible for re-election. Cambridge is offering a prize of £50 out of the Gordon-Wigan Fund—to be awarded at the end of Easter term, 1908—for a research in chemistry, of sufficient merit, carried out in the University of Cambridge. Candidates for the prize must be members of the university in their sixth term at least, and under the standing of M.A. The research may be in any branch of chemistry. The dissertation, with the details of the research, must be sent to the professor of chemistry not later than the division of the Easter term, 1908. It has taken our great seats of learning many years to consider whether engineering sufficiently merited a place in the curriculum, but any doubts which may have existed

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are soon dispelled by the satisfactory experiences of the younger and more energetic universities, who have from the very commencement of their careers closely identified themselves with commerce and industry. And here we are glad to note that the council of King's College, London, have appointed Mr. O. S. Sinnatt, M.Sc., as senior demonstrator in engineering.

Incandescent Illuminants.—Mr. James Swinburne's discourse on "Incandescent Illuminants," which he recently delivered before the Royal Institution of Great Britain, has been abstracted and published in the form of a pamphlet. The discourse is really a continuation and development of the investigations into metallic-filament lamps, the results of which Mr. Swinburne has already given in a paper read before the Institution of Electrical Engineers earlier in the year. In the Royal Institution discourse Mr. Swinburne discussed the theory of the incandescent gas mantle, pointed out the drawbacks of gas compared with electric lighting, and indicated the great change which the electric incandescent light is undergoing through carbon being replaced by metal wires. In dealing with the various metallic-filament lamps introduced, he referred to the great demand for the tantalum lamp and to the difficulty of running this lamp on alternating currents. Of the new lamps mentioned, one of the most interesting is the zircon, which is said to be made of zirconium and tungsten. Mr. Swinburne, however, thinks it is possible that the conductor is really a zirconide of tungsten, and this opens up a new series of compounds. A zircon lamp for 100 volts has really six separate loops of wire mounted in series inside a bulb. A recent improvement mentioned by Mr. Swinburne is to provide an extremely light spring for each loop, so as to keep it taut; the lamp can then be used in any position. Tungsten seems to be a favourite metal, as it gives a very high efficiency. It is probable that the lamps of the future will have an efficiency of nearly a candle per watt, and this is promised by the use of tungsten. The great difficulty in the way of securing such an efficiency by the use of tungsten is emphasised by Mr. Swinburne, who admits that "to make a wire with a resistance of 500 ohms small enough to give 20 candles with 20 watts is a triumph of inventive skill."

London Traffic. — An influential deputation was received by the General Purposes Committee of the London County Council on Monday with regard to asking the Council to use its influence in pressing upon the Government the necessity of instituting a Board for the regulation and control of London traffic. The deputation was introduced by the Hon. Charles Booth, and numbered about 30, including Lord Ribblesdale, Lord Montagu of Beaulieu, Sir David Barbour (chairman of the late Royal Commission on London Traffic), and Sir John Dickson Poynder, M.P., while letters of apology were received from Sir George Gibb (chairman of the Underground Electric Railways), Sir J. Wolfe Barry, and others, each of whom expressed his approval of the proposal to appoint a Traffic Board. Mr. Booth recalled the history of the movement, which had led to the appointment of a Royal Commission to consider the question of London's traffic, whose principal recommendation was the institution of a Traffic Board. Lord Loreburn had authorised him to say that his lordship sympathised with the proposal, and Mr. Balfour had informed him that he agreed with the desirability of the appointment of a Traffic Board. There was a fear on the part of the County Council that such a Board would interfere with and trench upon the duties and functions of the County Council. Anyone who studied the report of the Royal Commission would see that, on the contrary, such a Board would strengthen their hands as an executive body, for it would be entirely advisory and consultative, and would supply an intelligent link between the authorities whose duties included the control of the traffic. Sir David Barbour said the idea of a Traffic Board was to supply a thinking brain for Greater London to enable the various parts of the metropolitan area to work together in harmony. Other speakers addressed the committee, and the deputation was assured by the chairman, Mr. Sankey, that the London County Council were alive to the importance of the subject, and would consider the proposals submitted to them.

Electro-Metallurgy.—Electro-metallurgical processes have undergone substantial development within recent years, but of late the change has been largely in the direction of making the various processes commercially workable. The subject was treated by Mr. Bertram Blount in an interesting paper read before the engineering conference of the Institution of Civil Engineers on the 21st ult. Mr. Blount rightly said that at present more solid progress was being made in electro-metallurgy that at any previous time. The principal electro-metallurgical industries are the refining of copper, the manufacture of aluminium, of sodium, and of steel. The greater part of the world's output of copper is now refined electrolytically, with the result that good commercial copper is often almost chemically pure. The aluminium industry is in an exceptionally prosperous condition. There are several directions in which experiments are being made, which, if successful, may lower the cost of manufacture substantially and allow of the use of aluminium at least as freely as that of zinc. Mr. Blount believes that the largest of all electro-metallurgical industries will be the manufacture of steel, because suitable methods are now being developed. Some are already at work, and in his view there is no doubt of their rapid and fruitful growth. Much delay in arriving at the present status has, he says, occurred, because for years inventors tried to smelt iron instead of manufacturing steel from iron already smelted in the blast furnace. Now, however, attention is turned to steelmaking as a more easily attainable end, with the result that already steels of high grade can be successfully prepared in electric furnaces of various type—the Héroult and the Kjellin representing two of the most distinctive and promising. Probably, in the first instance, the electrical method will have its greatest measure of success in preparing steels of such high grade, that any extra cost will be quite outweighed by the certainty that the metal will absorb no impurity in the course of manufacture. But as methods are cheapened, it may well be that every grade of steel now prepared in open-hearth furnaces will be prepared in corresponding furnaces electrically heated. The power necessary should be obtainable from blast-furnace gases, for, after a liberal allowance for heating the blast and for the blowing engines, hoists, and subsidiary gear, there is certainly an ample surplus provided modern power plant is installed.

Society of Arts.—The annual general meeting of the Society of Arts was held on the 26th ult., Sir Steuart Colvin Bayley, chairman of the council of the society, in the chair. The principal business of the meeting was the election of the council for the year and the reception of the annual report of the council. H.R.H. the Prince of Wales was re elected president of the society, an office which his Royal Highness has filled since 1901. The report reviewed the proceedings of the society during the past session; it referred to the award of the Albert medal to Lord Cromer. Amongst the prizes announced for next year is a gold medal under the Benjamin Shaw Trust for industrial hygiene, similar medals under the Stock and Mulready Trusts to

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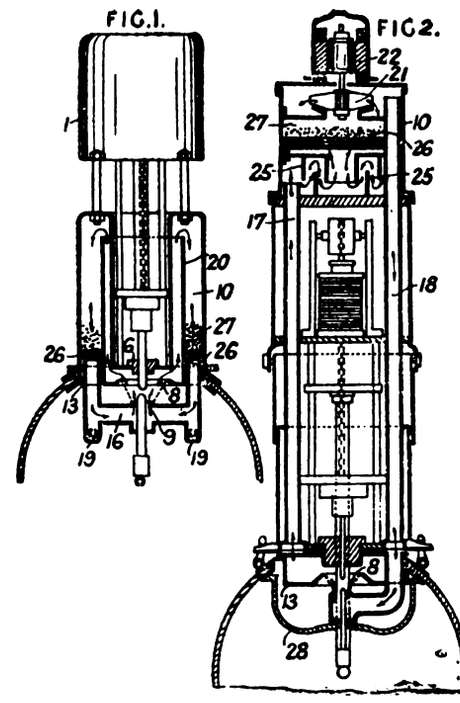
students of schools of art, and one under the Fothergill Trust for the best portable apparatus for use in mines and other places where the air is noxious, enabling men to undertake rescue work. It was noted that there had been a slight increase in the number of candidates at the society's examinations, the total number of papers worked being 24,568. The election of their Majesties the King of Norway and the King of Denmark as honorary Royal members of the society on the occasion of their visit to this country is mentioned. The report concludes with a reference to the members of the society who had died during the past year, the most noticeable of whom was Sir Benjamin Baker. The Society of Arts conversazione will be held on Tuesday, July 9, in the gardens of the Royal Botanic Society, Inner Circle, Regents Park. The conservatory, club-house, and tropical house will be open to visitors, for whose entertainment an interesting programme of vocal and instrumental music as well as a pastoral play has been arranged. The council have awarded the society's silver medal to the following readers of papers during the session 1906-7 : to Mr. John William Gordon for his paper on "Patent Law Reform"; to Colonel Sir Charles M. Watson for his paper on "Some Objections to the Compulsory Introduction of the Metric System"; to Mr. Herbert Wright for his paper on "Rubber Cultivation in the British Empire." Sir William Ramsay has undertaken to deliver during the autumn the first Aldred lecture; the subject selected will be connected with radioactive phenomena. The council hope that they may be able to continue the series of Aldred lectures either annually or biennially, as the funds may permit.

South Kensington College of Science.—The list of appointments to the governing body of the new College of Science and Technology at South Kensington has now been completed. The names of some of the gentlemen who accepted the offer of nomination for appointment by the Crown and the Board of Education have already appeared in these columns, but following is the complete list of appointments: By the Crown—Earl of Crewe, Lord President of the Council; Mr. Gerald W. Balfour; Sir Francis Mowatt; Sir Julius C. Wernher, Bart.; Sir William H. White; and Dr. MacAlister, principal of the University of Glasgow. By Mr. McKenna, President of the Board of Education—Mr. A. H. D. Acland; Mr. F. G. Ogilvie, C.B., a principal assistant secretary of the Board of Education; Mr. J. C G. Sykes, an assistant secretary of the Board; and Dr. R. T. Glazebrook, F.R.S., director of the National Physical Laboratory. By the University of London—Sir E. H. Busk, past vice-chancellor of the university; Prof. Capper; Prof. Farmer; Sir Henry E. Roscoe, F.R.S.; and Sir A. W. Rücker, principal of the university. By the London County Council—Mr. A. A. Allen, M.P.; Mr. H. Percy Harris, chairman of the Council; Sir C. Kinloch-Cooke; Mr. R. A. Robinson; and Mr. J. T. Taylor. By the City and Guilds of London Institute—the Earl of Halsbury, chairman of the council of the institute; Sir J. Wolfe Barry; Sir Owen Roberts, clerk to the Clothworkers' Company; Sir Walter S. Prideaux, clerk to the Goldsmiths' Company; and Sir John Watney, hon. secretary of the institute. By the Royal Commissioners for the Exhibition of 1851—Viscount Esher and Lieut.-Colonel Sir Arthur Bigge. By the Royal Society—Sir Archibald Geikie, F.R.S. By the professorial staff—Prof. Tilden; Prof. Gowland; and Prof. Dalby. By the Institution of Civil Engineers—Sir Alexander B W. Kennedy, F.R.S., president of the institution. By the Institution of Mechanical Engineers—Mr. T. Hurry Riches, president of the institution. By the Institution of Electrical Engineers—Mr. R. Kaye Gray, past-president of the Institution. By the Iron and Steel Institute—Sir Hugh Bell, Bart., president of the institute. By the Institution of Naval Architects—Dr. F. Elgar. By the Society of Chemical Industry—Dr. E. Divers, F.R.S., past-president of the society. By the Institution of Mining Engineers—Mr. A. Sopwith, past-president of the institution; and by the Institution of Mining and Metallurgy—Mr. W. McDermott, past-president of the institution.

Blondel Arc Lamps.—A patent has been granted to Mr. A. Blondel, of Paris, relating to the purification and circulation of gases in an electric arc lamp. In an enclosed arc lamp using mineralised electrodes gases from the arc pass upwards through an orifice, and after purification are returned through a second orifice below the arc and co-axial with the first, circulation being obtained either by the division of the purifying chamber by a vertical heat-insulating partition, or by the use of an electrically-driven fan. A cover, 13 (Figs. 1 and 2), preferably extending a little way into the globe, closes the latter except for the orifice, 8. When natural circulation is relied on, the purifying chamber, 10 (Fig. 1), is annular and the



partition, 20, cylindrical. The outer wall of the chamber may be corrugated, grooved, or ribbed to promote cooling. Chemicals, 27, such as alkaline carbonates, ferrous salts, or iron shavings adapted to absorb nitrous fumes, may be placed within the chamber. Tubes, 16, convey the gases to the lower orifice, 9, and are provided with plugs, 19, to allow access for cleaning. Both carbons are movable, the upper one through an "economiser," 6. The regulating mechanism is contained in a box, 1. A lamp with downwardly convergent electrodes is similarly arranged, except that both electrodes pass through the economiser. Fig. 2 shows the chamber, 10, which here contains baffle-plates, 25, netting, 26, chemicals, 27, and a fan, 21, arranged above the regulating mechanism, and communicating by tubes, 17, 18, with the two orifices. The fan, 21, is driven by a motor, 22, preferably having its armature and field coils connected in parallel with each other and in series with the arc. A glass cup, 28, is arranged as shown. In two other lamps, each having the regulating mechanism above the purifying chamber, the latter is cylindrical and has a cylindrical partition, the gases passing upwards through the inner space thus provided. A fan is arranged either at

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the upper end of the chamber or in a box under the globe, through which vertical tubes extend in the latter case. The upper electrode in each of these lamps is of non-consuming material, such as metal. The invention is applicable to multiple-carbon lamps.

Lighting and Tramways Committees.—Municipalities owning combined stations, and producing electrical energy for traction as well as for general purposes, are not infrequently called upon to deal with differences that arise between their electricity and tramways committees. This is scarcely surprising, for where municipal lighting and tramways departments are separately controlled by different committees there is an irresistible tendency on the part of the respective committees to secure from one another the most favourable terms, regardless of the effect which the rate at which electrical energy is supplied may have upon the success of one or other of the departments (in which the ratepayers are equally interested), or upon the finances of the corporation. This self-interestedness and narrowness of vision, which is at times a notable characteristic of the dealings between corporation committees, by no means arises from an intentional desire to impinge against any of the other departments; it is rather to be ascribed to the commercial spirit which pervades each of the departments, and makes their various interests subservient to one another. Thus it is not unusual for a tramways committee, when it finds that the tramways in its charge are not doing as well as was hoped, to grumble at the charges for electrical energy, and to endeavour to secure some reduction; on the other hand, electricity committees will sometimes try to make a little profit out of the tramways, although there are cases in which they have (with rare magnanimity) supplied energy to tramways at ridiculously low prices—judged from the standpoint of an ordinary commercial undertaking. An instance of the little friction that sometimes arises between tramways and electricity committees occurred at the Sunderland Town Council meeting the other week. The chairman of the Tramways Committee complained that his committee had to pay more than many other corporations for their electrical energy, the Electricity Committee charging them $1\frac{1}{16}$d. per unit, against $1\frac{1}{4}$d. at Wolverhampton and other places. Another member said the time had arrived when the Corporation Electricity Committee would have to face this matter. If the Tramways Committee were allowed to produce their own electrical energy, they would, he had been assured, be able to produce it at a trifle less than a penny per unit. Neither of the speakers seemed to remember that special plant was used for tramways traction, and it is to the credit of the Electricity Committee that they have gone carefully into the cost of supplying energy for the tramways, and that they refused to reduce their charge simply because other towns charged less. Various means have been suggested at different times for removing the little friction that sometimes arises between possibly the officials and also between the members of the committees where there are two; the suggestion which seems to have most to recommend it is for a combination of the two departments under one committee. In some places this has been found to work satisfactorily. Belfast is one example of the success of that method. The charges here are made out in the following way: The tramways department pay all capital charges on their expenditure, and the lighting department pay the capital charges on their expenditure. Then they charge for tramway supply the total cost of production less the cost of maintaining the lighting mains, and, in addition, a separate account is kept of the upkeep of the tramway overhead equipment and mains. This appears to be an equitable method of charging, besides the cost of energy to the tramways working out at considerably below one penny.

Birthday Honours.—Except in the case of the army and navy, and certain branches of the civil service, by far the larger proportion of honours are bestowed for political services rather than for distinguished merit in the quieter walks of life. It is, therefore, because the domains of science, of commerce, and of industry obtain recognition which is so incommensurate with that merited that every honour conspicuously marks the distinguished ability of the recipient. A long list of honours were announced last Friday morning on the occasion of the official celebration of his Majesty the King's birthday. The list contains very few names who are intimately connected with electrical engineering, but none can gainsay that those who have been honoured by the inclusion of their names do not merit the reward which has come to them. Sir James Kitson, Bart., M.P., P.C., who has been elevated to the peerage, has rendered yeoman service to his party, no doubt, but his association with the iron and steel industry alone would justify his elevation. He was born in 1835, and is an iron and steel manufacturer and locomotive engine builder in Leeds. He is chairman of the London and Northern Steamship Company and the Monk Bridge Iron and Steel Company, and director of the London City and Midland Bank, the North-Eastern Railway, and the West Galicia Railway Company. Sir James was president of the Iron and Steel Institute, 1888-90. His name will ever be identified with the London electric supply problem, for he has twice served as chairman of select committees appointed to inquire into measures for giving a bulk supply, the last time being the memorable occasion when the Administrative Counties Bill, having been reported for third reading by the committee, just failed to pass the House owing to lack of time Sir W. H. Holland, who becomes a baronet, is president of the Associated Chambers of Commerce, and Sir Charles Scotter, who joins the same rank, is chairman of the London and South-Western Railway Company and the Waterloo and City Railway Company. A notable addition to the baronetcy is Mr. William Scott, who began business as a builder and contractor in Newcastle-on-Tyne, and subsequently acquired quarries, brickworks, and iron and steel works. It was he who constructed the first electric tube railway in London. He is chairman of directors of Walter Scott and Middleton, Limited, who have recently constructed various tube railways in London and throughout the kingdom; also he is chairman of Walter Scott, Limited, who own several collieries, iron and steel works at Leeds, and cement works on the Tyne. He is proprietor of the Tyne Brass and Copper Tube Manufacturing Company at Jarrow, and is interested in a variety of undertakings. The honour which will be hailed with greatest satisfaction, however, will be the knighthood conferred upon Mr. John Gavey, who recently retired from the post of engineer-in-chief of the Post Office, and who in 1905-6 was president of the Institution of Electrical Engineers. Mr. Gavey's work at the Post Office, as well as at the recent Radio-Telegraphic Convention at Berlin, where he acted as one of the British delegates, and his eminent services towards the advancement of electrical science, were so recently recounted in these columns that it would be superfluous to add anything at the present moment. While congratulating him on his well-merited distinction, we hope that as Sir John Gavey he will long be spared to enjoy the honour which has been bestowed upon him by a grateful King and country.

Street-Lighting Specifications.—The committee appointed by the National Electric Light Association of America to consider specifications for street-lighting have

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made the following recommendations: "(1) Under ordinary conditions of arc lighting, with lamps spaced 200ft. to 300ft. apart, specifications for street lamps should define the mean illumination thrown by the individual lamp, in position in the street, as measured at the height of the observer's eye and perpendicular to the rays, at some point not less than 200ft. nor more than 300ft. distant, along a level street, from a position immediately below the lamp, with all extraneous light screened off and with no reflection from surrounding objects not forming part of the lamp equipment. (2) When using smaller units of light, such as series incandescent lamps spaced shorter distances apart, a correspondingly shorter distance from the lamp should be chosen in measuring the illumination. (3) The lamp contracted for should give a mean normal illumination at the test point not less than the illumination given by the stationary standard incandescent lamp of 16 c.p. at 1/x of the distance. The said standard incandescent lamp should be a standardised seasoned lamp having a determined candle-power in a fixed direction. (4) When the lamp tested fluctuates in intensity, a number of observations of the maximum normal illumination should be made at a distance of not less than 200ft. horizontally from beneath the lamp, and the average of these measurements should be taken as the average maximum illumination. A similar number of observations of the minimum normal illumination should be made, the average of which should be taken as the average minimum illumination. The arithmetical mean of the said average maximum and minimum illuminations should be taken as the mean normal illumination called for in Section 1. (*a*) When a reading distance instrument is used for measuring the mean normal illumination at specified horizontal range, the average of a number of maximum distances at which a certain size of print can be distinguished may be called the average maximum distance, and the average of a similar number of minimum distances the average minimum distance. From these, the mean distance at which an illumination is cast normally, sufficient for distinguishing that size of print, can be determined. This mean distance must lie within the 200ft. to 300ft. horizontal range specified in Section 1. In most cases the arithmetical mean of the average maximum and average minimum distances may be taken as the said mean distance with an accuracy sufficient for practical purposes. The illumination needed for distinguishing the size of print may be determined for each particular observer from measurements of the reading distance with the standard incandescent lamp referred to in Section 3. (*b*) When a portable photometer is used as a fixed horizontal distance, such as 250ft., the mean normal illumination of a fluctuating lamp may be obtained by taking the average of not less than 50 observations at intervals of not less than one-half minute. (5) A reasonable number of lamps covered by the contract should be tested. (6) For measuring the mean normal illumination of a lamp, comparison with the standard incandescent lamp may be made either with a suitable portable photometer or with a reading distance instrument. (7) The unobstructed mean normal illumination must not be less at shorter distances than at the point of test." In discussing the report at the Washington Convention, Dr. C. P. Steinmetz said that a new metallic-oxide lamp of the magnetite type would shortly be placed upon the market. The highest efficiency and the best will results, he added, be obtained from the metallic-filament incandescent lamp and the magnetite arc lamp. He was of the opinion that contracts for street-lighting should always recognise total illumination, and not merely the number of lamps.

The London County Council Bill.—The majority of the members of the London County Council are naturally sore at the rejection of their Electricity Supply Bill by a House of Commons Select Committee, and the Parliamentary Committee asked the Council on Wednesday to declare their disgust at the treatment which their measure received in an emphatic manner. The committee presented a report to the Council at last Wednesday's meeting, in which was set at some length the proceedings before the committee. They complain that they were hampered by the difficulty that whilst, on the one hand, they wanted to meet the views of the Hybrid Committee, on the other hand, they wished to avoid tying the hands of the Council in future negotiations. The amended proposals placed before the committee it was understood fully carried out the views of the Board of Trade, and the committee gave no indication that in their opinion the proposals failed to carry out the instructions given by the House. Referring to the chairman's laconic announcement that "the committee find that the preamble of the Bill is not proved, and we will report to the House accordingly," the Parliamentary Committee observe: "It was not to be expected that a case of this importance would be dismissed in this summary manner, particularly in view of the strong report of the Hybrid Committee which dealt with the Council's Bill of last session and upon which the scheme placed before the committee was based We may again remind the Council that the Select Committee of last year in their report stated that 'the committee consider that the provision of cheap electrical power for London is so important and pressing that they do not view with favour the possibility of the question being indefinitely hung up. They, therefore, urge that the Council should be prepared to make a decision as to their action early enough to allow other Bills to be presented for next session.' We should have thought that this expression of opinion alone would have induced the committee to afford the Council an opportunity of considering as to how far it might have been possible to meet objections entertained in regard to the Bill. Such an opportunity was not, however, allowed, and the committee not only gave no indication as to the reason which led them to arrive at the decision above set out, but have not made any report on the subject which might have served for guidance in the future." The only inference which the Parliamentary Committee could draw from the action of the Hybrid Committee was that they thought the Council should itself carry out and find the money for the proposed undertaking, and that there should be no transfer of the powers. This, of course, would have been contrary to the policy to which the Council was pledged. The Parliamentary Committee thought that the Council should place on record an expression of its opinion on the subject. They accordingly recommend that the following resolution should be passed by the Council—namely: "That, in the opinion of the Council, it is a matter for deep regret that the London County Council (Electric Supply) Bill, 1907, has been rejected, thereby depriving the elected representatives of municipal London of the opportunity of securing the provision of a cheap supply of electricity subject to public control." To this Mr. Gordon proposed to move the following amendment: "That with a view of ascertaining what steps should be taken to place again before Parliament a comprehensive scheme for the development of electricity for London and adjoining districts, the Highways Committee be instructed to convene a conference of the various local authorities concerned, and to report the results of such conference to the Council as soon as possible." The Council are now no nearer a solution of this urgent question, and one of the results of the rejection of the Bill will be the probable growth of small and uneconomical generating stations and undertakings.

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ELECTRIC POWER PLANT OF THE CAMBRIAN COLLIERIES, LIMITED.

The Cambrian Collieries, situated in Clydach Vale, a branch of the better-known Rhondda Valley, Glamorgan, is one of the largest collieries in South Wales. The coal produced in the three pits of the company averages about 1,000,000 tons per annum, and employment is found for some 3,500 men. Up to a few years ago, steam power was exclusively used for operating the machinery both above and below ground, and this agency is still used for a number of purposes above ground. About three years ago, however, J. H. Thomas, Esq., the chairman of the company, fully realised the advantages to be gained by electric power, more particularly for underground purposes, so also did Leonard W. Llewellyn, Esq., the general manager, who decided to introduce electricity for working haulages, coal-cutting machinery, pumps, and so forth. Current was accordingly bought from the South Wales Power Company, and distributed to various motors in the mine and on the surface. Electrical working proving satisfactory, the progressive management, advised by their consulting engineer, Charles P. Sparks, Esq., M.I.C.E., decided to go a step further and to produce their own current. Tenders were accordingly invited for the equipment of an up-to-date power station, and the result was that Siemens Bros. Dynamo Works, Limited, were entrusted as main contractors with the entire work. All the electrical plant in connection with the power-house has been supplied and erected by this firm, the engines, boilers, condensers, and so on being sublet. The electric power developed by the two 1,000-kilovolt-ampere generating sets at present installed and running is principally used for operating induction motors for a great variety of purposes in all parts of the mine. There are at present some 21 induction motors in use, ranging in size from 220 h.p. to 3 h.p., the total horse-power of motors being 1,890. Motors on the surface are supplied with three-phase current at low tension, the current being transformed for this purpose by static transformers from 2,200 volts (the voltage produced by the alternators in the power-house) to 400 volts. The bulk of the supply, however, is conveyed in cables at a voltage of from 2,000 to 2,200 volts down the pits, and distributed to the various motors at this pressure. Continuous current for exciting the main alternators, and for lighting and working the original motors, is supplied at a pressure of 110 volts by a 36-kw. steam-driven dynamo or by two 70-kw. motor-generators taken over from the original plant. Only part of the electric energy available is utilised at present, but as electric motors are being constantly added, the power-house will be fully loaded at no distant date. Space has been left in the engine-house for the erection of a third generating set when this becomes necessary, and ample provision has been made in the design of the switchboard, boiler and condenser plant, and so on, to carry out this extension with a minimum amount of expense or alteration.

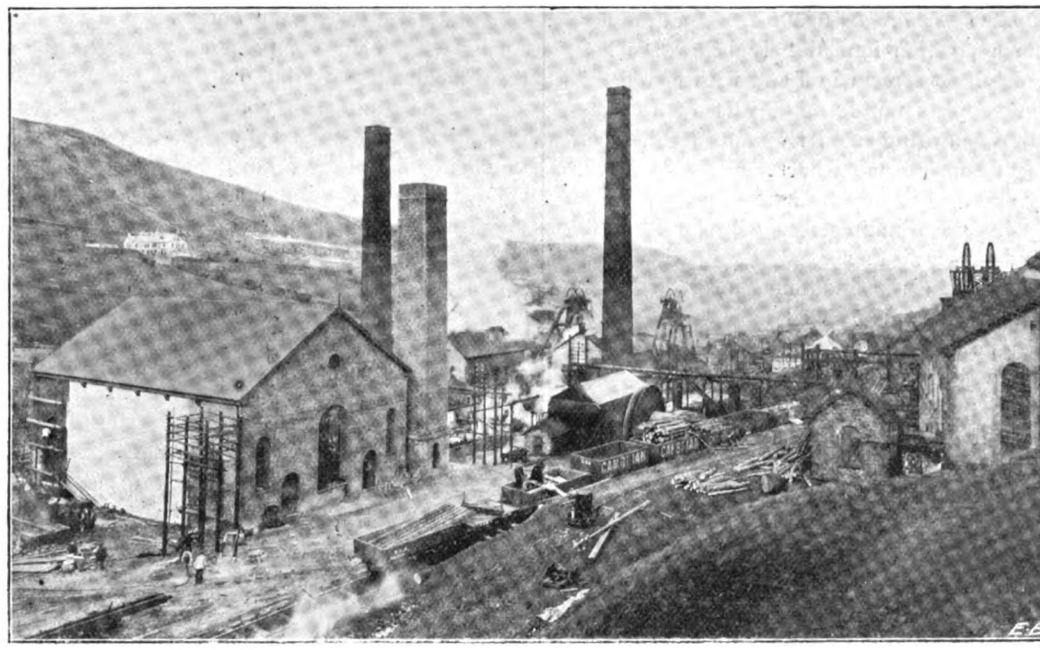

FIG. 1.—View of the Power Station at the Cambrian Collieries, showing Overhead Feeders.

The engine-house, of which an external view is given in Fig. 1, is a substantial and lofty stone building built by the colliery company. It contains one room only, which is provided with very large windows on three sides, and is, therefore, exceptionally well lighted. Its floor is covered with red tiles, and the walls are painted in a light pink of pleasing colour. The engine-room is spanned by a 15-ton hand-operated crane. The lighting equipment consists of six enclosed arc lamps. These will be supplemented by further arc lamps and incandescent lamps when required.

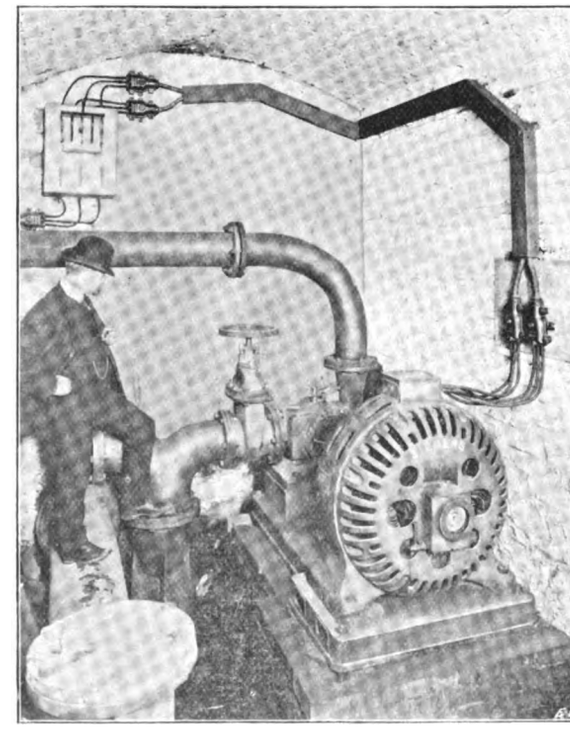

FIG. 2.—Siemens 20-h.p. Three-Phase Motor driving Circulating Pump

The boilers are erected at the side of the engine-house They are covered with a 1½in. layer of asbestos composition, and built into brickwork, but are not at present under a regular roof. The fronts of the boilers, however, are provided with a short overhanging roof for the protection of

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the stokers. The boilers are quite close to one of the pit-heads, and it was, therefore, not necessary to install any coal-conveying plant. Water for the boilers and condensers is obtained from a pond at a short distance from the engine-house, the head of water being about 50ft. Before entering the boilers the feed water is softened in a water-softening plant erected close to the engine-house

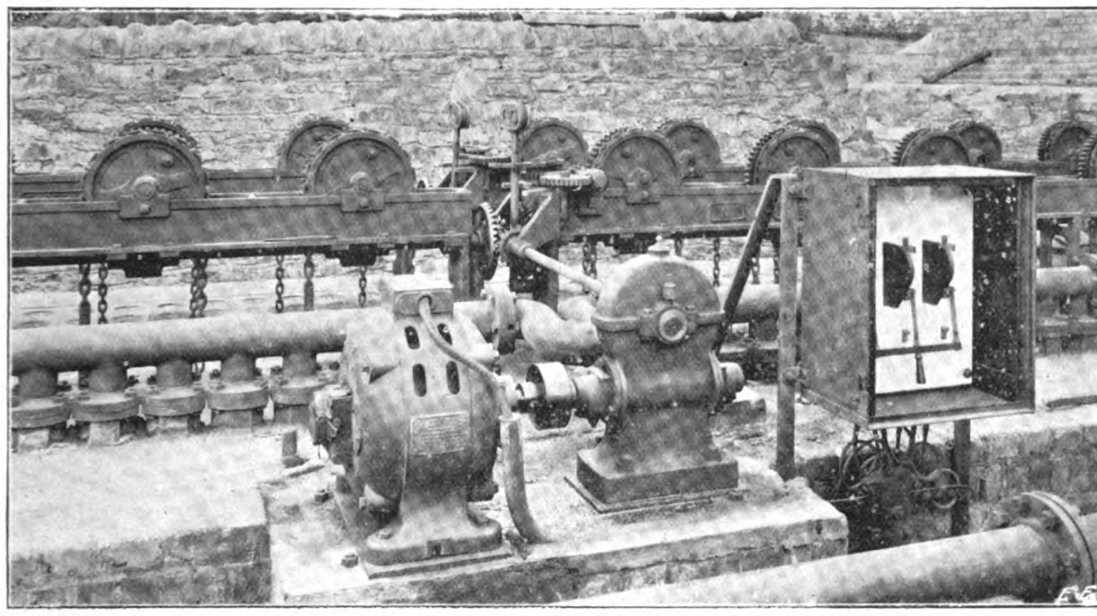

FIG. 3.—Siemens Three-Phase Motor driving Economiser Scrapers.

Usually the water from the condensers is run to waste, but in case of prolonged dry weather it may be returned to the pond through a separate pipe line. The electrically-driven centrifugal pump used for this purpose is shown in Fig. 2. There are four Lancashire boilers by Messrs. Tinker, Shenton, and Co., Hyde. These are 30ft. long and 9ft. in diameter, and are suitable for a working pressure of 160lb. per square inch, at which pressure the safety valves are set. The boilers were tested with a hydraulic pressure of 280lb. to the square inch. They are hand-fired and provided with sliding grids for the prevention of smoke. Each boiler is equipped with a Sugden superheater, to give 150deg. F. superheat when the boiler is evaporating 9,000lb. of water per hour. The complete superheater was subjected to an hydraulic pressure of 280lb. per square inch on site. The Green's economiser raises the temperature of the feed water from 60deg. to 200deg. F. when the boilers are evaporating at the rate of 30,000lb. per hour. A Siemens three-phase, 3-b.h.p., 400-volt motor is provided for driving the scraping gear. A view of this motor and its watertight control panel, with front cover removed, is given in Fig. 3. The economiser was tested at a pressure of 280lb. per square inch after erection. Feed water from the water-softening plant is supplied to the boilers by two Weir's vertical single-cylinder, double-acting, feed pumps, each capable of supplying 3,000 gallons of water per hour and by one Korting injector for a duty of 1,250 gallons of water per hour. There is a cast-iron feed-water storage tank holding 5,000 gallons of water. All live-steam piping is suitable for a working pressure of 160lb. and a temperature of 520deg. F. The main steam range over the four boilers consists of solid-drawn mild-steel piping with 9in. bore, and provision is made for draining off any condensed steam when starting up. The steam-pipes between the boiler superheater and steam range are also of solid-drawn steel, the bore being 6in. One end of the steam main is fitted with a blank flange, and the other end is connected by a bend to

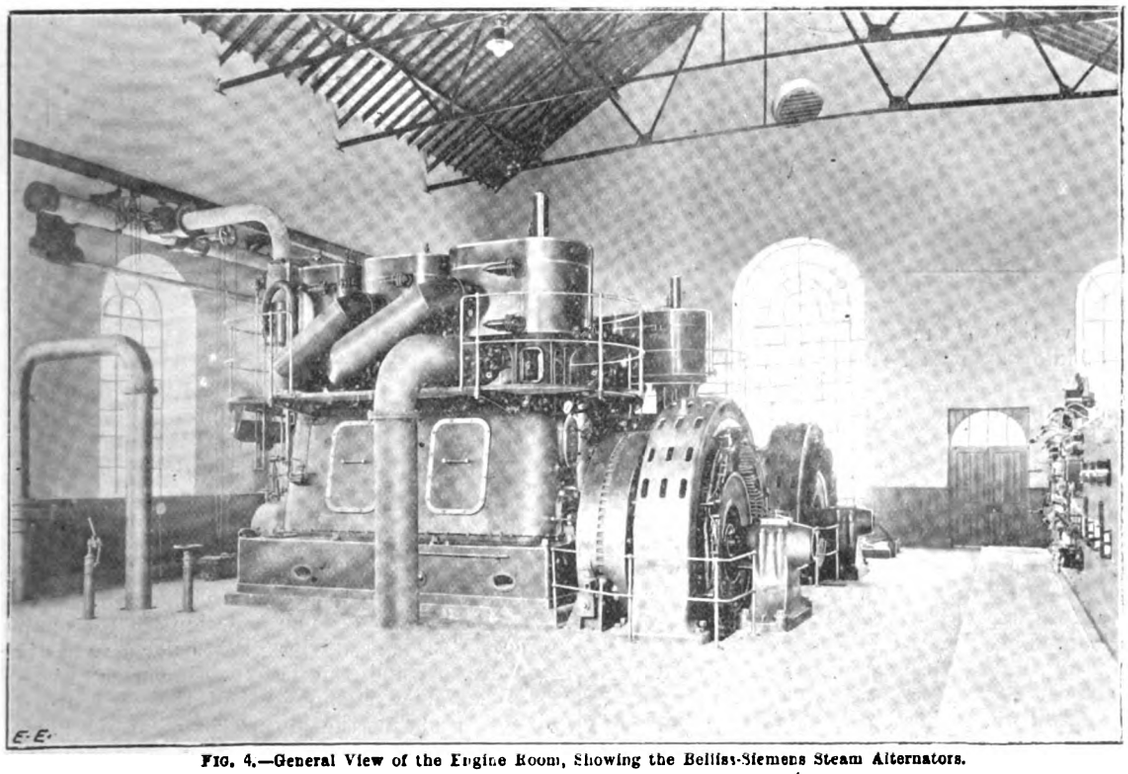

FIG. 4.—General View of the Engine Room, Showing the Belliss-Siemens Steam Alternators.

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the engine-room range of 9in. and 7in. piping. Arrangements are made for cutting off the superheaters when it is desired to apply saturated steam to the engines. All steam and hot feed mains, including bends, valves, and tees, are efficiently lagged with white asbestos plastic non-conducting composition. Pipes up to and including 4in. in diameter are covered with a layer 1in. thick, all larger pipes being provided with lagging 1½in. in thickness with the exception of the 9in. steam main, which has a 2in. layer. The lagging is painted with black varnish, and, in addition, is covered with sheet steel suitably painted on the outside. All flanges are covered with removable lagging. An auxiliary steam main for the feed pumps, etc., runs across the top of the boilers at the front end, and consists of a 3in. solid-drawn steel main The pipes between the feed pumps and the boilers are so arranged that the feed water may be either fed directly to the boilers or by way of the economiser. The steam and feed water piping, and also the water-tank, are of Messrs. Babcock and Wilcox's make, the valves being of Messrs John Hopkinson and Co.'s manufacture.

In the engine-room space is provided for three generating sets. At present, however, the generating plant consists of two Siemens-Belliss and Morcom sets only. These two sets are alike in all respects, each consisting of a Belliss and Morcom vertical steam-engine direct coupled to a Siemens 1,000-kilovolt-ampere, three-phase, 2,200-volt, 25-cycle alternator. The normal speed of the set is 250 r.p.m., and it was found from tests on one of the sets that the speed rose momentarily to 263 r.p.m., settling to 254 r.p.m. when full load was switched off, while it dropped momentarily to 240 r.p.m, settling to 250 r.p.m. when full load was switched on. The duration of the momentary rise and fall in speed was seven and five seconds respectively. The engine speed can be varied while the engine is running from 240 r.p.m. to 260 r.p.m. A tachometer, belt-driven from the engine shaft, serves to indicate the speed at which the sets are running. For starting and inspection, the engine may be turned by a suitable hand-operated gear. Steam-consumption tests were carried out at the makers' works, with the following results: Steam consumed per kilowatt-hour at full load, 17·3lb. of steam at a pressure of 155lb. per square inch, and a temperature at the stop valve of 472deg. F., the vacuum being 25·9in. of mercury. At half load the steam consumption was found to amount to 18·6lb. of steam at a pressure of 163lb., a temperature of 461deg. F., and a vacuum of 26in. These figures are highly satisfactory, and considerably lower than the specified figures. The internal diameters of the high-pressure, intermediate, and low-pressure cylinders are 18½in., 27in., and 40in. respectively, the stroke being 20in. The cylinders are lagged with non-conducting material, covered with planished steel sheet. The engine is capable of carrying an overload of 25 per cent. for two hours, and momentary overloads of 50 per cent. When running non-condensing, the engine is capable of developing 680 kw. All working parts are lubricated under pressure, oil being supplied by a valveless pump worked direct from the crankshaft. The flywheel weighs 12⅛ tons.

The Siemens three-phase 2,000-2,200 volt alternators are the rotating field type, the phases being star-connected. They have a continuous rating of 750 kw. at a power factor of 0·75, and are capable of dealing with the same overloads as the engines. After a six hours' run at 750 kw. and unity power factor, no accessible part of the machine, with the exception of the stator iron, has a temperature rise of more than 35deg. C. above the surrounding air as measured by thermometer; the temperature rise in the stator iron does not exceed 45deg. C. The machine is wound to have a wave-form as nearly sinusoidal as possible. When full non-inductive load is thrown off, the percentage rise of voltage does not exceed 6 per cent. at constant speed and excitation. At a power factor of 0·75 the rise does not exceed 18 per cent. Before leaving the works the armature was tested with an alternating pressure 2½ times the normal pressure, while the field system was subjected to a test pressure of 1,000 volts.

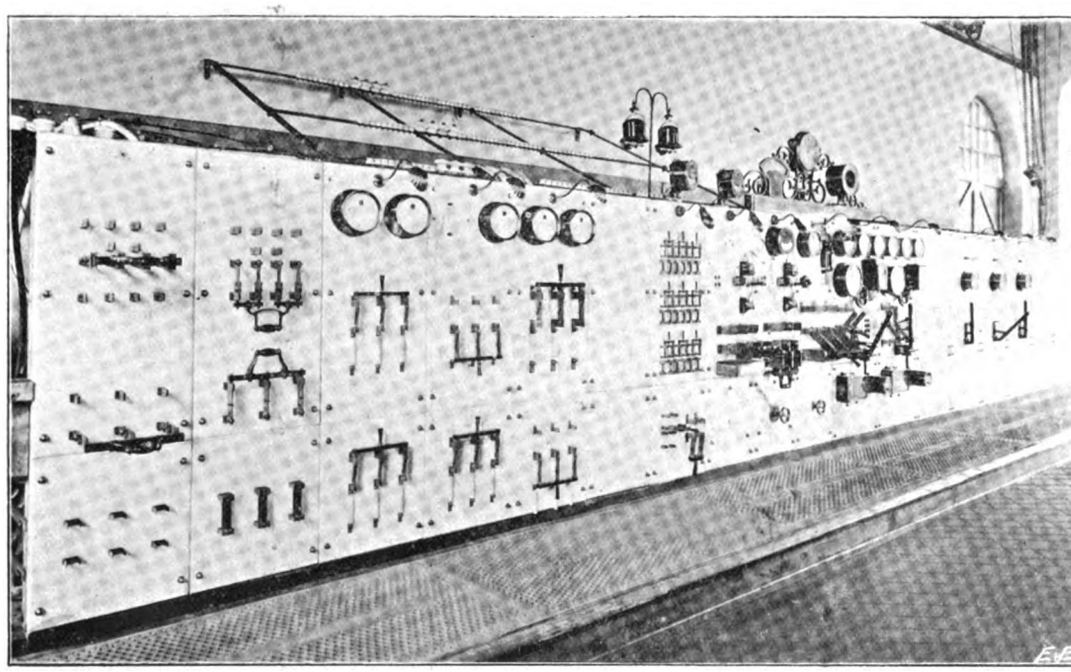

FIG. 5.—View of the Three-Phase Switchboard at the Cambrian Collieries.

With regard to the mechanical design, it may be mentioned that each alternator stands on its own independent bed, and is split horizontally, so that the upper part of the armature may be readily removed, if necessary, by the overhead crane in the engine-house. The rotor is directly bolted to the engine flywheel, and the energy stored in the rotor field magnets and engine flywheel amounts to 2,000 foot tons at normal speed. The poles are circular in section, and the pole-shoes are laminated. The stator is of cast iron, and of such a design as to combine great stiffness with light weight. Particular care has been taken to ensure thorough ventilation. The armature core is built up of laminated stampings, and the armature coils, after being placed in the open slots, are firmly held in position by wooden wedges. The coils are amply insulated, both inside the slots and outside, to withstand all voltage fluctuations which are likely to occur in practice, and the end connections are well supported to prevent distortion from extra heavy currents. They are protected against external injury by the shields on the frame, which cover them completely. These shields were not on the machines at the time the photographs were taken. The exciting current at 110 volts is fed to the rotating field by copper gauze brushes impregnated with

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carbon, which are pressed against the two slip-rings by brush-holders of the lever type, the tension on the brushes being maintained by helical springs. The shaft runs in ring lubricated bearings of ample size, lined with white metal to reduce friction. Any surplus oil at the end of the shaft is drained off into the oil well in the pedestal bearing, and efficient means are provided for preventing the oil from creeping towards the interior of the machine. Current for excitation and for auxiliary purposes is supplied by a 36-kw. steam-driven generator, or by two 70 kw. motor-generators. The engine of the steam exciter is by Belliss and Morcom, and runs at 600 r.p.m. It is capable of carrying a 10 per cent. overload for two hours. The Siemens dynamo, to which it is directly coupled, supplies continuous current at from 100 to 110 volts.

The two main engines exhaust into ejector condensers, supplied by Messrs. Korting Bros., and placed in the basement underneath the floor, each capable of dealing with 13,000lb. of steam per hour, and producing a vacuum of 26in. of mercury. A smaller Korting condenser, capable of maintaining the same vacuum when condensing 1,000lb. of steam per hour, is provided for the steam exciter. The exhaust piping and valves, also supplied by Messrs. Korting Bros., are so arranged that any one of the condensers can be shut down without interruption to the service. The condensers discharge into a bank 20ft. by 10ft. by 6ft, built up of cast-iron plates.

The centrifugal pump for pumping the condenser discharge back into the pond is of Messrs. Korting Bros.' make, and is capable of delivering 50,000 gallons of water per hour against a head of 80ft. when rotating at 1,450 r.p.m. It is directly driven at the speed mentioned by a Siemens three-phase squirrel-cage ventilated-type 40-h.p. motor, which is fed with current at 25 cycles per second from the 400-volt alternating supply. Near to the motor, and in a handy position for the attendant, is a motor-control panel equipped with a star-delta switch and three fuses. All the joints of both the live-steam piping and the exhaust-steam piping are made with corrugated metal joining rings.

The switchboard is erected at one end of the engine-room, as shown in the illustrations It is built of fire-proof material throughout. The high-tension apparatus is mounted near to the wall, but the operating gear for the high-tension apparatus is mounted on separate panels in front of and at a certain distance from the high-tension gear. The operating panels contain only low-tension instruments and apparatus, and the high-tension oil switches are operated from this board by a system of suitable levers. The low-tension operating board is separated from the high-tension gear by a passage of a clear width of 3ft. 6in. There are three alternator panels, of which one is blank, and six feeder panels, of which three have been fitted up with apparatus so far. Each of the two motor-generators is controlled from one continuous-current and one alternating-current panel. There is also a lighting panel in the centre of the board, an exciter panel and three transformer panels, and a number of blank panels are provided for future extensions. The main panels facing the engine-room are of white marble and supported on an iron framework. Access to the chamber between the high-tension apparatus and the low-tension operating board is gained through two doors of expanded metal, one at each end of the switchboard, and unauthorised persons are prevented from entering by providing the doors with a lock which can only be opened from the outside by a special key. The high-tension panels next to the wall are insulated from one another by slate division pieces, and the front of each high-tension panel facing the passage way is provided with a substantial metal screen, so arranged that the screen cannot be removed until the isolating switch has been opened. It is, therefore, impossible for an attendant to come into contact with the high-tension switchgear while it is under pressure. The switchboard is equipped with all the usual instruments and apparatus necessary for an efficient and reliable control. The equipment includes low-tension integrating watt-hour meters, with the requisite potential transformers, single-phase high-tension fuses, synchronising gear, electrostatic leakage indicator to indicate a fault developing on any one of the three phases, overload releases with time-limit relays, and so on. The secondary windings of all instruments, as well as the switchboard frame and screens, are permanently earthed. The 'bus bars are carried above the high-tension chambers on porcelain insulators.

The power station will be formally inaugurated on Tuesday, July 9, when Mrs. J. H. Thomas, wife of the chairman of the company, will assist in the opening ceremony.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

TWELFTH ANNUAL CONVENTION

(Continued from page 901, Vol. XXXIX.

The Costs of Electricity Supply and their Relation to Scales of Charges.

BY H. R. BURNETT, CHIEF ELECTRICAL ENGINEER, BARROW-IN FURNESS.

Introductory.—In view of the fact that several papers dealing with the methods of ascertaining the costs of electricity supply have already been read before this association, it is with some diffidence that the author has undertaken to add another to their number. It will be generally admitted by anyone who has made a study of the scales of charges in force in connection with many of the electrical undertakings of this country, that, not only are the methods of charging in many cases unnecessarily complicated and numerous, but the charges themselves do not bear that relation to the costs of production which one might reasonably expect to find. This state of affairs apparently arises either from the fact that many engineers do not accurately ascertain the costs of supply from the works of which they have charge, or having obtained this information, do not give it the consideration which it deserves in fixing the scale or scales of charges.

That greater uniformity of action and simplicity in the methods of charging are desirable will hardly be denied. With a view to obtaining the opinions of members of the association upon this subject, the author proposes briefly to describe the method which he has adopted of ascertaining the costs of supply from the works for which he is responsible, and the manner in which he considers the information thus obtained should be applied in fixing the scale of charges.

The Costs of Electricity Supply.—Never in the history of electricity undertakings has it been of greater importance than at the present time that the engineer should possess a very intimate knowledge of the costs of supply from the particular works of which he has charge. Those who are fortunate enough to have a monopoly with regard to the supply of electricity have still to face the competition of various forms of economical producers of power and light, assisted in some cases by enterprising travellers ready to guarantee anything for the sake of obtaining an order for the particular plant which it is their business to sell. In order that the costs of supply may be accurately ascertained, it is essential that the books of the undertaking should be so arranged that the expenditure can be readily watched week by week. Doubtless there are few works in which this is not already done, but to those engineers who have not yet paid particular attention to this part of their

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business, the form of works costs book appended to the paper, which the author has used for the past eight years, may be of some interest and use. A book of station records such as this made up weekly serves the double purpose of enabling the engineer to at once detect and check any excessive expenditure, and also facilitates the preparation of quarterly balance-sheets and annual records in connection with the works. It will be observed that the "estimated cost of repairs," and not the "actual cost," is recorded each week, the reason for this being that the actual cost during any particular week cannot reasonably be charged against the units generated during that week, and would be liable to vary to such an extent as to destroy all comparison between one week and another. The method adopted in dealing with this item has been to make an estimate of the cost of repairs and output for the year and to debit each week's expenditure with a fixed amount per unit generated. If, at the end of the year, it is found that there is an appreciable discrepancy between the estimated and actual cost of repairs, the quarterly figures are adjusted accordingly. From the "works costs" and other books, a balance-sheet showing the receipts and expenditure on electricity supply is prepared quarterly. The figures obtained from these quarterly balance-sheets are plotted as in Fig. 1, and curves are obtained from which the law underlying the total costs of supply (or any particular item of the total costs) may be ascertained. As an illustration, the results obtained at the Barrow Corporation electricity works during 1905-6 are given. Actual results such as these, although falling far short of the ideal which every engineer should aspire to obtain,

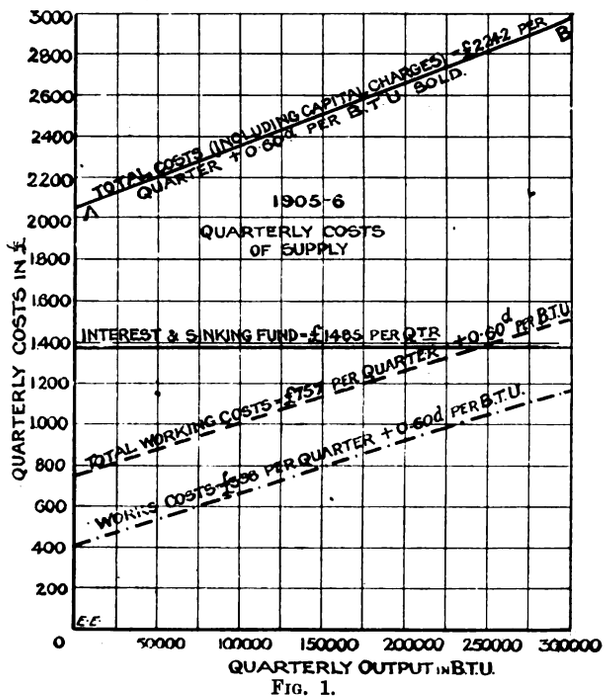
QUARTERLY COSTS IN £
QUARTERLY OUTPUT IN B.T.U.
1905-6
QUARTERLY COSTS OF SUPPLY
INTEREST & SINKING FUND - £1485 PER QTR + 0·60d PER B.T.U.
TOTAL WORKING COSTS - £757 PER QUARTER + 0·60d PER B.T.U.
WORKS COSTS - £636 PER QUARTER + 0·60d PER B.T.U.
E.E.

Fig. 1.

will prove to be of infinitely greater value to the engineer in charge of any works than any which may be obtained by the consideration of hypothetical cases. From the curve A B it will be seen that the law for the costs of supply from these particular works during 1905-6 was: total costs = £2,247 per quarter + 0·60d. per unit sold. If the standing charges are divided by the sum of the lighting consumers' maximum demands,* it is found that the costs of supply were: total costs = 6·74d. per kilowatt per day + 0·60d. per unit. This law is shown graphically by curve C D (Fig. 2), while the curve E F represents the price charged on the maximum demand system (6d. per unit for one hour per day, 3d. per unit after); these curves will be found of considerable assistance in explaining to members of committees and consumers the maximum demand system and the reason for charging different rates to various classes of consumers. In Fig. 3 are given the curves representing the total costs (including capital charges) at the works for which the author is responsible during each of the years 1899-1900, 1902-3, 1905-6. These curves are of interest, illustrating as they do the progress made year by year in reducing the costs of production, either due to increased output, improved load factor, economies effected in the working of the plant, or these and other alterations in the conditions of supply. While it is not suggested that the method of ascertaining the costs of supply, which has been

* At the works referred to it is found that the sum of the lighting consumers' maximum demand is approximately 33⅓ per cent. in excess of the maximum load observed at the generating station, and since the partial abandonment of the use of demand indicators due to the introduction of flat rates, this figure has been used in arriving at the costs per kilowatt.

briefly described, is infallible, the author is confident that it will be found to be sufficiently accurate for all practical purposes.

Having described the methods by which the costs of supply from any particular works may be ascertained, the author proposes to consider to what extent the information thus obtained may be applied in fixing the scale of charges. Broadly speaking, there are three classes of supply for which practically all works have to cater and for which scales of charges have to be fixed: (1) lighting—under this heading are included all ordinary lighting consumers whose supply may reasonably be expected to increase, to a lesser or greater extent, the maximum demand upon the generating plant; (2) power and heat, including all ordinary users of the supply for these purposes, whose supply,

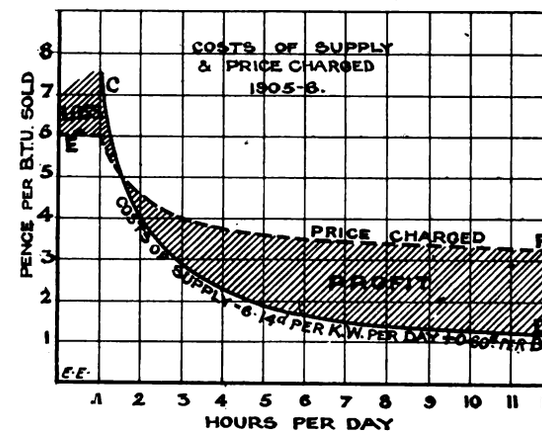
COSTS OF SUPPLY & PRICE CHARGED 1905-6.
PENCE PER B.T.U. SOLD
HOURS PER DAY
PRICE CHARGED
PROFIT
COSTS OF SUPPLY - 6·74d PER K.W. PER DAY + 0·60d PER B.T.U.
E.E.

Fig. 2.

by reason of the hours at which it is required and the large diversity factor, does not materially increase the maximum demand upon the generating plant; (3) special, including supply for public lighting, traction, large power and other consumers, who, by reason of the extent or conditions of their supply, are entitled to special consideration. The scale or scales of charges for each class of consumer should be so arranged that each consumer, as far as possible, bears a fair proportion of the standing charges as well as the running costs incurred on his behalf, and that over and above these charges his supply should result in a reasonable profit to the undertakers.

1. *Supply for Lighting.*—The scale or scales of charges for supply for lighting are necessarily *based* upon the maximum demand system, and the curve representing the cost of production (Fig. 2) is of considerable assistance in deciding what the scale should be. It must be borne in mind that there are always a certain number of short-hour consumers who do not bear their fair proportion of the standing charges, and who

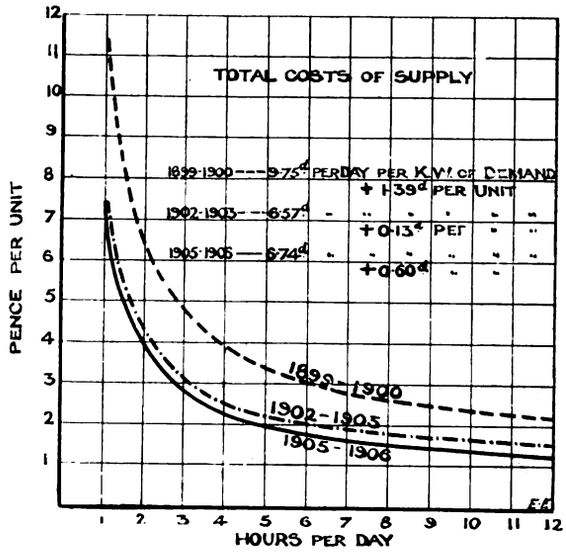
TOTAL COSTS OF SUPPLY
1899-1900 — 9·75d PER DAY PER K.W. OF DEMAND + 1·39d PER UNIT
1902-1903 — 6·57d " " " + 0·13d PER " "
1905-1906 — 6·74d " " " + 0·60d " "
PENCE PER UNIT
HOURS PER DAY
1899-1900
1902-1903
1905-1906
E.E.

Fig. 3.

must, in consequence, be supplied at a loss, which loss has to be made up by increasing the profit on the long-hour consumers. Having decided what is the maximum demand scale upon which the works can supply at a profit, the fixing of flat rates for various classes of consumers is a simple matter. For example, suppose the maximum demand rate decided upon is 6d. per unit for the first hour's use of maximum demand per day and 3d. per unit for the remainder. In a provincial town, such as that with which the author is connected, it is found that the average consumption in ordinary shops is equivalent to two

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hours' use of the maximum demand per day; in dwelling-houses and public-houses three hours per day. It follows, therefore, that the flat rates for these consumers should be: shops (two hours per day), flat rate, 4½d. per unit; public-houses and dwelling-houses (three hours per day), 4d. per unit.

2. *Supply for Power and Heat.*—The fixing of a scale or scales of charges for power and heat supply upon an equitable basis is a very much more difficult matter than in the case of lighting supply, owing to the great variety of purposes for which the supply may be required. Connected to the mains of almost any undertaking it will be found that there are consumers using approximately the same number of units per annum, having the same maximum demand, possibly using the power for similar purposes and paying the same rate per unit—yet one may be using his supply at such times as to increase the maximum demand upon the generating plant by the amount of his demand, while another uses his supply at such hours as to result in no increase in the demand upon the generating plant. Obviously the one consumer is very much more desirable from the supplier's point of view than the other—yet no scale of charging in vogue, other than the two-rate referred to hereafter, will discriminate between the two. Where the maximum demand system is adopted for power supply, the rough-and-ready method of fixing the scale of charges appears to be to make the initial and final prices per unit about one-half of those decided upon for the lighting supply. It is generally found expedient to have an alternative flat rate or sliding scale, in which the price per unit is usually about the same as that to which the consumer would be entitled

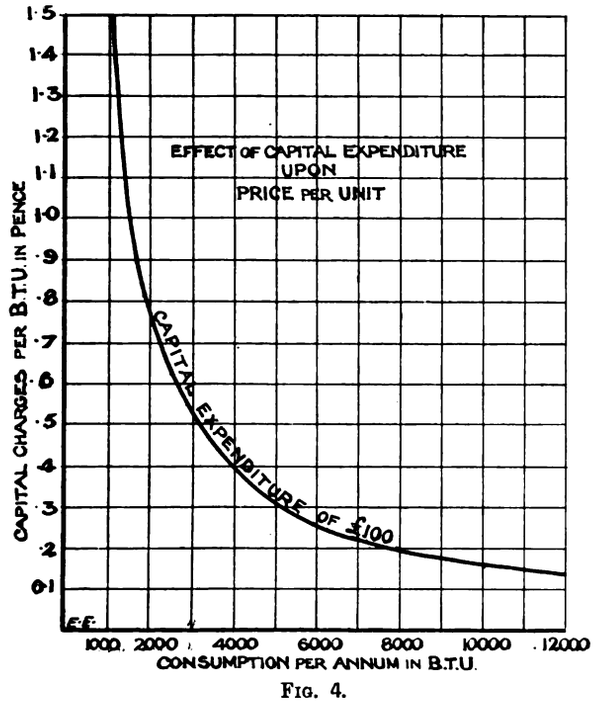

FIG. 4.

on the maximum demand system by two hours' daily use of the supply.

3. *Special.*—The third and, perhaps, most important class of consumers for whom the engineer has to decide upon scales of charges are those who, by reason of the nature or extent of their supply, are entitled to special consideration. Under this category the author includes public lighting, traction supply, supply to large power or lighting consumers, and stand by supply. In considering the price to be charged for any of these purposes, it is well to bear in mind that the charge should be made up of the following items—viz.: (1) running charges, consisting of a proportion of the works costs; (2) standing charges, consisting of (*a*) proportion of works costs, (*b*) proportion of rents, rates, and taxes, (*c*) proportion of management charges, (*d*) proportion of capital charges (general), (*e*) special capital charges; (3) profit. (1) This item is ascertained from the curves of costs of production (Fig. 1). (2) (*a*) (*b*) (*c*) (*d*) (*e*) It is usual to apportion all these items according to the maximum demand of the consumer, and in cases where the consumer's maximum demand is liable to occur simultaneously with the maximum load upon the generating station, this is a rational course to follow. (3) When the above charges have been properly apportioned, it is only necessary to add a small percentage—say 10 per cent.—for profit.

Supply during Restricted Hours.—When the supply is only given at such hours that it will not increase the maximum load upon the generating station, the standing charges (2) (*a*) (*b*) (*c*) (*d*) will not be materially affected by the supply, and the price charged should, therefore, be made up of the following items: (1) running charges; (2) (*e*) capital charges on special capital expenditure, if any; (3) profit. The running charges are ascertained, as before, from the curves, and the effect of any special capital expenditure, such as an extension of mains, entailed by the supply is readily calculated, and must be allowed for. The allowance for profit should, however, in this case be considerably increased to cover the use of plant, mains, etc. Exactly what margin should be allowed is, of course, a matter of opinion, but in justice to the consumers who have the capital charges upon the plant to bear, and as a matter of sound business, the allowance should, in the opinion of the author, be in the neighbourhood of 50 per cent. on the cost. Even with this margin for profit it will be seen from the following example that the prices arrived at are quite moderate:

(1) Running charges as obtained from curve A B (Fig. 1)	0·60d.
(2) (*e*) Capital charges on special capital expenditure (if any), say	0·10d.
Net cost of supply	0·70d.
(3) Add for profit, use of plant, etc., say, 50 per cent.	0·35d.
Price to be charged	1·05d.

The important bearing which even a comparatively small special capital expenditure may have upon the price which should be charged is often overlooked. In order to illustrate and emphasise this point, the author gives in Fig. 4 a curve showing the cost per unit resulting from a capital expenditure of £100 on a sale of from 1,000 to 10,000 B.T.U. per annum, the capital charges being calculated at 6½ per cent. on the expenditure.

Suggested Basis for Fixing Scales of Charges.—The author suggests that, with a view to obtaining greater uniformity in tariffs for electricity supply, members of this association in advising their committees should recommend tariffs based upon the following lines: Supply for lighting—(1) a maximum demand rate so arranged that the price charged to a consumer using the supply for two hours per day is from 10 to 15 per cent. in excess of the ascertained cost of the supply; (2) (*a*) an optional flat rate for any consumer based upon two hours' daily use of the supply on scale (1); (2) (*b*) optional flat rates for particular classes of consumers, such as hotels, clubs, public-houses, and dwelling-houses, based upon scale (1), the rate being fixed according to the ascertained average daily use of the supply by these consumers. Supply for power and heat—(3) a maximum demand rate in which the initial and final prices are each one-half of the prices charged on scale (1); (4) an optional flat rate for all consumers based upon two hours' daily use of the supply on scale (3). Supply to special consumers—(5) the price charged to be the ascertained cost of supply plus 10 per cent. to 15 per cent. for profit. Restricted-hour or two-rate supply—(6) the price to be based upon the ascertained "running costs" of supply plus 50 per cent. for proportion of standing costs, use of plant, and profit. Any supply taken between sunset and 12 midnight to be charged at maximum price on scale (1).

Sliding Scales.—In cases where it is deemed desirable to adopt a sliding scale, the scale should be obtained by varying the discount upon the flat rate according to the consumption as follows: for the first 1,000 B.T.U. (or other quantity) per quarter, price = flat rate, net; for the next 1,000 B.T.U. per quarter, price = flat rate, less 10 per cent.; for the next 1,000 B.T.U. per quarter, price = flat rate, less 15 per cent.; for all over 3,000 B.T.U. per quarter, price = flat rate, less 20 per cent. By arranging a sliding scale in this manner the anomalous position of a consumer being able to reduce his total bill by increasing his consumption (which is possible upon the scale of charges in force in some towns) is avoided.

In conclusion, the author hopes that, even if his paper fails in its main object, his suggestions and attempt to establish a definite relationship between the cost of supply and the scale of charges will at least result in an interesting discussion which will be of benefit to members of this association in particular, and ultimately to the industry in general.

The papers by Mr. C. E. C. Shawfield and Mr. H. R. Burnett were discussed together. The PRESIDENT called on Mr. J. F. C. Snell to open the discussion, and hoped that, although he could no longer be a member of the association, he would be present at many more conventions.

Mr. J. F. C. SNELL appreciated the kind remarks of Mr. Fedden. He complimented the authors on two most practical papers. It was a critical time, and required great efforts to meet the competition of the gas industry. There was much in Mr. Shawfield's paper with which he disagreed, including the general conditions laid down. The maximum demand system must underlie any proper system of charging. Most stations were laid down for lighting, and had to be increased for the supply of power. In allocating the capital charges, he criticised the author's figures both for cost of plant and cost of running. He seemed to have allowed no spare plant and to have assumed that the

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maximum demand possible corresponded to the capacity of the plant installed for the supply of power. In practice some 5,000 kw. of plant was really needed to supply 3,500 kw. maximum load. This raised the cost per kilowatt demanded from £26 to £36. For distribution the capital outlay was nearer £20 per kilowatt than £13. He thought 3·75lb. of coal per unit low, and would expect 4lb. with a 25 per cent. load factor. As regards Mr. Burnett's paper, special consumers should be charged a special rate, and he had found it advisable to charge the tramways more than the ordinary power user. In many towns the tramways were supplied at a rate that was not remunerative. The system of charging shown in Fig. 2 was not correct, as it made an undue profit out of the long-hour consumer.

Mr. S. L. PEARCE, of Manchester, remarked on the disagreement between the two authors as to charges. He did not endorse Mr. Shawfield's policy, and believed that electricity was quite able to compete for power purposes, unless the load factor was extremely high. He did agree, however, that it was well to look ahead for two or three years, and to fix prices in accordance with the load to be obtained. They must not, however, make lighting consumers pay charges which should be debited to power consumers. The author's estimate of £10 per kilowatt demanded was too low, and he thought the figure should be £16. In contracts with large power consumers, there should be a clause included to correct for fluctuations in the price of coal. He had arranged that the charge should increase by ·015d. per unit for every 1s. per ton paid in excess of 10s. Thus, if coal was £1 per ton, the price would be increased by ·15d.

Mr. A. M TAYLOR, of Birmingham, considered that Mr. Shawfield's figures were too low, as he had not included in his estimate of capital cost several items of expenditure. There was no spare plant, no coal storage or conveyors. At Manchester he believed the capital outlay was from £40 to £50 per kilowatt of maximum demand He considered that buildings would cost £17 per kilowatt, and not £12, as given by the author. Other items omitted would cost about £3. 10s. per kilowatt, and the final figure per kilowatt of maximum demand would be from £30 to £35.

Mr. S. CLEGG, of Lincoln, spoke of the increase in the power load obtainable there. In the last two years the units sold had gone up from 400,000 to 1,280,000. The works cost per unit sold had decreased from 1·07d. to 0·75d., and the total cost from 1·61d. to 0·93d. They had sold some 800,000 units for power purposes. With their large consumers, one of whom paid on an average about 0·9d. per unit, they had a coal clause in the contract.

Mr. W. W. LACKIE, of Glasgow, agreed that to charge a flat rate was likely to cause the loss of the best customers. The system of charging should be in proportion to the cost of supply. A charge of £7 per kilowatt demanded and ¼d. per unit would meet the case. Mr. Burnett's curves were equivalent to £8 per kilowatt and ·6d. per unit. At Glasgow he had found the diversity factor was about 33 per cent. for power consumer and 66 per cent. for lighting. Their coal per unit was now under 4lb. He suggested that in Mr. Burnett's calculations for the equivalent flat rate for power consumers, 10 hours' use per day could be assumed instead of two hours.

Mr. E. E. HOADLEY, of Maidstone, said that he had ascertained in the first place the cost of production in order to find roughly what should be charged. He had then fixed a low tariff, which had enabled him to secure a thousand horse-power of motors in a small town of 35,000 nhabitants. Last year they sold 400,000 units for power purposes only. He had inserted a coal clause in the contracts. A restricted-hour rate was exceedingly difficult to arrange, and he had found that the overlapping of the power and lighting load was not a serious matter.

Alderman WEST, of Coventry, gave particulars of the growth of that undertaking, taken from the tables which we reproduced in curve form in our issue of May 17.

Mr. C. E. C. SHAWFIELD, in reply, explained that Mr. Snell was not correct in his comments as to spare plant. The turbines he proposed to use had an overload capacity of 100 per cent., which was equivalent to spare plant. Mr. Snell had obtained prices of power at Sunderland which made the mouths of other engineers water, but which it was quite useless to quote elsewhere He contended that, to sell electricity in competition with rival power producers, low prices had to be quoted. His running costs were based on guarantees from the makers. As regards Mr. Pearce's comments that £10 per kilowatt for distribution cables was too low, he had found that, when calculating for the laying of special mains to individual consumers, the cost had come under this. He had not included a conveyor, because one was not used.

Mr. BURNETT agreed with Mr. Snell that the charges shown in Fig. 2 were not correct, but this was due to the wording of their provisional order. They could not charge more than 6d. per unit, and hence lost on the small-hour consumers, and had to make it up by overcharging the long-hour consumers.

Mr. S. E. FEDDEN proposed a vote of thanks to the authors for their papers. He had found at Sheffield that the hiring out of motors was of great advantage, and it enabled them to commence the electrification of works. When one motor had been installed others were soon added, and the motors lent on hire were usually purchased. They had in Sheffield borrowed £10,000 for motor hire, but only half of this had been used. The charge per unit varied from 1d down to 0·6d., and the average price obtained for the 3,000,000 units sold was 0·9d.

LAUNCESTON, TASMANIA.

Report on Electricity Works.

We have for several years noticed Mr. William Corin's excellent reports on the undertaking of which he has had charge at Launceston, Tasmania. Now we hear that he is relinquishing the position of city electrical engineer to develop his consulting practice. The following will, therefore, be his last report, and it gives not only a *résumé* of progress, but also an idea of the probable extensions in the near future. There is now the equivalent of 65,000 8-c.p. lamps connected to the mains in an area with only 21,000 inhabitants. This averages three lamps per head, which is an exceptionally high figure. The report, dated March 22 reads :

I have the honour to furnish the following report, together with accounts and tables dealing with the work of the electric light department for the year 1906.

1. *Financial Results.*—The gross revenue for 1906 was £14,934 (less bad debts, £19), as against £13,079 (less bad debts, £84) for 1905, an increase of £1,920. Against this increase, working expenses increased £987 (from £5,533 to £6,520), the main items of which were : renewals of poles, increase, £313 ; general maintenance, £216 ; public lamps, £112 ; generating and management expenses together, £302. The increase in the last item is chiefly owing to a larger proportion of salaries and management expenses being charged against construction account during the two previous years whilst the plant extensions were in progress. The extensions being now complete, for 1906 the construction account is relieved of part of these charges, which are debited to maintenance. The balance carried to net revenue account is thus £8,395, as against £7,462 last year, an increase of £933. But interest and sinking fund have risen from £5,994 to £7,163, an increase of £1,169. Thus the actual surplus on the year's working is £1,232. For this year working expenses are not likely to increase, but interest and sinking fund charges will increase by about £260. Increased receipts to the extent of £1,000 are already assured from motors, and receipts from lighting, which for 1906 were £1,155 over those for 1905, may be expected to increase another £1,000 this year, so that a considerably greater surplus, probably over £3,000, is practically assured for the current year. It is to be noted that, whereas the capital expenditure amounts to £160,843, this sum includes £11,330 worth of fittings and motors on hire, earning an average of 8·46 per cent.

2. *Sinking and Reserve Funds.*—These continue to increase satisfactorily. Adding the credit balance on last year's working to the total, it is evident that the undertaking has during its existence earned £20,000—*i.e.*, 12½ per cent. of the total capital—in excess of working expenses and interest. If a comparison is drawn between this result and the profits a private company would have made, it must be remembered that the policy of the Council has ever been to make the price as cheap as possible, so that all users might share in the benefit, whereas a company's policy would be to make as much profit as possible

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out of the users for distributing amongst the shareholders. The reserve fund alone, including last year's cash balance, amounts to £6,535, and this is available to meet such exceptional expenditure as was recently incurred in the extensions and in writing off the value of the recently superseded plant.

3. *Motors.*—The most notable event of the year in this connection was the passing by the Council of a new by-law reducing the price of energy for motors. The charges in this by-law are so planned that electric power may successfully compete with any other form of power in the city. In connection with the framing of these charges, I must acknowledge with thanks the assistance I received from most of the the larger steam users of the city, who kindly supplied me with data as to cost of working, fuel, labour, material, etc., and horse-power used, or where the latter, as in most cases, was uncertain they allowed me to indicate their steam-engines or make brake tests of them, so as to ascertain exactly the horse-power employed. This was a work of several months, but, when complete, I was provided with the actual local cost of steam power under varying conditions, and with engines of varying outputs. Having already the cost of power from gas-engines and the results of reliable tests of suction gas plants (the latest form of cheap power for small independent units), I was able to construct a sliding scale with a minimum of ½d. per unit, the details of which are set out below in Table III., which has the effect of making local electric power as cheap or cheaper than power from any competitive source. The by-law was considered at length by the

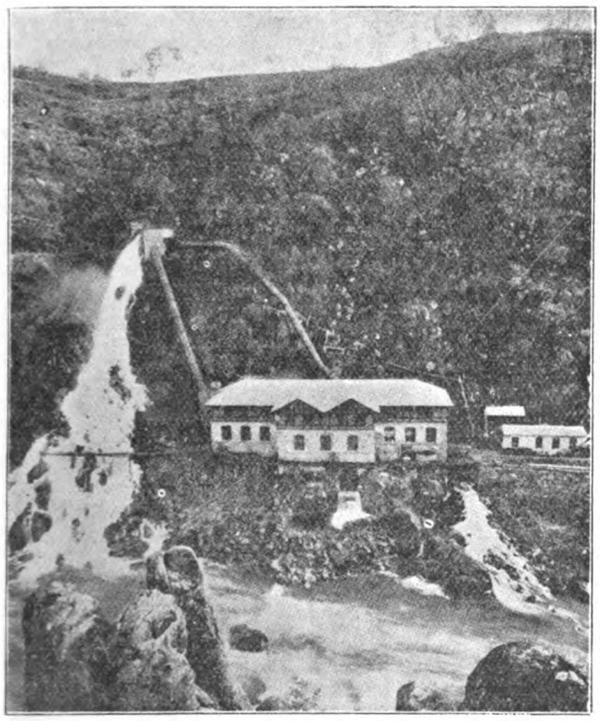

FIG 1.—Launceston Power Station, showing New Pipe to left of photograph and Measuring Cill in front of Station.

Council, and finally passed in August last year, with the result that an immediate impetus was given to this branch of the Council's business, and, apart from small motors, an additional £800 per annum from large motors was assured within a few months—too late, however, to influence the receipts for 1906. Small motors already connected since the close of the financial year promise £300 more, so that over £1,000 per annum additional revenue from this source is practically assured for the future, apart from the fact that there is no diminution in the rate of connecting new motors. Three years ago I was taken to task for being too sanguine in predicting additional connections totalling 100 b.h.p. per annum. Actually the connections since the three-phase plant started have been over 200 b.h.p. per per annum, the total connections being: 217 b.h.p. early in December, 1904; 424 in December, 1905; and 642 in December, 1906; whilst the motors now at work or on order total 726 b.h.p. This is exclusive of motors at the railway workway workshops, totalling at first about 60 h.p., but eventually increasing to 150, for which the Council has agreed to supply power under a satisfactory arrangement which was last year concluded with the Minister. It is worthy of note that the demand on the power station is less than half the rated power of the motors connected. For instance, at the present date 666 b.h.p. are connected, but the load on the power station which they occasion is only 300 e.h.p.

4. *New Lamps.*—The carbon-filament lamp, which has held the field for indoor lighting for the past 25 years, appears to be doomed, except possibly for the smallest candle-powers. Inventors throughout this period have sought to improve its efficiency, or to substitute some other substance for carbon, and the results of their activity are seen in the Nernst, osmium, tantalum, tungsten, Gem, Osram, and Helion lamps, together with Cooper Hewitt and other forms of mercury-vapour lamps. Several of these are only suitable for use with direct current. The tantalum is the best so far obtainable, but its life proves to be short on alternating current, and its cost, together with the certainty that a still better lamp is now being placed on the market, make it inadvisable to go to the expense of stocking it largely. A considerable number of Gem lamps are now in use, but the most promising of any, the Osram and Helion, are not yet obtainable. The Council's London agents have an order to send supplies for testing of these or any other new lamp directly they are placed on the market, and the present year will, doubtless, bring some within the reach of our customers. It is not to be anticipated that a lamp will be produced using less power than an ordinary 5-c.p. lamp, but what is practically certain is that lamps using as much as an 8-c.p. or 16-c.p. lamp will give three or four times as much light.

5. *Tramways.*—While absent on leave last year I received instructions to visit and report upon certain of the tramways systems of Australia and New Zealand, and I spent some time in investigating those of Brisbane and Sydney, and especially as being more directly comparable with Launceston in point of size, of Wellington, Auckland, Christchurch, Dunedin, and Hobart. I embodied my conclusions in a report upon my return, and I have little doubt the heavy affirmative vote in favour of trams shortly afterwards secured was largely influenced by the figures I was able to adduce proving the successful working of the systems in the four New Zealand cities. The main point I sought to emphasise was that for tramways to pay they should be primarily looked at as an everyday convenience for the citizens, tourists and exceptional traffic taking second place, and they should be so arranged that

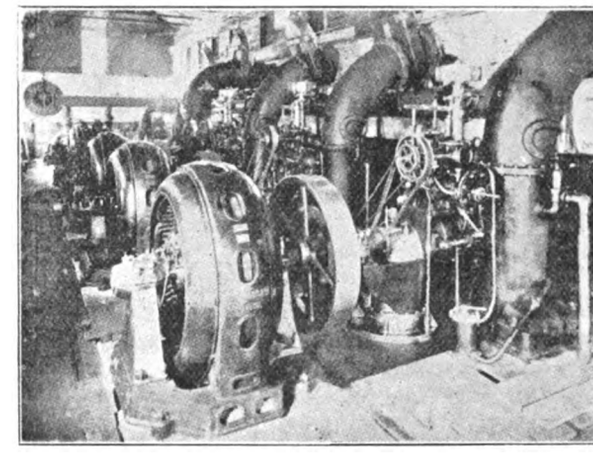

FIG. 2.—View of the Interior of the Station, showing the new 300-kw. Three-Phase 5,000-volt Turbine Generators.

any resident should be able to ride to at any rate within half a mile of his door, and that of all routes those serving the residential districts on the hills were likely to pay best. As it has now been decided that the tramways shall be privately owned and worked, and a preliminary contract has been signed, it is to be expected that the company to be formed will work on some such lines as laid down above, and the results cannot but be satisfactory alike to the company and the citizens, whilst the revenues of the electrical department will be swelled by the price paid by the company for the necessary electrical energy.

6. *Completion of Extensions, New Pipe.*—The addition of a new pipe line consequent on the increase of plant and the alterations to the old pipe were completed in May last. The old pipe, of 5ft. diameter, for the upper portion, reduced to 4ft. for the more rapid part of its descent, is unaltered, save at its lower end, where, instead of as hitherto being led into the receiver at right angles, it proceeds with a sweep into the down-stream end of the receiver, 6ft. in diameter. The receiver itself has been cut in two, and a 4ft. valve fixed between the two portions. The up-stream end of the receiver has been removed, and a bellmouth section reducing from 6ft. to 5ft. riveted on. To this, again, is riveted the end of the new pipe, which is 5ft. in diameter, and proceeds first in a line with the receiver, then bends with an easy sweep, and again proceeds in a straight line up the hill to the by-wash. Both the cutting of the receiver and inserting the 4ft. valve and the alteration of the old pipe presented considerable difficulty, particularly on account of the limited time (from midnight on Saturday to 4 p.m. on Sunday afternoon) available for any one operation, but it was satisfactorily completed, the contractor being Mr. W. Knight, who supplied and erected the original pipe. Either pipe may now be shut off for painting or repairs without shutting down the station. With one exception, the outlets to the

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turbines have been replaced by bends or pipes proceeding at a convenient angle. One object has been kept in view throughout these alterations—to lead the water direct to the turbines, as far as possible avoiding shock or sudden change of direction or of velocity, and consequent loss of head, a precaution which is the more necessary on account of the high velocity of the water adopted with the new turbines.

7. *Tests of Plant, etc.*—I carried out a complete series of tests on the new plant with a view to determining the ratio of energy received at the generator terminals to the work done by the falling water, and, in order to determine accurately the amount of water, I constructed a testing tank, and made a further series of experiments with this. Such tests with steam plants are very usual, and the methods adopted are more or less standardised, and many descriptions have been published. With water-power plants the reverse is the case, and consequently as difficulties arose they had to be separately met and overcome. Eventually, however, a satisfactory series of tests was completed, of which, on account of their interest and unusual character, I intend to shortly write a description for publication. The final results showed that on full non-inductive load, the generators being separately excited, the electrical horse-power developed at the generator terminals was 75½ per cent. of the hydraulic horse-power of the falling water, the exciting power being just over 1 per cent. of the electrical horse-power developed.

8. *Maximum Power Obtainable from Works.*—As soon as the new pipe was completed I commenced a series of tests to deter-

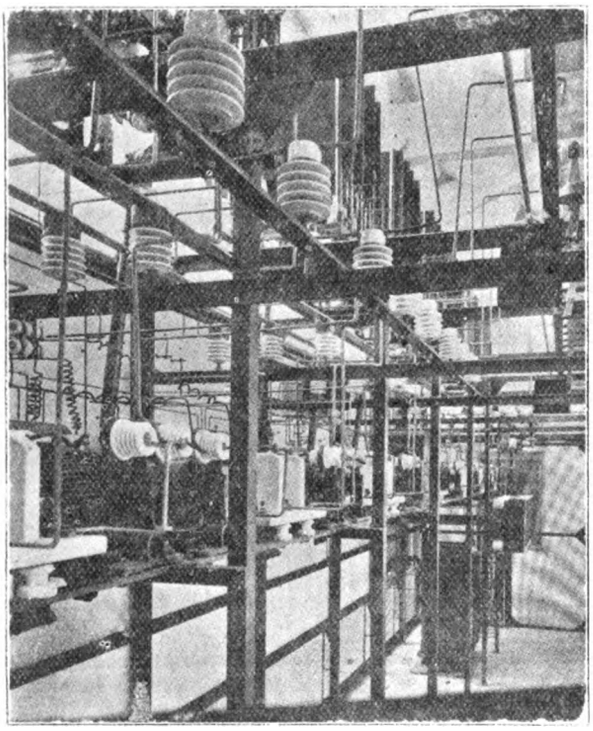

FIG. 3.—High-Tension Connections behind Sub-station Switchboard, Launceston.

mine how much power could be obtained from the plant under existing conditions, of which I summarise the results below. Four sets, each of 400 e.h.p., have been erected. It is not, of course, contemplated to run all four sets at once, but one set is always to be kept as spare, so that, until a fifth set is erected, the rated capacity of the plant is three sets of 400 e.h.p. each, or 1,200 e.h.p. in all, and the minimum total power I have measured under normal summer level conditions has always been in excess of this figure. Not only so, but the water usually available in the winter time permits of an overload of 15 per cent. (which may be safely carried by the machines), making a total of 1,380 e.h.p. I refer below to how this may be increased. Now, the maximum load on the plant during the summer months occurs on Saturday evenings, but towards the middle of May, as the sun sets earlier, the maximum rises, and simultaneously shifts to a weekday evening between 5.30 and 6 p.m. Last year, for instance, the monthly maxima for the first six months of the year consecutively were 405, 433, 480, 721, 768, 803, whilst the maximum for the year was 821 on July 5, at 5.35 p.m. Judging, therefore, from last year, a load of 405 e.h.p. in January is bound to grow to 821 in July, a difference of 416. Hence, as 1,380 is for the present the allowable winter maximum, the plant must not be loaded with more than 964 in January or it will be overloaded in July. February and March are the months when a shortage is most likely to occur in the river. A load of 964 in January will grow to 1,039 in March, and 1,039 e.h.p. requires 6,800 cubic feet of water per minute through the tunnel, and with the storage provided by the dams at Arthur and Woods Lakes there should be no fear of the water falling below this, even in an exceptionally dry summer. It is fortunate that the midwinter maximum occurs at a time when invariably the rainfall increases the flow of water in the river, and it is evident from what I have stated above that the maximum safe load which can be put on the plant must be determined by midwinter conditions. For the present year I anticipate that the maximum evening load will be about 1,000 e.h.p., including lighting and the few motors—"six o'clock motors"—which may be then running. To ascertain what balance is left for ordinary extensions, I assume that the tramways will require 200 e.h.p., which is as much as is likely for several years, especially if, as I recommended in my report, the company provide a secondary battery, a provision in any case highly advisable if not an absolute necessity. This, then, leaves 180 e.h.p. available for additional lighting and six o'clock motors for the next year or two. I have been treating above of the maximum evening load. It remains to inquire what additional day load is provided for by the existing plant. The majority of ordinary factory and workshop motors run from 7.30 a.m. to 5 p.m. On a midwinter afternoon the total load on the station, comprising chiefly motors and lighting, commences to rise about half-past four, and the lighting load, though nowhere near its maximum, has already grown considerably by five o'clock, at which hour the total load is suddenly reduced by the majority of the factory motors being stopped. The demand between 4.30 and 5 in midwinter thus

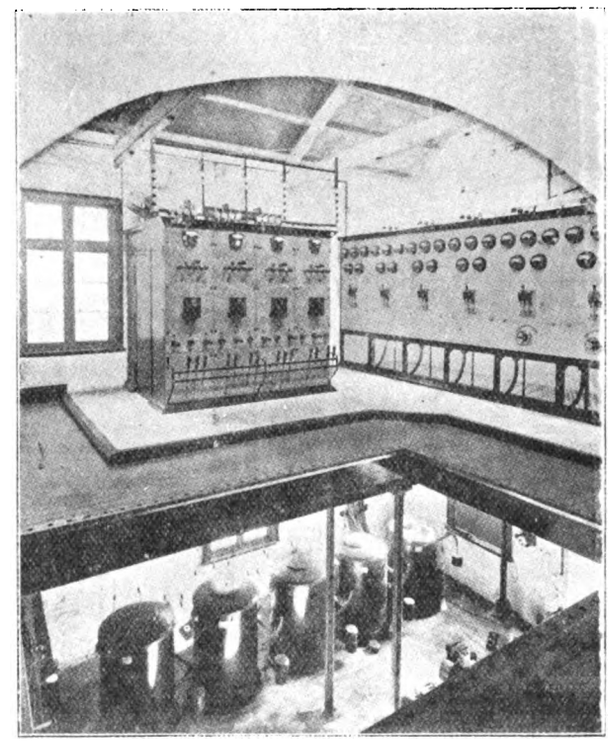

FIG. 4.—The Cameron Street Sub-station Switchboard and Transformers controlling Street Arc Lamps. Constant-Current Series System. 50 Lamps worked off each Transformer.

determines the maximum allowable day load, and I anticipate that the maximum during this half-hour for the coming winter will be 700 e.h.p., leaving a balance of 680 e.h.p., so that for future years, after reserving 200 e.h.p. for trams, the margin is 480, as against 180 only at six o'clock. It is thus apparent that the evening midwinter maximum is the governing condition, and, as I showed above, 180 e.h.p. is all that may be relied upon, so that in two or three years' time, with the trams at work, the plant will be fully loaded at midwinter between 5.30 and 6 p.m., other things being equal. But I am confident that within this period the provision of more efficient incandescent lamps will largely reduce the maximum lighting load, so that the time when the plant will be fully loaded will be postponed for a year or two longer.

9. *Further Increase of Power.*—It remains to be considered how the capacity of the plant can be increased. This may be carried out in three steps. Firstly, the full overload capacity of the present generator sets may be drawn upon for the short interval of maximum load. The makers' guarantee is 20 per cent. overload for two hours. I have myself put over 40 per cent. overload on a machine, and all have been tested to 30 per cent. overload, and personally I should have every confidence in maintaining this overload for the shorter period of maximum load in midwinter, especially after a slight alteration has been effected to the turbine thrust bearings. Thirty per cent. overload would give 1,560 e.h.p. at the power station, leaving a margin of 360 e.h.p., instead of the 180 given above.

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To ensure this, certain improvements which I have referred to in a previous report are necessary to the tunnel inlet. To provide against a dry winter and a level consequently lower than normal, it would be necessary to improve the existing dam, raising it 2ft. or 3ft., so as to maintain the height of water at the tunnel intake at the normal winter level. Past records, however, invariably show a rise in the river as the maximum loads increase from April onwards. Secondly, to further increase the station capacity, an additional 400-e.h.p. generator set may be added, and the tunnel sufficiently improved by complete lining for a greater length, or perhaps throughout, to provide enough water either for the normal load of four machines, 1,600 e.h.p., or to allow for any overload which the total water obtainable through the tunnel will carry, an overload limited so far as the machines are concerned to 30 per cent., giving 2,080 e.h.p. for the short period of maximum load. This would require, however, 13,650 cubic feet per minute, which is more than the maximum rated capacity of the tunnel. Thirdly, if over 2,000 e.h.p. at the time of maximum load is required, it will be wise to seek a new site for the power station, arranging to use the same water, with a greater head. As I showed in a report last June, such a site may be found in a position nearer the city than now, and without any unreasonable expense 5,000 e.h.p. or more may be provided ; and I would here emphatically repeat my former recommendation that the Council should take immediate steps to acquire all necessary rights to enable them to develop this power in the future. This would be a reasonable step, if required only for posterity, and not for the present generation, but in my opinion it will be required within 10 years, and perhaps sooner. Twelve years ago 400 h.p. was all that was spoken of. Now over three times this is provided for, and four or five times as much is contemplated. It is not, therefore, too soon to look ahead at once.

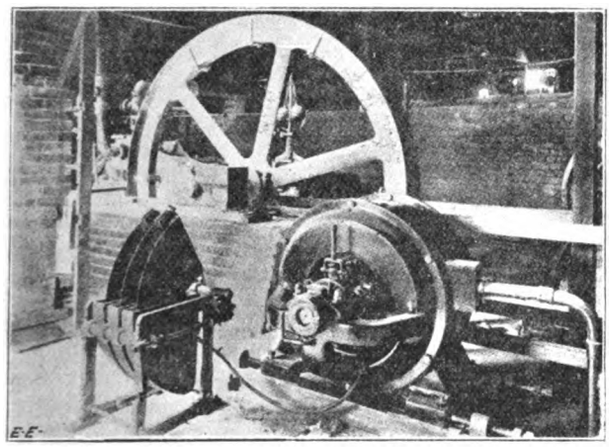

Fig. 5.—82-h.p. Motor driving Corporation Air-Compressor and Stone Crushers. Disused Steam-Engine and Boiler in background.

Were the site properly surveyed and estimates made, and were the execution of the work definitely adopted as part of the Council's future policy, it would become a question whether it is worth while to make the provision for increase of power under the second heading above by providing a fifth set and improving the tunnel to correspond. And, again, work will shortly be necessary upon the existing transmission line, and if this is to be made a permanency it would be worth while once for all to replace the wooden poles by steel poles spaced at greater intervals. Hence the whole of this subject should be seriously considered by the Council, and decided upon without unnecessary delay.

10. *Advisability of Doubling Supply Voltage.*—If the lighting load in the residential districts of the city continues to increase as at present, it will be necessary in the near future, in order to maintain a good average pressure at the consumers' terminals, either to add more transforming centres at closer intervals, or to increase the weight of copper in the secondary mains, or to follow the modern method of doubling the supply voltage. This was a question which I carefully considered when specifying for the new transformers four years ago, but I decided that the task of doubling the pressure simultaneously with the change of system was beyond our powers to satisfactorily carry out, and I, therefore, contented myself with as far as possible providing for this change whenever it should be necessary by having the transformer windings so arranged that by a mere alteration of the terminal connections with a spanner, the work of a few minutes, the pressure may be doubled, and thus one heavy expense incidental to such a change is already avoided. The chief expense will be in suitably altering the meters, in overhauling the wiring of houses, providing high-voltage fittings for those wired during the first five or six years of the undertaking, since when I have prepared for such a change by using high-voltage fittings exclusively. The operation could be carried out piecemeal, the several transforming areas being changed to the higher pressure one at a time. I may say, by the way, that to economise copper in the new work at the Cataract Cliff grounds I have arranged to use 220 volts. The effect of such a change is to allow four times as many lamps to be connected with a given percentage fall of pressure, and, consequently, equally good illumination, without increasing the size of mains ; or, if only two or three times as many lamps are connected, the drop in pressure will be reduced, and the general lighting improved. The day when this change may become necessary may be postponed in those residential districts where 16-c.p. lamps form a large part of the lighting, if my anticipations of a satisfactory new lamp being shortly placed on the market are realised.

11. *Approaching Retirement.*—As, after over 11 years in the service of the Council as city electrical engineer, I am relinquishing the position on April 30, in order to devote my attention exclusively to my private practice, I desire to take this opportunity of briefly reviewing the results attained. The most striking feature to an outsider coming to Launceston is the very large number of houses, and especially small cottages, electrically lighted, and the large proportion which these bear to the total number of houses in the city. This proportion is far and away above any results obtained in Great Britain, and probably is only equalled in a few American towns, whilst the actual number of consumers is greater than in either Melbourne or Sydney, unless these have caught us up during the past few months. The comparatively few complaints received testify to the general satisfaction given by the service. One feature tending to this large proportion is the wiring of premises and supply of motors on the rental and hire-purchase systems, the introduction of which was chiefly due to the initiative of the late Mr. Alderman Sutton, who ever worked hard for the success of the undertaking. These systems were in full swing here when free-wiring companies were only commencing their operations in Great Britain, and when such municipal trading as ours in this respect was unknown there. Launceston was, I believe, the first city in Australia to adopt the maximum demand system of charging, which is now largely in vogue in Melbourne and Sydney, and as regards the price of electricity, we are still leading with our ½d. per unit. It gives me satisfaction to know that the new three-phase plant is not only working well, but is a financial success, and that, if the Council should decide to limit its capacity to 1,380 e.h.p., it will, with the present tariff for light and power, when the tramways are running and the extra load in sight is connected, be earning a yearly surplus of from £5,000 to £6,000. It is an additional pleasure to me, at the termination of my past cordial relations with the Council, that they have signified their satisfaction with my services by appointing me as consulting engineer for a year from the date of my retirement.

12. *Conclusion.*—In conclusion, whilst I wish to express my thanks to your worship and the Council for your past kind consideration, I desire also to thank the entire staff for their loyal co-operation at all times in the working of the department. And, as regards my successor, I note with pleasure the statement in the Press that the committee has recommended the appointment of Mr. R. J. Strike as acting city electrical engineer, for I have at all times highly valued Mr. Strike's services, and feel convinced that he will give the Council satisfaction in this capacity.

The following analysis of the accounts for 1906 shows what can be done in a water-power station where the fuel charge is absent. Source of power—South Esk River. System—alternating three-phase, 50 cycles. Pressure—primary, 5,000 volts; secondary, 110 and 190 volts.

I.—Financial Position.

Amount of loans sanctioned	£160,000
Amount borrowed	£154,767
Amount expended	£160,843
Amount of sinking funds	£13,310
Amount of reserve fund	£5,498
Total of above two items	£18,808

II.—Financial Results for year ending Dec 31.

Completed year of working	Tenth
Capital expenditure at end of year	£160,843
Revenue from lighting rate	£2,349
Revenue from electricity supply	£11,217
Revenue from rental of meters, motors, and fittings, and from other sources	£1,368
Total revenue	£14,934
Total costs	£6,520
Gross profit before providing for interest and sinking fund	£8,414
Percentage of gross profit to average capital	5·31
Interest on loans, less interest receivable	£5,601
Sinking fund contribution	£1,561
Percentage of ditto to average capital	·99
Financial results after payment of all charges, including interest and sinking fund, surplus	£1,252

III.—Supply Records.

Number of 8-c.p. lamps connected at end of year (arcs, incandescents, and motors equivalent in 8 c.p.)	65,140

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Average for the year	56,369
Units generated	1,313,620
Units sold—	
Lighting, power, and heating (ordinary rates)	575,949
Lighting, power, and heating (special rates)	121,171
Street-lighting (incandescent)	124,361
Street-lighting (arc)	173,042
Total	994,523
Units sold per 8-c.p. lamp (connections during year averaged)	17·65
Maximum load reached (including arc lamps)	616 kw.
Load factor	26·76
Capacity of plant at end of year (including spare plant)	1,200 kw.
Average price obtained per unit—	
Private supply	3·86d.
Street-lighting	1·90d.
Total supply	3·27d.
Population of area supplied (last census)	21,000

Prices charged: Private lighting—maximum demand system, with initial charge of 6d. per unit for daily average of two hours and 1½d. per unit after. Private lamps in streets half rates. Power and heating, 2d. per unit for first 200 units per quarter per brake horse-power or kilowatt, ½d. per unit after. Motors and heating apparatus for other departments, ¾d. per unit. Street-lighting paid for by lighting rate. Under the new by-law (August, 1906) the price per unit for power for the first 200 units per brake horse-power per quarter, falls uniformly from 2d. for a total consumption of 10,000 units per quarter to ½d. for 60,000. Over 60,000 a flat rate of ½d. is charged.

IV.—Analysis of Costs, per unit sold.

	d.
Generation and distribution costs—	
Oil, waste, and station stores	·056
Wages of workmen	·595
Repairs and maintenance of buildings, plant, instruments, tools, mains, transformers, meters, etc. (materials only)	·358
Works costs	1·009
General costs—	
Rent, management expenses, election expenses, assessment roll, mayor's allowance, salaries town hall staff, hallkeeper, and messenger, salaries engineer's department and clerical staff, printing, advertising, and general establishment charges	·564
Total costs	1·573
Capital charges—Interest	1·352
Sinking fund	·377

V.—Further Supply Records—Detailed.

Private Lighting.

Number of consumers connected, Dec. 31	2,369
Increase of ditto during year	42
Number of 8-c.p. lamps connected, Dec. 31	35,139
Increase of ditto during year	1,428
Average number of lamps for year	33,875
Units supplied	416,161
Revenue obtained	£9,711
Units used per 8-c.p. lamp	12·29
Revenue per 8-c.p. lamp	5s. 8½d.
Price obtained per unit	5·6d.

Power.

Number of motors in use, Dec. 31	144
Increase of ditto during year	20
Total aggregate horse-power, Dec. 31	641
Increase of ditto during year	217
Average horse-power for year	452
Units supplied	182,547
Revenue obtained	£1,096
Units used per horse-power	404
Price obtained per horse-power per annum	£2 8 6
Price obtained per unit	1·44d.

Heating.

Number of consumers, Dec. 31	454
Increase of ditto during year	99
Total kilowatts in use, Dec. 31	242
Increase of ditto during year	61
Average kilowatts for year	195
Units supplied	61,758
Revenue obtained	£409
Units used per kilowatt	317
Price obtained per kilowatt per annum	£2 1 11
Price obtained per unit	1·59d.

THE USE OF LIGHTING MAINS FOR TELEPHONIC COMMUNICATION.

Telephonic communication between the various stations and districts of large electricity supply undertakings is essential to satisfactory operation, and connection with the ordinary town telephone system does not altogether meet the case. If, for instance, two departments of the undertaking wish to communicate simultaneously—a very likely occurrence in the case of a breakdown—the telephone operator, instead of making the connection, will inform both applicants that the line is engaged. The technical controlling arrangements in use on telephone systems are, in fact, not suited to meet such cases. The only satisfactory solution consists in maintaining a private telephone network. Private lines can, however, only be cheaply run if the supply is an overhead one, as the telephone wires can then be mounted on the existing poles. If the supply is by underground cables, however, the only economical method of dealing with the matter is to use the existing cables and pilot wires for the telephonic connection. There are not usually enough free pilot wires to make up circuits from, and it is almost essential to bring in the main cables as well—especially as the use of pilot wires of different cables as lead and return is unsatisfactory owing to the high inductance introduced by the iron armourings. The remaining arrangement is the use of the main cable as one lead and the pilot wire of the same cable as the other lead of the telephone circuit, and the necessary connections are different according as the pilot wire is an idle one or is one already used for voltage measurements. If the former is the case, the connections would be those shown in Fig. 1. In order to prevent the voltage drop in the calls when under load ringing the direct-current call bell, a high resistance—for instance, a suitable lamp, G_1—must be introduced between the cable and the apparatus Calling up is then accomplished by opening the connection between the pilot wire and one cable, and making a connection to a second suitable cable through another resistance lamp, G_2. The calling battery is, therefore, superfluous, although the microphone battery is, of course, necessary. An installation of this type (which is fully described by Dr. R. Hiecke in *Elektrotechnik und Maschinenbau*) has been in use in Vienna for some months on a 450-500 volt system, and has worked quite satisfactorily with voltage drops in the calls up to 40 volts. It was installed by the Austrian Allgemeine Elektricitäts-Gesellschaft, and all the parts connected to the lighting main conformed to the ordinary wiring rules. When the pilot wires are also to be used for pressure measurements the telephone apparatus is not connected directly to the mains, but through a small transformer, as shown in Fig. 2. The pilot wire can then be permanently connected to the cable at one end as required for voltage tests The voltmeter, S_p Z, must be arranged by means of a switch for only momentary measurements, as is usually the case. The same switch can then be arranged as shown, so that when the voltmeter is not in use the near end of the pilot wire is also connected to the cable, and that, further, the telephone circuit is short-

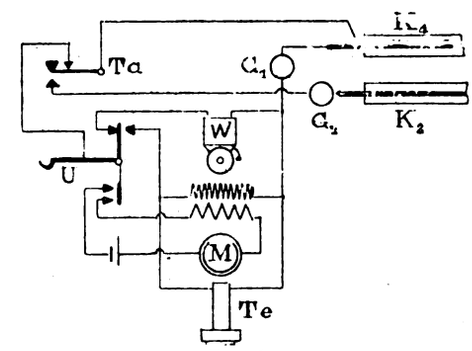

FIG. 1.

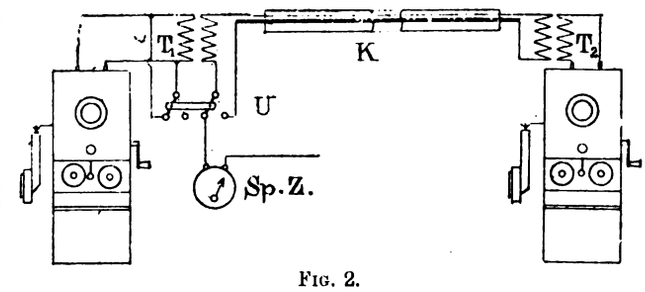

FIG. 2.

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circuited or broken before the connection to the cable is opened again. This last operation prevents the bell ringing through the induced current set up. Only induction signal bells are, of course, suitable for calling up with this arrangement. This method has also been found quite satisfactory in practice, although some difficulty was at first experienced in obtaining sufficiently efficient transformers to deal with the small low-frequency calling currents. This difficulty was got over by employing transformers of the size shown in Fig. 3, made of the new silicium iron, having a low hysteresis loss and also a high specific resistance, and wound with ·35mm. to ·4mm.

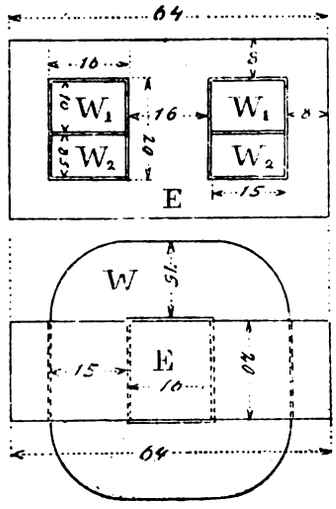

FIG. 3.

diameter wire. The effect of the additional resistance of the transformer secondaries on the voltmeter readings is negligible. With either of the arrangements described it is possible to connect a number of points, provided that all the pilot wires used for the joint arrangement belong to one pole of the system. Good insulation at the interconnecting board must, of course, be insisted upon.

GLOVER'S ALMANAC.

The perusal of Glover's almanac is always enjoyable, and for once we have an opportunity of glancing through two almanacs within the short period of six months. The issuing of a year's calendar commencing July 1 is a new feature, which is likely to secure more attention than when the almanac comes only as one of a number. The arrangement of the present calendar, which runs until the end of June, 1908, is different from any of its predecessors, as the leaflets can be taken off the file and preserved in a case provided for that purpose.

The first leaflet for July follows on with the ideas of Mr. Dooley on commercial electricity:

"Th' Station Ingineer iv to-day," said Mr. Dooley, "aint phwat he used to be. In th' ould days he was a pure-bred ingineer who could sometimes hit a chisel without barkin' his knuckles, an' who could also calc'late Ohm's law wid his slide-rule. If he ain't an accountant to-day it's because they don't teach double-entry at th' ingineerin' colleges; but he goes to night school f'r to learn all he can about orfice wur-ruk. So he's not pure-bred, but high-bred, as Hogan says." "Phwat's that?" interrupted Mr. Hennessey. "Mongrel," said Mr. Dooley; "but a mongrel dawg is ginerally more business-like whin it comes to dealin' wid thieves. So it is wid th' mongrel station ingineer. All ratepayers are thieves, an' he's got to catch thim. He don't think only about how he makes th' juice or how much iv it leaks on th' way to th' consoomers' houses ——" It don't, if he uses Glover's," said Mr. Hennessey. "I'll thank ye not to interrupt again," said Mr. Dooley, angrily, "or else they won't have room to print phwat I want to say. He's also got to think about how much he can sell, an' he's tryin' all day an' all night, too, to make th' rascally consoomer use elictric ceegar-lighters, bed-warmers, curlin'-irons, and hat-pads. 'This is th' way,' he says, 'to make life worth livin'. Use th' elictric f'r all th' luxuries iv th' Hotel Poplar,' he says; 'come and see our show; step up this way an' observe th' loominous sausages givin' out radiant heat,' he says; 'test th' elictric milk bilers f'r your babies; bring your babies here an' give them elictrizone,' he says; 'step-up, step-up, an' buy, buy, buy our best an' cheapest elictric,' he says; 'an' give up th' gas man next dure, who pizens th' air f'r ye,' he says. "True f'r ye," said Mr. Hennessey. "But if he's got to sell th' elictric chape he must make it chape, too. He must be a good ingineer as well as a good business man, bedad." "So he must, so he must," replied Mr. Dooley, "an' th' sooner th' councils an' companies learn that if they want a good man they must be afther payin' a good price, th' bether for th' elictric."—*Contributed.*

Glancing over the others we still find interesting electrical extracts, livened up by photographs of works executed, which leads to the conclusion that there are very few places where Glover's cables are unknown.

Those engineers who refuse to look ahead will wait till June next year before reading the following verses on "Three Bare Wires."

Three bare wires—three bare wires,
See how they run—see how they run!
They all run over above your head
From the tip of a pole to the top of shed;
They may be alive or they may be dead,
Three bare wires.
Three bare wires and one rough day,
Very rough day—real rough day;
It tangles the wires in a terrible knot
And the part which is tangled gets terribly hot,
Grows quite incandescent and melts on the spot
And runs a—way.
Three bare wires—one rough day;
See how they run—see how they run!
They fall in the road with a fiz and a flash;
They cover the causeway with copper and splash;
The man who remains underneath them is rash,
Must mind his eye.
Mind his eye—the crowd all fly,
See how they run—see how they run!
They all run into the houses near,
They creep into corners and pubs for be/er fear (*sic*)
They cut off to blackguard the engineer,
Oh poor man—Oh poor dear!
See how they run—see how they run!
He felt quite content in his lofty abode,
He thought he had got such a record load,
With quite the peak current in Wottizzitt-road.
Three sets on—full steam on,
See how they run—see how they run!
The crowd all hurry to tell him why
His amps have risen so extra high,
A teardrop springs in his eagle eye.
Both his eyes—both his eyes,
See how they run—see how they run!
So great his grief and his rage profound
He says if even it costs a pound*
He'll bury those cables underground.
Three core wire.—*Contributed.* MR. P. BLAGG.

* Many chiefs are Scottish.

We wish the almanac every success.

FORTHCOMING EVENTS.

FRIDAY, JULY 5.

Junior Institution of Engineers.—Summer meeting in the Clyde district.

SATURDAY, JULY 6.

Junior Institution of Engineers.—Summer meeting.

TUESDAY, JULY 9.

Society of Arts.—At 9 p.m., conversazione in the gardens of the Royal Botanical Society, Regent's Park.

Dynamicables.—Tuesday, July 16, welcome dinner to Lord Kelvin at the Trocadero Restaurant, at 7 p.m.

Liverpool and District Electrical Association.—Tuesday, July 16, first meeting at the Common Hall, Hackins Hey, Dale-street, at 8 p.m.

British Association.—July 31 to Aug. 7, seventy-seventh annual meeting at Leicester.

Iron and Steel Institute.—Sept. 23, 24, and 25, Vienna meeting.

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THE

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THE INQUEST ON THE LONDON COUNTY COUNCIL ELECTRICITY SUPPLY BILL.

The sudden death of this Bill last week whilst under the consideration of the Hybrid Committee of the House of Commons, was the subject of an inquest on Tuesday. The London County Council felt fully qualified to ascertain the cause of the death, but the experts differed, as is usually the case. The debate arose out of the epitaph to be placed over the grave, and Mr. W. Peel moved: "That, in the opinion of the Council, it is a matter for deep regret that the London County Council (Electricity Supply) Bill, 1907, has been rejected, thereby depriving the elected representatives of municipal London of the opportunity of securing the provision of a cheap supply of electricity subject to public control." In support of this, he attributed the failure of the Bill to the fact that it was "stabbed to death, not on its merits, but because it was promoted by the Reform majority of the Council." Mr. M'Kinnon Wood took the view that the Bill had died of inanition, and because it had not enough substance in it to keep it alive. He added that "the whole policy of Parliament in this connection had been that this should be a municipal undertaking, and this Bill came in and said that this should not be a municipal undertaking for at least fifty years." This is the view that we took in considering the Bill when introduced. All the essentials for a successful measure were struck out by the Reform party, who proposed to obtain powers to carry out a scheme only to hand them over to the highest bidder. The financing of any such undertaking at the present time would be a matter of great difficulty to any company, and the cost of obtaining the capital would have made the estimates of the County Council experts quite inadequate. These figures and the scheme generally were quite feasible so long as the money could be borrowed on the security of the rates. This is the most valuable adjunct to a municipal scheme, and when the electors decided not to carry out the work in this way, the proper course would have been to drop the measure entirely. As it is, another year has been wasted, and we are as far off a comprehensive scheme of cheap power supply for London as ever. From the debate in the Council on Tuesday, there seems no chance of another attempt being made next year. Private enterprise may introduce Bills, but with the Radical party in power there seems little chance of success. The linking up of the existing undertakings, even if into two groups—company and municipal—offers the only solution likely to be accepted, but for such schemes to become facts, Parliament must devote more consideration to electrical subjects than they have done in past years. Our last Electric Lighting Act is dated 1888, and while the Board of Trade draft and introduce Bills amending this Act at regular intervals, no real attempt is made to pass these measures. The only hope is for the electrical engineers to influence, through electric lighting committees and corporations, the members of Parliament for each district, and to impress on them the fact that changes are needed for the benefit of industry. The same influence would, if properly exerted, solve the London problem at a cost which would be trifling compared with the futile attempts to pass Power Bills.

TRAMWAY ACCIDENTS.

The report on the Croydon accident by Major Pringle will be carefully read by all tramway engineers. The net conclusion of this and of similar reports of other accidents is that more training should be given to those men who

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are employed as extra drivers during the holiday times, when the rush of traffic requires a temporary increase in the staff. This is a matter with which the directors of tramway companies and the members of municipal tramway committees have as much to do as the engineers and managers. The training of drivers to act on such occasions is costly, but the expense should be treated as insurance against accidents. Thus in one town, where many accidents have occurred in the past, the electric tramway department is crippled by the capital sums paid as compensation for accidents with the old steam cars. The supervision of the extra rolling stock used during the holiday rushes is equally important. For instance, due to the want of this the Swindon accident occurred, for which compensation entailing a two-shilling rate has already been paid. It is better to incur the extra cost of tuning-up the spare cars and of training a special staff than to pay compensation on avoidable accidents.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TELEPHONE TARIFFS.

SIR,—The reply made by the Postmaster-General to Colonel Phillips to the effect that the unlimited service rate had to be withdrawn because experience had shown that it was not profitable calls for immediate notice. In truth, experience has demonstrated quite the opposite, since the National Telephone Company, with millions of "water" in its capital, has paid dividends ranging from 5 to 6 per cent. for many years, dividends earned by an unlimited tariff, for payment per call is quite an innovation, and has hitherto been only very partially applied. Municipal trading has been much contemned, in some of its aspects not unjustly. I am no advocate for it, but the municipalities entered the telephone business at the pressing invitation of the then Government, to save a situation which the Select Committee of 1898 pronounced intolerable. They are, therefore, entitled to fair play and to have their efforts honestly appraised. What have they shown? That superior telephones can be supplied at a profit at rates varying from £5 to £6. 6s. per annum without any limitation in the number of calls, and consequently that the new Post Office tariffs are entirely unjustifiable.

The Corporation of Hull's telephone undertaking, which has had to fight a very hard battle against unfair competition, came out at the end of its second financial year, March 31 last, with a surplus of £1,388. 12s. 7d, that being the excess income after paying interest on its loan and sinking fund on its capital. This net income was realised on a gross revenue of £8,989. The capital expenditure stood at £52,864, which, however, included a good deal of work provided for developments, and not yet brought into use. The Corporation tariffs are very low, £6. 6s. per annum for business and £5 per annum for house connections, without limitations as to calls—besides cheaper ones. In order to discover how they would have stood had the new Post Office and Company's tariffs been applied throughout the year instead of their own, the Telephone Committee instructed their city accountant and telephone manager to prepare a statement showing what the income would have been under the new Post Office rates. These officials reported that instead of an income of £8,989 there would have been a revenue of £19,700—or £10,711 more! This means that the modest profit of £1,388 would have been swelled to £12,099—practically one-fourth of the total capital expenditure recovered in one year! And this is the tariff that the Postmaster-General calmly asserts to be necessary!

Facts like these should be carefully weighed by telephone users and chambers of commerce. Cheap and efficient intercommunication is a vital condition of commercial success. Municipalities apart, the British telephone tariffs are already the dearest in Europe. Mr. Sydney Buxton proposes to double or treble them, and so impose a restraint on trade from which our competitors on the Continent are, happily for themselves, free. Foreign Governments are not so foolish as to tax intercommunication.

I do not plead for a resumption of municipal licences if any other method of freeing telephony from its present thraldom can be devised. But I do contend that a searching parliamentary inquiry is urgently called for. Let the Postmaster-General be given an opportunity of proving his astounding assertion to the satisfaction of an independent committee, and of showing, if he can, in what respect the municipal results are defective and incapable of being reproduced by the Post Office. Let him also explain why the Post Office has done its best, in conjunction with the Local Government Board, to render it difficult, and in some cases impossible, for the municipalities to continue their telephone undertakings. The reason, of course, is that the municipalities prove that cheap telephones are practicable, which is the last thing that the Post Office wishes to have recognised.

If the new Post Office tariffs become the rule, telephone subscribers will have to pay hundreds of thousands of pounds per annum in additional subscriptions for facilities in many cases inferior to those at present enjoyed—treasure trove which will largely go to reinforce the already overflowing coffers of the Telephone Company. Under the new tariffs economy and good administration on the part of the Post Office become unnecessary, as it would be practically impossible for even the grossest mismanagement to bring about a loss.

In a letter which has to be kept within narrow limits it is impossible to do justice to the telephone question, or even to merely indicate the different points which call for investigation and discussion; but I have said enough to show that immediate action is necessary if the pit dug for the commercial community is to be avoided.—Yours, etc.,

A. R. BENNETT.

Queen Anne's-chambers,
Dean Farrar-street, Westminster,
London, S.W.

ELECTRIC MOTORS.

SIR,—Some time ago I read in a monthly magazine an account of an electric motor which maintained its efficiency in spite of what seemed to me excessive abuse. The words of the magazine article are as follows:

"... Small motors are now in the market which yield a remarkable performance in the way of reliable service, so that one need not fear excessive maintenance charges and costly interruptions with the best makes. It would be difficult to name a more exacting service than the 'body ironers' of the laundry imposes upon a direct-connected motor. This machine is repeatedly reversed while running at full speed, and as these reversals sometimes occurs every second, averaging 19 or 20 in the ironing of a single white shirt, the strain upon the motor is not difficult to appreciate. Yet motors are to-day in service driving such machines and are constantly reversing from 600 r.p.m. + to 600 r.p.m. −, practically as fast as the operator can work the treadle, with comparatively little sparking and every evidence of being able to keep up the pace for months to come."

I wrote to the editor of the magazine about it, and he very courteously acknowledged receipt, and promised to communicate with the author—an American gentleman.

Several months passed, and I had given up all hope of hearing further about it, when I received a note from a New York firm of motor makers saying that my letter had been forwarded to them, and saying that, whilst they made the motors described in the article, they would not furnish one for use in my country.

As I am interested in the motor in question, and should like to get one if it will accomplish all that it is said to do, I write to ask if any of your readers know of such motors, and if any are made in England.—Yours, etc.,

MULTIPLE BREAK.

June 28, 1907.

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MODERN APPLICATIONS OF ELECTRICITY TO MINES.*

BY CHARLES PRATT SPARKS, M.I.C.E.

The importance of increasing the application of power to reduce labour costs renders he use of electricity a matter of interest to all mine owners, as no other system has equal flexibility in distribution or is so well adapted to meet every form of drive above or below ground.

Economies.—The principal economies resulting from the use of electricity are through (1) reduced stand-by charges; (2) small loss in transmission; (3) high efficiency of the electric motor; (4) the lower capital cost of producing and transmitting energy. The saving is specially noticeable where the workings are spread over a large area, as the whole of the steam plant can be concentrated at one point. The cost of electric power varies over wide limits, and depends upon (1) the size of the undertaking; (2) capital outlay (influenced by locality); (3) cost of fuel and circulating water (if water power is not available); (4) load factor. Where electric driving has been adopted on an extensive scale, the load factor at the power-house is between 30 and 40 per cent. This high load factor makes the fuel cost important. With the cheap fuel available at collieries, the cost of the coal only accounts for one-quarter of the total cost at the power-house, whereas, when fuel is purchased, its cost may amount to more than one-half of the total; thus the advantage to be gained in applying electric driving in mines, where fuel has to be purchased, is much greater than the economy obtained in colliery working. The following figures of the Powell Duffryn Company were recently quoted by me as representative costs at a discussion at the institution:

Power-House.

Low-speed steam-driven generators = 3,000 kw.
(Largest unit 1,500 kw.)

Average horse-power of motors at work during the last year.

Haulage	2,900 h.p.
Winders	180 ,,
Fans	380 ,,
Pumps	340 ,,
Screens	240 ,,
Auxiliary motors on surface	480 ,,
Total	4,500 h.p.
Output of power-house for 12 months	4,800,000 units.
Average cost of coal during year	5s. per ton.
Coal consumption per unit	3·7lb.
Running costs	0·18d.
Interest and depreciation charges 10 per cent. on capital	0.17d.
Total cost per unit	0·35d.
Average load factor	36 per cent.

Advantages for Underground Work.—The difficulties of ventilation, even when no gases have to be dealt with as in collieries, render the application of steam difficult, and until electricity was applied compressed air was the only available agent for the inner workings. In consequence of the high capital and running costs of compressed air, the haulage gears were generally steam-driven, being placed on the surface or at the bottom of the intake shaft.

Principal Applications.—While electric motors are now used for every form of colliery drive, the most important applications in England have been for haulage. Owing to the intermittent character of this work, the percentage saving by remodelling existing haulages is greater than that obtained in modifying any other part of a colliery equipment. Next in importance to haulage is the use of electricity for pumping, which has received great impetus through the development of the high-lift centrifugal pump.

Owing to the comparatively large powers, the foregoing uses attract special attention, but the use of electricity for detailed purposes, while already of importance, will attract even greater attention in the future. Great progress has been made in electric coal-cutting, which not only reduces the cost of winning a ton of coal and increases the percentage of large coal won, but allows the thinner seams to be profitably worked, thus increasing the coal reserves. The possibilities of electric drilling are now coming to the front, and it is in the extension of the use of electricity in detail that the future reduction in mining costs are to be looked for.

Electric Winding.—While there is a substantial saving in the running costs, owing to the low cost of fuel available at collieries, this saving is at present counterbalanced by the interest charges due to high capital cost of electric winding plant; in consequence, this is the last part of a colliery plant to receive attention in conversion from steam to electric working. Where the hours of winding are long, or the cost of fuel high, a substantial saving can now be made by adding electric winding, the whole power required being obtained from a single power-house.

Haulage.—In addition to the lower power costs the first advantage gained with electrically-driven haulage is the freedom in choice of position and speed; and second, the decreased wear and tear on the ropes and road through the steadier drive. In collieries it is seldom possible to consider the use of electric locomotives, owing to the difficulty of sparkless collection of current, but where mines are sufficiently dry and gradients not excessive, a considerable gain in efficiency and maintenance will result in operating by electric locomotives in place of main and tail haulage. The 2,900 h.p. of haulage motors in use in the Aberdare colleries of the Powell Duffryn Company are divided between 32 motors of 300, 150, 75, and 50 brake horse-power; these are all 3,000-volt motors, 50 periods. The 300-b.h p. motor runs at 120 r.p.m., driving the haulage gear through single-reduction gear. The greater number of the haulages are driven by 150-b.h.p. motors of 290 r.p.m., driving through double reduction, while the smaller motors run at 365 revolutions. These motors are wound to give a maximum torque of 2½, and have an average efficiency from half to full load of 89 per cent. and power factor of 0·7.

Pumping.—The comparatively high speed at which it was necessary to run the motors in order to keep down the capital cost was a disadvantage in the first pumping applications when three-throw pumps were driven by ropes or gearing, but the combination of the electric motor with the high-lift centrifugal pump has resulted in a great advance on previous methods of pumping. The high speed and purely rotary motion has much reduced the capital cost and the space occupied compared with any previous system. The Powell Duffryn Company have several high-lift centrifugals at work. At Lower Duffryn a seven-stage Sulzer pump, delivering 800 gallons per minute against 1,150ft. head, is driven by a 3,000-volt, 50-cycle, 1,450-revolution induction motor supplied by the Electrical Com pany, rated at 450 b.h.p. The motor is of the slip-ring type, and is started by varying a liquid resistance in the rotor circuit. It is generally run seven hours each night when the haulage machinery is shut down, and thus equalises the load on the power-house. Tests show an over-all efficiency from motor terminals to output of water at surface of 65 per cent. when delivering 798 gallons per minute against a head of 1,115ft., suction 20ft., pump speed 1,480 r.p.m. In the Brithdir seam at Bargoed a five-stage Simpson pump is at work, driven by a 3,000-volt, 50-period Westinghouse squirrel-cage induction motor, running at 1,450 r.p.m., delivering 800 gallons per minute against 700ft. head. Two turbine pumps have just been completed for the East Elliot pit, each capable of delivering 1,300 gallons per minute against a head of 1,650ft. These pumps are of the six-stage Simpson type, and are to be driven by Westinghouse 3,000-volt, 50-period squirrel-cage induction motors, started by autostarters. The guaranteed efficiency from input at motor terminals to output at surface is 69 per cent. It is proposed to run these pumps at night, when the haulage gears and other machinery are shut down, thus providing a steady load for the power-house, this being equipped with Nuernberg gas-engines of 1,200 b.h.p. and 2,400 b h.p. driven from the surplus gas of the by-product coke-ovens.

DISCUSSION.

Mr. E. M. HANN, who opened the discussion, said he could only approach the subject from the mining point of view. The

* Paper read at the Engineering Conference of the Institution of Civil Engineers.

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only point upon which he could touch was that of pumping, and it seemed to him that owing to the small size of the centrifugal pumps, and the avoidance of long piping when driven by electric motors, there was a decided inducement for mining engineers to adopt them. The saving of space underground was a matter of considerable importance, and many mining engineers found considerable difficulty in having large engine-houses and maintaining them. Smaller centrifugal pumps as compared with larger pumps offered two distinct advantages: (1) greatly reduced cost, and (2) avoidance of occupying large spaces underground.

Prof. REDMAYNE said that several of the author's points could not be borne out. The efficiency with compressed-air transmission was great, and he mentioned a case in Paris where an efficiency of 72 per cent. was attained with compressed air. As to the future, he did not think that electricity would supersede compressed air; by far the greater number of coal-cutters in the United Kingdom were driven by compressed air, which was easier to handle. In mining work, an increase in the efficiency of 2 or 3 per cent. of any apparatus did not matter so much as convenience. Electrically-driven rock drills had been found unsuitable, and in the Western States of America these had now been replaced. Percussive drills were considered to be best. With regard to electric winding, he thought that what stood in its way in this country was not so much the high capital cost as the lack of a really good system of electric winding. It was not until the Siemens and Halske and the Ilgner systems came into practice that electric winding was feasible. He was of the opinion that the winding of deep mines would be performed electrically in future.

Mr. H. DAVEY quite admitted the greater flexibility of electrical pumping, but he disagreed with the author's generalisation that because electricity has been successfully applied to one particular mine it would be to the advantage of every mine to adopt it. In every case local circumstances of mines must determine the choice. Centrifugal pumps were now being installed in the opening up of old Cornish mines, though their application there was altogether different from their application in collieries. He criticised some of the author's figures, and he said that, working from the power-house figures given in the note, they got a different result from that stated later on. He calculated the over-all efficiency to be 49 per cent., as against 65 per cent. which the author arrived at. If the author wanted to show the commercial economy of electrical transmission in mines he should have given them the electrical losses, then the mechanical losses, and, finally, the work done with each.

Mr. W. H. PATCHELL thought the author of the paper and the managers of the collieries were to be congratulated upon publishing their results, which were too often kept under a bushel. He thought the author had not sufficiently brought out the fact that the economical application of electricity depended largely on the motor to be served. He asked for the cost of the small coal used at the pits before and after the application of electricity. On the question of pumping, one might be led to believe that the introduction of the centrifugal pump would do away with the reciprocating pump. The former was not suitable everywhere. If there was much water in the pit a centrifugal pump could be used efficiently, but in every case the use of a centrifugal or reciprocating pump depended upon the volume of water. He impressed upon colliery owners who went in for electricity the necessity of seeing that the work was well done and well looked after.

Mr. J. S. PECK (British Westinghouse Company) said that although a great many coal-cutters were driven by compressed air, the large number of orders for electrical coal-cutters showed the use of the latter was spreading. The electric motor had shown ability to perform as well and as economically as the steam-engine. With regard to winding, the question was still being disputed, but in spite of the fact that the steam-engine manufacturer had improved the economy of the engines, and had introduced steam-turbines, he believed electric winding would eventually replace steam winding, because of the rapid acceleration, uniform torque, and, on certain systems, the ability to use the inertia of the moving masses to regenerate current. He preferred the three-phase alternating-current system of working, using a frequency of 25 ~, which he considered to possess many advantages over 50 ~.

Mr. H. MAVOR disputed the general statement that compressed air was superceding electricity for coal-cutting, and gave it his opinion as a manufacturer of both types of coal-cutter that electrical coal-cutting was proving the best method. He thought that the use of conveyors in association with coal-cutting would take a great part in mining work, and in this direction the application of electricity would be very useful. He thought there was something wrong about the figures given by the author for the efficiency of centrifugal pumps. He was unable to give any figures himself, but thought he could safely say that the practical result of pumping work by no means bore out the high efficiency claimed for the pump.

Dr. HERZFELD described a large pumping installation which was being carried out at Ulverston in the Lake district, where a mine which had been flooded for five years was about to be reopened. Very little space was available for the pumping plant, and centrifugal pumps driven by squirrel-cage motors without any connections on the rotor, and artificial means for protecting them, were adopted. Sixteen thousand gallons had to be raised per minute; this can be reduced at a lower level to 8,000 gallons, and there the centrifugal pump offers great facilities. The equipment would be running in about six weeks' time, and showed that electricity was revolutionising mining work.

Major A. H. MEYSEY-THOMPSON said that where work was to be done intermittently, and where power had to be supplied over great distances, an electrical system was advantageous, but where the power to be supplied was regular there was nothing to compare with steam-engines. After allowing for losses between the motor and engines, the cost of an electrical system amounted to £20 per actual horse-power per year. This compared unfavourably with the results of the steam system employed by the South Staffordshire Mines Drainage Committee, which had been working during the last 10 years at a cost of from £9 to £10 per horse-power per year.

Mr. SPARKS, in opening his reply, apologised for not bringing more figures forward, but mentioned that he had already dealt fully with the subject in papers read before the Civil Engineers and kindred institutions, so that it was not now discussed for the first time. He agreed with Prof. Redmayne that certain classes of mining rendered compressed air desirable. But even then he thought that a combination of compressed air and electricity—using electricity for the purposes of transmission—was much better than the use of a long pipe line. The practical efficiency of compressed air in every-day mining did not even approximate that of Paris. There were various winding systems in the field, but the crux of the matter was capital cost, and only under special conditions—*i.e.*, where fuel is dear—could the use of electric winding be justified at the present moment. Local circumstances must always come into consideration, as Mr. Davey had said, and he never suggested that a good and efficient steam plant should be at once scrapped. He could not follow Mr. Davey's calculations, but he promised that he would deal with them when replying fully at a later date. He informed Mr. Patchell that the only figures which he could not make public was the cost of small coal used at the pits; he could say, however, that there had been a substantial saving after the application of electricity. The suitability of centrifugal pumps depended a great deal on the volume of water in the pit. In the first instance, slip-ring motors were used, but it was found that there were no difficulties with squirrel-cage motors.

Mr. Sparks was thanked for his paper, and the CHAIRMAN (Colonel Crompton) paid a tribute to the work of the three secretaries of the section, and proposed a vote of thanks to them, which was cordially carried. On the motion of Prof. G. KAPP, thanks were also awarded to the chairman and vice-chairman.

PHYSICAL SOCIETY.

At the meeting held on June 14 in the Pender Electrical Laboratory, University College, by invitation of Prof. Fleming (Mr. H. M. Elder, vice-president, in the chair), a paper by Mr. UPSON on the "*Electric Arc*" was read by the author. It dealt with observations made during the past session at the Pender Electrical Laboratory, at the suggestion and under the direction of Prof. Fleming, F.R.S., with the object of elucidating some of the facts connected with the production of electric arcs between cooled metal and carbon terminals in air and hydrogen. Apparatus was exhibited for maintaining the arc in various gases, while one electrode was cooled by means of a water circulation. Arcs were described in which the electrodes consisted of carbon, copper, iron, and aluminium in different combinations, maintained in air, hydrogen, and coal gas. With 110 volts supply, metal arcs in hydrogen took the form of a spark discharge. At that voltage the maximum length of arc it was possible to obtain with current up to 15 amperes was 0·05in., except where both electrodes were of the same metal. When carbon is one of the electrodes a true arc is formed. If carbon is negative, the maximum length of arc with the above voltage is 0·07in. Volt-ampere characteristic curves were shown for arcs in air and hydrogen of length 0·05in. The general position of the curve is determined by the material of the negative electrode. With carbon negative, in hydrogen, the curves for various positive electrodes very nearly coincide. With carbon positive they keep the same curvature, but vary in distance apart, according to the material of the negative. In general, the position of the curve is governed by the negative, but its particular shape seems to come from the influence of the surrounding gas. The slope of the curve (amperes horizontal, volts vertical) of the carbon arc in air is much less steep than

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that of the curve of any arc in hydrogen. The former curve cuts the latter in the neighbourhood of 6·5 amperes. The curve for the arc with carbon positive, aluminium negative, in air, is very steep, being equal in this respect to the curves for arcs in hydrogen. Volt-ampere characteristics were shown for copper arcs in air, with (1) positive electrode cooled, (2) negative electrode cooled, and (3) neither cooled. Equations for various arcs were obtained giving the voltage in terms of current and arc length. It was much more difficult to obtain a carbon arc in hydrogen with alternating currents; and no arc could be obtained when the electrodes were copper positive and carbon negative, with 100 volts supply and frequencies of 50 and 80. Similar results were obtained in coal gas. Apparatus was devised in accordance with a suggestion by Dr. Fleming to interrupt the arc for a definite period of time. Experiments were tried to determine how long the arc could remain extinguished without losing the power of restarting itself when the E.M.F. was again applied. Curves were shown for arcs with electrodes of solid and cored carbons, in air. With cored carbons the time of interruption is greater than with solid, and both are much greater than that for the copper-carbon arc. In hydrogen the copper-carbon arc could not be made to restart itself if the E.M.F. was removed for more than 0·04 of a second, and for this arc the minimum interruption possible is far shorter than for any carbon arc in air.

Mr. W. Duddell said the paper was a most interesting one. He asked if the author had noted the character of the different arcs which he had used. The characteristic curves for arcs in coal gas or hydrogen were steeper than those in air, and, therefore, arcs in coal gas were more suitable for the production of oscillations. He asked if the curves remained steep when the current was quickly changed. He had noticed the phenomenon of an arc between two cored carbons relighting, and said that on high-voltage circuits the length of time was considerable, and amounted in some cases to seconds.

Mrs. Ayrton said the paper was a valuable one, but she was sorry the author had not given a careful description of the appearance of the arcs and carbons under different conditions, and also the observations upon which the curves were founded. It was difficult to arrive at any general conclusions from the author's curves. The steep parts depend not only on the composition of the electrodes, but on their size and on the length of the arc. The author had only used short arcs, which with carbons only gave the flat part of the carbon. With metal-carbon you get the steep part. Mrs. Ayrton also expressed her interest in the relighting experiments shown by the author.

Mr. A. Campbell asked if the characteristic curve of a mercury arc was similar to that of the other metal arcs investigated. He pointed out that the use of unscientific units (inches and feet) in giving the results of such interesting researches was most deplorable. In all standard work on the subject the lengths of arc are always given in millimetres, and even in commerce the diameters of carbons are similarly expressed—*e.g.*, 12mm., and not 0·47in.

Mr. Alexander Russell stated that Mr. Upson's paper would be extremely useful to all engaged in research in connection with the electric arc. He agreed with the author that coal gas was very unsuitable for experiments with the arc. He had recently been experimenting with high-voltage alternating arcs in coal gas, and in most cases the enclosing vessel was soon filled with black cobwebs. When, however, the high-voltage high-frequency arc between iron-iron electrodes was shunted by a Leyden jar in series with a small coil of wire, the discharge between the electrodes became simply a torrent of sparks, and no appreciable quantity of soot was formed. The difficulty the author experienced in certain cases in obtaining an arc was due probably to the low voltages used. When high voltages are applied, it is easy enough to maintain an arc. More experimental research was wanted on the upper part of the statical characteristic curve of the arc. A good deal of exploration has already been made in this direction in Dr. Simon's laboratory at Göttingen with the help of a motor-generator from which three or four amperes of direct current can be obtained at 5,000 volts. The results already obtained were of great importance. The success of the statical characteristic method as an instrument of research was mainly due to the care with which Mrs. Ayrton had specified the method of obtaining the curve. He hoped that Mr. Upson would make further researches at high voltages.

Dr. Fleming congratulated Mr. Upson on his paper, and said that it represented a considerable amount of careful work, and even if all the conclusions to be drawn from it were not yet absolutely clear, it would furnish a statement of facts which would assist in future theorising. He said that the interesting part to him at the moment was the difference between the form of the volt-ampere characteristics for the carbon-carbon arc in air and the metal-carbon arc in hydrogen, but on that matter he would defer his remarks until he had shown some other experiments.

Mr. Upson, in reply, stated that the primary object of the paper was to compare metal arcs with carbon arcs. He had also performed some experiments with charge of voltage and variations in the length of burning of the arc, and he hoped to carry out a series of experiments using high voltage.

Experiments were then exhibited by Dr. J. A. Fleming, F.R.S., with the Poulsen arc as a means of obtaining continuous electrical oscillations, repeating some of those shown by him at the Royal Institution on May 24 last. Dr. Fleming showed and described an apparatus for forming an electric arc in an atmosphere of coal gas between a carbon rod kept in slow rotation and a cooled copper anode, the arc being formed in a magnetic field of 600 to 1,000 C.G.S. units. The arc was supplied with continuous current at a pressure of 400 to 500 volts. A condenser of 0·003 microfarad capacity in series with an inductance of 200,000cm. was shunted across the arc, and experiments shown to prove the existence of high-frequency oscillations in the condenser circuit. A long resonance helix of insulated wire was then joined to the condenser circuit, and when tuned to it created a powerful high-frequency field round it in which vacuum tubes glowed brilliantly. By vibrating or rotating a neon vacuum tube of spectrum type near the helix, and showing that the band or disc of light was cut up by dark spaces, Dr. Fleming supported the contention that the oscillations so produced are not absolutely uninterrupted, but cut up into groups. Another experiment was shown to confirm this. The oscillations produced by the arc in one circuit were caused to create secondary oscillations in another circuit, in which was a condenser shunted by one of Dr. Fleming's oscillation valves and a telephone. The valve rectifies the secondary oscillations, and if they were absolutely continuous the telephone would be traversed by an uninterrupted direct current. But, as a fact, a discontinuous sound is heard in the telephone which can arise if the primary oscillations come in batches or groups. Dr. Fleming then gave some figures showing the kind of values obtained for the efficiency of transformation of continuous to oscillatory current by the arc, and compared them with similar measurements for the spark method. He concluded with some discussion of the *modus operandi* of the metal-carbon arc in the production of oscillations in a shunt circuit containing capacity and inductance. In the first case the curve was (as shown from Mr. Upson's diagrams) much steeper than in the second. This implied that the same amount of energy could be conveyed to the oscillatory circuit by means of a condenser of smaller capacity, and, therefore, give higher frequency. This was confirmed by the fact that the curve for small currents in the case of the carbon arc in air was steeper than for large currents, and it was found that a Duddell carbon arc could give high-frequency oscillations when actuated with small currents. He thought that there was still much work to be done before the whole of the phenomena of the oscillatory arc were understood.

Mr. W. Duddell expressed his interest in the experiments, especially those in which it was shown that the oscillations were broken up into groups. He pointed out, however, that it was possible to obtain continuous oscillations with a musical arc using high frequencies. The question as to the measurement of the power put into the Poulsen arc was of great interest, as also was the question as to the amount of power which could be taken from the secondary without stopping the arc. He questioned Dr. Fleming's statement that the power put into the arc was equal to the product "A V" and said that the power should be measured with a wattmeter.

Mr. A. Campbell remarked that Mr. Altberg in Odessa had lately shown that sparks of high oscillation frequency produce actual air vibrations of the same frequency, and by measuring the wave-lengths of these air vibrations by diffraction methods he had been able to determine the high frequency.

Dr. Fleming, in reply, said he was prepared to accept Mr. Duddell's criticism that the power put into the Poulsen arc should be measured with the wattmeter. The really important matter, however, was the reason why the metal-carbon arc in coal gas could produce oscillations of so much higher frequency than the carbon arc in air. This he thought was intimately connected with the slope of the characteristic curve.

Mr. Rollo Appleyard exhibited a direct-reading conductivity bridge for testing rods of steel or other material where there is considerable range of conductivity between successive specimens, and where it is necessary to eliminate the resistance of end contacts. The instrument is provided with two scales and with corresponding sliders. By setting one of the sliders with reference to its scale, compensation is made for any small difference of diameter or of mass between the standard rod and a test rod. The second slider is then adjusted to the position of balance, and the conductivity is read off the second scale as a percentage, according to Matthiesen's standard, or in terms of any desired unit. All arithmetic is avoided, and the results are the results are obtained at the rate of two or three a minute. Mr. Appleyard gave the equations for the calibration of the scales, and showed that the errors involved by the use of the compensation scales were for practical purposes negligible.

Mr. A. Campbell said he had used the author's conducto-

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meter and testified to its convenience. He objected, however, to the measurement of conductivity in terms of Matthiesen's standard, and suggested that for work with nickel steels, etc., the bridge should be graduated in resistivities.

CROYDON AND DISTRICT ELECTRIC TRAMWAYS.

Board of Trade Report on Accident.

Major Pringle's report has now been issued on the accident which occurred on April 1 on the Carshalton branch of the above tramways. At the time there were from 65 to 69 passengers on the car. About 22 of these appear to have been inside the car, and the remainder, of whom it is stated that 10 were children under the age of five years, were outside on the top deck. About 36 of the passengers were injured more or less seriously. Two, unfortunately, subsequently died from the effects of the injuries received. The driver of the car was not seriously hurt, but the conductor was cut about considerably. After describing the accident and the track, which he found in good order, Major Pringle concludes:

The whole evidence, in my opinion, proves that the car travelled down Park-lane at a speed considerably in excess of the authorised limit—eight miles an hour. Further, the unusual action taken by conductor Linney after passing Springfield-road indicates that the car had attained an unusually high speed, possibly quite as high as the figure given by Linney himself. It appears to me that it was Linney's action in screwing down the brake hard on greasy rails which locked the wheels, and that the driver, Woodley, whatever he may have thought, was unable on that account to control the movement of the car or stop it before it entered the curve. Previous accidents have proved that a heavily-loaded car, which commences to skid with a momentum due to a velocity of 12 to 15 miles an hour, will not, even on such a comparatively easy gradient as 1 in 36, readily lose its velocity, more especially when the rails are greasy. I am persuaded, therefore, that when the car entered the curve its speed was considerably in excess of the three to five miles an hour estimated by both Woodley and Linney. It may easily have been as much as eight or ten miles an hour. But taking the whole evidence into account, the speed must have been considerably less than that theoretically necessary to cause overturning by the effect of centrifugal force.

In passing round a curve a car truck should be free to rotate round one of its wheels as a centre—generally the inside rear wheel may be taken as the pivot. The remainder of the wheels are constantly slipping either longitudinally or laterally, and thereby accommodating themselves to the change in direction as far as the clearance and axle play permits. In this case freedom of movement was interfered with by the action of the brake. The wheels being unable to accommodate themselves to the change in direction, the flanges must, I think, have got jammed in the grooves, with the result that the truck came to a sudden stop as described by Woodley. The tendency of the heavily-loaded body would be to overrun the truck, and a severe lurch must have followed the sudden stoppage of the truck All the live weight on the car must have swung outwards with the lurch, and, acting with the effect of centrifugal force, must have suddenly tilted the car so that, as it appears to me, the flanges lifted out of the grooves. The truck was then free to jump forward, and skated on its outer wheels for 10ft. or 15ft. The car was unable to recover its equilibrium owing to the probable displacement of the live load on the top deck, and fell over on its side, just as its inertia was exhausted. It can be shown by experiment that a vehicle with freely rolling wheels will travel safely round a curve where proper superelevation is provided, but will, on the same curve and at the same speed, overturn if the wheels are prevented from rolling, and thereby become track-bound.

My conclusions on the case are as follows: (1) that the car entered the curve at a higher speed than that authorised by the regulations, or justified by the superelevation, and, therefore, ran the risk of derailment; (2) that the overturning of the car was caused by the wheels being locked by the severe application of the brake blocks. I hold that driver Woodley is mainly responsible for the speed of the car, which should not have exceeded eight miles an hour down Park-lane, and that conductor Linney is responsible for the locking of the wheels, although his intentions were good. Both these men have first-class characters, but have small experience.

I wish to draw the attention of the company to the following points in connection with this accident:

(*a*) Men who are employed as spare drivers, unless they have had long and continuous experience in driving, require to be more constantly exercised under service conditions than is generally recognised. Woodley's experience of driving—about two months during May and June last, and occasional weekly trips subsequently—was small. He cannot, with this record of service, have acquired such judgment of speed, intimate knowledge of brake effect, etc., as a tried motorman will possess. His action in applying both his hand and electric brakes on entering the curve at considerable speed, with the avowed intention of stopping quickly on the curve, showed want of judgment, accounted for by his inexperience. More practice, not with empty but with fully-loaded cars, under bad conditions of rail, is advisable, in my opinion, for men who are only occasionally employed as drivers.

(*b*) On some tramway systems, conductors have to undergo the same training as motormen. This is the best system, but even where it is not followed, it is necessary that conductors should be trained in the proper use of the brakes, and taught how to obtain the maximum braking effect on good and bad rails, as well as the danger incurred by locking the wheels. Linney's knowledge on these points appears to have been nil, and his ignorance is a feature in the case.

(*c*) The instructions lay down that only one sand pedal is to be taken on service cars. This is an instruction common, I understand, on most tramway systems. I cannot but think it is a mistake. If Woodley obeyed this instruction, it is evident, from Inspector Bassom's evidence, that he was unable to use sand in Park-lane, as one pedal only was found after the accident at the rear platform. Woodley states that he took two pedals with him on this occasion, and, therefore, had not to change the pedal at the Croydon terminus. But no second pedal was found on the overturned car, and there is grave doubt as to whether Woodley's statement is correct. It is not improbable that a man, only occasionally employed as a driver, might forget to change the sand pedal at a terminus. Moreover, in the event of a car running backward, if there is no pedal at the rear platform, there is no possibility of using sand on the rails. An alteration in the instruction on this subject is, in my opinion, desirable.

(*d*) The wording of the company's regulations regarding compulsory stops requires revision. Woodley appears to have understood that a stop anywhere on the curve was implied. The Board of Trade regulation reads that all cars should be brought to a standstill "immediately before reaching the junction of Park-lane and Ruskin-road."

(*e*) It is very undesirable to allow the top deck of cars to be overcrowded by more passengers than there is seating accommodation for, and it is dangerous to allow passengers to stand on the upper deck. Instructions on the last point are advisable.

(*f*) The superelevation at the tangent points of the curve between Park-lane and Ruskin-road should be at least 1in., and preferably 1½in.

PARLIAMENT.

Telegraph (Money) Bill.

In the House of Commons on Friday last the debate was resumed on the amendment moved by Mr. H. Cox to the motion for the second reading of the Telegraph (Money) Bill. The amendment urged that: "It is undesirable to authorise further capital expenditure upon telegraphs or telephones until a full statement has been presented to Parliament showing the financial results of the past working of the Post Office telegraphs and telephones, judged from the standpoint of an ordinary commercial undertaking."

Replying to the debate on this amendment, the POSTMASTER-GENERAL (Mr. Buxton) said the six millions asked for were for the telephone service. He undertook to get a financial statement showing the results of the working of the Post Office telegraphs and telephones, and the amendment was by leave withdrawn and the Bill read a second time.

Radiotelegraphic Convention.

Sir J. Dickson-Poynder's Committee appointed four months ago to consider the Radiotelegraphic Convention signed at Berlin on Nov. 3, 1906, and to report what from the point of view of national and public interests would in their opinion be the effect of the adhesion or non-adhesion of this country to the convention, held their final meeting on Tuesday. The committee agreed to a majority of five to four to report to the House that, in their opinion, the effect of adhesion would be advantageous to national and public interests, and that non-adhesion would be seriously detrimental to those interests. Having arrived at the conclusion that rejection of the convention presents serious drawbacks, and that postponement differs from rejection only for the worse, the committee submit that, in view of the unanimous testimony of the Admiralty and War Office witnesses that the convention obviates injury and secures substantial advantages not otherwise attainable, it is manifest that universal compulsory intercommunication, with the exceptions

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and exemptions secured in the convention, is a principle to be aimed at, and one that must be of benefit both nationally and internationally. It is further pointed out that if, after the substantial changes made on the initiative of the British delegates, Great Britain refuses to ratify, the result might have a material effect in weakening the moral position of Great Britain at future international conferences. The convention comes into operation in July next year, and the Government will now have to consider whether it will give effect to the recommendations of the committee.

London County Council (Tramways and Improvements) Bill.

The London County Council and Mr. Horner, lessee of the Spitalfields Market, having failed to come to an agreement in respect of the proposal in the Council's Bill to construct a double set of tramlines in Commercial-street, a Select Committee of the House of Lords have acted on the suggestion of Mr. Pollock, K.C. (for the County Council), that a proviso should be inserted in the Bill to safeguard Mr. Horner's legal rights in respect of any injury sustained. The committee refused to insert a clause restricting the use of the double lines to certain hours. The preamble of the Bill, which has already passed the Commons, has been declared to be proved.

MESSRS. J. H. HEATHMAN AND CO.

On Monday last a very pleasant day was spent on the river, when the members of the above firm, some of their friends, and their employés went for a trip on the launch "The King." The party went from Richmond to Staines, where they spent an hour in the town, afterwards returning to Richmond Bridge. The weather was everything that could be desired, and a most enjoyable time was experienced by everyone on board. Luncheon and tea were provided, and Mr. J. H. Heathman, who with his wife was present, did his best, and succeeded in making everything go well. The cordial relations between himself and staff were apparent throughout the day, and in responding to a vote of thanks given to him at the end of the day, Mr. Heathman spoke of the great assistance he received and had received from the chief members of his staff—Messrs. Mitchell (the general foreman), Braund (the foreman of blacksmiths, fitters, and turners), and Stark and Manders (of the office staff), and others. He said that during the last three years especially—although his business had increased—he personally had had less anxiety respecting it owing to the excellent co-operation of his staff. As is well known, Messrs. Heathman and Co., of Parsons Green, are the old-established and well-known specialists in the manufacture of ladders, steps, etc., tower ladders for arc lamp trimmers, and overhead tramway tower wagons, as well as fire-extinguishing appliances, fire hydrants and hose, in which they have special experience.

MUNICIPAL ELECTRICITY ACCOUNTS.

Erith Urban District Council.

The statutory accounts for the year ended March 31, 1907, together with the fourth annual report of the electrical engineer, Mr. Geo. E. Heath, have now been issued. The total capital expended on the undertaking is £64,340. 11s. 3d., from which £4,746. 5s. 1d. should be deducted for depreciation, being amount of repaid mortgages and charged to revenue. The following table summarises the revenue account:

Dr. *Expenditure.*	£	s.	d.
Generation of electricity	4,634	17	7
Station lighting	11	7	10
Distribution of electricity	190	1	5
Maintenance, renewals, and repairs	532	16	4
Public lamps	617	1	2
Rents, rates, taxes, and insurance	291	15	0
Management expenses	789	1	3
Insurances	40	3	3
	7,107	3	10
Balance to net revenue account	4,463	4	2
	£11,570	8	0

Cr. *Income.*	£	s.	d.
Sale of current—ordinary lighting	3,320	16	10
,, ,, outside arc lighting	45	14	2
,, ,, power	2,142	10	5
,, ,, power for traction	2,647	15	7
Public lighting	2,199	0	10
Attending, repairing, and renewing public lamps	617	1	2
Rental of meters and other apparatus	95	10	4
Hire of motors	54	18	1
Sundry sales, etc.	447	0	7
	£11,570	8	0

The gross profit has increased from £3,832. 17s. 3d. last year to £4,463. 4s. 2d. this year. But the net result of the year's working is a small loss of £68. 1s. 7d., as will be seen from the table given below:

		£	s.	d.
Total revenue for the past year	£11,570 8 0			
Expenditure for the past year	7,107 3 10			
Gross profit		4,463	4	2
Loan charges—Principal	1,790 19 7			
Interest	2,740 6 2			
		4,531	5	9
Net deficit for year		£68	1	7

It should be pointed out that the standing charges on loans in connection with the scheme amount this year to the sum of £4,531. 5s. 9d., as against £3,260. 15s. last year, showing an increase of £1,270. 10s. 9d.; £567 of this amount being increased repayment of principal this year over last. The analysis of costs given shows satisfactory reductions, economies being effected in all items with the exception of repairs and rates and taxes; the former, however, rises by only $\frac{1}{1000}$d. The total reduction on the works costs for the year amounts to ·128d. per unit sold, or a reduction of 8 per cent. on the year's working. The total cost per unit sold is 1·340d. The public street lamps connected are 596 in number, comprising 20 arcs, 84 half-ampere Nernst, seven Meridians, and 485 two 8-c.p. incandescent lamps. The capacity of the plant installed at the works is 1,350 kw. The maximum load observed during the year was 700 kw., leaving normal reserve of 650 kw. capacity. The connections to the mains during the year amounted to the equivalent of 14,798 8-c.p. lamps for lighting and power, bringing the total 8-c.p. lamp connections up to 54,939.

Grimsby Corporation.

Before dealing with the statement of accounts itself, it is interesting to point out that the annual report and statement for the sixth year's working of the Grimsby Corporation electricity department was set and cast on a Lanston monotype machine, driven by a motor supplied with electrical energy from the Grimsby Corporation mains. This is, indeed, an appropriate preface to the work of the department itself, which for the 12 months ended March 31, 1907, showed a net profit, after paying all working expenses, interest, and repayment of loans, of £1,261. The following is a statement of the revenue account:

Dr. *Expenditure.*	£	s.	d.
Generation of electricity	3,843	8	5
Distribution of electricity	405	10	2
Public lamps	399	11	3
Rents, rates, and taxes	311	12	6
Management expenses	1,180	5	0
Law charges, insurances, etc.	139	9	8
Total expenditure	6,279	17	0
Amount set aside for bad debts	59	18	2
Balance carried to profit and loss account	6,754	7	4
	£13,094	2	6

Income.	£	s.	d.
Balance from last account	55	17	0
Rebates not allowed to customers	7	9	6
	63	6	6
Less bad debts written off	19	11	6
	43	15	0
Sale of current (public and private)	12,482	0	5
Rental of meters and sale of incandescent lamps, etc.	421	6	5
Rents, fees, and discounts	147	0	8
	£13,094	2	6

Instalments of principal money borrowed absorbed £2,212. 6s. 1d., and interest on mortgage debt £3,212. 12s.; £504. 10s. 8d. was transferred to net revenue appropriation account, and £500 paid towards local rate, leaving a profit on the year's working of £1,261. 11s. 1d. The number of units generated during the year was 1,491,687. The units sold were: for traction, 448,832; public lighting, 121,939; private consumers, 649,967; railway company, 85,990—total, 1,306,728 units, or 87·4 per cent. of the number generated. 109,446 units (7·45) were used on works and 75,513 (5·15 per cent.) were lost in feeders, etc., and unaccounted for. The total works cost of production amounted to ·762d. per unit, and the total cost of production amounted to 1·062d. per unit, which shows a reduction of 5½ per cent. compared with the previous year. The price to private consumers was reduced last year from 4½d. to 4d. per unit.

APPOINTMENTS VACANT.

Lecturer in Electricity and Physics, Birmingham Municipal Technical School. Salary £140. Particulars from the Secretary. See advertisement.

Improver for power company in Scotland. See advertisement in last issue.

Burgh Electrical Engineer, Stirling. Salary, £200. See advertisement in last issue.

Sub-Station Attendant for tramway sub-station in Scotland. See advertisement in last issue.

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LEGAL INTELLIGENCE.

EDWARDES v. DALY.

Electric Lighting at Daly's Theatre.

This summons was heard in the Chancery Court before Mr. Justice Kekewich last week. The question at issue was whether Mr. George Edwardes, as landlord of Daly's Theatre, or the executors of the late Mr. Augustin Daly, as the lessees, were liable to pay the cost of carrying out certain alterations to the electric installation at Daly's Theatre as required by the London County Council. The Court had to determine whether, under a lease dated Dec. 12, 1901, between the plaintiff and the Hon. B. E. E. Barrington (the English administrator of the late Mr. Augustin Daly), and an agreement dated June 16, 1903, the plaintiff or the defendants were liable for the work in question. The lease is now vested in the defendants as executors of the late Mr. Daly.

Mr. JESSEL, K.C., who appeared for the plaintiff, said there was a covenant in the lease by which the lessee undertook, during the said term, to comply with all lawful requirements of the London County Council with regard to the structure of the theatre, provided, nevertheless, that any structural alterations or works of that nature, which might be so required, should be done by, or at the expense of, the lessor. But that, said Mr. Jessel, was only with regard to the structure. The alterations in question involved no structural alterations. The County Council had for some time been urging upon the parties the desirability of making the alterations, but they could not quite agree as to who should pay for them. They very sensibly arranged, however, that the alterations should be made. So Mr. Edwardes did the alterations, and, by an arrangement between the parties, without prejudice to the question in dispute, it was arranged that a summons should be taken out in order that his lordship should decide the point. By the agreement it was stipulated that for five years from Aug. 1, 1903, the plaintiff should have the sole use, management, and control of the theatre for the purposes, and subject to the stipulations, therein mentioned, the profits being shared between the parties.

Mr. P. OGDEN LAWRENCE, K.C., for the defendant, submitted that there was nothing in either of the documents referred to which proved more than that compliance with the notice to carry out the alterations was simply compliance by Mr. Edwardes with his obligation to keep the theatre open, which he could not do unless he carried out the requirements. He also contended that Mr. Edwardes could not recover from the defendants any money he had paid for the alterations.

HIS LORDSHIP, in giving judgment, said the difficulty of the case had arisen from the fact that something had occurred which was not contemplated by the parties at the time of the contract. His view was that the parties must have been taken to have intended that Mr. Edwardes should do whatever was necessary to keep the theatre open and make it profitable, exercising his own choice as to complying with any requirements made on him. He, therefore, directed that plaintiff must bear the cost of the alterations.

BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING CO.

In the Chancery Division on Tuesday Mr. Justice Neville sanctioned a petition by the British Westinghouse Electric and Manufacturing Co., for a reduction of its capital of £3,250,000 to £1,875,000 by writing off £1,375,000 lost or unrepresented by available assets.

Mr. KIRBY, in making the application, said the capital was divided into 500,000 preference shares of £5 and 75,000 ordinary shares of £10 each, and it was proposed to write £2 off the preference and £5 off the ordinary shares. The company was formed by an American company of the same name, and erected large works in the belief that the patents they held would give it a practical monopoly over certain classes of business. As it turned out, however, it did not get the business it expected.

BLACKPOOL TRAMWAYS.

At Manchester, before Vice-Chancellor Leigh Clare, the action brought by the Attorney-General of the Duchy of Lancaster and Frederick Joseph Ash against the mayor, aldermen, and burgesses of Blackpool came on for trial last week. Plaintiffs sought to restrain the defendants from proceeding with the construction of an extension and junction in connection with the Corporation, and their counsel, in opening the case, said a motion was heard a few days previous, in which the plaintiffs asked for an injunction until the trial. The Corporation had consented to the action being set down for trial, and did not oppose the granting of an injunction. Counsel for defendants explained that the order was not to be made by consent. He wished his Honour to put in words defining that the order only extended to the present powers of the Corporation.

The VICE-CHANCELLOR said he rather suggested the other day that he should make a declaration that what was proposed to be done was not within the Corporation's powers. He made a declaration to the effect indicated, giving the plaintiffs their costs.

TAYLOR v. DUBLIN UNITED TRAMWAYS.

In the Dublin Courts on the 21st ult., before Mr. Justice Kenny and a special jury, William Hugh Taylor sued the Dublin United Tramways Co. to recover £2,000 damages for personal injuries caused by the alleged negligence of the servants of the defendants by reason of a trolley pole striking him while he was a passenger on one of the company's cars. He further claimed £2,000 as special damages, owing to the circumstance that since the accident he had lost his situation, and was unable to do any work.

The defendants denied the alleged negligence, and submitted that the damages sued for were not the reasonable or probable result of the acts complained of. The accident occurred on the morning of Oct. 17, when plaintiff was coming to the city.

After hearing the evidence, the jury awarded plaintiff £550 damages.

SWINDON TRAMWAY ACCIDENT.

The last of the claims for injuries arising out of the Swindon tramway accident in June last, when four people were killed, was decided at Bristol Assizes on Wednesday. Mr. Richard Townsend, Stroud, who received an injury to his spine, and which, it is feared, will be permanent, was awarded £8,000 damages against the Swindon Corporation.

WHITTLE v. OLDHAM CORPORATION.

Tram Collision.

At the Oldham County Court last week Henry J. Whittle, a carrier, sued the Corporation for £25 damages for personal injuries received as a result of a collision between a tramcar and a carrier's cart driven by the plaintiff. The Corporation counterclaimed £6.

Plaintiff alleged that the tram driver remarked to him that the brakes did not act, and he lost control of the car, and evidence corroborating this statement was given.

The driver denied the statement attributed to him, and stated that he was going slowly and repeatedly sounded his gong, and that the accident would not have happened but for contributory negligence on the part of the plaintiff, who travelled on the tramlines without taking sufficient caution against approaching cars.

HIS HONOUR remarked that the Corporation had not any monopoly of the road. If a man thought it advisable to drive his lurry on the tramlines owing to the crown in the road, he had a perfect right to do so. A driver was not bound to stop in the road until the Corporation tramcars passed. When the plaintiff saw the tram he immediately tried to get out of the way, but was not successful owing to the speed of the car. His Honour came to the conclusion that the car driver's statement that he was only travelling four miles an hour was wrong. He, therefore, gave judgment for the plaintiff for £25, and also on the counterclaim.

COMPANIES' MEETINGS AND REPORTS.

BRITISH ELECTRIC TRACTION.

The eleventh ordinary general meeting of the British Electric Traction Co. was held on the 28th ult. at Salisbury House, London-wall, E.C., Sir Charles Rivers Wilson, chairman of the Company, presiding.

The CHAIRMAN, in moving the adoption of the report (*Electrical Engineer*, June 21), said that the gross profits of all the associated companies, after debiting expenses but before charging interest on capital or rental of lines, had increased from £464,000 to £539,000. The enhanced amount which the British Electric Traction Co. had received in respect of dividends was £9 273, notwithstanding the fact that the Brush Co., which gave a return of £13,711 for 1905, paid no dividend for 1906. In addition to the increased dividends the various associated companies had applied £40,000 more than in the preceding year to writing off depreciation and adding to reserves. A prominent aspect of the position of the Company's business was the fact that their various tramway and light railway undertakings were not obtaining a sufficient net profit commensurate with the services which they rendered. The Company's various undertakings carried during the past year over 300,000,000 passengers, and the gross receipts were only about £1,500,000, or at the rate of 1¼d. per passenger. The tramway facilities now offered to the public were immensely superior in point of comfort and in other respects to the horse and steam tramways which preceded them. On their Metropolitan system, they were carrying ordinary passengers for 2½ miles for 1d., and working people had the privilege of travelling as many as five miles for the same fare. Owing to a large number of the tramway undertakings in the country being in the hands of local authorities (two-thirds of the whole tramway mileage was so worked, as compared with about one third before electric traction was adopted), there had been a never-ceasing agitation for a reduction of fares. This Company's fares were not as low as those charged by some of the local authorities in big cities, but, nevertheless, they were too low having regard to the character of the districts served, as well as to the large capital outlay which had been necessary for the purpose of adopting electric traction. He thought the time had come when it must be recognised that this industry was to be worked upon a commercial basis, and the public, who generally took a fair and honest view of things when they thoroughly understood the question, would, he was confident, sympathise with the movement of the traffic companies to obtain more equitable treatment and to get a fair but not an unreasonable return upon their investments in these useful and important undertakings. Alluding to the remarks made by the President of the Board of Trade at the opening of the Charing Cross and Hampstead Tube, he said it was refreshing to read what Mr. Lloyd-George had stated. That gentleman remarked as to fares that it was not to the interest of the public that great enterprises like "tube" railways should be run at a loss. In the public interest investors should be able to look for a reasonable return. However, they had received but scant support from the Department over which Mr. Lloyd-George presided. He was well aware of the great difficulties of the position of the President of the Board of Trade, for they knew

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he had very limited authority, and that prominence and priority were not given to any measures he wished to bring forward. He believed that the passing of a Bill creating a "Ministry of Commerce" would give the utmost satisfaction to the mercantile community.

Mr. EMILE GARCKE seconded the motion, which was carried unanimously after a short discussion.

J. G. WHITE.

The eighth annual general meeting of J. G. White and Co. was held on the 28th ult. at the offices of the Company, 9, Cloak-lane, Cannon-street, E.C., Lord Arthur Butler presiding in the absence of Mr. J. G. White (the chairman).

The CHAIRMAN said he was glad to meet the shareholders once again with a favourable report, showing that good progress had been made by the Company. The year's profits, which had been arrived at on the usual conservative basis, were nearly £5,000 in excess of the previous year's result, and the Company had a large amount of satisfactory contract work in hand, which should enable them to present a favourable report next year. The total profits earned up to Feb. 28, 1907, aggregated £142,859, which gave an average annual profit for the 6½ years of nearly £22,000. The dividends distributed, including those now recommended to be paid, amounted in the case of the preference shares to 45 per cent. of the subscribed capital, and in the case of the ordinary shares to 39 per cent., no dividend having been paid on the ordinary shares for the first year of the Company's trading. The average annual distribution on both classes of shares had been slightly in excess of 7 per cent. per annum. During the same period the Company had set aside out of profits to reserve fund the sum of £60,000, and hoped to carry forward to next year's accounts the sum of £18,311. 12s. 5d., which was more than sufficient to cover a full year's dividend on both classes of shares. He moved the following resolution: "That the directors' report and statement of accounts at Feb. 28, 1907, be received and adopted, and that the dividends and bonus therein recommended be declared and paid—namely: (*a*) a dividend free of tax at the rate of 6 per cent. per annum on the cumulative preference shares for the half-year to Feb. 28, 1907, the previous half-year's dividend at the same rate having been paid on Jan. 1, 1907; (*b*) a dividend free of tax at the rate of 6 per cent. per annum on the ordinary shares for the year to Feb. 28, 1907; (*c*) a bonus of 1 per cent. on the full amount of the preference and ordinary share capital."

Mr. A. N. CONNETT seconded the resolution, which was unanimously adopted.

NEW GENERAL TRACTION.

The report of the New General Traction Co. for the year ended March 31 last states that the revenue for the year, received and accrued from the various sub-companies, amounts to £14,767; but, to make a true comparison with the revenue for the 12 months ended March 31, 1906, which amounted to £14.127, it would be necessary to deduct from the latter amount £2,211 received in 1905 for the Coventry dividend accrued in 1904, thus leaving £11,915 as the income for the year 1906, on which the income for the year 1907 shows an increase of £2,851. General expenses, including directors' fees and legal charges, amounted to £2,482, as against £1,899 in 1906. Interest on debentures amounted to £12,540, as against £12,613. Interest on loans £1,836, as against £2,620. The loss for the year amounted to £20,816, which was reduced to £17,241 by the transfer of £3,574 from the special reserve fund. As stated in the circular issued to shareholders on Jan. 9, 1907, the lease of the Company's Philadelphia undertakings to the Philadelphia Rapid Transit Co. has been duly carried out. The New General Traction Co. now holds a total of 848,000dol. 4½ per cent. first mortgage bonds and 695,000dol. of the capital stock issued to it in the Darby Media and Chester Street Railway Co. in exchange for the securities held in the two companies before amalgamation. As stated in the circular referred to above, to enable this lease to be concluded, the New General Traction Co. had to release the Darby Media and Chester Street Railway Co. of its obligations for certain sums standing in the accounts as "cars leased to the Media Middletown Aston and Chester Electric Railway Co." and "remittances to Philadelphia," which have been written off in the profit and loss account, as the property was leased free of debt other than the bonds. These items together amount to £19,224, and account for the greater portion of the loss incurred in the year under review. No further expenditure will have to be incurred for the Philadelphia undertaking, whilst a revenue of £9,022, gradually increasing to £14,582, will be derived from the securities held by this Company therein. The Coventry company is showing substantial progress, but, owing to this very fact, further capital expenditure became necessary, and the requisite advances have been made by this Company.

CITY OF WELLINGTON ELECTRIC LIGHT AND POWER.

The report of the City of Wellington Electric Light and Power Co. for 1906 states that the report shows a balance at the credit of profit and loss account of £12,886 (including £2,306 brought forward), after paying interest on the debentures and dividends on the preference shares and expenses, etc., in connection with the issue of further debentures. An interim dividend at the rate of 8 per cent. per annum for the half-year ended June 30, 1906, has been paid during the current year to the ordinary shareholders, absorbing £1,390. The directors now recommend a final dividend on the ordinary shares at the rate of 22 per cent. per annum for the half-year ended Dec. 31, 1906 (making 15 per cent. for the year), and writing off £5,000 from goodwill. This will absorb a further £8,822, and leave £2,673 to be carried forward. In view of threatened opposition to this Company by the Wellington Corporation, Mr. H. E. Salt, a director of the Company, visited Wellington at the request of the directors at the end of last year to come to an understanding with the Wellington Corporation. The result of the negotiations was that the Corporation agreed to purchase the Company's undertaking and to take over the management as from July 31 this year. The directors consider this procedure to be in the best interests of the Company. The directors report with regret the resignation this year of Mr. J. A. Kelman, the managing director of the Company, and more especially so as the same is caused by his ill-health.

NEW COMPANIES REGISTERED.

McAlpine Hennebique Ferro-Concrete Co. — Registered on June 22. Capital, £50,000 in £1 shares. Objects: to carry on the business indicated by the title; to construct, equip, improve, work, and control quays, docks, harbours, piers, wharves, canals, railways, tramways, etc. No initial public issue. The first directors (to number not less than two nor more than seven) are to be appointed by the signatories. Qualification, £500. Remuneration as fixed by the company. Registered office: 25, Victoria-street, Westminster, S.W.

Glenfield Mill Co.—Registered June 21. Capital, £10,000 in £1 shares. Objects: to acquire lands, buildings, and hereditaments in England, for the erection thereon of factories and workshops, with suitable plant, with a view to letting such premises on any terms, including the provision of power, and to carry on the business of spinners, doublers, weavers, knitters, and manufacturers of and dealers in cotton, cotton waste, etc. No initial public issue. Registered office: Glenfield Mill, Nelson.

James Pearson.—Registered June 18. Capital, £12,000 in £1 shares. Objects: to acquire the business carried on at Brampton and Walton, Derby, by Harriett H. Goodfellow as James Pearson, and to carry on the business of pottery and earthenware manufacturers, brick, tile, and drain pipe makers, electrical and general engineers, joiners, wheelwrights, timber merchants, pottery, glaze, and cement manufacturers, etc. No initial public issue. Registered office: 388, Chatsworth-road, Chesterfield.

Switch Electric Lamps.—Registered June 21. Capital, £15,000 in £1 shares. Object: to take over, on the terms of an assignment made by Atkinson's Patents, Limited, certain patents and rights relating to a variable-candle-power incandescent lamp. No initial public issue. First directors (not less than three nor more than seven) to be appointed by signatories, subject to right of Atkinson's Patents, Limited, to nominate one. Said nominee, two shares; others, 200 shares. As fixed by company. 14, Devonshire-square, E.C.

Hendon Electric Supply Co.—Registered June 27. Capital, £50,000 in £5 shares. Objects: to adopt an agreement with the Electric Supply Corporation and Crompton and Co., and to carry on the business of an electric light and power company. No initial public issue. First directors (not less than two nor more than five): C. F. Tufnell, K. A. S. Moncrieff, and Colonel H. Wood, C.B. £500. £100 each per annum (£50 extra for chairman) and 5 per cent. of surplus net profits after 7 per cent. dividend is paid, divisible.

Liens Registered.

Newcastle-on-Tyne Electric Supply Co., Limited.—Lien registered June 24 for £2,200 4½ per cent. debentures, part of £250,000. Amount previously issued, £185,300. No trustees. Charged on the business, assets, and effects.

Oliver Arc Lamp, Limited, Woolwich.—Particulars required by Sub-Section 4, Section 14, of the Companies' Act, 1900, registered June 20, relating to £15,000 first mortgage debentures. No trustees. Secured on the undertaking, stock-in-trade, business, goodwill, property, and the uncalled capital for the time being.

Etruscan Copper Estates, Limited, London, E.C.—Lien registered June 18 for £21,960 6 per cent. debentures, part of an authorised issue amounting to £24,000. No trustees. Charged on the undertaking and all the other assets, including various freehold and other properties in Italy, subject to £200,000 6 per cent. first mortgage debenture stock.

Kalgoorlie Electric Power and Lighting Corporation, Limited, London, E.C.—Trust deed registered June 7 for securing an issue of £60,000 6 per cent. first mortgage debentures. Trustees: Mines and Banking Corporation. Secured by a specific first charge on various leasehold hereditaments situated on the East Coolgardie Goldfields, Western Australia, together with the fixtures and appurtenances, also by a floating charge on the undertaking and the other assets for the time being, present and future, including the uncalled capital.

PERSONAL.

Mr. Herbert J. Hawkins, of Enfield, Middlesex, has been appointed deputy borough electrical engineer at Salford at a salary of £250 a year.

Mr. E. W. L. Nicol has been appointed a charge engineer at the Greenwich electricity generating station at a salary of £250 per annum.

The Belfast Town Council have appointed Mr. A. N. Moore (who has been in the service of the Corporation) assistant electrical engineer at a salary of £275 a year, without residential quarters.

Mr. G. Pickrance, chief assistant engineer at the electricity works, Malvern, has secured the post of electrical engineer to the borough of Wrexham, and will take up his duties in about a month's time.

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We regret to announce the death of Mr. John Arthur Croxson, manager since its formation of the Electric Landaulette Co., Upper Manor-place, S.W., and formerly of Niagara, York-street, Westminster.

The Electricity and Tramways Committee have recommended to the Warrington Borough Council that the salary of the tramway manager, Mr. J. Telfer, be increased by £25 per annum, making it £175 per annum in all.

Mr. Harold Hale, who has been manager and secretary to the North of Scotland Electric Light and Power Co. for the past five years, has resigned his appointment in order to take up the position in London of chief engineer to the Savoy Hotel Companies.

We regret to announce the death of Mr. J. J. Tinker, who died at his residence, Ashton-road, Hyde, on the 24th ult. He has been connected with the firm of Tinkers, Limited, Daisyfield Boiler Works, Hyde, Manchester, since its commencement, and for the last 10 years has been managing director of the company.

With regard to an intimation appearing in these columns in our issue of June 21 concerning the appointment of Mr. A. Murray Coombes as a director of Messrs. Frank Suter and Co., we regret that the address of this firm was inaccurately given. It should have been 66, Berners-street, Oxford-street, London, W.

An interesting presentation took place on Saturday last at Messrs. Wm. Cory and Sons' works, when Mr. H. W. Goodfellow, assistant foreman of their Erith department, was presented with a handsome marble time-piece on the occasion of his leaving Erith to take over the management of their new electric coal-discharging department at Rochester.

Mr. W. B. Peat, the president of the Institute of Chartered Accountants, has selected as his colleague for the special investigation of the accounts of the London County Council tramways, steamboats, and working-class dwellings, Mr. Francis W. Pixley, an ex-president of the institute and a member of the firm of Messrs. Jackson, Pixley, Browning, Husey, and Co.

We have been asked by Messrs. R. Henzell and Co. to announce that for private reasons they are changing the name of their firm to the Henzell Oil Co., to take effect as from July 1 this year. The name is the only change. The management, representatives, agents, and entire staff remain exactly as before, and their address continues to be Northern Oilworks, Forth Banks.

Mr. John G. Ames, who was for many years connected with Messrs. R. W. Blackwell and Co., engineers and contractors, of City-road, E.C., as the manager of their Manchester branch, has severed his connection with that firm, and, after visiting the United States, has been appointed the manager of the Barrett Manufacturing Co., Spencer House, South-place, Finsbury-pavement, E.C.

The Bermondsey Borough Council electricity and destructor works held their first annual outing on Saturday last, June 29, when a party of about 60 journeyed down to Herne Bay. They were most fortunate in having fine weather throughout the day. Dinner was held at the Albany Restaurant, Mr. W. E. J. Heenan, borough electrical engineer, in the chair. Drives, etc., were indulged in during the day, and the outing was a pronounced success.

An interesting event took place at the Devonport Corporation electricity works on Monday, July 1, when the borough electrical engineer, Mr. J. W. Spark, was presented on behalf of the staff and employés with a complete set of table plate in an oak case suitably inscribed. The presentation was made by Mr. W. F. Stamp, the chief assistant engineer, who in a well-chosen speech dwelt on the cordial relations that had always existed between the engineer and the staff, and incidentally referred to the changes that had taken place in the works since Mr. Spark's first connection with the same. The plant capacity had been considerably increased and the good relations had done likewise. He was supported by Mr. E. A. Tout, chief clerk, who remarked that he had never worked under a chief whom he could honestly say he respected more than he did Mr. Spark. Mr. Stamp, in making the presentation, wished Mr. and Mrs. Spark every happiness and long life to enjoy it. Mr. Spark suitably responded, thanking the givers.

Mr. H. E. Brain, A.I.E.E., will shortly again be in this country in connection with his business in Buenos Ayres. On the expiration of his agreement with the Buenos Ayres and Pacific Railway, Mr. H. E. Brain has decided to undertake on his own account the carrying out of contracting work in South America. He will be able, on account of the conditions existing in that country, to combine this with his practice as a consulting engineer—a combination which has often been advocated in England, but not officially attempted. Mr. Brain was for seven years chief electrical engineer to the Buenos Ayres and Pacific Railway, and was responsible for the installation of the electrical plant at Bahia Blanca, both in regard to the electrical equipment at the docks (where there is a most extensive installation of polyphase cranes), and in regard to the lighting of that city. In addition to this scheme, Mr. Brain was responsible for the design and supervised the manufacture of the extensions to the direct-current generating station at Junin, and for the equipment of the Buenos Ayres and Pacific Railway Co.'s new carriage and wagon shops at Caseros upon a polyphase system.

OPENINGS FOR CONTRACTORS.

ABERFAN—Business premises. Architect, Mr. C. N. Davies, Merthyr.

BEXHILL—Enlargement of Town Hall (£2,750).

BOURNEMOUTH—Wesleyan Church at Springbourne, Bournemouth (electric fittings to be installed as stand-by). Architects, Messrs. Lawson and Reynolds, Bournemouth.

CARLISLE—School for 400 children. Messrs. Oliver and Dodgshun, Lowther-street, Carlisle.

BRIGHOUSE—Warehouse and offices for Messrs. Turner and Wainwright. Architects, Messrs. Sharp and Waller, 32, Bradford-road, Brighouse.

CHELTENHAM—Refuse destructor (£3,400).

COWDENBEATH—Technical school for the Beath School Board.

CREWE—School for County of Chester Higher Education Sub-Committee. County architect, Mr. H. Beswick, Newgate-street, Chester.

DERBY—Nurses' house at infirmary—Architect, Mr. F. C. Coulthurst, 4, Albert-street, Derby.

DUBLIN—Proposed extension of electric light to Phœnix Park.

DUNDALK—Villa for Mr. T. C. Macardle. Architects, Messrs. Hague and McNamara, 50, Dawson-street, Dublin.

DUNFERMLINE—Carnegie School of Textile Industries (£11,000). Architects, Messrs. Barclay and Co., Glasgow.

EARBY—Twenty-one houses. Architect, Mr. W. H. Atkinson, Colne.

GATESHEAD-ON-TYNE — Motor-repairing shop for North-Eastern Railway Co. Architect, Mr. William Bell, Central Station, Newcastle-on-Tyne.

GELLI (WALES)—Manager's house for Messrs. Cory Bros. and Co. Architect, Mr. W. D. Morgan, Post Office-chambers, Pentre, Rhondda Valley.

GLASGOW—Police buildings at Crosshill. Office of Public Works, City Chambers, 64, Cochrane-street.

GREAT AYTON—School for North Riding Education Committee. Mr. W. H. Brierley, 13, Lendal, York.

GRIMSBY—Coal for electricity works. Borough electrical engineer, Mr. W. A. Vignoles, Grimsby.

HUCKNALL HUTHWAITE—Houses near new factory. Architect and surveyor, Mr. E. W. Bostock, Huthwaite, near Mansfield.

HULL—Five shops in Jameson-street. City architect, Mr. J. H. Hurst, Town Hall, Hull.

KEIGHLEY—Fireproof mill with boiler-house, etc. Architects, Messrs. Moore and Crabtree, York-chambers, Keighley.

KNARESBOROUGH—Laundry for Guardians. Architects, Messrs. Bland and Bown, North Park-road, Harrogate.

LEEDS—Warehouse premises in Bishopsgate-street and Swinegate. Architects, Messrs. Thomas Winn and Sons, 84, Albion-street, Leeds.

LEEDS—Business premises in Meadow-lane. Architect, Mr. C. S. Nelson, Sun-buildings, 15, Park-row, Leeds.

LIVERPOOL—Electricity undertaking extensions (£200,000).

LLANDAFF—House on the Fairwater-road, Llandaff. Mr. Geo. E. Halliday, 19, Castle-street, Cardiff.

LONDON—Tools and stores for the Burma Railway Company, 199, Gresham House, Old Broad-street, London, E.C.

LONDON, W.—Enlargement of Metropolitan Music Hall, Edgware-road. Architects, Messrs. F. Matcham and Co

LUDDENDENFOOT (HALIFAX, YORKS)—Spinning mill and weaving shed (£10,000). Architects, Messrs. Sutcliffe and Sutcliffe, Hebden Bridge.

MONEYREA (CO. DURHAM)—Memorial school. Architects, Messrs. Hobart and Heron, 126, Scottish Provident-buildings, Belfast.

NEWBURY—Elementary school (£10,000).

NORTH SHIELDS—Wesleyan Church in Coach-lane. Architects, Messrs. Marshall and Sweedy, Camden-chambers, Camden-street, North Shields. New elementary school (same architects).

PLYMOUTH—Electric light at new workhouse infirmary buildings. Architects, Messrs. Thornely and Rooke, 11, The Crescent, Plymouth.

PRESTON—Police station at Sankey for the Standing Joint Committee of Lancashire County Council.

RAMSGATE—Secondary school for the Education Committee (£13,000).

ROCHESTER—Seamen's institute. Messrs. Drake and Butcher, 115, High-street, Rochester.

ROTHERHAM—Cables and meters for the borough electric light department.

SKIPTON—Infirmary extensions for the Guardians (£2,450).

SLOUGH—Schools for Bucks Education Committee. Architects, Messrs. Lee and Farr, High-street, Slough.

SMARDALE—Cottage for the Directors of the North-Eastern Railway. Architect, Mr. Wm. Bell, York.

SMETHWICK—Fire station in Rolfe-street. Borough surveyor, Mr. C. J. Fox Allin, Council House, Smethwick.

TAUNTON—Private residence in Wild Oak-lane, Trull. Architect, Mr. F. W. Roberts, 2, Hammett-street, Taunton.

TONYPANDY—Fire station for Rhondda Urban District Council. Engineer and surveyor, Council Offices, Pentre, Rhondda.

USWORTH COLLIERY—School. Architect, Mr. J. W. F. Phillipson, Merton-chambers, 8, Grainger-street, Newcastle-on-Tyne.

WALLSEND-ON-TYNE—New municipal buildings (£14,000). Architects, Messrs. Liddle and Browne, Newcastle.

WALTON-ON-THAMES—Four marine type steam-engines, seven centrifugal pumps, three hydraulic turbines, two 25-kw. electric generators, water-tube boilers, mechanical stokers, etc., for the new pumping station of the Metropolitan Water Board. Engineer of the Southern District, Southwark Bridge-road, S.E.

WANDSWORTH—Elementary school (£18,000).

WEST HOUGHTON (LANCS.)—Hotel for Messrs. John Sumner and Co., Haig Brewery, Wigan. Architect, Mr. E. W. Dyson, 10, Regent-street, Barnsley.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

Melbourne.—The Postmaster-General's Department invite tenders for the supply of telegraph and telephone material. Tenders by July 16.

Beckenham.—The Urban District Council invite tenders for the supply of meters for the electricity generating station. Tenders by July 22. See advertisement.

Adelaide.—The Postmaster-General's Department invite tenders for the supply of switchboards, telephone sets, transmitters, cells, and galvanometers. Tenders by July 10.

Warrington.—Tenders are invited for extensions to the electricity station. Particulars from the Borough Electrical and Tramways Engineer, Warrington. Tenders by July 16.

Handsworth (Birmingham).—The Urban District Council invite tenders for traction and lighting feeders, fibre ducts, and roadwork. Tenders by July 10. See advertisement in last issue.

Brussels.—The Sea Canal Co. invite tenders for power-house and plant. Particulars from the Société du Canal et des Installations Maritimes de Bruxelles, Rue de Canal, Brussels. Tenders by July 10.

Pontypridd.—The Urban District Council invite tenders for the supply of feeder and distributor cables. Particulars from Mr. J. E. Teasdel, electrical engineer and tramways manager. Tenders by July 8.

Brisbane.—The Postmaster-General invites tenders for the supply and delivery at Brisbane of four sections of a common battery switchboard and 650 subscribers' telephones to specification No. 145. Tenders by Sept. 2.

Stepney.—The Electricity Committee invite tenders for the supply of a testing switchboard, motor-generator, and transformer, also a three-pole distribution board and earthing panel. Tenders by July 22. See advertisement

Hammersmith.—The Borough Council invite tenders for the supply of Welsh steam coal at the electricity works. Forms of tender, etc., may be obtained on application to Mr. G. Gilbert Bell, borough electrical engineer. Tenders to the Town Clerk by July 10.

Grimsby.—The Public Lighting Committee invite tenders for 5,000 tons of fine slack coal required during the 12 months ending Aug. 30, 1908. Particulars from Mr. W. A. Vignoles, borough electrical engineer, Corporation Electricity Works, Grimsby. Tenders by July 15.

London.—The London County Council invite tenders for the installation of electric lights, bells, telephones, and motors at the Central School of Arts and Crafts, Southampton-row, London. Tenders to the Chief Engineer of the Council, County Hall, Spring-gardens, S.W., by July 9. See advertisement in last issue.

Cardiff.—The Guardians invite tenders for the provision of telephones, necessary wiring, switchboard, etc., and alteration of present telephone service at their Cardiff and Ely Workhouses. Particulars and forms of tender may be obtained from Mr. Arthur J. Harris, clerk, Union Offices, Queen's-chambers, Cardiff. Tenders by July 16.

New South Wales.—The Postmaster-General at Sydney invites tenders for the supply and delivery at the departmental stores, Sydney, of telegraph, telephone, and electric light material. Specifications, general conditions, and tender forms may be obtained at the General Post Offices, Sydney, Melbourne, Brisbane, Adelaide, Hobart, and Perth. Tenders by Aug. 14.

New South Wales.—The Postmaster-General, Sydney, invites tenders for the supply and delivery at the Department's Stores, Sydney, of 180 quantity and intensity detectors, wound with two circuits of about 150 ohms and 0·22 ohm respectively, the quantity coil fitted with a fifth shunt, in accordance with sealed pattern Q. No. 317. Tenders by Aug. 21.

Woolwich.—The London County Council invite tenders for (*a*) supply and erection of 78 tramway feeder pillars for the Council's tramways, and (*b*) the supply, delivery, and erection of overhead electrical equipment for 2,400 yards of double tracks for the Council's tramways in the borough of Woolwich. Tenders to the Clerk of the Council, County Hall, Spring-gardens, S.W., by July 16.

Pontypridd.—The Urban District Council invite tenders for the supply of various stores, materials, etc., for the surveyor's, electricity, and tramways departments during the period ending June 30, 1908. Specification can be obtained from Mr. P. R. A. Willoughby, engineer and surveyor to the Council. Tenders to Mr. J. Colenso Jones, clerk of the Council, Municipal Buildings, Pontpridd, by July 9.

Western Australia.—The Postmaster-General at Perth invites tenders for the supply of two ringing dynamometers for central exchange. Tenders must be accompanied by a deposit or receipt for deposit, lodged with the Deputy Postmaster-General in a state other than Western Australia, of 5 per cent. on the amount thereof up to £1,000, and 2½ per cent. on any further amount in excess of £1,000. Tenders by Aug. 6.

Western Australia.—The Postmaster-General at Perth invites tenders for a desiccating apparatus with motor-driven air-pump for telephone cable work. Tenders must be accompanied by a deposit or receipt for deposit, lodged with the Deputy Postmaster-General in a state other than Western Australia, of 5 per cent. on the amount thereof up to £1,000 and 2½ per cent. on any further amount in excess of £1,000. Tenders by Aug. 6.

London, S.E.—The London County Council invite tenders for the manufacture of two 5,000-kw. three-phase steam turbo-generators, with surface condensers, etc., to be delivered and erected at the tramways generating station, East Greenwich. Tenders must be upon the official forms to be obtained from the Clerk of the Council, County Hall, Spring-gardens, S.W., upon payment to the Cashier of the Council of £2 for the specification, drawings, etc. Tenders by July 9.

Rotherham.—The Corporation invite tenders for the supply and delivery of cable and meters according to their requirements between Aug. 1, 1907, and July 31, 1908, as follows: single vulcanised bitumen (covered) cable of various sizes; electricity meters of sizes for maximum currents of 2, 5, 10, 25, and 50 amperes. The supply pressure is 230 and 460 volts continuous current. Further particulars can be obtained upon application to the Borough Electrical Engineer. Tenders to Mr. W. J. Board, town clerk, Town Hall, by July 12.

Walton-on-Thames.—The Metropolitan Water Board invite tenders for the provision of four high-class triple-expansion marine type steam-engines, seven centrifugal pumps, three hydraulic turbines, sluice valves, steel mains and cast-iron branch pipes, two 25-kw. electric generators, 10 water-tube boilers, mechanical stokers, two economisers, steam-pipes, feed pumps, coal conveyor, ash hoist, motors, etc., to be erected at the new pumping station at Walton-on-Thames. Tenders to the Clerk, Metropolitan Water Board, Savoy-court, Strand, W.C., by July 24.

Rotherham.—Tenders are invited for the supply of stores and materials required by the tramways department during 12 months, commencing on Sept. 1, including oils and grease, tools, brake blocks, cast-iron brake blocks, paints and varnishes, brass castings, nuts, bolts, and screws, incandescent lamps, etc. Forms of tender, specification, and further particulars can be obtained upon application to the Tramways Manager, Tram Depôt, Rotherham. Persons whose tenders are accepted will be required to enter into a contract which will contain the usual fair wages clause. Tenders, endorsed "Tramway Stores," to be sent to Mr. W. J. Board, town clerk, Town Hall, Rotherham, by July 12.

Bristol.—Tenders are invited for the construction, delivery, erecting in place, fitting, testing, and maintenance for 12 months after completion, of 10 electric two-ton wagon capstans, to be erected at the Royal Edward Dock now in course of construction at Avonmouth, in the port of Bristol, for the Docks Committee. Specification, etc., can be obtained from Mr. W. W. Squire, engineer, Engineer's Office, Cumberland Basin, Bristol, on payment of a deposit of £3, which will be returned to *bona fide* tenderers after receipt of a tender accompanied by all the prescribed documents and drawings. Tenders to the Secretary of the Docks Committee, Dock Offices, 19, Queen-square, Bristol, by July 26.

Bristol.—Tenders are invited for the construction, delivery, erecting in place, fitting, testing, and maintenance for 12 months after completion, of the following electric jib cranes to be erected at the Royal Edward Dock now in course of construction at Avonmouth, in the port of Bristol, for the Docks Committee of the Council: (Schedule No. 1) 12 30cwt. movable electric jib cranes to be erected on the roofs of sheds No. 1 and No. 2 in course of construction on the east side of the dock; (No. 2) two 10-ton movable electric jib cranes on high pedestals, to be erected on the wharf on the south side of the dock; (No. 3A) three 30cwt. movable electric jib cranes on high pedestals, to be erected on the wharf on the south side of the dock; (No. 3B, as an alternative to Schedule 3A) one 30cwt. movable electric jib crane, two 3-ton movable electric jib cranes. Tenders to the Secretary of the Docks Committee, Dock Offices, 19, Queen-square, Bristol, by July 26.

Calcutta.—Tenders are invited for lighting by gas, oil, electricity, or other illuminant of the streets, thoroughfares, and public resorts of the city of Calcutta, as vested in the Corporation of Calcutta. The city comprises approximately an area of 20 square miles, containing about 170 miles of main thoroughfares and 130 miles of smaller streets and lanes, besides several squares, markets, latrines, slaughter-houses, and other public resorts, the whole being lighted at present by 9,225 gas lamps of 24 c.p., 84 higher power lamps equivalent to 2,074 lamps of 24 c.p., and 2,400 oil lamps. The new contract is timed to commence on May 1, 1911, and the successful tenderer or tenderers will be required to have all arrangements completed and ready to begin and continue the lighting with effect from that date. Tenders should be for 10, 15, or 20 years. It is left to tenderers to propose their own plans for carrying out the project, the end in view being to considerably improve the present lighting of the city, and, to this end, it is suggested that representatives should be deputed to personally inspect the area to be lighted and the system now in force, in order that they may be in a position to judge for themselves as to the best means to be adopted for attaining the desired object. Mr. P. N. Mookerjee, secretary to the Corporation. Tenders to the Vice-Chairman by Jan. 2 1908.

RESULTS OF TENDERS.

Luton.—The Town Council have accepted the tender of G. Buckingham, Luton, at £1,857 for the whole of the work in connection with the extension of the electricity station buildings.

Warrington.—The following tenders have been accepted by the Borough Council: Goodbrand and Co., economiser, £364; Newton, Chambers, and Co., cast-iron tank, £135; Bell Bros., water-softening plant, £185; W. and J. Richardson, supply of slack to the electricity station for 12 months; St. Helens Cable Co., supply of cables, £178. 14s. 2d.

London County Council.—The following tenders have been received for the supply of low and high tension switchgear required for various sub-stations: Johnson and Phillips, Charlton, S.E., £12,692. 1s. 6d. and £7,664. 17s. 10d. (recommended for acceptance, with power to sublet to Messrs Everett, Edgcumbe, and Co.); British Westinghouse Electric and Manufacturing Co., Manchester, £14,197

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and £8,348. 10s.; General Electric Co., London, £14,801. 12s. and £8,548. 3s. 8d.; Spagnoletti and Co., London, £8,924; Whipp and Bourne, Rochdale, £15,198. 1s. 10d. and £9,036. 13s. 2d.; Electric Construction Co., Wolverhampton, £16,254. 17s. 4d. and £9,305. 15s. 6d.; Ferranti Limited, Hollinwood, £16,565. 3s. and £9,512. 14s. 9d.; Evered and Co., Birmingham, £20,057. 15s. and £10,236. 2s. 6d.

London.—For wiring the new offices of the London, Edinburgh, and Glasgow Assurance Company for electric light and power, for which the consulting engineers were Messrs. Morgan Williams and Couzens, and the architect Mr. Beresford Pite:

Peto and Radford	£1,261	0	0
Benson and Co.	1,114	4	0
Foot and Milne	841	3	3
H. J. Cash and Co.	814	0	0
Belshaw and Co.	774	5	0
R. Dawson, Limited	706	14	0
H. M. Leaf	681	7	9
Lea and Warren	689	15	1
Alternative tenders.			
Peto and Radford			
Benson and Co.	1,079	14	0
Foot and Milne	834	4	10
H. J. Cash and Co.	811	0	0
Belshaw and Co.	754	5	0
R. Dawson, Limited	696	14	0
H. M. Leaf	664	7	9
Lea and Warren (accepted)	656	15	1

BUSINESS NOTES.

TRACTION.

Southampton.—Requests have been made to the Town Council asking them to extend the tramway to Northam.

Halifax.—The Town Council have authorised the Tramways Committee to extend the loop line at Mason Green, on the Illingworth section, at an estimated cost of £433.

Switzerland.—A syndicate headed by M. Joseph Troller, of Triengen, has been authorised by the State to construct and work a railway (steam or electric traction) between Sursee and Triengen.

Rotherham.—The Council have referred to the Tramways Committee for further consideration the question of constructing the tramways authorised by the Act of 1904, in the College-road district of the borough.

Luton.—The Tramways Committee of the Town Council are applying to the Board of Trade for an extension of another year in which to commence and complete the Luton tramways. The present period of grace expires on Aug. 1.

Aberdeen.—The Tramways Committee of the Aberdeen Town Council have agreed to institute a parcel delivery system on the cars as soon as possible. They have agreed to draw out specifications for six covers for tops of cars.

Brisbane.—The Brisbane Electric Tramways Investments Co. announce that the traffic receipts of the Brisbane tramways for the month of June, 1907, amounted to £12,500; corresponding month last year, £11,595; increase, £905.

Islington.—The Works Committee are recommending the Council to consent to the construction by the London County Council of a tramway along Pemberton-gardens connecting the Holloway-road lines with the car-shed in Caledonian-park.

Warrington.—The tramways manager has been authorised to obtain meters for the cars. The balance-sheet of the tramways undertaking for the year ended March 31 last shows a net profit of £1,309. 17s. 10d. on the year's working.

Leyton.—The Tramways Committee have recommended that the manager should make suitable arrangements for through booking between the electric cars in Lea Bridge-road and the London General Omnibus Co.'s 'buses to the Elephant and Castle.

Shanghai.—A tramway system covering 25 miles of road has been inaugurated during the past year. The concession has been granted to a British firm, who will sell on completion to a syndicate of British capitalists, and it is expected that a public company will eventually be formed.

Hackney.—The Highways Committee of the London County Council have intimated that if the Borough Council would consent to the tramways in Mare-street and Clapton High-road being reconstructed on the overhead trolley system, they would be prepared to recommend that the electrification of the line be immediately proceeded with.

Kirkcaldy.—The question of the extension of Kirkcaldy tramways to Dysart is again being considered by Kirkcaldy Town Council. The Tramways Committee have recommended that the question be delayed until an arrangement has been arrived at with Wemyss Tramway Co. with reference to the running of their cars on the upper route. There is a growing feeling in favour of the Dysart extension, and it is expected that steps will shortly be taken.

Light Railway.—The Light Railway Commissioners have conducted an inquiry at Elsenham, Essex, to consider an application for an order authorising the construction of a light railway from Elsenham station to Thaxted. The Treasury, it was stated, had promised a contribution of £15,000 to the scheme, and the Commissioners granted the application, subject to the terms of the order being settled by the Light Railway Commissioners and the promoters of the scheme.

Madras.—The traffic receipts of the Madras Electric Tramways (1904) for the fortnight ended June 30, 1907, amount to Rs.15,606, an increase of 22·1 per cent. compared with the corresponding period of the preceding year. The gross receipts from Jan. 1, 1907, are returned as Rs.203,902, compared with Rs.170,415 for 1906, an increase of 19·6 per cent.

Leeds.—The Town Council on Wednesday decided to make application to the Board of Trade for their sanction to (*a*) a rectification and adjustment of the various borrowing powers for tramway purposes; (*b*) the borrowing of the sum of £15,562. 15s. 1d. (being £13,964. 18s. 9d. for permanent way and £1,597. 16s. 4d. for electrical equipment) in respect of the Horsforth extension; and (*c*) the borrowing of the sum of £8,365 in respect of the extension of the Chapeltown depôt.

Liverpool.—Among the matters down for discussion at Wednesday's meeting of the Liverpool Town Council was a motion to establish a motor-'bus service on the Edge-lane route as an experiment for six months, and for this purpose it was proposed to instruct the Tramways and Electric Power and Lighting Committee to purchase six motor 'buses at a cost of about £850 each, as mentioned in the report of the Finance and Traffic Sub-Committee submitted to the Council on June 1, 1907.

Cardiff.—In presenting to the Council his monthly report on the working of the tramways, Mr. Ellis, the tramway manager, said that the tramway department receipts for May amounted to £10,369, as against £9,160 during the corresponding month of 1906, an increase of £1,209. During the same period there had been a reduction of 3,631 miles in the total distance travelled by the cars, and an increase of 214,300 in the number of passengers carried. The gross profit for May was £5,215, as against £3,831 in May, 1906.

London United Tramway Sports.—The annual sports of the London United Tramways Co. were held last week at Brentford before about 2,000 spectators, the object being, as usual, to aid the funds of the L.U.T. Philanthropic Society. The tramway band (under the direction of Driver W. H. Bryan) played selections of music throughout the day. In the evening an *al fresco* concert was given by members of the Tramway Club and Institute, and an Old English fair was largely patronised. Sir Clifton Robinson addressed the men during the afternoon, and Lady Robinson presented the prizes to the successful competitors.

Motor Traffic.—The attention of the Home Secretary was called recently to the increasing nuisance caused by motor omnibuses, and to the losses sustained through those nuisances by householders on motor-omnibus routes, and he was asked in the House of Commons if he could see his way to represent to the London County Council that the construction of a complete London electric tramway system, to make omnibuses unnecessary, would be for the common good and profit of all classes in London. Mr. Gladstone said he was disposed to consider that the objectionable features of that traffic showed signs of diminution rather than of increase. The dropping of oil was being dealt with specially by the police and by an influential trade association. He had no authority to make to the London County Council any such representation as was suggested in the question.

Leeds-Huddersfield.—Leeds and Huddersfield provisional orders are included in a Bill to confirm certain provisional orders made by the Board of Trade under the Tramways Act, 1870, which came on Tuesday afternoon before an Unopposed Committee of the House of Lords, the Earl of Onslow in the chair. The Leeds order authorised the Corporation to construct additional tramways in the city, and the Huddersfield order also authorises an addition to the tramway system by the Corporation of that town. Mr. Bonner Maurice, who appeared on behalf of the Board of Trade, said that the Board had now agreed with the Postmaster-General as to the clause which they suggested should be inserted in all these tramway orders as defining the requirements of the Postmaster-General in regard to the corporations and tramway companies. After the insertion of this clause the Bill passed through committee stage, and will be reported to the House for third reading.

Fulham.—The scheme to construct tramways along the Fulham Palace-road between Putney and Hammersmith is engaging the close attention of the Works Committee of the Fulham Borough Council. The proposal has taken practical shape, the Works Committee having just received an important letter on the subject from the Highways Committee of the County Council. The attention of the committee has been called to the opening early in 1908 of a Franco-British Exhibition at Shepherd's Bush, and the committee state that if arrangements could be made for the construction at an early date of the whole of the route from Putney to Harlesden for electric traction in connection with the London United Tramways system a very valuable addition would be made to the facilities which now exist for reaching Wood-lane. The Highways Committee argue in favour of an overhead system, and say that if the Fulham Council will agree to this method they will advise the County Council to at once carry out the work of the tramway tracks and wood paving. At a recent meeting of the Borough Council the Works Committee recommended that the Highways Committee's proposal be accepted on condition that (1) the road be made up from kerb to kerb at the cost of the London County Council; (2) Fulham Palace-road improvement scheme to be effected at the same time; and (3) wood paving be laid down the whole length and width of the road. The inhabitants of Fulham Palace-road are opposed to the overhead system.

Doncaster.—The tramways revenue income shows, by traffic, receipts amounting to £12,029. 10s. 10d., advertising on cars, £337. 10s., and sale of scrap £30. 6s. 3d., a total income of £12,397. 7s. 1d. Expenditure—power £3,596. 13s. 9d.; wages, £2,826. 16s. 11d.; general expenses, £997. 7s. 3d.; repairs and maintenance of permanent way, £777. 8s. 7d.; of cars, £369. 15s. 8d.; car, track,

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and general wages, £948. 16s. 11d.; and £2,538. 0s. 9d. is carried to the net revenue account. The net revenue account shows a loss of £1,367. 0s. 5d. on the year's working, against one of £2,338. 4s. 8d. last year. The following statistics are given in the annual report of the tramways manager: mileage of track—single, 6 miles 0 furlongs 4 chains; double (including crossing-places), 2 miles 1 furlong 9 chains—total, 8 miles 2 furlongs 3 chains. Population served by the tramways, 41,500; car miles, 495,404; passengers carried, 2,753,506; total number of units used, 575,470; number of units used per car mile, 1·16; average number of cars used per 15½-hour day, 13; percentage of working expenses to receipts, 79·5 per cent.; average traffic revenue per car mile, 6·01d.; average working expenses, including cost of current, 4·76d.; cost per car mile of interest and sinking fund, 1·88d.; total expenses per car mile, 6·66d.; average car miles per car per day, 122; average car hours per day, 222; scale of fares—½d., 1d., 1½d., 2d., 2½d., 3d., and 6d.; average distance—1¼ miles at 1d., 2 at 1½d., and 2·6 at 2d.; average fare paid per passenger, 1·05d.; average number of passengers per car mile, 5·55; number of cars in stock, 25.

Glasgow.—The balance-sheet of the Glasgow Corporation tramways department for the year ended May 31 has been issued. The traffic revenue for the year was £887,380. 14s. 1d., and £8,461. 0s. 2d. of other receipts brought up the total income to £895,841. 14s. 3d. The working expenses (excluding depreciation) amounted to £485,256. 2s. 4d., leaving a balance to be carried to net revenue account of £410,585. 11s. 11d., in addition to which there was £3 510. 10s. 6d. of interest on surplus revenue, making a total of £414,096. 2s. 5d. From this there fell to be deducted interest on capital £63,769. 8s. 5d., sinking fund £49,776. 16s. 6d., income tax £9,931. 19s. 5d., rental of Govan and Ibrox tramways £5,078. 15s. 7d., payment to Paisley District Tramways Co. £4,874. 5s., depreciation fund £85,031. 13s. 7d., permanent-way renewals fund £83,376. 14s. 1d., parliamentary expenses £6,977. 9s. 5d., and payment to common good £35,000—a total of £343,817. 2s., leaving a net balance of £70,279. 0s. 5d. The net balance has been appropriated as follows: special depreciation on buildings £25,000, and on power plant £20,000; and there has been carried to general reserve fund £25,279. 0s. 5d. The gross revenue for the year shows an increase of £74,902. 19s. 8d. over that of the previous year, and the average traffic revenue per car mile has increased from 10·341d. to 10·465d. The working expenses show a slight reduction per car mile, the year's figures being 5·721d. as against 5·797d. for the previous year. The total borrowing powers of the department were £3,100,000. These have been exercised to the extent of £2,227,352. 12s. 7d., and the amount still unexhausted is £872,647. 7s. 5d. The total amount of the sinking fund is £547,378. 12s. 1d. The amount expended on capital account during the year was £139.613. 17s. 2d., making the total expenditure on capital acount £3,104,060. 15s. 9d. No further sums have been borrowed during the year for capital purposes, and the balance of tramway debt to the common good now amounts to £1,679,974. 0s. 6d. The balance at the credit of depreciation and permanent-way renewals fund is £1,079,252. 18s. 2d., and at the credit of the general reserve fund there is a balance of £42,851. 4s. 10d. The tramway undertaking is now valued at £262,958. Last year the taxes paid amounted to £44,204. 12s. 4d., of which £40,970. 16s. 6d. was Glasgow municipal rates, £1,506. 4s. 5d. municipal rates in adjacent burghs, £21,773. 8s. 11d. poor and school rates, £5,173. 18s. 3d. county rates, and £780. 4s. 3d. water rates. The total payments to the common good since 1894 have been £226,760. 5s. 6d. During the year there were open for traffic 168½ single miles of line, and the average traffic revenue was £5,035 per mile. The car miles run were 20,350,367, and the number of passengers carried was 224,063,098. The percentage of working expenses to total receipts was 54·17, the average traffic revenue per car mile was 10·465d. The population served by the tramways in the city and suburbs numbers 1,050,000. The average traffic revenue per head of the population served was 16s. 11d., and the average total revenue per car mile was 10·565d. The average car miles per day per car was 101·20, and the average speed per hour was 7·91 miles. The average working expenses per car mile (excluding power works cost) was 5·353d.; average working expenses per car mile (including power works cost), 5·721d.; average working expenses per passenger (including power works cost), ·520d.; average working expenses per car mile (including power works cost and amount expended on permanent-way renewals), 6·186d.; average working expenses per car mile (including total power cost and amount expended on permanent-way renewals), 7·226d. The scale of fares ranges from ½d. to 7d., and the average distance of the stages ranges from ·57 of a mile for the former to 14·32 miles for the latter, and the average fare charged per mile is ·45d. The average fare paid per passenger was ·95d., the average number of passengers per car mile was 11·01; average journeys per head of population per annum, 213·39; number of cars in stock, 780. The percentages of expenses to total receipts were: working expenses, 53·96; Corporation of Govan, ·56; Paisley District Tramways Co., ·55; interest on capital, 7·09; sinking fund, 5·53; income tax, 1·10; parliamentary expenses, ·78; annual payment to common good, 3·89; depreciation and permanent-way renewals fund, 18·73—92·19, leaving a net balance of 7·81.

LIGHTING AND GENERAL

Hoddesdon.—The Council's electric lighting order has been transferred to the North Metropolitan Electric Power Supply Co.

Edward's Air-Pump Syndicate.—An interim dividend has been declared for first half of year 1907 at the rate of 10 per cent. per annum.

Plymouth.—The Electricity Committee have decided to reduce the charge for current consumed between midnight and 3 p.m. from 2½d. to 2d. per unit.

Electrical Power Storage Co.—The directors recommend the payment of a dividend of 6 per cent. on the paid-up ordinary share capital for year ended May 31, 1907.

Lion Babbitt Metal.—Messrs. Andrew Barclay and Sons and Co., Caledonia Works, Kilmarnock, N.B., are sending out a card advertising their Lion Babbitt anti-friction metal.

Stockton.—The Cleveland and Durham Electric Power Co. have applied to the Stockton Rural District Council for permission to construct overhead lines at Haverton Hill.

Dublin.—The Corporation are considering the question of extending electric lighting to Phœnix Park, and Mr. Ruddle, chief electrical engineer, has been asked to prepare a report.

Simplex Conduits.—The directors of Simplex Conduits, Limited, have issued an interim dividend for the six months ended 30th ult. at the rate of 7½ per cent. per annum on the ordinary shares.

Cheltenham.—The Cheltenham Council have resolved to provide an additional refuse destructor at a cost of £3,400, including steam-raising plant. The Electricity Committee will pay a portion of the cost.

Leyton.—The Urban District Council are seeking a loan for £5,770, £3,000 of which is for new electricity mains and the balance for paying off excessive expenditure on previous loans for the electricity department.

Malton.—The committee have decided to ask the Malton Gas Co. and the Northern Counties Electricity Supply Co. to tender for the lighting of St. Leonard's Church clock for the 10 months ending May 31, 1908.

Stock Exchange.—The Stock Exchange Committee have ordered Electric Traction Co. of Hong Kong £195,000 5 per cent. mortgage debentures of £100 each, Nos. 1 to 1,950 (registered), to be quoted in the official list.

Norwich.—The loan of £25,000 for which the Corporation are seeking sanction is for the following purposes: one 750-kw. steam dynamo, boilers, feed pump, etc., £10,000; meters, £3,000; mains and services, £12,000.

Acton.—A man engaged in cleaning insulators at the sub-station of the Great Western Railway at Acton on Tuesday morning inadvertently touched a live wire (which at the time had a pressure of 6,000 volts), with fatal results.

Cryselco.—At the ninth ordinary general meeting of the shareholders of Cryselco, Limited, a dividend of 10 per cent. was declared after placing the usual amount to reserve, and the balance, amounting to £3,216. 9s. 9d., was carried forward.

City of London Electric Lighting Co.—The directors of the City of London Electric Lighting Co. announce a dividend on the ordinary shares of 5s. per share, being at the rate of 5 per cent. per annum for the half-year ended 30th inst.

Cuckfield.—Notice has been received by the Council that the Haywards Heath Electric Supply Co. intend to apply to Parliament for power to supply electricity in the districts of Haywards Heath and Cuckfield Urban and Cuckfield Rural District Councils.

Brentford.—The offer of the Heston and Isleworth District Council to supply electric light to the workhouse at 3d. per unit for five years, provided the Guardians took at least 50,000 units, has not been accepted. The new buildings have been wired for electric light.

Bridgend.—The Council have resolved to seek the sanction of the Local Government Board to borrow £6,500 for the purpose of purchasing the local property of the South Wales Electrical Power Co., and to obtain legal advice on the power of the Council to take over the obligations of the company.

Reinforced Concrete.—From the Trussed Concrete Steel Co., 5, Caxton House, Westminster, we have received a copy of their "Typical Factory Book," showing some of the uses of reinforced concrete in large buildings which the company have carried out on the Kahn system of reinforcement.

Swansea Telephones.—It appears that the difficulty which arose between the General Post Office authorities and the National Telephone Co. as to the sale of the Swansea Corporation telephones to the latter has been got over, and that there is now no further obstacle to the immediate transfer of the concern.

Burglary.—On Tuesday night burglars entered the showrooms of Mr. Paul, the well-known electrical instrument maker, at 68, High Holborn, but found themselves too late, as the cashier's department was removed on the previous day to the works at New Southgate. They secured only a few pounds in cash and some cigars.

Antioyl Soap.—Messrs. F. S. Cleaver and Sons have sent us some samples of a new soap bearing the name Antioyl. It is intended for engineers who in the course of their work handle oily surfaces. From a practical trial we find the soap very effectual in removing grease and oil from the hands. Motorcar owners who do their own repairs should try this soap.

Telegraph and Telephone Extensions.—The Postmaster-General has decided to commence work from Newcastle on the extension of the underground telegraph line to connect Leeds with Newcastle. A good telephone service is also to be maintained between Newcastle and Sheffield, and if the traffic increases sufficiently a direct circuit will be provided.

St. Marylebone.—A City firm having declared, as the upshot negotiations with the Finance Committee of the St. Marylebone Borough Council, that it would be impossible for them to find the Council's electricity loan of £1,400,000 at 3⅞ per cent., the committee have finally approved borrowing from the London County Council at 4 per cent., as originally proposed.

Hanley.—The Town Council have adopted the recommendations of the Lighting Committee respecting the reduction in price of electric

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current. As a result of this, the charge for private lighting to consumers, paying on the regular scale, is 6d. for the first 73 hours' quarterly use of the maximum supply taken in such quarter, 3d. for the second and third hours, and 2d. after.

Worthing.—The report of Mr. Rycroft, who was engaged to inquire into the Worthing Corporation electricity undertaking, has not been made known, but the Council, who discussed the matter in committee, have issued a statement to the effect "that the proceedings and recommendations of the Electricity Committee in relation to the report of Mr. Rycroft" were adopted by the Council.

Merthyr.—The Council have accepted the offer of the Merthyr Electric Traction Co. to light the main street of Dowlais. The Dowlais Gas Co. offered to light three three-light cluster incandescent lights and 15 incandescent gas lamps for a total cost of £70 per annum, as compared with the payment of £89. 5s., the cost of three electric lamps and 14 gas lamps, but the Council passed them over.

Accrington. — Several application having been received from Clayton-le-Moors for a supply of electricity for lighting purposes, the Electricity Committee of the Accrington Corporation have decided to communicate with the local authorities of the surrounding townships asking their consent to an application by the Corporation for a provisional order to enable them to supply current when requested.

Robertson Lamps.—We have just heard that the Robertson Lamp Co. have had the plans passed for the erection of a large building for the manufacture of metallic-filament lamps. This will place the company and the General Electric Co. in a position to supply these lamps, for which such a large demand has arisen. With these manufactured in England, we shall have a further industry added to those for which the General Electric Co. are responsible.

City of London Electric Lighting Co.—The directors have declared the following dividends for the year ending Dec. 31, 1907: 6s. per share on the preference shares, being at the full rate of 6 per cent. per annum for the half-year ended June 30, 1907, and 5s. per share on the ordinary shares, being at the rate of 5 per cent. per annum for the half-year ended June 30, 1907. The dividends will be subject to income tax, and will be payable on or after July 17 to all shareholders registered on the books on July 2.

Liquidations.—The *London Gazette* announces that a general meeting of the A.B.P. Accumulator Co. will be held at 39, Victoria-street, Westminster, on Aug. 1, at 3 p.m., for the purpose of receiving the liquidator's report, showing the manner in which the winding-up has been conducted and the property disposed of. A general meeting of the Atmospheric Electrical Purification Co. will be held at 21, Spring-gardens, Manchester, on Aug. 2, at 4 p.m., for the same purpose. The I.T.E. Electrical Co. has been wound up voluntarily, and Mr. Percy F. Huddleston, 72, Finsbury-pavement, London, E.C., appointed liquidator.

Petrol-Electric Sets.—Messrs. R. J. Nicholson and Co., Manchester, now have branches at Newcastle-on-Tyne and Bath. From the former, which is situated at 77, High Bridge, the North of England will be worked under the supervision of Mr. T. R. Martin, while Mr. C. G. Smith and Mr. Talbot will look after the West of England from the Bath office at Northgate Works. The Newcastle telephone number is 04662 Central and the Bath telephone is 363. At each of these branches one of the "Ideal" petrol-electric sets will be on view, and an opportunity will be afforded of judging the merits of these plants.

Brandon.—A general public meeting was held recently to consider the charges in connection with the electric light, which it is intended should be put in all the colliery houses. A representative from the firm of electricians who are contracting for the putting in of the light attended, and stated that the costs of the lights would be 4d. per week for the first light and 2d. per week for every additional light. He also stated that in the event of a man being off work through illness, he would be exempt from payment, but should a man be off work through accident, and receiving compensation, he would have to pay for the light. It was unanimously resolved to accept the terms on a three years' agreement.

Secret Commissions and Bribery Prevention.—At a meeting of the council of the Secret Commissions and Bribery Prevention League, held on Tuesday at the London Chamber of Commerce, Sir Edward Fry was elected as first president and the Archbishop of Canterbury, Earl Fortescue, Lord Avebury, Sir W. H. Holland, Sir W. Mather, and Mr. David Howard were elected vice-presidents. Mr. David Howard, who presided, was able to report that the league had made considerable progress, and was obtaining an increasingly influential membership. Mr. R. M. Leonard having been recently appointed secretary, the offices of the league have been removed now to 3, Oxford-court, Cannon-street, London, E.C.

Liverpool.—The Liverpool Corporation Tramways, Electric Power, and Lighting Committee recommend the City Council to make application to the Local Government Board for sanction to borrow the further sum of £200,000 for purposes connected with the supply of electrical energy. The Liverpool and District Electrical Association has been formed, and the first meeting of the society will be held at the Common Hall, Hackins Hey, Dale-street, at 8 p.m. on Tuesday, July 16. It is intended that the association shall meet fortnightly, and that papers be read, followed by general discussions, as well as a number of social meetings. The subscription is 10s. 6d. per annum, payable on entry or in a first instament of 3s., followed by three further payments of 2s. 6d.

Electrical Plant for Collieries.—The British Westinghouse Co., of Trafford Park, Manchester, are supplying to the Powell Duffryn Steam Coal Co. two 950-h.p., three-phase, 3,000-volt, 50-period, squirrel-cage induction motors to run at 1,450 r.p.m. These motors are for driving, through flexible couplings, two Worthington six-stage turbine-type centrifugal pumps, each capable of delivering 1,350 gallons per minute against a head of 1,645ft., including suction, lift, and friction of discharge mains. The guaranteed efficiency of each set, from input at motor terminals to output at surface, is 69 per cent. These two pumping sets are to be installed in the East Elliott Pit. It is proposed to run them at night, when the haulage gears and other machinery is shut down, thus providing a night load for the power-house, and making the fullest use of the generating plant.

Warrington.—Mr. F. V. L. Mathias, electrical and tramway engineer to the Warrington Corporation, has just issued his annual report, which shows that there has been an increase in the consumption of current by all classes of consumers. The gross revenue amounted to £16,238. 16s., and the working expenses £8,528. 18s. 5d., leaving a balance of £7,709. 17s. 7d. Out of that sum had been paid £2,634. 1s. 1d. interest on loans and £2,558. 17s. 2d. contribution to sinking fund, which left a net profit on the year's working of £2,516. 10s. 4d., as against £2,762. 19s. 7d. for the previous year. The smaller net profit was accounted for by the fact that the undertaking has been reassessed, and a total of £923. 3s. 8d. was being paid this year for rents, rates, and taxes, as compared with £318. 8s. 11d. last year. The revenue from private lighting and power consumers was £15,616. 11s. 7d., an increase of £1,480. 3s. over last year. The average price obtained was 1·52d. per unit, and during the year £2,107. 19s. 3d. has been expended on main accounts.

Islington.—During the seven weeks ended June 15, 1907, the premises of 38 additional consumers were connected to the Corporation mains; additions to existing installations were made in 12 cases, and reductions were made to existing installations in two cases, and 16 consumers were disconnected. The result is a net increase in the maximum supply of the equivalent of 4,229 8-c.p. lamps. The Government district auditor of the borough accounts (Mr. A. Carson Roberts), in his report of the last audit, issued on Wednesday, states that the charge made for current by the electricity undertaking of the Council for street lamps is at the rate of 3·31d. per unit, which is twice as high as the average amount charged in other metropolitan boroughs. The electrical engineer agrees that 1·75d. would be a reasonable and fair charge. Mr. Roberts adds: "The charges for public street-lighting represent in this case a full third of the gross income from the sale of current, and means in effect that a rate contribution in aid of the undertaking to the extent of about £7,000 per annum is now being treated in the accounts as payment for street-lighting."

Beckenham.—The annual statement of the accounts of the Beckenham electricity undertaking was presented at a meeting of the Council on Monday night. These showed that during the year ended March 31 last the total quantity of Board of Trade units generated was 1,112,757, of which 974,642 were sold and used at the works, while 136,115 were unaccounted for. The total receipts for the sale of current, rent of meters, etc., were £14,666. 11s. The past was the first complete year in which the undertaking had been worked by the Council. The result of the year's working showed that after deducting interest on mortgage debt, which might be taken as equivalent to a company's interest on its capital, there was a profit of £3,259. 5s. 6d.; £2,795. 17s. 10d. had been applied in reduction of capital indebtedness, bringing the total reduction to March, 1907, to £12,810, and the actual surplus which could be used by the Council was £1,550. 13s. 2d. There had been charged against the revenue the sum of £617, which was in part a relief to the general district rate.

Melbourne.—The annual report of the Electric Supply Committee for the year ended Feb. 28, 1907, has been issued to the members of the City Council. The return contains some interesting facts and figures. The gross revenue for the year amounted to £81,189. 10s. 10d., while the working expenses reached only £35,660. 8s. In this way is shown a gross profit of £45,529. 2s. 10d. From this sum several deductions have been made. Interest on capital, commission, and exchange, £14,385. 9s. 2d.; sinking fund at 1 per cent., £4,400; depreciation and renewals at 2 per cent. on £415,150. 14s. 9d., £8,303. 0s. 4d.; and recoup to capital account expenditure during the year on charging over installations. The net profit is £17,601. 11s. 9d., which, added to the credit balance of £229. 5s. 6d. from last year's account, totals £17,830. 17s. 3d. The annual contribution to the loan fund was increased from £1,000 to £1,500. With the exception of some small auxiliary plants, no additions were made to the plant at the supply station, but two additional underground feeders were laid in connection with the direct-current system.

Manchester.—In presenting the annual report of the Electricity Committee to the Town Council on Wednesday, the chairman pointed to rapid progress made by the department despite the heavy capital outlay. In five years the average price per unit of current had been reduced from 3·07d. to 1·73d. The working expenses had been reduced very considerably also, and a renewals suspense account of £100,000 had been secured. The committee's policy was to put the department on a sound commercial basis and supply current at the lowest possible price. The increase in consumption last year was equal to 46 per cent., and he was sanguine enough to believe that rate of increase would be maintained this year, and that at the end of the current year the committee would be able to propose a reduction in price in addition to the one they now recommended. The Council assented to the reductions in price of current now recommended by the committee—to consumers on the flat rate a reduction from 4½d. to 3¾d. per unit, and to long-hour consumers a reduction from £7 per kilowatt of maximum demand and 1¾d. per unit to £7 per kilowatt of maximum demand and 1½d. per unit.

Buxton.—The report on the past year's working of the Corporation electricity department shows an increase of £579. 12s. on revenue, being an increase of £118. 12s. above the increase of last year. There is a decrease in the total expenditure of £290. 6s., mainly in the

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public lighting, which last year included the erection of the new lamps with hoisting gear. The balance over the working expenses amounts to £2,638. 3s. 7d., and the amount of interest paid on the capital is £1,074. 10s. 9d., still leaving a balance of £1,563. 12s. 10d. There is £1,566. 19s. 11d. to be paid as repayment of principal, leaving an adverse balance of £3. 7s. 1d. The balance after paying interest this year exceeds last year's by £871. 12s. 8d. There has been connected to the mains during the year 3,138 8-c.p. lamps, and also 11 motors (total of 23 h.p.), in addition to motors for working Messrs. Bagshaw's quarries at Nithen, and two or three private houses. This year there will be a big increase in the price of coal, and the electrical engineer is experimenting in trying to use coke mixed with the coal, which he thinks can be worked in, at light loads at any rate.

Bermondsey.—The Electricity and Street-Lighting Committee of the Bermondsey Borough Council have submitted the accounts of the electricity undertaking for the past year. These show that the total expenditure in connection with the generation, distribution, etc., of current amounted to £9,016. 17s. 5d., and that the income, including a balance of £705. 5s. 0½d. from the previous year's accounts, came to £16,209. A balance of £7,192 is left, which after interest charges have been met is brought down to £590, being the net profit on the year's working. The expenditure on the undertaking to March 31 last amounted to £133,922. The number of units generated during the year was 2,180,106. The committee have also submitted estimates for the year ending March 31, 1908. The estimated total expenditure is £19,700; this includes £7,253 as works costs for the generation of electricity, or ·62d. per unit, £785 for rates, taxes, and insurance (·07d. per unit), and for management expenses £9,578 (·82d. per unit. The sum of £1,110 is estimated for public lamps, and £9,012 for the redemption of debt. The estimated income is £20 324, which includes £18,989 for sale of electrical energy, £1.110 for public lamps. £175 for meters, and £50 sundry accounts, thus leaving an estimated surplus on the year's working of £623.

Kensington.—The existing agreements between the electric lighting companies and the Borough Council relative to the supply of electrical energy for street-lighting and other purposes are to be determined. The Council have been in negotiation with the three electric lighting companies having areas of supply within the borough with a view of securing some reduction in the amount charged by them for the supply of electricity to the Council, and the following quotations have been obtained for the supply of current during the ensuing five years: energy for street lamps kept alight all night, 1d. per unit; energy for street lamps extinguished at midnight, 2½d. per unit; energy for public buildings, depôts, etc., 2½d. per unit. It may be mentioned that the price at present paid by the Council for electricity for all purposes is 2½d. per unit, and that there are 67 arc lamps in the borough which are kept alight all night and 41 lamps extinguished at midnight. The Works Committee consider that the terms quoted by the company are advantageous to the Council, and they recommend (*a*) that the existing agreements with the electric lighting companies be terminated as from July 22 next; (*b*) that agreements be entered into with the three electric lighting companies for the supply of electricity for street-lighting and other purposes on the terms proposed for a period of five years from July 22 next; (*c*) that all electric lamps installed in the streets in the borough be kept in lighting all night.

Camberwell.—The town clerk has just issued a statement of facts relating to the Camberwell Electric Lighting Order, 1896, in view of the raising of the question on the Board of Trade estimates. The town clerk says the point at issue is briefly as follows: "The County of London Electric Supply Co. (formerly the Brush Co.) hold powers of supply in Camberwell under the Camberwell Electric Lighting Order, 1896. This was consented to by the local authority only upon condition that the area of supply was limited to Camberwell, special and exclusive purchase terms also being inserted, of which the Borough Council might avail themselves at any time. In order to prevent the Camberwell mains from being used as through mains for the supply of outlying boroughs, the Borough Council, and also the London County Council, have, when asked by the company to sanction the laying of mains, imposed the condition that such mains shall be laid solely for the purposes of the Camberwell order. The company appealed to the Board of Trade in March, 1906, against this condition, and the Board of Trade upheld the appeal, thus deciding against the two public authorities, who merely required that such works should be limited to the purposes of the Camberwell order. Hence it follows that any company can construct through mains against the wishes of both the central and the local authority, and, incidentally, without paying any wayleave rental. This action of the Board of Trade the Council are of opinion is *ultra vires*, and against the best interests of local authorities." The town clerk appeals to local authorities and members of Parliament to support the Camberwell Council in upholding its rights as a local authority.

Loughborough.—The revenue account of the Loughborough Corporation electricity undertaking presented at the last meeting showed a total expenditure of £2,516. 17s. 10d., and receipts from sale of current, rent of meters, etc., amounting to £3,121. 3s. 5d., leaving a profit balance of £604. 5s. 7d. A grant of £1,000 was made for the general district fund, £1,132. 3s. 8d. was paid in interest on loans, and £584. 14s. 6d. to the sinking fund. The chairman, in reviewing the progress of the undertaking, said their consumers last year, compared with the previous 12 months, showed an increase of 50 per cent., while the amount of current had increased by 300 per cent., or three times as much. An interesting point which consumers seemed to be grasping was the economy of the newer lamps. If all their consumers were using the old lamps an enormously larger amount of current would be consumed, but they were replacing the common-type lamp by others, with the result that they obtained twice as much efficiency for a given sum. That in the long run would be very satisfactory to the undertaking, because it would lead to the extended use of the electric light, but for the moment it had prevented the extension of consumption which would otherwise have occurred. One of the difficulties in the first year of the undertaking was the extraordinary parsimony displayed by consumers in the amount of light they used, the average being only 7½ units per 8-c.p. light. He was glad to find they had got over their extraordinary caution, and were now burning about 14 units per 8-c.p. lamp. The year had been one of very satisfactory progress, and in all respects the staff had worked cordially and efficiently for the success of the undertaking.

Dover.—The accounts of the Dover Corporation electricity departments have just been circulated. The report states that during the year ended March 31, 1907, applications had been received for an equivalent of 2,691 8-c.p. lamps, exclusive of public lighting. The total connections now number about 40,000 8-c.p. lamps. The output to private consumers was 713,210 units, being an increase of 40,895 over the previous year. Since the last report the Local Government Board has sanctioned two loans—viz., £6,590 for six years and £15,555 for 18 years. The Board has refused sanction in respect of an item of £462, and it has been necessary, therefore, to transfer this amount from reserve fund account. The natural growth of the undertaking has made necessary a further expenditure on capital account during the year of £6,615. 14s. 10d. The principal items are £221. 3s. 5d. for buildings; £3,566. 13s. 6d., the cost of the new power plant, etc.; £2,260 for main extensions and service connections; and £266. 18s. for meters. These together with several smaller sums, bring the total capital expenditure to date to £179,823. 13s. 8d. The amount received from the sale of current, after deduction of bad and doubtful debts, is £16,754. 14s. 7d., and the total receipts from all sources £19,580. 10s. 7d. The total cost of working the undertaking, including generation and distribution of the current and the expenses of management, etc., amounts to £9,307. 7s. 4d., thus leaving a gross profit for the year of £10,273. 3s. 3d. This profit is equal to a return of 5·82 per cent. on the average capital expended, as compared with 5·24 in respect of last year. The sum of £7,388. 8s. 8d. has been expended in the payment of interest on loans, and £4,009 has been placed to the credit of the sinking fund, and the resulting balance to the debit of net revenue account has been met by the transfer of £470. 11s. 2d. from reserve fund account. The amount of £4,009 carried to the sinking fund is the annual payment in respect of the whole of the loans sanctioned. The total amount standing to the credit of the sinking fund, including interest received from investments, is £9,290. 12s. 10d., and is invested in local loans 3 per cent. stock.

Stepney.—At a meeting of the Council held on June 19 the Electricity Committee submitted a resolution that, subject to the Council agreeing to the terms of remuneration to be allowed to the borough electrical engineer and manager, the work of preparing the plans, etc., for the designing and construction of Blyth's Wharf scheme be entrusted to such officer; and that on the completion of such plans, etc., expert advice be sought on the matter. Consequent upon the passing of this resolution the General Purposes Staff and Education Committee submitted various recommendations for the reorganisation of the staff. The Council, however, did not see their way to adopt the recommendations, but passed the following resolution: "That, having reconsidered the matter, this Council is of opinion that the further development of the electric lighting undertaking should be entrusted to an expert to be specially employed for the purpose; and that the matter be referred to the Electric Lighting Committee to consider the advisability of recommending the employment of such an expert." After again considering the matter, the Electric Lighting Committee propose to ask the Council to rescind the resolution which was submitted to them on June 19, and recommended at the Council meeting held on the 3rd inst. that Mr. Arthur Wright be appointed consulting engineer upon the following terms: (*a*) the term of employment to be for a period of six years from the date instructions were given him; (*b*) the remuneration to be on the basis of an annual salary of £800; (*c*) the Council to pay quantity surveyor's fees in respect of the erection of the station building at Blyth's Wharf, Mr. Wright to employ his own architect therefor and to pay such architect, the quantity surveyor to be selected by him; (*d*) the Council to pay quantity surveyor's fees, the fees of the district surveyor, and other fees of a like description payable in respect of the river work at such wharf, Mr. Wright to design and to pay for any advice he may require in connection with such river work. At a meeting of the Borough Council on Wednesday night a discussion took place regarding the proposed erection of the second electricity generating station at Limehouse. The Electricity Committee, in their report, declined to make any recommendations, and the question was again referred to the committee, with a view to definite recommendations being brought up at the next council meeting.

University of Birmingham.—The council of the University of Birmingham has recently created an Advisory Board of business men in connection with the faculty of commerce, believing that the active co-operation of such a body with the academic staff will tend to bring those who control large undertakings throughout the country into closer touch and sympathy with the aims of this section of the university. This object must commend itself to everyone conversant with the requirements of modern business. In the departmental administration of large concerns, technical skill is so evidently called for that experts with the highest available training are employed in subordinate positions of authority. Yet this country has hitherto neglected the training of general managers, who not only engage and superintend these experts, advance them for proved competency, or dismiss them for inefficiency, but, at the same time, have the responsibility of buying materials to the best advantage, deciding as to the extension or replacement of plant, assuring the disposal of the output, and planning financial policy. The aim of the

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faculty in relation to commerce is to devise such a system of training as, combined with a liberal education, shall be a suitable preparation for the proposed career. The course extends over three years, and embraces the study of subjects specially selected to bring out the broader qualities necessary in men who aspire some day to fill positions of great responsibility. The expectation of those interested in the development of the new section of the university is that it will do for commerce preliminary work similar to that which is undertaken for the army by the Royal Military Academy and the Royal Military College, and that its graduates will enter upon their careers not only with the advantage of a liberal education, but also with an intelligent understanding of the commercial and economic sides of business in general, and an initiatory training in methods and functions appropriate to their intended pursuits. Such graduates should take positions in the world of commerce akin to those of cadets from Woolwich and Sandhurst in the army, and should be fitted, after assimilating the lessons of their practical experience, to qualify themselves for the higher posts in the branches of manufacture and trade with which they may become identified. The Advisory Board state that those interested in the objects of the faculty can assist its work by bringing the advantages of the training now offered to the knowledge of those, whether themselves engaged in commercial or in professional life, who intend their sons to follow a business career; taking advantage of the material offered by the faculty by filling positions in its service from among its graduates.

Shoreditch.—The special sub-committee which was appointed some time ago by the Borough Council to inquire into the working and financial position of the electricity undertaking, and also into the question of the cost of the public street-lighting, have now concluded their labours, and a report on their investigations has been presented by the Lighting Committee to the Borough Council. As to the public lighting, the committee have tested the effect of reducing the illuminating power of the arc lamps in certain streets by 20 per cent., which, while reducing the quantity of electricity consumed, appears to have provided sufficient lighting in those streets, and as by this means an annual saving of some £120 per circuit (or £720 for six circuits) can be effected at a cost for the first year of about £25 per circuit. With regard to the refuse destructor, the steam raised is utilised in generating electricity at the Coronet-street station. The borough electrical engineer has recommended the shutting down of that station except as a stand-by, but the committee are against this course, and advise placing the whole of the steam plant (boilers and engines, etc.) at Coronet-street in the charge of the engineer who is responsible under Mr. Russell for the working of the destructor, charging the destructor account with the cost of running and maintenance of same; the electricity department to take and pay for all electricity which it is possible to generate from refuse—the price per unit to be based on the coal and oil cost per unit at Whiston-street, plus 20 per cent. for stand-by charges. From a table showing the figures of 25 undertakings in London it appears that the Shoreditch total costs per unit (which is the standard of comparison generally adopted) are 1·53d., against the lowest in the list, ·84d., and the highest, 2·27d. per unit, being almost exactly the average for London. The fact that two stations are running is responsible for some increase in the costs. On the other hand, the committee point out that the costs per unit are steadily decreasing, and it is anticipated that the current year will show a substantial diminution. The cost of generating at Whiston-street station compares favourably with any station in London. The committee have considered the financial results of the department, and find that up to the present the electricity department has borne all charges and met all payments for interest on and repayment of capital without making any charge on the rate fund, but, on the other hand, the scavenging department and the baths at Hoxton have benefited considerably during the last 10 years at the expenses of this department, the late borough surveyor, Mr. J. Rush Dixon, estimating the saving to the scavenging department at £2,000 per annum. As regards depreciation, the committee are of opinion that the redemption of debt account or sinking fund payments cannot be regarded as equal to a depreciation fund unless the life of the plant coincides with the term of repayment, and as the term of nearly all the loans at Shoreditch is 42 years, the department has not up to the present accumulated sufficient funds to meet the requirements of a depreciation fund. As the same time, it is necessary to point out that all renewals and replacements of plant have been met out of revenue. It is essential, they state, that every effort should be made to build up a reserve fund for this purpose, and this cannot be done if the electricity department is made to contribute indirectly to the relief of the rates by doing work for other departments of the Council at less than market price.

PROVISIONAL PATENTS, 1907.

JUNE 24.

14474. Improved method of distributing electrical currents for internal-combustion engine ignition. John Joseph Robson, 33, Lovaine-place, Newcastle-on-Tyne.

14491. Improvements in high-tension magnetos. Mortimer Arthur Codd, 27, Addington-square, Camberwell, London.

14494. Improvements in electrical ignition apparatus for use with internal-combustion engines. Arthur Leonard Cliburn and George Thompson, 8, Elgin-crescent, Wealdstone, Middlesex.

JUNE 25.

14567. Improvements in electrically-operated electric switches. August Eckstein, Arthur Cecil Heap, and David Barclay Mellis, Waverley Mills, St. Simon-street, Salford.

14572. New and improved detector switch for electrically detecting the position of railway points. Thomas Eli Haywood and McKenzie and Holland, Limited, Vulcan Ironworks, Worcester.

14594. Improvement in electric tramcars. Jesse Orlando Millard, 192, Peel Green-road, Patricroft.

14620. Improvements in or relating to the regulation of electric circuits, and to means therefor. Siemens-Schuckertwerke, G. m. b. H., 139, Queen Victoria-street, London. (Date applied for under Patents Act, 1901, June 26, 1906, being date of application in Germany.) (Complete specification.)

14637. Improvements in electromagnetic appliances for playing pianos and other musical instruments. Friedrich Schnbbe, 37, Essex-street, Strand, London. (Complete specification.)

14649. Improved electric battery. Alfred Wydts and Frédéric Jeudi, 118, Holborn, London. (Date applied for under Patents Act, 1901, June 28, 1906, being date of application in France.) (Complete specification.)

14681. Improvements in electrical measuring and recording instruments. Thomas Edward Slaughter and Haydn Thies Harrison, 46, Lincoln's-inn-fields, London.

JUNE 26.

14713. Improvements in arc lamp electrodes. Henry Stafford Hatfield and Frank Michael Lewis, 18, Palmeira-square, Hove, Sussex.

14725. Improvements in or relating to electrical potential regulators or speed-controlling devices. Siemens Bros. Dynamo Works, Limited, 139, Queen Victoria-street, London. (Siemens-Schuckertwerke G. m. b. H., Germany.) (Complete specification.)

14752. Improvements in protective means for electrical circuits. Charles Felton Scott, Westinghouse Building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, July 9, 1906, being date of application in United States.) (Complete specification.)

14753. Improvements in protective and phase-adjusting means for electrical circuits. Charles Felton Scott, Westinghouse Building, Norfolk-street, Strand London. (Date applied for under Patents Act, 1901, July 9, 1906, being date of application in United States.) (Complete specification.)

14756. Improvements relating to secondary batteries. Rudolf Ziegenberg, 7, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Aug. 10, 1906, being date of application in France.) (Complete specification.)

14762. Improvements relating to secondary batteries. Rudolf Ziegenberg, 7, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Aug. 11, 1906, being date of application in France.) (Complete specification.)

JUNE 27.

14797. Improvements relating to boxed electric switches, fuses, and the like. Veritys, Limited, and Arthur Edgar Gott, 11, Burlington-chambers, New-street, Birmingham. (Complete specification.)

14803. Improvements in or relating to magneto-electric machines. Piet Reinouts van Haga, High-street-chambers, Coventry. (Complete specification.)

14831. Improvements in prepaid hour meters for electricity. Wilfrid Bertram Thorpe, 185, Fleet-street, London.

14838. Improvements in or relating to the compounding of alternate-current dynamo-electric machines. Siemens Bros. Dynamo Works, Limited, 139, Queen Victoria-street, London. (Siemens-Schuckertwerke G. m. b. H., Germany.) (Complete specification.)

14839. Improvements in or relating to electric switches or cut-outs. Siemens Bros. Dynamo Works, Limited, and Claude Martineau Toplis, 139, Queen Victoria-street, London. (Complete specification.)

14847. Improvement relating to the electrodes for searchlights. Gebrüder Siemens und Co., Birkbeck Bank chambers, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Sept. 26, 1906, being date of application in Germany.) (Complete specification.)

14861. Improvements in connection with magnetic clutches. Henry Leitner, 4, South-street, Finsbury, London.

14876. Improvements in and relating to dynamo-electric machines. Jakob Emil Noeggerath, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, June 30, 1906, being date of application in United States.) (Complete specification.)

JUNE 29.

15310A/06. Improvements in or relating to electric arc lamps. Charles Oliver, Birkbeck Bank-chambers, Chancery-lane, London. (Date applied for under Rule 5 of the Patents Rules, 1905, July 5, 1906.)

14881. New excitant for primary batteries. Alfred Wood Somers and Richard Joseph Crowley, Spring Bank, Bradford, Yorks.

14930. Method of and materials for connecting together certain conductors of electricity. James Grieve Lorrain, Norfolk House, Norfolk-street, Strand, London. (Friedrich Bölling, Germany.)

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14935. Improvements in the distribution of electric currents in the three and more wire systems. Theodore Torda and Ludwig Torda, Chescombe, Netheravon-road, Chiswick. (Complete specification.)

14990. Improvements in and relating to electric motor control. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

15009. Improvements in altornating-current electromagnets. Felten und Guilleaume-Lahmeyerwerke Act.-Ges., 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, April 2, 1907, being date of application in Germany.) (Complete specification.)

15012. Improvements in or relating to coils for electrical apparatus. Sidney John Ross, 139, Queen Victoria-street, London.

15016. Apparatus for facilitating and checking code telegraphy. Arthur Tracey, 37, Essex-street, Strand, London.

15017. Improvements relating to electric incandescence lamps with metal filaments. Hans Kuzel, 322, High Holborn, London. (Complete specification.)

15023. Improvements in or relating to electrical contact makers or counters for turnstiles. Isidore Fluegelman, 7, Southampton-buildings, London. (Complete specification.)

15028. Improved construction of electric lamp. Thomas Ward and Malcolm Cooper, 173, Fleet-street, London.

15029. Improvements in lamp shades and lenses. Thomas Ward and Malcolm Cooper, 173, Fleet-street, London.

15050. Electric fire and burglar alarm, automatic or otherwise, portable or otherwise. John Yates, 21, Loxford-avenue, Barking-road, East Ham. (Complete specification.)

15058. Improvements in apparatus for separating iron and other magnetically permeable metals from flour, grain, and the like. Frederick King, 27, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on July 18.)

1906.

14517. Magnetic clutches. Ravenshaw, Middleton, and Townsend.

14577. Electric circuit breakers and makers. Statter.

14615. Electric railways working on the surface-contact system. Rothwell.

14642. Secret keyboard for central exchange switchboard. Beard.

14816. Method of producing metallic incandescence bodies for electric glow lamps. Deutsche Gasglühlicht Akt.-Ges. (Auerges). (Date applied for under International Convention, Oct. 28, 1905.)

15016. Point-shifting arrangements for electric tramways and the like. Tierney and Malone.

15428. Electric switches. Jones.

15587. Insulators for electric rail or tramways. Estler and Drake.

17981. Apparatus for the electrolytic production and separate collection of gases. Wetter. (Elektrizitäts-Aktiengesellschaft vormals Schuckert und Co.)

18365. Metallic cases for motor starters, switches, fuses, and the like electrical apparatus. Brook and Hirst.

18486. Time and like switches, especially applicable for use with electric metering apparatus. Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, Aug. 19, 1905.)

18835. Method of heating molten or semi-molten materials by electricity. Wynne.

19548. Electric transformers. British Thomson-Houston Company. (General Electric Company.)

21769. Connections for graphite carbon electrodes. Schoop.

21874. Electric arc lamps. British Thomson-Houston Company. (General Electric Company.)

22323. Magneto-electric ignition apparatus. Münz.

26940. Construction of electric accumulators. Marino and Barton-Wright.

27640. Electric arc lamps. New Century Arc Light Company and Baggett.

28015. Vent valves for galvanic batteries. Schalow.

29176. Insulator for electric conductors. Boltshauser.

29193. Unipolar dynamos. Matthiesen.

29271. Electric transformer furnaces. Frick. (Date applied for under International Convention, Dec. 27, 1905.)

29276. Telephone apparatus. Friedländer. (Date applied for under International Convention, Sept. 17, 1906.)

1907.

42. Time indicator for persons using the telephone. Cunningham.

99. Alternating-current commutating machines, the magnet fields of which are excited by the armature. Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, Jan. 29, 1906.)

287. Telephone installations having central and local exchanges worked by a central battery. Siemens Bros. and Co. (Siemens und Halske Akt.-Ges.)

288. Telephone exchanges. Siemens Bros. and Co. (Siemens und Halske Akt.-Ges.).

1080. Electric induction furnaces. Soc. des Procédés Gin pour la Metallurgie Electrique. (Date applied for under International Convention, March 7, 1906.)

1201. Device for igniting a gas or gaseous mixture by means of electric sparks. Marks. (Akt.-Ges. fur Automatische Zund und Losch Apparate).

1243. Starting and regulation of electric motors. Siemens-Schuckertwerke Ges. (Date applied for under International Convention, Feb. 3, 1906.)

2106. Thermal electric contact-making devices. Francombe.

3276. Crowns or covers of electric furnaces. Ransford. (Soc. Anon. Electrometallurgique Procédés Paul Girod.)

3933. Electric wave meters. Eisenstein.

4667. Electrode for sparking plugs. Aldigier.

6193. Electric transformer furnaces. Grönwall, Lindblad, and Stalhane.

7309. Armatures of magneto-electric and like machines. Glossel and Littmann.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	—	½-⅝
—— Ord., 1 125,000	1	..	¼-½
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	⅝-¾
British Aluminium Co., Ordinary, 2,001-40,000	5	..	5-5¼
—— 7 per cent. Cum. Pref., 1-40,000	5	..	5⅜-5½
—— "A" 6 per cent. Cum. Pref., 1-20,000	5	..	5¼-5⅜
—— 4 per cent. Funding Certificates, 1-20,000	5	..	3¾ 4¼ xd
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	100-103
—— 5½ per cent. Loch Leven Deb. (Reg.), Red., 1-3,000	100	..	98-101
British Insulated and Helsby Cables, Ord., 1-100,000	5	—	6¼-6⅜
—— 6 per cent. Cum. Pref., 1-100,000	5	—	5⅜-6¼
—— 4½ per cent. Mortgage Debentures	100	—	102-105
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	—	92-97
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	5	..	1-1½
—— 4 per cent. Mortgage Debenture Stock	100	..	63 67
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	⅛ ¼
—— Non. Cum., 6 per cent. Pref.	2	..	2-1¼
—— 4½ per cent. 1st Debenture Stock	100	..	88-91
—— 4½ per cent. 2nd Debenture Stock	100	..	75-78
Callender's Cable, Debentures	100	..	106½-108½
—— Ordinary	5	—	9½-10½
—— 5 per cent. Pref.	5	..	5¼-5⅜
Consolidated Electrical Co., Ordinary, 1-110,000	1	..	5/16-7 16
Crompton and Co.	3	..	1 13/16-2 1/16
—— 5 per cent. Debentures	100	—	96-99
Dick, Kerr, and Co., Ordinary, 1 260,000	1	..	1 5/16-1 9/16
—— 6 per cent. Cum. Pref., 1-305,000	1	..	1-1¼
—— 4½ per cent. Debenture Stock, Red.	100	..	102-105
Edison and Swan United, "A" Shares, 1-99,261	3	—	1-1¼
—— "A" Shares, 01-017,139	5	—	2¼-2¾
—— 5 per cent. Debentures	100	—	81-82
—— 4 per cent. Deb. Stock, Red.	100	—	85 87
Electric Construction, Nos. 1 to 112,100	2	—	⅛-¼
—— 7 per cent. Cumulative Pref.	2	—	1¼-1½
—— 4 per cent. Perp. 1st Mort Deb.	100	—	79-83
Electrolytic Alkali Co., Ordinary, 1-202,218	1	..	⅛-¼
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	—
General Electric Company (1900), 5 per cent. Cum. Pref.	10	—	8¼ 8⅜
—— 4 per cent. 1st Mort. Deb. Stock	100	—	82-86
W. T. Henley's Telegraph Works, Ordinary	5	—	11¼-12½
—— 4½ per cent. Preference	5	—	5-5½
—— 4½ per cent. Debentures	100	—	105 107
India Rubber, Gutta Percha, and Telegraph Works	10	—	15-16
—— 4 per cent. Debentures	100	—	97-99
National Electric Construction Co., 1-170,000	1	..	27/32-31/32
Parker, Thos., Limited, Ordinary	1u	—	10-10¼
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,031-50,000	5	..	3¾-4¼
Telegraph Construction and Maintenance	1⅛	—	30-32
—— 5 per cent. Bonds	100	—	101-104
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	..	9½-10
Electric Lighting and Supply.—			
Adelaide Electric Supply Co., 6 p. c. Cum. Pref., 1-10,000		..	4⅜-5
Bournemouth and Poole, Ordinary	10	—	10 11
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	—	9⅝ 10¼
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	—	10-10½
—— 4½ per cent. Debenture Stock, Red.	100	—	101-104
Bromley (Kent) Electric Light and Power Co.	5	—	4¾-5¼
—— 4½ per cent. 1st Debenture Stock, Red.	100	—	98 100
Brompton and Kensington, Ordinary	5	—	7¾ 8¾
—— 7 per cent. Preference	5	—	7½ 8½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	—	7¼ 8¼
—— Nos. 80,001-100,000	4	—	5¼-6¼
Cambridge Electric Supply Company, £10 Ord.	8	—	12¼-13¼
Canadian General Electric Co., Common Shares	$100	..	130-134
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	—	99-102
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	—	3 4
—— 4½ per cent. Cum. Pref., 1-80,000	5	—	4 4¼
—— 4 per cent. Debenture Stock, Red.	100	—	94 97 xd
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	—	3¾ 4¼
—— ditto (1903) 40,001-80,000	5	—	3¾-4¼
Chelsea Electricity Supply	5	—	3¼ 4¼
—— 4¼ per cent. Debentures	100	—	103-106
Chicago Edison Co, 1st Mt. 5 p. c. 30-yr. Gld. Bds, Red., 1-1,200	$1000	..	98-101
City of London, Ordinary	10	—	9-10
—— 6 per cent. Cumulative Pref.	10	—	11¼-12¼
—— 5 per cent. Debenture Stock	100	—	123-126
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	—	97-100
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1,650	50	—	48-5

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Name.	Amount paid. £		Last price £
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100	..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-30,000	5	..	4½-5
—— 5 per cent. Preference, 1-50,000	5	..	4½-5
County of London Electric Supply, Ordinary	10	—	7½ 8½
—— 6 per cent. Cum. Pref.	10	—	10½-11½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	—	106-109
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	—	93-96
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5	—	½-1
—— 6 per cent. Cum. Pref.	5	—	1½-2½
—— 4½ per cent. First Mort. Deb	100	—	78 85
Electrical Development Co. of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, 10,751-15,75	—	..	79-81 p.c.
Electric Lt. & Traction Co of Aust., 6 p c Cm Pf, 1 30,000	5	—	2½ 2¾
—— 5 per cent Debenture Stock Red	100	—	88-92
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red.	100	—	97 99
Folkestone Electric Supply, Ord. Nos. 1-10,000	5	—	4¼-5⅛
—— 4½ per cent. First Deb. Stock, Red.	100	—	98-101
Hove Electric Lighting, Ord., 1-13,000	5	—	7-7½
Indian Electric Supply and Traction Co, 6 per cent. Construction Deb. Stock, Red.	100	..	106-109
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk. Red.	100	—	94-97
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	—	25/32-29/32
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5	—	8½-9½
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	—	97-100
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9¾-10½
London Electric, Ordinary	0	—	1¾-2½
—— 6 per cent. Pref.	5	..	4⅞-5½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	93-96 xd
Madras Electric Supply Corporation, 5 per cent. Construction Deb. Stock., Red. (Prov. Certs.), all paid	—	..	94½-97½
Metropolitan Ordinary, 100,001-300,000	5	..	5 6⅜
—— 4½ per cent. First Mortgage Debenture Stock	100	—	105 109
—— 4½ per cent. Cum. Pref.	5	—	4¾ 5⅛
—— 3½ per cent. Mortgage Debenture, Red.	100	—	88 93
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds., 1935, C 1-1,000 ($100), D 1-3,000 ($500), M 1-4,400 ($1,000)	—	..	77-79 p.c.
Mexican Light and Power Co., Capital Stock	$100	..	45-47
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14,000 ($1,000)	—	..	84-86
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	—	86-88
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009	5	—	7¼ 7⅜
—— do., 57,010-75,000	5	..	7¼-7⅜
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid)	2	—	2½-3
—— 5 per cent. Pref., 1-57,009	5	..	5 6
—— do., 75,001-87,500 (issued at 10s. prem., 4s. paid)	2	..	1¾-2¼
Notting Hill Electric Lighting	10	—	12 15
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	—	96 99
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	—	6 6½
—— 4 per cent. Debenture Stock	100	—	96 98
River Plate Electricity Co., Ord., 1-119,687 & 120,501-120,507	1	..	⅜-½
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	..	½-1
—— 4 per cent. Debenture stock, Red.	100	..	97-100
Rosario Electric Co., 6 per cent Cum Pref., 1-20,000	5	..	5-5½
—— 6 per cent. Cum. 2nd Pref., 1-15,000	4	..	4-4½
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	—	96 98
Shawinigan Water and Power Co., 5 p c. Cons. 1st Mt. Bds.	—	..	100 102 p.c.
Smithfield Markets Electric Supply, Ord. 1-12,000	5	—	1½-2½
—— 4 per cent. Debenture Stock	100	—	73 77
South London, Ordinary	5	—	2 2½
South Metropolitan Electric Light and Power, Ord.	1	—	⅞ 1
—— 7 per cent. Cum. Pref.	1	—	1¼-1⅜
—— 4½ per cent. 1st Mort. Deb.	100	—	100-103
St. James's and Pall Mall, Ordinary, 101-20,080	5	—	7½ 8½
—— 7 per cent. Pref.	5	—	6½ 7½
—— 3½ per cent. Deb.	100	—	88 93
Urban Electric Supply Co., Ordinary, 8-30-007	5	—	1½-2½
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	—	2½-3½
Westminster, Ordinary	5	—	9 10
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	—	5½-6⅜

Electric Tramways.—

Anglo-Argentine, 5½ per cent. Cum. Pref., 1-260,007	5	—	5¾-6
—— Ord.	5	—	8 8½
—— Permanent 6 per cent. Debenture Stock, 1888	100	—	134-137
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	—	104-107
Barcelona Tramways, Ord., 1-20,000	10	—	—
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	—	—
—— 5 per cent. Deb., Red., 1-600	100	—	—
—— 4½ per cent. Red. Deb. Stock	100	—	—
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1	—	¾ ⅞
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	—	¾-1
Birmingham and Midland Trams., 4½ p c. 1st Db. Stk., Red.	100	..	94-99
Blackpool and Fleetwood Tramroad	10	—	13⅜-13⅝
Bombay Elec. Supply & Trams. Co., 6 per cent. Cum. Pref.	8	..	7½-8¼
—— 4½ per cent. Deb. Stock, Red.	100	..	95-98
Brisbane Tramway Invest., Ord., 1-75,000	5	—	2 15/16-3 3/16
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	—	4¾-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	—	98-102
British Columbia Electric Railway Co., Ord. Def.	100	—	120-125
—— Ord. Pref.	100	—	103½-108½
—— 5 per cent. Cum. Perpetual Pref. Stock	100	—	102-106
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40	—	99-101
—— 4½ per cent. Vancouver Power Deb.	100	—	103-105
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	—	2½-2¾
—— 6 per cent. Cm. Pf., 30,001-60,000	10	—	6¾ 7¼
—— 5 per cent. Perpetual Debenture Stock	100	—	103-106
—— 4½ per cent. 2nd Deb. Stock	100	—	78 81
Buenos Ayres and Belgrano Trams.	5	—	3 15/16 4 3/16
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	—	4¾-5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	4¾ 5⅛
—— 5 per cent. Deb. Stock, Red.	100	—	105-115
—— Prov. Cert., all paid	100	—	101-104
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100	—	95-100
Buenos Ayres Gd. Nat. Trams Co, 5½ per cent. Pref. Deb. Bonds, Red., 1-1,500	100	..	100-104
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	..	100-105
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	93-95
Calcutta Tramways, 1-105,000	5	—	7¼-7⅜
—— 105,001-157,610	5	—	7¼-8 xd
—— 4½ per cent. 1st Deb. Stock, Red.	100	—	104-107
Cape Electric Tramways, Nos. 1-480,000	1	—	5/16 7/16
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	—	4¼ 5
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100	—	98 101
City of Buenos Ayres Trams. Co. (1904) 1-248,000	5	..	5¼-5⅜
—— 4 per cent. Deb Stock, Red. 1935	100	..	97-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	00	—	96-100

Name.	Amount paid. £		Last price. £
Cork Electric Tramway and Lighting Co., Ordinary	10	—	13½-14½
—— 6 per cent. Cum. Pref.	10	—	13-14
—— 4 per cent. Debentures	100	—	98-100
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	—	13½-14½
—— 6 per cent. Pref., Nos. within 1-60,000	10	—	13-14
—— 3½ per cent. Mort. Debs., 1-3,000 Red.	100	—	94-96
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100	..	98-101
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6,957	$1,000	—	85-90
Imperial Tramways, Ordinary	all	—	18-19
—— 6 per cent. Cum. Pref.	all	—	14-14¼
—— 4 per cent. Deb. Stock	100	—	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5	—	1-1½
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	—	68-73
Kalgoorlie Electric Tramways, 1-250,000	1	..	5/32-5/32
—— 5 per cent. "A" Deb. Stock	100	..	89-93 xd
—— 6 per cent. "B" Deb. Stock	100	..	78-82 xd
Kidderminster and District Lighting and Traction. Pref.	5	—	8-8½
Lancashire United Tramways Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	—	96-98
—— £296,500 2nd Mort. Deb Stock	—	—	—
—— £83,330 Deferred Deb. Stock (all fully paid)	—	—	—
Lisbon Electric Tramways Limited, Ord., Nos 1-594,188	1	..	1¼-1⅜
—— 6 per cent. Cum. Pref., Nos. 1-425,553	1	..	1 1/16-1 3/16
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100	..	98-101
London United Trys. (1901), 5 per cent. Cum. Pref.	10	—	7¾ 8¾
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	—	£4 88
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Rd.	100	—	98-101
Manila Elec. R.R. and Lghtg. Corp., 5 p c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000	..	93-95
Manx Elec Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 23,436-25,000	5	..	4⅞-5⅛
—— 4½ per cent. 1st Mort Deb. Stock, Red.	100	..	97-100
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	—	3/32-5/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	—	27 32 31 32
—— 4½ per cent. Deb. Stock, Red.	100	—	96-99
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	—	..	84-85 p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	—	103 105
Montreal Street Rail., 4½ per cent. Sterling Deb., 601-2,000 (1922)	100	—	103-105
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	—	⅜ 1½
Oldham, Ashton, and Hyde Tramway, Ordinary	10	—	12
—— 5 per cent. Cum. Pref.	10	—	8⅜-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100	—	102-106
Potteries Electric Traction, Ordinary, 1-24,000	1	—	⅜-½
—— 5 per cent. Cum. Pref., 300,001-545,000	1	—	⅜-½
—— 4½ per cent. Debenture Stock	100	—	95 98
Provincial Tramways Co., Ordinary, 1-24,912	10	—	5-5½
—— 6 per cent Cum. Pref., 1-10,000	10	..	10½-11½
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-30,000	5	..	5½-5⅝
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	97-100
Sao Paulo Tramway, Light, and Power Co.	$100	—	123-1.8
—— 5 per cent. 1st Mort. Deb., Red 1929, 1-11,000	$500	..	92-91 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1	..	29 32-1 1/32
—— 4 per cent. Deb. Stock, Red. 1940	100	..	82-86
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs, Red., 1-1,600	100	..	86-90
Yorkshire (West Riding) Elec. Tram Co., Ord., 70,001-110,000	5	..	1-1½
—— 6 per cent. Cum. Pref., 1-46,261	5	..	3½-3⅝
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	9.-95

Electric Railways.—

Central London, Ordinary	100	—	72-74
—— 4 per cent. Pref.	100	—	92-94
—— " deferred	100	—	53-56
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	—	103-106
City and South London, Consolidated Ordinary	100	...	45-47
—— 4 per cent. Debenture Stock	100		102-105
—— 5 per cent. Pref. Stock '91	100	—	117-121
—— " " " '95	100	—	115-118
—— " " " '01	100	—	109-112
Liverpool Overhead, 5 per cent. Pref.	10	—	10-10¼
—— Ordinary, 1-50,000	10	—	3¾-4¼
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	—	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	...	61-64

Telegraphs and Telephones.—

Amazon Telegraph Co., 1-25,000	10	..	3-3½
—— 5 per cent. Debs., Red., within 1-1,069	100	—	88-91
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000	$1,000	..	92-94
Anglo-American Telegraph Co., Ordinary	100	..	61-64
—— 6 per cent. Preferred Ordinary	100	...	107½-108½
—— Deferred Ordinary	100	...	19½-19¾
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort Deb. Stock, Red.	100	...	98-101
Chili Telephone Co., 1-44,000	5	...	6¾-7¼
Commercial Cable Co., Ster. 500-year 4 p.c. Deb Stk., Red.	100	...	92-94
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	...	7¾-8¼
—— 10 per cent. Preference, 1-6,000	10	...	15¾-16¾
Direct Spanish Telegraph Co., Ordinary	5	...	3⅜-3⅝
—— 10 per cent. Cum. Preference	5	...	8¾-9¼
—— 4½ per cent. Debs., 1-600	50	...	100-103
Direct United States Cable Co.	20	...	15¼-16¾
Direct West India Cable Co., 4½ per cent. Debs., Reg. within 1-1,200, Red.	100	...	100-102
Eastern and South African, 4 per cent. Mort. Debs., within 1 3,000, 1909	100	...	98-101
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8,000, 1913	25	...	97-100
Eastern Extension, Australasia and China, 1-300,000	10	...	12⅝-13¼
—— 4 per cent. Mort. Deb. Stock, Perp.	100	...	104-106
Eastern Telegraph Co., Ordinary Stock	100	...	135-140
—— 3½ per cent. Preference Stock	100	...	89-91
—— 4 per cent. Mortgage Debenture Stock	100	...	104½-106½
Great Northern Telegraph Co. (of Copenhagen)	10	...	34-36
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1,200, Red.	100	...	100-102
Indo-European Telegraph Co.	25	...	56-58
Marconi's Wireless Telegraph Co., 1-256,127	1	...	⅝-¾
—— 256,128-384,190	1	...	⅝-¾
Monte Video Telephone Co., Ordinary, 1-72,680	1	..	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492		...	¾-1
Oriental Telephone and Electric Company	1	..	1¼-1⅜
—— 6 per cent. Cum. Pref.	1	..	1¼-1½
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100	...	95-98

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Name	Amount paid. £		Last price £
National Telephone, Preferred	100	...	108-110
—— Deferred Stock	100	...	105-107
—— 6 per cent. Cum. First Pref.	10	...	11½-12½
—— 6 per cent. Cum. Second Pref.	10	...	10-12
—— 6 per cent. Non. Cum. Third Pref.	5	...	5 5/16-5 9/16
—— 3½ per cent. Deb. Stock, Red.	100	...	95½-97½
—— 4 per cent Deb. Stock, Red.	100	...	100-102
United River Plate Tele. Co., Ordinary, 1-100,000	5	...	6¾-7½
—— 5 per cent. Cum. Pref., 1-40,000	5	...	5-5½
—— 5 per cent. Debenture Stock, Red.	100	...	108½-111½

Name.	Amount paid. £		Last price. £
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	...	99-102
West African Telegraph Co.	10	...	10-10½
West Coast of America, 1-30,000 and 53,001-53,008	2½	...	1¼-1⅝
—— 4 p c. Debs., 1-1,500, Gua. by Western Telegraph	100	...	99-102
West India and Panama Telegraph Co., Ordinary	10	...	9/16-1 /16
—— 6 per cent. Cum. 1st Preference	10	...	7⅛-7½
—— 6 per cent. Cum. 2nd Preference	10	...	6¼-6½
—— 5 per cent. Debs., Red., 1-800	100	...	101-104
Western Telegraph Co., 1-207,930	10	...	13¾-14¼
—— 4 per cent. Debenture Stock, Red.	100	...	102 105

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week. Ending	1907.	1906	Increase or decrease. Week.	Current year.	Miles of single track open. 1907.	1906.	Accounts for past year. Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	Cost per car mile.
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	June 26	1,421	1,409	+ 11	− 255	25½	25	May 31	64,071	15,530,351	1,379,723	J·98	11·14	2,512	6·45
Ayr Corporation	,, 29	318	327	− 9	—	8	8	,, 15	14,328	3,316,380	353,945	1	9·71	1,830	5·16
Baker Street and Waterloo Ry.	,, 29	2,705	1,419	+1,285	+15,392	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 30	1,071	1,105	− 34	− 550	23·53	3·53	March 31	55,025	11,145,531	1,309,903	1·18	10·08	2,338	6·03
Birmingham Corporation	,, 23	6,117	—	—	—	55½	—	,, 31	17,133	4,709,798	266,526	·86	14·5	8,866	—
Blackburn Corporation	,, 26	1,060	1,102	− 42	+ 624	24	24	,, 25	48,875	8,661,72 0	986,953	1·35	11·89	2,036	7·44
Blackpool Corporation	,, 27	1,090	1,2 7	− 127	− 1,709	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	,, 29	716	873	− 157	+ 441	16½	16½	Dec. 31	31,846	2,325,677	579,264	3·28	13·19	—	7·27
Bolton Corporation	,, 30	2,245	2,170	+ 75	+ 871	42		March 31	5,766	20,205,196	2,161,130	1·13	10·63	2,394	6·14
Bournemouth Corporation	,, 26	1,571	1,624	− 53	− 124	17·41		,, 31	55,276	10,058,288	1,121,623	1·32	11·83	3,226	7·19
Bradford Corporation	,, 23	4,605	4,694	− 89	− 319	95	95	,, 1	230,085	47,108,000	5,053,392	1·172	10·927	2,396	—
Brighton Corporation	,, 30	882	1,020	− 138	− 1,155	9½	9½	1	50,339	11,321,160	1,152,828	1·06	10·48	2,914·8	8·014
Bristol Tramway Company	,, 28	5,029	5,306	− 277	—	51½	½	Dec. 31	259,799	45,312,37	6,127,135	—	—	—	—
Burnley Corporation	,, 29	1,217	1,189	+ 28	—	40		March 31	57,992	11,092,704	1,197,772	1·31	11·61	5,388	8 17
Burton Corporation	,, 30	288	316	− 28	− 262	8½	8½	1	17,950	3,878,269	454,082	1·07	9·21	2,068	6·76
Cardiff Corporation	—	—	—	—	—	52·62	†32·26	1	112,209	24,134,363	770,04	1·12	9·72	3,782	9·44
Carlisle Tramways Company	,, 30	194	202	− 8	− 350	8·5	·5	Dec. 31	10,713	2,935,002	359,756	—	7·14	—	5·18
Central London Railway	,, 29	5,621	6,164	− 543	−16,739	6	6	,, 31	347,588	4,875,54 7	1,281,21	1·86	65·10	57,931	5·80
City and South London Railway	,, 30	3,650	2,566	+1,034	+ 5,455	6½	½	,, 31	—	—	—	—	—	—	—
Colchester Corporation	May 8	195	195	—	—	8		March 31	10,588	2,457,553	320,78	·97	7·47	1,401	·12
Cork E. T. and L. Company	June 27	503	558	− 55	− 405	15½	5½	Dec. 31	24,895	,814,376	882,256	1·01	6·64	—	4 69
Darwen Corporation	,, 14	268	261	+ 7	− 41	7·23	23	March 31	—	—	—	—	—	—	—
Dover Corporation	,, 23	230	282	− 52	− 355	4½	4	,, 31	11,250	2,853,200	284,34	·94	9·49	,500	—
Dublin and Lucan Electric Ry.	,, 28	124	126	− 2	− 84	6¾		Dec. 31	6,358	402,511	110,7 3	3·79	13·78	942	·55
Dublin U. T.	,, 28	6,519	5,794	+ 725	+ 9,055	48½		,, 31	267,489	0,050,949	7,077,3	1·28	9·07	691	5·05
Dundee City Tramways	,, 12	1,152	1,141	+ 17	+ 129	22	22	May 15	50,154	13,086,396	1,005,911	·906	11·96	2,18	7 42
East Ham Corporation	,, 29	901	955	− 55	− 406	14	14	March 31	36,652	3,689,658	863,816	·64	10·18	2,994	6·79
Glasgow Corporation	,, 29	18,284	16,963	+1,321	− 2,918	79½	79½	May 31	756,480	195,767,519	17,945,555	—	10·12	—	—
Gloucester Corporation	,, 25	253	288	− 32	—	15	15	March 31	15,466	3,902,077	563,595	·90	6·58	999	55
G. N., Piccadilly, and Brompton.	,, 23	4,130	4,210	+ 220	—	9	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	37	37	,, 31	74,019	17,849,642	1,540,707	—	11·53	2,088	8·60
Huddersfield Corporation	,, 22	1,606	1,530	+ 76	+ 650	35	35	,, 31	69,938	12,838,150	1,666,26	1·24	9·71	1,982	—
Hull Corporation	,, 29	2,485	2,310	+ 176	+ 1,735	26	26	,, 31	112,651	27,102,92 1	2,910,	1	9·29	—	—
Ilford Corporation	—	—	—	—	—	10½	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 26	142	150	− 8	+ 147	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	11,586	3,626,65	419,80	·737	6·62	1,480	5·22
Lancashire United Tramways	,, 26	1,295	913	+ 347	+ 8,121	38½	28	—	—	—	—	—	—	—	—
Leeds Corporation	,, 29	6,515	6,235	+ 270	+ 3,405	89½	89½	March 25	298,233	64,223,66	7,121,03	1·10	10·02	,351	—
Leicester Corporation	,, 29	2,360	2,467	− 106	—	42	42	Dec. 31	26,011	2,039,25	1,229,50	1	9·79	—	4·82
Liverpool Corporation	,, 22	11,187	11,035	+ 112	+ 3,573	104	104	,, 31	547,625	116,642,	12,166,419	—	—	—	—
Liverpool Overhead Railway	,, 30	1,529	1,528	+ 1	+ 479	6·65	6·65	June 30	81,302	11,171,8	1,024,275	—	—	—	—
London County Council	,, 22	32,972	27,382	+5,590	+53,536	98	98	—	—	—	—	—	—	—	—
Lowestoft Corporation	—	—	—	—	—	6	6	Sept. 30	14,511	3,128,867	359,435	1·08	9·68	2,63	6·48
Maidstone Corporation	—	—	—	—	—	2	2	March 1	4,740	850,121	112,227	1·33	10·13	2,3	—
Manchester Corporation	,, 29	15,107	13,733	+1,369	—	149	149	,, 31	631,956	126,900,87	14,123,1	1·19	10·73	4,2	6·99
Metropolitan District Railway	,, 30	8,181	7,978	+ 203	− 3,853	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 30	16,495	15,174	+ 322	−25,296	74	* 74	—	—	—	—	—	—	—	—
Nelson Corporation	,, 29	114	145	− 1	+ 45	2¾	2¾	,, 31	6,159	1 932,647	206,358	82	7·14	2,239	—
Newcastle-on-Tyne Corporation	,, 29	6,711	6,433	+ 278	+ 1,437	50	50	,, 31	197,849	43,069,93	4,326,152	1·0	10·98	3,957	7·0
Newport (Mon.) Corporation	,, 29	639	623	+ 11	+ 1,397	15½	15½	,, 31	30,356	7,252,535	783,435	—	9·29	—	6 4
Oldham Corporation	—	—	—	—	—	34	34	,, 25	65,553	13,466,245	1,504,740	1·16	10·45	1,886	—
Portsmouth Corporation	May 25	2,370	1,578	+ 753	+ 632	28½	28½	,, 31	95,702	19,625,32	197,499	1·17	11·63	—	—
Reading Corporation	June 27	612	679	− 37	− 270	33½	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	21·29	21·29	,, 31	14,881	2,837,110	386,547	1·24	9·24	1,102	7·96
Rotherham Corporation	—	—	—	—	—	9½	9½	,, 31	23,569	5,251,472	593,054	1·07	9·53	2,612	7·46
Salford Corporation	July 1	4,726	4,648	+ 78	+ 1,134	70¾	70¾	,, 31	214,11	39,213,56	4,884,590	1·28	10·29	—	—
Scarborough Tramways Co.	—	—	—	—	—	4½	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	June 30	5,424	5,307	+ 117	+ 3,268	35¾	35¾	,, 25	240,565	63,952,283	6,049 899	·903	9·543	3,65	6·477
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,365	9,294,771	1,108,369	1·27	11·02	—	7·85
Southend-on-Sea Corporation	,, 26	407	437	− 30	− 254	9	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	,, 31	39,550	6,766,031	1,027,73	—	9 23	—	4 75
Sunderland Corporation	,, 30	1,826	1,527	+ 239	+ 63	20	20	,, 31	64,858	15,364,463	1,495,685	1·004	10·36	—	6·57
Swindon Corporation	,, 5	153	—	—	—	4½	4½	,, 31	4,937	1,315,757	102,751	0·87	11·53	1.37	
Torquay Tramways	,, 27	138	—	—	—	5·16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 29	836	864	+ 22	+ 203	11·85	11·85	,, 31	38,768	7,412,881	778,851	1·30	11·94	3,2	7·04
Warrington Corporation	—	—	—	—	—	9	9	,, 31	17,057	4,418,225	403,363	—	9·85	—	6·53
West Ham Corporation	,, 27	2,450	2,427	+ 23	+ 1,000	14·7	14·7	,, 31	—	15,773,742	1,237,165	—	—	—	·
Wolverhampton Corporation	,, 26	824	824	—	—	20	20	,, 31	41,905	8,847,066	950,338		0·583	2,062	

* Including steam trains † And 9½ miles of interlacing track a Train mile. b Per mile of single track. h Half-year's figures. k Double track

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NOTES.

London Electric Supply Bill.—This Bill, which would empower a joint committee to take over and work most of the large company stations for the supply of electricity throughout London, has again been put on the list of measures to be read a second time. The date, however, is not until July 19, which is too late in the session for any useful result to be obtained. The last time this Bill was put in the list it was blocked by a motion which prevented it being reached. This shelving of measures introduced by companies does not add to the reputation of the Government.

Graphite.—A Brisbane journal, in pointing out that the demand in graphite is at present greater than can be supplied, and that adulterated materials are coming into use, calls attention to the existence of an extensive deposit of this valuable material four miles from Netherby railway station, on the North Coast line, Queensland, with a railage of only 30 miles to the port of Maryborough. This deposit, it states, holds out every inducement for an extensive and profitable manufacturing industry being opened up in Australia, as hitherto the production of clean graphite in that country has been unknown, although the mineral has been looked for in many places. The Queensland graphite plumbago mine was opened up three years ago. The development of the mine is extensive, showing a good body of the material about 30ft. thick, with bands of other material through it. The great difficulty was to cut a road down the mountain, which has been done. The material has been shipped to various parts of the world, and is said to have given great satisfaction for all uses.

The Deceased Bill.—The report from the Select Committee on the London County Council (Electric Supply) Bill has been issued as a Parliamentary paper. The proceedings of the committee have now no further interest, and the report is only useful as showing the attitude of the different members of the committee towards the emasculated Bill, which received its quietus with decorous brevity. It seems that on Tuesday, June 25, after the case for the preamble was closed with the completion of Mr. H. F. Parshall's evidence, the committee deliberated, and then divided on the question, "That the committee do hear further evidence." This was rejected, the ayes being Major Renton and Mr. Nolan, and the noes Mr. J. Ward, Mr. A. E. Dunn, Sir Philip Muntz, and Sir Albert Spicer. It will be observed that Mr. W. Howell Davies and Mr. W. W. Rutherford, who were also members of the committee, and the chairman, Mr. D. A. Thomas, did not vote. The question was then put, "That the preamble be read a second time," but this was negatived without a division, as we all learned on the following morning, when we assembled to hear the opening of the case against the preamble.

Engineering Group of the Franco-British Exhibition.—A meeting of the chairmen of the Executive Committee of the engineering and shipping group of the Franco-British Exhibition was held on July 2, at which Sir William H. White presided. Among those present were: constructional engineering—Sir Alexander Binnie, M.I.M.E. (past-president of the Institution of Civil Engineers); mechanical engineering—Mr. T. H. Riches (president of the Institution of Mechanical Engineers); electrical engineering—Dr. R. T. Glazebrook, F.R.S (president of the Institution of Electrical Engineers); gas engineering—Mr. Henry E. Jones (past-president of the Institution of Gas Engineers); mining engineering—Mr. Maurice Deacon, M.I.C.E. (president of the Institution of Mining Engineers), iron and steel—Sir Hugh Bell (president of the Iron and Steel Institute); other metals—Prof. W. Gowland, A.R.S.M. (president of the Institution of Mining and Metallurgy); shipbuilding and marine engineering—Dr. Francis Elgar, F.R.S. (vice-president and treasurer Institution of Naval Architects); shipping—Mr. James Dixon (chairman of Lloyd's Register of Shipping). The general opinion was expressed that the engineering section, which already covers several hundred thousand feet of floor space, of which one-half will be devoted to the British section, should be materially increased, as from present indications it is fully anticipated that the demand will far exceed the space at the disposal of this committee, notwithstanding the fact that it will be the largest machinery hall ever constructed for an exhibition in this country. Meetings of the separate sectional committees are now in course of formation, with the view of making the engineering and shipping departments the most important ever held.

The Industrial Freedom League.—This vigorous opponent of municipal trading held its fifth annual meeting last week. Considering that electrical schemes are so largely responsible for the trading proclivities of municipalities, it is only right that the operations of the Industrial Freedom League should engage the attention of electrical engineers who strive for the removal of all obstacles to genuine electrical enterprise, whether public or private. Lord Avebury (to whom the community is indebted for his services on behalf of fair and untrammelled trading) referred at the meeting to a statement made by the President of the Board of Trade—viz., that the provincial municipalities had made a gross profit of £2,000,000 on their electricity supply, and that this was really a great triumph for municipal enterprise. Lord Avebury, however, said that the amount of gross profit told them very little; the question was, what was the net profit? He then proceeded to give figures. The total amount of capital invested by provincial local authorities in electrical supply undertakings was put down as £34,318,000. The gross profit being £2,000,000, if they took depreciation at 3½ per cent., it amounted to over £1,000,000, and if they took interest at 3½ per cent., that amounted to another £1,000,000, leaving practically no balance Though he considered that the pecuniary results due to municipal trading were serious, they did not, to his mind, form the most serious danger. He attached more importance to the facts that local expenditure and local indebtedness were increasing more rapidly than rateable property; that municipal trading could not fail to give rise to awkward labour problems, and that it had seriously interfered with private enterprise and foreign commerce; that it was unwise to give votes to those who paid no rates, and unjust to withhold them from those who did; and that, by reducing the demand for labour, while increasing prices and raising rates, it had not only injured the ratepayers generally, but especially the working classes, and that, if carried to its logical conclusion, it would involve the loss of their freedom. These facts will, no doubt, have to be faced some day.

Publications Received.—The May issue of the *Proceedings* of the American Institute of Electrical Engineers can be regarded as a "convention" number, for it contains papers that were to be read in the following month at the Niagara Falls convention. Chief among the papers contained in this issue we may mention the following: "The Properties of Electrons," by Samuel Sheldon; "Choke Coils *versus* Extra Insulation on the End Windings of Transformers," by S. M. Kintner; "Protection of the Internal Insulation of a Static Transformer against High-Frequency Strains," by W. S. Moody; "Transmission Line

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Towers and Economical Spans," by D. R. Scholes; "Lightning Rods and Grounded Cables as a Means of Protecting Transmission Lines against Lightning," by Norman Rowe; "Location of Broken Insulators and other Transmission Line Troubles," by L. C. Nicholson; "One-Phase High-Tension Power Transmission," by E. J. Young; "Some Power Transmission Economics," by Frank G. Baum; "The Vector Diagram of the Compensated Single-Phase Alternating-Current Motor," by W. I. Slichter; "Inductive Disturbances in Telephone Lines," by Louis Cohen; "Report of Committee on Engineering Ethics."—We have received from the authors, Messrs. E. A. Kennelly and G. E. Whiting, a copy of the paper entitled "The Frequencies of Flicker at which Variations in Illumination Vanish," which was read last month before the National Electric Light Convention at Washington. An abstract of the paper has already appeared in these columns.—There has just come to hand the *Transactions* of the Institution of Civil Engineers of Ireland (vol. xxxii.). This volume makes a somewhat belated appearance, for it contains papers read before the institution during the session extending from November, 1904, to May, 1905. It has only recently been published by Mr. John Falconer, 53, Upper Sackville-street, Dublin. The only paper of electrical interest is one on "The Lorain Surface-Contact System of Electric Traction," by Mr. John Rochford—read as far back as Nov. 2, 1904. Since that date surface-contact systems of electric traction have been adopted in other towns besides Wolverhampton (which figures largely in the paper), and many of the author's remarks bear little value at this remote date.

Low-Frequency Incandescent Lighting.—At the recent convention of the National Electric Light Association held at Washington, U.S.A., Dr. A. E. Kennelly and Mr. T. E. Whiting gave an account of the results of their experiments on the cyclic variation in illumination due to current frequencies. Their paper is an important contribution to the literature on the subject of frequency of incandescent lighting, and their experimental investigation of the minimum frequencies at which certain variations in luminous intensity cease to be recorded by the eye as "flicker," goes a long way to show that satisfactory illumination can be obtained from incandescent lamps operated with 25-cycle current. In a particular experiment described, the smallest range of flicker that was found to be recognisable with certainty was 1·4 per cent., observable only at a low frequency. The most sensitive flicker frequency for small ranges of flicker was in the neighbourhood of 2·5 cycles per second. Flickering ceased to be objectionable with ranges less than 7·5 per cent. Their investigation further indicated that the eye is unable to detect any "flicker," quite independent of the range of brilliancy, when the frequency is above 55 cycles per second; and that at low frequencies no disagreeable "flicker" is noticeable when the range in brilliancy is properly decreased with the decrease in frequency. In this country we are working with 25 and 50 cycle apparatus for motor circuits, and central-station engineers are loth to go in for the smaller frequency. For lighting circuits, however, frequencies of 50 and up to 80 cycles are adhered to. Experience in the United States indicates that 16-c.p., 110-volt, carbon-filament incandescent lamps in use at Buffalo and Baltimore give thoroughly satisfactory lighting at 25 cycles, the variation being probably about 17 per cent. Similar lamps built for 8 c.p. at 55 volts would produce similar results at the same frequency. One of the causes of "flicker" is the cyclic fluctuation in the temperature of the lamp filament when the supply of heat energy thereto is not uniform. It has been suggested that by properly enlarging the diameter of the filament as the frequency is lowered the percentage fluctuation in the temperature of the filament may be held constant, and the *Electrical World* draws attention to the result of a series of carefully conducted tests by Messrs. Keilholtz and Branch, who found that at 25 cycles a 16 c p., 50-watt, carbon-filament, 100-volt lamp changed in candle-power from a maximum of 17·4 to 14·9, and that a certain 15-c.p., 46-watt, 27-volt lamp, which showed a variation of 11·7 per cent. in luminous intensity at 42 cycles, suffered a variation of 28 per cent. at 15 cycles.

Yokohama.—A record of the increasing volume of trade enterprise which is carried on at this rapidly developing Japanese port finds expression in the annual report to the Foreign Office on the trade of the consular district of Yokohama for the year 1906. The outstanding feature of the report from the electrical engineering point of view is the large import of machinery. The import in 1905, value £951,274, was phenomenal, and was specially remarkable for the increases in electric motors and machine tools. In the latter item the high figures were fairly maintained last year, but electric motors declined, and the total for machinery during 1906 fell to £848,509, which figures are, nevertheless, far above those of years prior to 1905. During the latter year the import of electric motors amounted to £167,799, while it fell during 1906 to £79,805. The import of electric light apparatus likewise showed a decline from £39,182 to £30,332 The import of electric light wire during 1906 is valued at £60,018, compared with £66,970 during 1905; 4,082 tons of telegraph wire were imported, valued at £47,404, while the value of the import of submarine and underground telegraph cable rose from £5,709 in 1905 to £10,512 in 1906. The latter is largely a British trade. Last year was marked by the usual commercial activity, which extended in several directions. The amount of capital invested in electrical enterprises last year was £1,743,583, bringing up the total capital to £12,123,927. There does not appear to be many public works in hand at the moment. One or two schemes may, however, be mentioned. Slow progress is being made with the Yokohama harbour works. The buildings will consist of 12 large iron sheds. A network of railway lines will be laid down 11 miles in length. At each quay wall head a fixed crane of 30 tons capacity will be erected, and 31 travelling electric cranes of one to five tons capacity will be placed in front of the sheds. The year 1912 is mentioned as the probable date of the completion of the works and superstructures. With regard to possible openings for British energy in the growing industrial activities of the country, the consul advises caution. He says: "The British artisan cannot look for remunerative employment here. Though at the moment Japan does not command a sufficiency of skilled labour, the material and a latent skill, perhaps unequalled elsewhere, are in process of development. A few foreign experts may find places, but they are too expensive for most Japanese establishments, of which even the largest often employ as engineers youths just fresh from college, possessing good theoretical knowledge perhaps, but slight practical experience."

Electric Tramways of Buenos Ayres.—The conversion of the old horse tramlines of Buenos Ayres to systems of modern electric railways has taken place, and is taking place, with such rapid strides that statistics as to the volume of business the local tramways are doing may cause a little surprise to those who have not followed developments in the South American city. From an exhaustive article published in the *Street Railway Journal* of New York, in which the various types of construction employed and the style of cars in use are described, as well as an account of the method of conducting business

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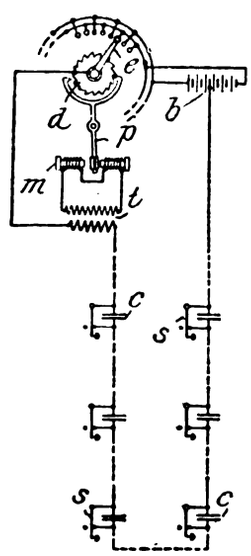
and other interesting data, we gather that there are nine street railway companies owning tramways in Buenos Ayres, two of which own horse lines, and may, therefore, be left out of account, and a third—La Neuva—is included in the Gran Nacional. The Anglo-Argentine, La Capital, Gran Nacional, Metripolitano, Buenos Ayres and Belgrano, and the Tramway Electrico de Buenos Ayres Companies own between them 421·715 km. of electric line. The same companies own 1,501 electric cars, 966 of which are in daily service. The cars are principally of the Dick-Kerr and Brill closed types, with A.E.G., Dick-Kerr, and G.E. motor equipments; two companies employ rheostatic brakes, two hand brakes, and another two electric disc brakes. There are no separate power stations in Buenos Ayres, the entire supply of electric current for railway and lighting work being in the hands of a German company. The distribution of the railway current is divided among five power stations at present, though there will soon be a sixth in operation, as the company is to erect a large station in the Darsena Sud. This station will be of 120,000 h.p., and will be equipped with turbines. The output of the existing stations for January, 1907, was 1,225,820 units for lighting, 708,448 units for power, and 3,788,244 units for traction. Our contemporary states that the famous Falls of Iguazú, situated in the North-East of Argentina, may some day be utilised for supplying power for the tramways and for lighting. These falls are 2½ miles wide and 230ft. high, with an abundant supply of water all the year. Chief interest, however, centres upon the projected new works near Buenos Ayres. The first is a high-speed up-to-date line from Buenos Ayres to La Plata, a distance of 30 miles. It is proposed to run cars on this route at 62 miles an hour. The other is for a line from Belgrano to the Tigre, on the Lujan River. As to the future, it is intended to consolidate most of, if not all, the independent lines in Buenos Ayres, and a Belgian company—the General Buenos Ayres Tramways Company—is being formed in Brussels to bring this about.

Electric Telegraphs.—Messrs. Siemens and Halske, of Berlin, have recently patented a device which relates to



means for enabling an alternating-current generator, or a commutator for diverting direct into alternating current, to be put into and out of action from any one of a series of stations on the same line wire. The alternating currents may be employed to work step-by-step printing telegraphs working in synchronism at the various stations. At each of the stations on the line a condenser, *c*, is provided, the condensers being normally short-circuited by switches, S. A direct current flows normally in the line from one to the other of the sections of the split battery, *b*. If at any station the switch, S, is opened, the current which charges the condenser causes a current to be induced in the secondary winding of the transformer, C, which effects a movement of the polarised armature, *p*, and ratchet wheel, *d*. The reversal of the battery potential so produced causes the recharge of the condenser in the opposite sense, and a further induced current in the circuit of the electromagnet, *m*. Consequently, so long as the switch, S, remains open, the commutator arm, *e*, continues to rotate, and an alternating current is supplied to the line and condensers. The reclosing of the switch brings the armature, *p*, to rest, and the alternating current ceases. The alternating impulses cause the simultaneous rotation of the type wheels at the various stations. The direct current which replaces the alternating current when the circuit is again closed effects the printing of the selected character at all the stations. In an alternative form of the system the armature of a relay which is normally held attracted by the direct current falls away when the circuit is interrupted, and effects the closing of two switches, one of which connects an alternating-current generator to the circuit, and the other closes the circuit of a direct-current motor driving the alternator. When the condenser is again short-circuited a direct current is superimposed on the alternating current, the alternator and its driving motor being then cut out by the relay.

Engineering at Oxford University. — There appeared in the *Times* of the 6th inst. a letter from Mr. T. A. Brassey, A.M.I.C.E., of 4, Great George-street, Westminster, S.W., giving some additional details with reference to the proposed school of engineering at Oxford, to which we referred in these columns last week. Mr. Brassey emphasises the fact that the new professorship is to be called one of "engineering science," and not simply of "engineering." "The new professor, when appointed, will," he says, "be expected to teach only what can be learnt from laboratory instruction, and not in a workshop. This proposal should," he adds, "commend itself to the friends of higher scientific education. There is no talk of introducing technical teaching into the old university, no workshops with noisy and heavy plant are contemplated; but it is proposed to introduce the more scientific and less technical work of an engineering laboratory, which presumably will include such subjects as engineering, drawing and machine design, thermodynamics, hydraulics, electrical engineering, and surveying; much of the scientific equipment of an engineer—mathematics, physics (including heat, light, and electricity), chemistry, geology, and mineralogy—being, of course, already taught within the university." That there is need in the engineering professions for men of the stamp of Oxford and Cambridge graduates none can gainsay, and the workshops of electrical and mechanical firms, as well as the profession generally, would be all the better for a greater infusion of such men. But it is open to doubt whether men who have no knowledge of the rough and tumble of industrial life, who have acquired a distaste for the habits and customs of the life they must later be called to live, and who, through lack of association, have no insight into the character and temperament of those with whom they will have to associate, will make the safest captains of industry and most respected leaders of men. The efforts of the older universities in pursuing the study of pure sciences are recognised as great. The need of to-day, however, is for a wider and more general application of scientific principles to engineering, to the management (technical and commercial) of engineering establishments, and to the control of men. This need the younger

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universities are doing much to fulfil by giving students an insight into the conditions which they will find prevailing in their *post*-collegiate days, and allowing them to develop in an atmosphere which contains the germs of reality. We have never seen cases where the high character and general culture of engineers thus trained has been open to reproach. It does not seem likely that Oxford (and Cambridge) will be more largely represented among the heads of the engineering professions than at present, unless the margin between "engineering science" and "engineering" is narrowed.

The British Association.—As is now generally known, the British Association will meet this year at Leicester on Wednesday, July 31, and continue till Wednesday, Aug. 7. Arrangements for the meeting seem to be well in hand, and many of the sectional programmes are now issued. The arrangements made in connection with the various sections which interest us will be noted in due course. But we may at present refer to Section L (Educational Science), of which Sir Philip Magnus, M.P., is president, and Mr. W. M. Heller and Prof. M. E. Sadler are vice-presidents. Several interesting discussions are promised in this section. Sir Philip Magnus, in his presidential address to be delivered on the morning of Thursday, Aug. 1, may be expected to reflect experience gained in a long career of educational work as lecturer and examiner in technical subjects, and as superintendent and secretary of the department of technology of the City and Guilds of London Institute. The provisional educational programme has just come to hand, and from it we see that the whole of Friday, Aug. 2, will be occupied with a discussion on the scholarship system. Invitations to contribute papers on this subject have been accepted by a number of prominent educational authorities. The curricula of secondary schools will form the subject of discussion on the morning of Monday, Aug. 5, in connection with the report of a committee on that subject. The committee was appointed at the York meeting "to consider and advise as to the curricula of secondary schools; in the first instance the curricula of boys' schools," the members being: chairman, Sir Oliver Lodge; secretary, Mr. C. M. Stuart; also Mr. T. E. Page, Profs. M. E. Sadler, H. E. Armstrong, F.R.S., and J. Perry, F.R.S., Sir Philip Magnus, M.P., Principal Griffiths, F.R.S., Dr. Gray, Prof. H. A. Miers, F.R.S., Mr. A. E. Shipley, F.R.S., Prof. J. Findlay, and Sir William Huggins, K.C.B., F.R.S. In recent years the scientific teaching of various school subjects has been considered, and there have been reports or discussions on the teaching of chemistry (Leeds, 1890), of mathematics (Belfast, 1902), and of botany (Southport, 1903). This year there will be a joint meeting of Section D (Zoology) with Section L on the "Teaching of Biology in Schools," to be introduced by Mr. O. H. Latter, senior science master at Charterhouse. Among other papers, on Tuesday, Aug. 6, there will be one by Mrs. Ramsay Macdonald on "The Technical Day School for Girls." In the afternoon a discussion on "Scientific Teaching in Relation to Trade Classes and Industrial Requirements" will be opened by Mr. C. T. Millis, principal of the educational department of the Borough Polytechnic Institute, London, who will deal with "Problems of Trade Education considered in Relation to our School System"; and Mr. J. H. Hawthorn, headmaster of the Municipal Technical School, Leicester. The latter subjects have an important bearing at the present day, and the discussions upon them will be followed with interest in engineering and trading as well as in educational circles.

Hints for Consumers.—West Ham affords an excellent and commendable example of intimacy between electricity supply producer and consumers. Not only does the Corporation electricity department, under the able management of the engineer, Mr. A. H. Seabrook, show unrelaxing energy in finding new avenues through which to introduce electricity into houses, but consumers are made to feel that a serious interest is being taken in them, and that they are not being preyed upon through lack of technical knowledge. This fine spirit of enterprise finds reflection in the bright and vigorous quarterly *Bulletin*, published by the West Ham Corporation electricity department. In the current issue Mr. Seabrook contributes some pointed notes, entitled "Straight Tip from Headquarters." Scorning literary flights, Mr. Seabrook puts his points in such a way as is calculated to impress the readers of the *Bulletin*, and it is because we think that his example is worthy of emulation by other central-station managers that we reproduce his notes here: "By using *metal lamps* you can reduce the cost of electric light by two-thirds. Don't worry about our revenue decreasing; that is our business, and we are not a philanthropic society. By taking advantage of the low prices charged for electricity, combined with the facilities offered by the Corporation for *the hire of* apparatus, lamp signs, fans, etc., you are in the position to make the shopping districts of the borough the most attractive to customers for miles around. Shopkeepers in West Ham do not realise the advantage of flashing signs for advertising. *Make your sign talk.* (From £1. 1s., or on hire.) Why should not churches and chapels have notice boards which can be read by night as well as by day? The adoption of electricity for light and power marks the man who is not content to continue in the rut made by his great-grandfather. It gives confidence to his customers that his goods as well as his methods are *up to date*. Five years ago a unit of electricity in West Ham cost about a penny for coal alone; it now costs about one-fifth of a penny. Such alterations are not brought about by 'following in father's footsteps.' Adopt new methods, as we have done, and reap a like reward in doubling your output. Electric light is cheaper than gas. If you experience incompetency, incivility, remissness, and the other ills that most trading concerns are heir to, let the manager know at once, and don't grumble to your next-door neighbour that the Corporation can't run a winkle stall. You are a shareholder in the concern, and, therefore, can't afford to deprecate it; the managing staff have not eyes in the backs of their heads. Help them a little and they will help you. Do your little bit to counteract and refute the bad impression made recently; it damages your business and ours too. West Ham is not played out, it has only begun to know it is alive. When you see our advertisements do not sneer and say the Corporation has plenty of money to throw about. The Corporation has thereby *increased its electricity business by 100 per cent.* compared with last year. These notes may be blunt, but they are right. The editor is the only man who has time to indulge in literary flights. All the rest are either doing overtime or else recuperating from overstrain."

The Radio-Telegraphic Convention.—Sir John Dickson-Poynder's Committee on the Radio-Telegraphic Convention gave out its report last week, one of the main features of which is, as stated in these columns last week, the expression of opinion that the effect of the adhesion of this country to the convention would be advantageous to national and public interests, and that non-adhesion would be seriously detrimental to those interests. The matter then to be dealt with was the relations subsisting between the Government and the Marconi Company in the altered circumstances, and the settlement of this matter has

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promised many difficulties; indeed, it has seemed as though the matter would have to be thrashed out in the courts of justice. So much may be gathered from the circular which the directors of Marconi's Wireless Telegraph Company, Limited, addressed to the shareholders just before the publication of the committee's report, in which the latter were informed of the intention of the directors "to postpone the general meeting of the company until the intentions of his Majesty's Government" were known. Though these intentions are not known at the time of writing, the committee's report indicates pretty clearly the scope and likelihood of these intentions, and from this it is open to be inferred that the Marconi Company will be treated not at all badly. There is nothing to show that the valuable work which has been done by the Marconi Company as the pioneers of practical wireless telegraphy will be treated with anything but respect, and, recognising the obligation which they are under to that company, the Government must see that nothing is done that will prove injurious to them, or, if that is unavoidable, the company are entitled to generous treatment. The committee see no reason to apprehend that the obligations of the convention, if faithfully carried out by all concerned, will prove injurious to the Marconi Company. They consider, indeed, that the convention will be to the ultimate advantage of Marconi's; but if, on the other hand, it is found by practical experience that the company are injuriously affected, the committee recommend that they should be treated with generous consideration. While making this recommendation, the committee deny that the company have any equitable claim. Now in all cases of legislation in the public interest, and where damage can be shown to accrue to private interests, something in the nature of compensation is granted. But in this instance the committee do not believe, looking at the Post Office-Marconi agreement, that the Marconi Company can make any equitable claim. In view, however, of the particular circumstances of the case, the committee recommend that, provided the Marconi Company loyally co-operate in carrying the convention and the policy which it represents, and in the event of its being shown, under proper conditions of audit, that the Marconi Company, during the transition period, under the new conditions brought about by the convention, have suffered diminution of business at their British stations, they should be granted compensation for a period of three years from the day of the convention's coming into operation, and that the compensation should be based upon a comparison with the average annual net traffic receipts from their British stations during the three years preceding ratification.

Municipal Electrical Finance.—The accounts of the electric lighting undertaking of the Hammersmith Borough Council for the year ended March 31, 1907, which have just been issued, are fairly satisfactory in some respects. But Hammersmith cannot be commended on the way in which it deals with the profits accruing from the working of its undertaking, and it affords yet another instance of that imprudent financial policy which municipalities show a tendency to adopt—namely, in allocating to borough rates that which should more properly go to reserve. On examining the electric lighting accounts of the Hammersmith Borough Council, we find that the aggregate amount of capital borrowed to March 31 of this year was £268,406, and the amount expended on capital account was £275,444. Of the above total capital indebtedness, an amount of £38,909 had been redeemed at termination of financial year. This redemption represents 14·5 per cent. upon the amount of loans taken up, and the amount of unpaid borrowed capital at the end of the year was, therefore, £229,497. The revenue account shows an increase over the previous year, although this is the first complete year during which the recent reduction in price of current has taken place. The gross income has been £37,302, whereas at the corresponding date last year it was £37,013. The total number of units sold for private purposes during the year was 3,657,610, and the revenue obtained therefrom averaged 2·01d. per unit. During the previous year the total units sold was 3,146,672, and the average revenue obtained therefrom was 2·33d. per unit. The actual increase in income derived from private lighting supply has been £88, and from public lighting supply £246. The revenue from meter rents has been £174. 4s. 10d., an increase of £78. 15s. 7d. when compared with last year, whilst revenue derived from miscellaneous receipts has reached £1,885. 4s. 9d. The working expenditure for the year has been £21,753, and the gross surplus £15,549. This gross profit represents a percentage of 5·6 upon amount of capital expended upon the undertaking. Last year the gross profit was 6·13 per cent. upon amount of capital expended, and in the previous year the corresponding gross profit amounted to 8 per cent. After meeting charges of interest on indebtedness on amounts temporarily borrowed, for redemption of capital, and for writing off a sum of £54. 14s. 2d. for irrecoverables, the net profit made for the year was £14. 4s. 11d. The corresponding sum last year was £2,631. 8s. 1d., which represented 1·01 per cent. upon capital expended at that date. The above amount required to be written off as being irrecoverable is the smallest loss incurred under this head for the past four years, and is £126. 4s. 1d. less than last year. The borough accountant in his annual report upon the electric lighting accounts makes the following statement: "A gratifying circumstance attending the working of the undertaking is the substantial monetary assistance it has been enabled to afford in reducing the burden of the borough general rate." But, judged from the point of view of sound commercial working, it is just this feature which gives cause for dissatisfaction, for, as the following figures show, it has resulted in the starving of the reserve fund. The total contribution to date made towards the borough rate from accumulated revenues has been £4,000, whilst a further contribution of £3,000 is provided for in the estimates for the current financial year. On the other hand, the reserve fund of £2,500, formed in 1903, has not since been added to. The amount originally allocated to reserve was far from adequate, and we would suggest that it is wrong in principle to keep it at such a low figure. For, after all, the first function of a trading concern (especially one which is liable to such fluctuations, and is dependent upon so many variable factors, as an electricity supply undertaking), after meeting all necessary expenditure, is to put aside sufficient to meet future contingencies and unforeseen events. It is only after this has been done, and the stability of the concern assured, that the paying out of moneys, either by the way of dividends to shareholders or towards relief of ratepayers' burdens, is justified. Now, in the case of Hammersmith, where, as we have already shown, net profits of the electricity undertaking are on a downward course; where, during the past three years, the profit on capital expended has declined from 8 per cent. to 6·13 per cent., and last year to 5·6 per cent.; and where further expenditure must be undertaken at no late date in order to meet the requirements of a growing industrial and residential district, the importance of an adequate reserve is obvious, quite apart from reasons of sound finance.

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CENTRAL STATION SWITCHGEAR, ETC.

BY ARTHUR IMBERY.

The above subject in the writer's opinion has not by electrical engineers received the attention which so important a subject demands. No doubt a few remarks in this instance are justifiable. It is not within the scope of this article to deal with all types of switchgear, but to confine my remarks to direct-current switchgear, etc., as used in central stations, supplying electrical energy for lighting, power, and tramway purposes.

The supply of electricity for lighting and power purposes is in the majority of cases on the three-wire system (with neutral wire earthed at the station), the voltages employed being from 400-500 volts across the "outers," and 200-250

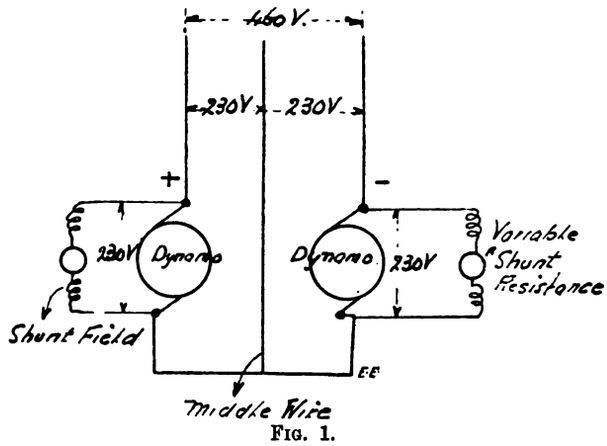

FIG. 1.

volts between either "outer" and neutral. The generators in a combined lighting and traction station are generally compound-wound machines, running as shunt-wound dynamos on lighting, and compound-wound machines on traction. In some stations, where separate machines are used for the two different systems of supply, the most modern method for lighting supply is to employ two 200-250-volt shunt-wound machines mechanically coupled on the same shaft. These machines are run in series across the "outers," the voltages between neutral and outers being regulated by a variable resistance in series with the field of each machine. It is believed by adopting this method that more satisfactory voltage regulation is

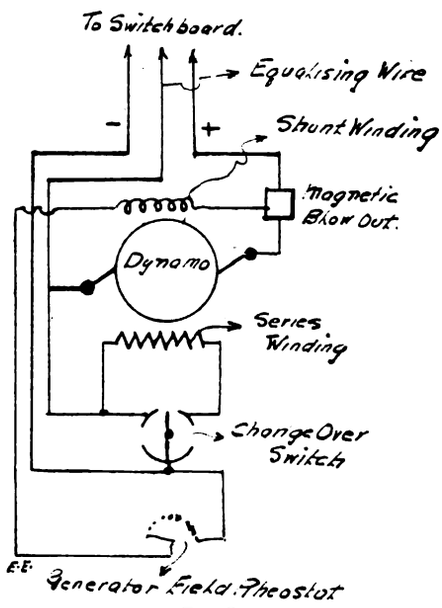

FIG. 2.

obtained on the two sides of the system, and has also the advantage that the machine can be used as a balancer. Fig. 1 gives a diagram of connections.

In the case where a dynamo has to do duty for lighting and traction, Fig. 2 is a diagram of connections showing "change-over switch" and leads from machine to switchboard. From this sketch it will be seen how the series winding is cut out of circuit when running as a shunt machine. Fig. 3 gives a diagram of wiring of direct-current machine switchboard. It will be noticed from this sketch that the generator is protected by a reverse-current circuit breaker in addition to the magnetic blow-out. The addition of this reverse-current breaker on the machine panel, has been found in practice to be well worth its

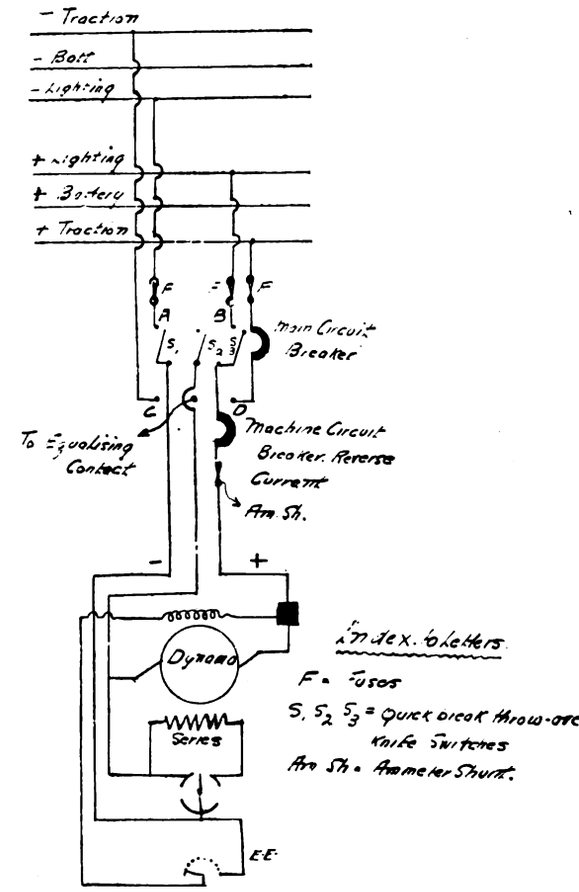

FIG. 3.

initial cost. Take, for example, two machines working in parallel (having no reverse-current breakers in circuit) on a varying traction load, and assume that the load suddenly drops considerably: one machine may "motor" the other and unless the machine voltages are regulated, damage may result owing to these "motoring currents." By addition

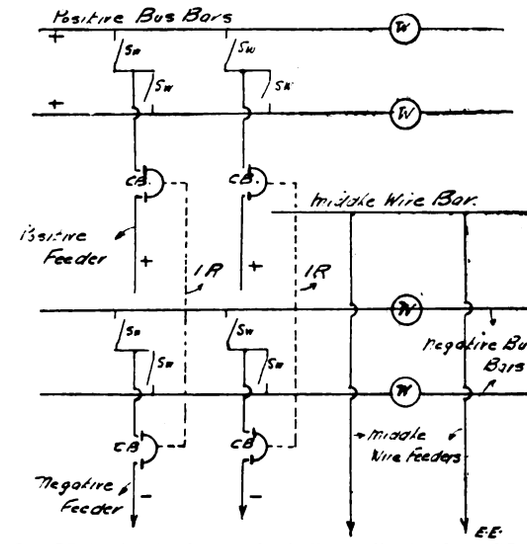

FIG. 3A.—I R, insulated rod for mechanically coupling breakers; C B, circuit breakers (L.T.E. type); Sw, Switches; W, wattmeter.

of reverse-current breakers, these motoring currents are prevented from becoming very excessive, as the breaker operates and throws the motored machine out of circuit.

Opinion differs as to the use or abuse of circuit breakers, some engineers placing their confidence in fuses, stating that breakers may or may not operate at the critical moment. These reverse-current breakers, as far as the writer's experience is concerned, have given very satis-

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factory results, providing proper attention and inspection is given to them. It is obvious that fuses could not be used under the same conditions as reverse-current circuit breakers, as some of these breakers will operate (with a reverse current only) from as low as 5 per cent. of the full-load current, according to adjustment. Circuit breakers, as a rule, operate instantaneously, while fuses have a time limit before they blow, according to the size and material of which the fuse is composed. The lighting feeders are protected by fuses or breakers, according to opinion. In one lighting station where breakers are employed, both the positive and negative breakers of each feeder are

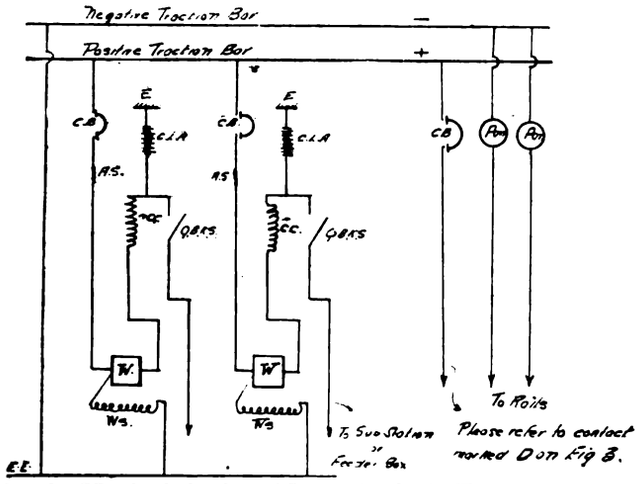

FIG. 4.—CB, circuit breaker; AS, ammeter shunt; W, wattmeter; WS, wattmeter shunt; CC, choking coil; CLA, carbon lightning arrester; Am, ammeter; QBKS, quick break knife switch.

mechanically coupled. Thus, in the event of any serious trouble, both breakers operate at the same instant, consequently preventing any out of balance. (See Fig. 3A.)

In some central stations, secondary batteries are used to maintain the supply during hours of light load. The addition of a battery has its disadvantages. As a rule, batteries are not very efficient, 85 per cent. being considered a very good efficiency, the efficiency in this instance being considered as the percentage ratio between the ampere-hours charge and ampere-hours discharge. The battery is generally connected across the outers, the wire from the centre of the battery being generally connected to the middle-wire bar. (See Fig. 6.)

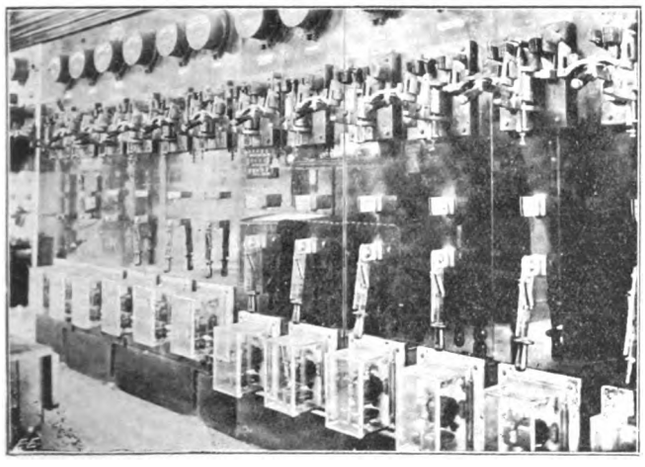

FIG. 4A.—Traction Feeder Panels.

Batteries.—It will be noticed from Fig. 6 that the lead from the middle of the battery is not permanently connected to the middle-wire bar, but is connected through a quick-break knife-switch. This is a great advantage; *e.g.*, assume the lead from the middle of the battery is permanently connected to middle-wire bar, and the battery is on discharge, with 50 amperes out of balance on the positive side. The positive side of the battery under these conditions is more heavily discharged than the negative, and it becomes necessary to put more regulating cells in circuit on the positive side of the battery in order to maintain the requisite voltage. At last a stage is arrived at where all regulating cells are in circuit on the positive side, and it becomes necessary, in order to maintain the desired voltage, to run a balancer in parallel with the battery, or start up a machine and take the battery off discharge. By running a balancer, more load is thrown on to the negative side of the battery to maintain the pressure on the positive: By the use of a switch in the middle wire (from the battery) a balancer can be run up and the switch broken. This leaves the battery working across the "outers," and the balancer

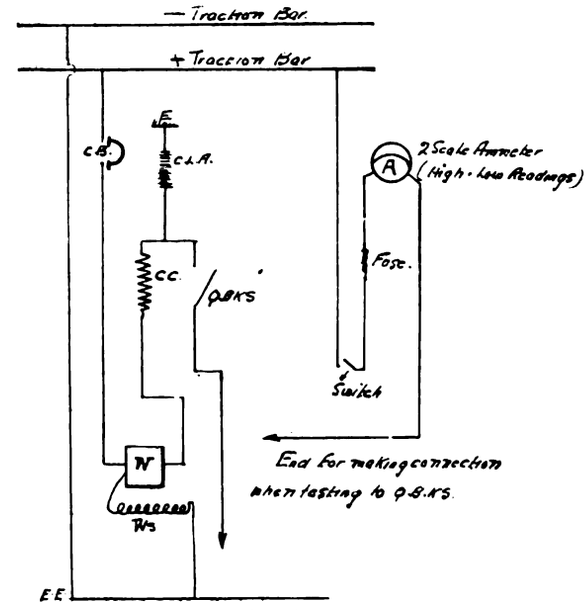

FIG. 5.

takes up any out of balance. The regulating cells on either side of the battery can be cut in and out of circuit as desired, provided the correct pressure is maintained across the outers, the balancer taking up any out-of-balance.

Tramways.—Fig. 4 is a diagram showing two traction feeder panels, etc. It will be noticed from Fig. 4 that the machines are protected by overload circuit breakers in

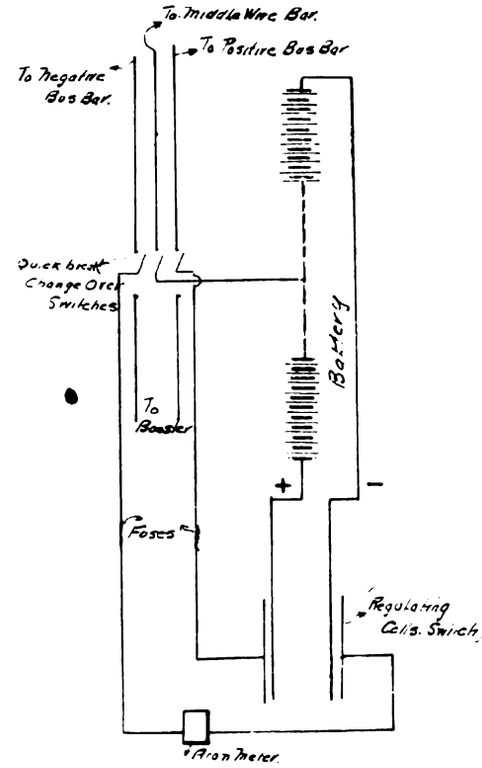

FIG. 6.

addition to the circuit breakers on the tramway feeders, thus assuring double protection for the machines. The tramway feeder circuit breakers should be inspected and thoroughly overhauled each day, preferably after shutting down the traction supply. The breakers should trip freely, and the copper contacts should be free from any "burns,"

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Care should also be taken that the carbons are making good contact, otherwise the arc which occurs on the breaker operating on a short-circuit or overload is broken across the copper contacts instead of the carbons, burning the copper contacts and causing the breaker to stick. The switchboard attendant should always test the circuit breaker before closing the circuit after a breaker has operated. To satisfy the Board of Trade regulations concerning tramway circuit testing, care should be taken in tramway feeder panel connections to observe that the shunt resistances of the wattmeters are out of circuit when making the test, otherwise errors will be introduced in your results; *e.g.*, assume a 500-volt traction supply, resistance of wattmeter shunt 10,000 ohms, then the current to earth $\frac{500}{10,000} = \cdot 05$ ampere (due to wattmeter). From Fig. 5 it will be seen how the connections are arranged to eliminate this testing through the wattmeter.

Wattmeters.—The feeder panels are generally provided with wattmeters of the motor type. It is very essential that these meters should register accurately the amount of energy consumed, otherwise it might result in the station showing a loss instead of a profit. The meters should each in turn be periodically examined and tested. A simple method is to place the meter to be tested in series with a standard wattmeter and note results. Should the meter read slower than the "standard," its speed can be increased by moving the permanent magnets inwards towards the spindle, and by moving the magnets outwards should the meter be going too fast. It is generally found after long use that meters have a tendency to run slow, owing to accumulation of dust, dirty commutators, etc. The commutator should occasionally be cleaned with a piece of fine "Crocus paper," care being taken, if possible, not to alter the tension on the brushes. The resistance boxes in series with the shunt of the wattmeter may occasionally "burn out" owing to several of the resistance coils becoming "short-circuited." Should this occur, the box should be disconnected from the meter to prevent the shunt of the meter from being burnt out. The switchboard instruments should also receive their share of attention, and should occasionally be taken down and tested by the potentiometer or other suitable instrument; also back connections of the boards should be inspected and tightened up where found necessary.

In conclusion, one of the most essential rules to remember in electrical work is "cleanliness."

TESTS ON A MERCURY-VAPOUR RECTIFIER.

A complete series of tests, including oscillographic records, of a mercury-vapour rectifier of the General Electric Company's standard design, has been carried out at Charlottenburg by Dr. J. Polak, and is described in a recent number of *Elektrotechnik und Maschinenbau*. The rectifier was a single-phase one for a primary alternating-current voltage of 340 at 50 ~, and a secondary (unidirectional) output of 110 to 155 effective volts at 30 effective amperes. The connections of the apparatus are shown in Fig. 1. It consists of the actual rectifier vessel, an auxiliary reactance, L′ L″, divided into two equal parts, two resistances, R_a and R_b, a voltmeter, an ammeter, and the necessary switches. The rectifier itself is an exhausted glass vessel with two positive graphite electrodes, A′ A″, a mercury cathode, K, and an auxiliary starting anode of mercury at A_h. The glass vessel rests in a movable brass support fitted with a handle to enable the vessel to be tilted by hand for starting purposes. Starting can be effected either from the direct-current side or the alternating-current side by placing switch S_6 on *a* or *b* respectively, and then tilting the vessel until the two lower mercury surfaces, K and A_h, are connected. The vessel is then allowed to return to the vertical position, and a small arc is formed between K and A_h, which serves to start the apparatus. The starting control, A_h, and its resistance, R_a, can then be disconnected. The resistance R_b is a temporary load resistance through which the unidirectional current passes until it is switched on to the actual working load. This is necessary because the apparatus cannot run on open circuit. In fact, if the secondary current falls below a certain minimum value, the arc is extinguished automatically. A maximum cut-out, S_2, is provided to prevent overloading.

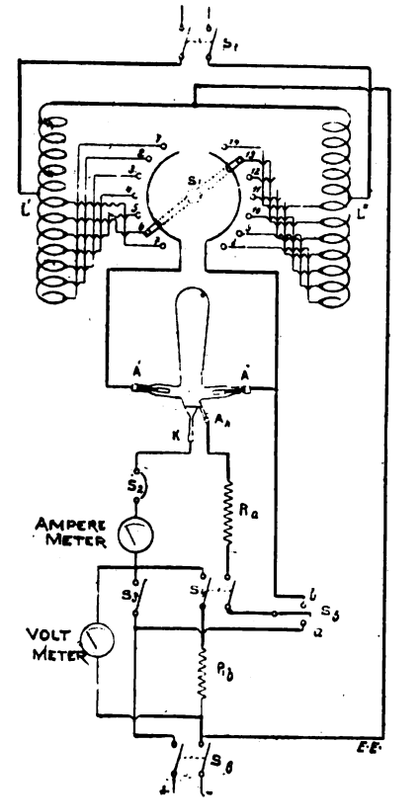

FIG. 1.

The action of the apparatus may be explained shortly by a reference to the simplified diagram in Fig. 2 and the oscillograms in Figs. 3, 4, 5, and 6.* The voltage and current curves for the alternator used are shown in Fig. 3.

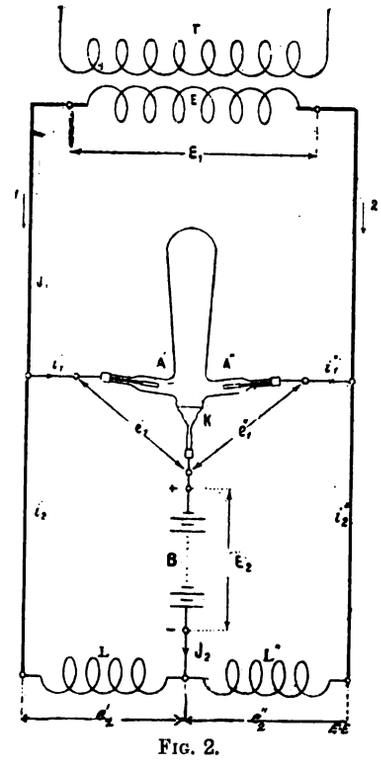

FIG. 2.

This voltage, E_1, is applied to the rectifier, and the reactance coils, L′ L″, in parallel, whilst the direct-current apparatus, B, is connected between the juncture of the reactances and the cathode, K, of the rectifier. During a

* The scale of volts in Figs. 3, 4, and 5 is 27·8 volts per millimetre, and in Fig. 6 14·5 volts per millimetre. The scale of amperes in Figs. 3 and 4 is 2·16 amperes per millimetre.

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given half-period the direction of the currents will be as shown by the arrows in Fig. 2. The main current passes from A′ to K, through the vapour into B, and out by the reactance L″, back to the transformer. The voltage, e', measured between A′ and K during this time is only the voltage of the vapour arc, which is from 14 to 20 volts.

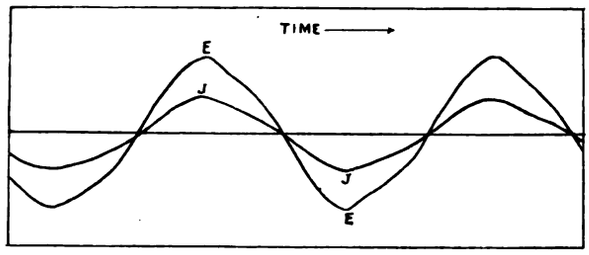

FIG. 3.

When the transformer voltage, E, falls below the arc voltage the discharge from A′ to K ceases momentarily, as shown at *a* (Fig. 4), and the voltage A′ to K rises almost to the full value, E. Besides the main current from A′ to K an additional current, i_2, is sent by E through the reactance L′, and this serves to store energy electro-magnetically in the reactance, to be given out again in the form of a prolongation of the discharge from A′ to K as soon as the fall in E begins to lower i_2. The reactance, in fact, acts the part of a flywheel in maintaining the unidirectional discharge during the period when E is smaller than the arc voltage. The voltage across one arc, e'_1, and the current through the same arc, i', are shown in Fig. 4. The voltage

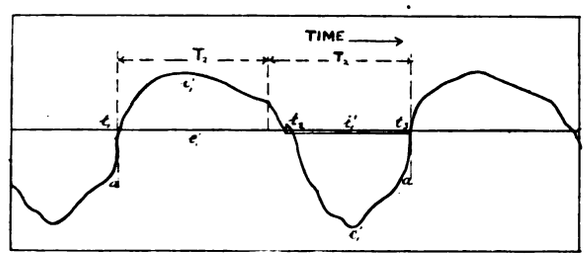

FIG. 4.

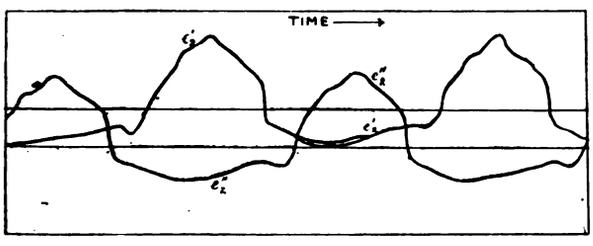

FIG. 5.

has a variable but unidirectional value during the time t_2 to t_3, and then remains at the arc value for the interval t_1 to t_2. The current has a variable unidirectional value of t_1 to t_2, and falls to zero during the interval t_2 to t_3. In the second vapour column, A″ K, the same action occurs, only with a phase displacement of half a period. The voltages across the two reactances are shown in Fig. 5, and for

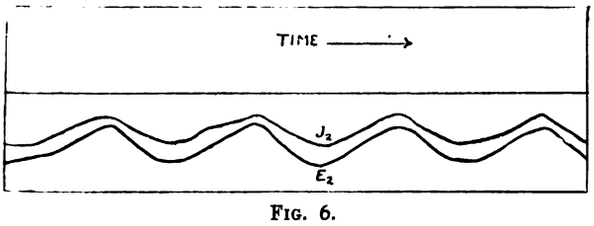

FIG. 6.

greater clearness the zero of the oscillograph has been shifted.

Finally, Fig. 6 shows the unidirectional voltage and current. In all these oscillograms the alternating current supply voltage was 217·5 at 50 ~, the supply current 10·2 amperes, the output (unidirectional) voltage 122, and the output current 13·8 amperes. The secondary circuit was non-inductive. The characteristic curves of the rectifier loaded on incandescent lamps are shown in Figs. 7 and 8. Fig. 7 was taken with the full primary voltage of 340 at 50 ~, and with the switch S_1 (Fig. 1) set for minimum secondary voltage—*i.e.*, on contacts 1 and 8. The curves in Fig. 8 were taken again with the full primary voltage (340), but with switch S_1 set on contacts 7 and 14 for

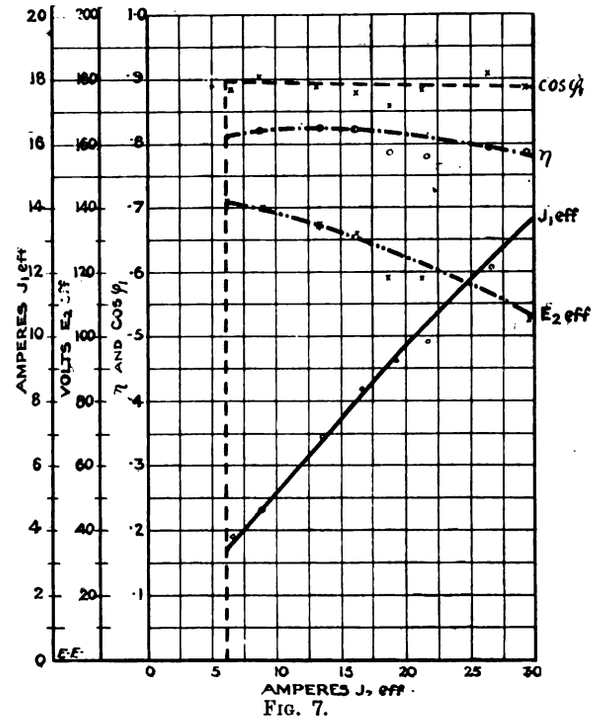

FIG. 7.

maximum secondary voltage. The minimum working current was 6·16 in the first case and 4·45 in the second. The value of this minimum current depends on the electrode distance, the cooling arrangements of the glass vessel, and the values of the reactances, L′ L″.

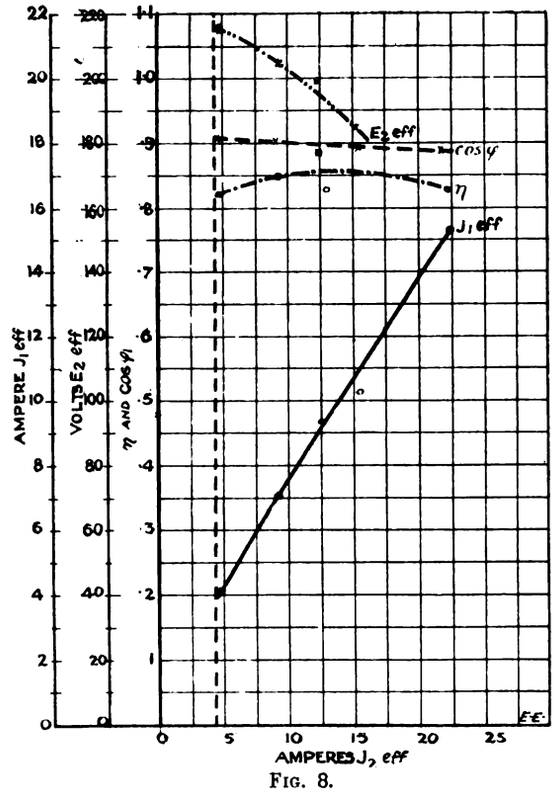

FIG. 8.

The fact that such a minimum current exists below which the apparatus will not work is somewhat of a drawback to this mode of operation, but against this the starting is very simple, and during the fortnight the above tests lasted the whole apparatus gave no trouble and was quite stable—reaching its steady state a few minutes from starting. A faint humming noise was noticeable, partly due to the mercury cathode and partly to the reactance.

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INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

TWELFTH ANNUAL CONVENTION.

(Continued from page 12.)

Depreciation and Reserves for Antiquation and Obsolescence from an Engineering Standpoint.

BY C. H. YEAMAN, CHIEF ELECTRICAL ENGINEER, HANLEY.

In the presentation of this short paper the writer is quite aware that he is raising one of the vexed questions connected with the financing of municipal electricity undertakings, and anticipates the expression of very varied opinions upon the views and arguments put forward. A discussion from the many different standpoints which may be taken with regard to the financial policy that looks to the electricity department's interests first and subordinates mere expediency to the soundness of the business position, both in the present and for the future, cannot but be interesting, and may tend towards a more general agreement as to the best and safest course to adopt. A dead level of uniformity cannot be expected, nor is it desirable with local conditions varying to the extent they do, but the divergence of practice in one town from that of another points to such a chaotic state of affairs that a more settled and definite general policy is much to be desired. If matters which are based on opinion could be separated from those based on principles generally accepted as fact in a scientific accountancy, a start could be made on common ground. Before reaching this stage, however, some agreement must be come to respecting the objects for which a municipal electricity undertaking is established. These are usually stated as: (*a*) the providing of a cheaper and better supply of electricity than would be given by a company covering the same area; (*b*) a less restricted policy in making extensions to outlying districts where the consumers are smaller and yield a revenue bearing a lower proportion to capital than in the central area; (*c*) reduction of the local rates by the application of profits from trading enterprises; (*d*) improvement in the mode and terms of employment in municipal as compared with company service.

At the last convention the subject was touched upon in the opening of Mr. H. Collings Bishop's paper, where it is stated that, "As we all know, the principal object of municipal trading is to advance the well-being of the ratepayer rather than to make municipal undertakings profitable." Let it be assumed that the object sought is the well-being of the ratepayer; then it is necessary to consider how far the term "ratepayer" approximates to or is identical with "consumer." The financial stability of local municipal undertakings is essential to the well-being of all ratepayers, but any profit arising from the sale of electricity is obtained, not from the ratepayers as a whole, but from a section of them. Assuming that the rates are relieved by the transference of "profits" from an electricity undertaking, it is not far from correct to say that in most towns each consumer pays £1 per annum more than he need do, and this sum is distributed in the proportion of 1s. each to some 19 other occupiers of premises using gas to aid of their rates. Conversely, if the consumer is given his supply at or about cost price, the growth of the business is more rapid, all classes are enabled to participate in the advantages of electricity, and the establishment of the undertaking is amply justified on this ground alone. The total receipts come from within the municipal area, and go back to it directly or indirectly. The only difference is that in one case those who support the undertaking pay towards those who do not, and in the other the consumers reap the reward of their own progressiveness. But it must not be forgotten that at some future date the municipal electricity works will be handed over as a going concern to the ratepayers of another generation. The loans will have been paid off, and there will be no financial burden to hamper a very cheap supply of electrical energy. Then the rates may be benefited by an amount at present set aside as the price of money, and in the meantime these who bear the burden are getting all the advantages of a good, reliable, and cheap supply. It is open to everyone to become a consumer and participate in the benefits. If 90 per cent. of the premises in a town used electricity, there would be no difficulty in selling cheaply, providing adequate depreciation, and, in addition, relieving the local rates by a substantial amount every year. Assuming that there is at any given date no indebtedness to nor payments made for the rates, and that the policy of supplying at the lowest possible cost be chosen, upon what basis would profits be calculated in order that there might be no call at any time upon the general body of ratepayers to make good a loss?

A profit has been defined as the difference between less and more efficient methods of production actually used in business by manufacturers engaged in the supply of any market. Those who assert that a local authority possesses a monopoly in the supply of electrical energy are stating a truth with an erroneous assumption, insinuated, although not made—namely, that the monopoly carries with it an absence of competition. Competition between rival manufacturers being the sole method of protecting the consumers and regulating the price, it is inferred that in the case of such a monopoly a profit can be made by excessive charges being levied. In the face of the acute competition of the gas undertakings with their mantle lamps where lighting is concerned, and of suction gas (to say nothing of town gas and steam) in the case of industrial power, it is obvious that at the present time electricity undertakings are not monopolistic in any sense in supplying light and power. Business can only be got at a price which pays the consumer, and existing consumers can only be retained by such periodic reductions in price as will keep their expenses at least equal to their neighbours and trading competitors. This requires the producers of electrical energy to be in a position to offer such advantages in price from time to time. The plant and mains have to be repaired and maintained out of revenue. It may be admitted that they will then remain in as good a condition as they were originally when put down, the assumption being that maintenance includes renewals of such parts as suffer by wear and tear during use, by accidental damage, or by such changes in the other constituent parts or methods of running as may be brought about by time, growth, or improvements.* But the value and utility of the plant as a factor of economical production are not maintained by keeping it in the *same* condition as it was at the time of purchase if, during the period it has been so upheld, the progress of the industry has led to more efficient, more cheaply repaired, and less expensive plant for the same work being designed, perfected, and put upon the market. A newcomer into the industry starts with a handicap in his favour if he is able to obtain plant equal in output with his competitor, yet calling for a smaller capital investment, taking less out of revenue for upkeep and costing less for fuel, oil, and wages.

If this argument be true, then the balance in a net revenue or profit and loss account cannot partake of the nature of a profit, or, at least, be wholly profit, until and unless there has been charged against revenue such a sum as will, for the period in question, cover the actual diminution in productive efficiency of the older plant, compared with the later. Otherwise, assuming that the balance on profit and loss account be appropriated and distributed as clear gain for a number of years, there will come a time when the more efficiently equipped producer will be in a position of such commercial advantage that he can reduce his price, and, by competing for and gradually seizing the business of the other, eventually drive him out of the field. To sustain the fight industrially, it is necessary that the plant and other fixed assets should be maintained, not merely in as good a position as they were originally, but equal to similar plant which might be employed by a competitor. In practice this resolves itself into debiting against each year's balance such sum as will provide new plant when that now in use ceases to be sufficiently cheap in its working costs to run in competition.†

Municipal electricity works are constructed with borrowed capital, and this is obtained in much the same way as a limited company issues its debentures, but the security is more than the assets created by the expenditure of such capital. A potential liability, unlimited in extent, is imposed on the ratepayers, who, to all intents and purposes, guarantee the repayments of the borrowings. No principles for fixing the periods which may properly be allowed for local loans for different purposes have ever been laid down by authority,‡ and consequently it is found that the practice of the sanctioning authorities for Scotland, for England, and in the county of London differs. Borrowing by means of mortgage deed seems to be the most popular method of contracting loans. Repayment is made, either at a fixed date, by setting aside annually sums to sinking fund from revenue which at the expiration of the loan period are available for its extinction, or by paying off a sum each year. The latter method has two variants. An equal instalment of principal, together with interest on the outstanding debt, may be paid yearly on the instalment plan, or an equal sum as will cover the interest and repay the principal within the prescribed period may be allowed on the annuity systems. In either case the redemption, repayment, sinking fund, or loan charges are such that the debt incurred is liquidated by the end of the period authorised for borrowing, and this period is,

* Examples of these changes are: removal of copper pipes in steam ranges upon adoption of superheaters, discarding of bare copper mains upon conversion from 220 to 440 three-wire system, substitution of oil-break for air-break switches and fuses upon installed capacity, rendering former ineffective, and such like improvements, of which every works presents instances.

† Take the extreme case of a direct-connected generating set, costing £20,000. The next year it might be found that a turbine set with output as economical as the reciprocating plant could be got for £14,000. It would then be quite proper to write off £6,000 for depreciation, but after that the value would fall less rapidly. Electric Light Convention (Cincinnati, U.S.A.), 1902.

‡ "Loans of Local Authorities," G. Biddell, p. 55.

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as a general rule, so limited as to warrant the expectation that the schemes and works on which the money is spent will remain in good condition and render *efficient* service throughout the whole of the period allowed. Although in the Metropolis 42 years were allowed for repayment, this was not based upon an estimate of the equated life, but was in the first place selected as the maximum period for which a company would, under the Electric Lighting Acts, be allowed to carry on its undertaking before the option of purchase could be exercised by a local authority.* Hampstead has been courageous enough to voluntarily provide for the liquidation of its capital expenditure in 25 years, and thus "occupies the most favourable position of the borough councils."

In the Board of Trade model form of electricity accounts, where the undertakers are a local authority, there are included in the net revenue account the following items: interest on mortgage debt; instalments repaid; sinking fund payments; payments to reserve fund; sum applied to local rates; balance carried forward. In the company model form, in the revenue account is included a section omitted from the local authority form. To depreciation: (1) to depreciation of leasehold works; (2) to depreciation of buildings; (3) to depreciation of plant, machines, etc. While the net revenue account contains: interest on debentures, mortgages, and bonds; interest on temporary loans; dividend on preference stocks; balance applicable as dividend on ordinary shares. The word "profit" does not appear in either form. In provisional orders and the Electric Lighting (Clauses) Act, 1899, it is enacted that all moneys received shall be applied in payment of working, establishment, and maintenance expenses, interest, dividends, instalments, sinking fund payments, and in providing a reserve fund, "if they think fit," such fund not to exceed one-tenth of the aggregate capital expenditure on the undertaking. The net surplus *shall* be carried to the credit of the local rate, *or*, "at their option," in reduction of the capital moneys borrowed for electricity purposes. The order in which these appropriations appear is significant, and while again no mention is made of "profit," ample provision is given for the wiping out of capital "if they think fit."

In 1902 the council of this association received a report from a sub-committee appointed to deal with the repayment of loans, and on Feb. 21 of that year a resolution was passed at a special general meeting, stating: "That, in the opinion of this association, electricity supply undertakings having to be maintained in a thorough state of efficiency out of revenue, no depreciation or further writing off of capital is necessary when the period allowed for repayment of loans is not greater than 30 years, as the equated life of the plant exceeds that period." As a rule, in municipal borrowings the period granted for the repayment of loans is supposed to be the equivalent of the life of the object for which the loan is sanctioned, but this principle is not applied in the case of undertakings granted an equated period for extension as well as original loans. The period granted on this basis is determined by the average life of each item specified in the capital account, so that taking the amount and life of each the weighted mean gives the equated period. In first or foundation loans the site and buildings are items, and these entering into the calculation prolong the equated period. When extensions are required, should the same period be sanctioned the loan extends far beyond the probable life of the assets upon which the money is spent, as they are probably only plant, mains, and perhaps meters, all of which, by themselves, would on the basis of calculation of the foundation loan be entitled to a shorter equated period than was allowable when the amount included long-lived assets such as site and buildings. The principle, therefore, of allowing an equated period at all is regarded as unsound by accountants, who frequently suggest that it should no longer be continued, but that each loan should be borrowed for a period corresponding to the estimated life of the object for which it is required.

Where there is an equated period for loan sanctions, the question arises whether a second loan may be, or in principle should be, granted for the replacement of a section of the assets, admittedly a short-lived portion, before the whole amount of the loan has been repaid. As the period was originally calculated upon the supposition that such section would only have a short life, it is argued that a replacement loan should be permitted, on the ground that the longer items are being paid off at a too rapid rate. While, strictly speaking, this may be the case, there is the objection that the rule of refusing sanction to reborrowing during the currency of a loan would be infringed, and the growing practice to sanction each item or class of asset separately has much to recommend it. Apart from the period being long or short, it is very desirable that the expenditure upon each item and against each sanction should be shown, or at least known by the accountant, and also that the amount redeemed should be ascertainable, so in the event of displacement the exact amount outstanding can be written off. To effectually do this requires a certain amount of trouble being taken in prime costing work carried out. The Local Government Board inspectors have frequently protested against the too common practice of lumping all sanctions together on one side of the capital account, and in like manner taking the total of the expenditure, everything being considered satisfactory so long as there is a balance of sanctions over expenditure.

Net profit correctly stated is the balance of earnings after charging all sums that ought properly to be taken into account. How are these sums to be ascertained? If in order to arrive at the profit earned it is necessary in the case of a company for due provision to be made for the depreciation of wasting assets, what relationship does such depreciation bear to the sinking fund of a local authority? The sinking fund, by intention, will have reached an amount equal to the original purchase price of an asset by the time such asset has fallen to zero value, or a negligible residual value, and, therefore, if the currency of the loan be equal to true life of the asset, sinking fund and depreciation fund are equivalent if not synonymous terms. Assuming that it has been proved that depreciation is chargeable against revenue in the profit and loss account, it is not then necessary or desirable to charge also sinking fund. On the principle that the greater includes the less, if the depreciation allowance be sufficient it covers sinking fund in any case. If the life of the plant and mains severally be equal to the currency of the loans covering them, depreciation and sinking fund will be equal in amount. If the life of such assets be less than the figure estimated in fixing the period for the respective loans, but the depreciation allowance be properly calculated, the depreciation allowance will be in excess of the sinking fund payments, and the provision expressly made for depreciation will be the difference between the two. Sinking fund payments or direct repayments of capital may not equal the full depreciation required, but they certainly are means to that end.

The argument on the other side is that if the betterment, additions to, and repairs of a plant from year to year are charged to maintenance and operation instead of to capital or construction account, it is for all practical purposes maintaining the plant at 100 per cent. value.* As an instance of the extremist views may be cited†:

Against.—The finances of our local authorities are in an "absolutely rotten" state, because in the great majority of instances no express provision is made for depreciation.

For.—So long as local authorities comply with their statutory requirements and set aside annually out of revenue a sinking fund to provide for the eventual payment of their loan capital, they have done all that is necessary.

The truth lies, where it usually does, in the golden mean. There is no sound argument in such a contention, for example, as that brought forward‡: "That depreciation should be charged in all undertakings liable to waste, obsolescence, or supersession on terms quite sufficient to renew or recoup the assets when required, *without recourse at any time* to reborrowing, repairs being charged direct to revenue year by year. Sinking fund should be charged separately, without regard to depreciation." It has been very clearly put that a balance in the net revenue account cannot be properly considered profit until the reserve fund has been built up to such an extent as to make the undertaking perfectly safe against all possible emergency demands, whether due to rise in prices or in working costs, to special maintenance or renewals, or to the necessity for adopting new methods or more modern machinery to replace those already existing. Were it not necessary to the very existence of an undertaking to keep generating plant and mains more or less up to date, the contention that once statutory obligations had been met nothing else is essential would carry the day. Engineers are constantly being offered plant which is being discarded by other undertakings, showing that, recognised or not, the process of eliminating the unfit is going on naturally all over the country. In such cases the unredeemed portion of the loan must be met by immediate calls upon revenue if a fund or balance in hand is not available for the purpose.

The confusion of ideas which prevails in connection with depreciation is very well exemplified by the editorial comments of a local journal upon the accounts of a South Coast electricity undertaking. Taking the analogy of furniture bought on the hire-purchase system, those who reckon the payments by instalment as a provision for depreciation and replacement are characterised as madmen or imbeciles.§ An inquiry of any firm supplying goods on deferred payment would have proved to the author of this dogmatic and sweeping dictum that the monthly payments, always called "hire rental," by the by,

* Statistical Return, London County Council, 1907, p. 15.

* In the certifiate attached to the statutory accounts of one local authority the consulting engineer certifies that "the mains and machinery have been maintained out of revenue in a very satisfactory condition, and were, at the date of the accounts, as efficient in their generating and conveying capacity as when new."

† Prof. Lawrence Dicksee's lecture on "Depreciation," 1907.

‡ Mr. Fred. Walmsley, Manchester Bankers' Institute, January, 1907.

§ *Bexhill Chronicle*, Nov. 10, 1906

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are simply $\frac{1}{n}$th part of the aggregate capital and calculated interest thereon for the n months allowed for completion of purchase. Assume the articles purchased last only for n months, then they cease to be useful at the time when the payments for them terminate; after this the whole process is repeated, going over the cycle again. There is no intrinsic difference between such hire purchase of furniture and the borrowing of money for the purchase of plant and repaying by instalments. The lender of the money may or may not be the seller of the goods, but in either case the financial transaction partakes of the same character. In one case only one ledger account is opened, covering both the purchase and loan; in the other two personal accounts have to be kept, one for the seller and the other for the lender; but these are details of book-keeping, and not of finance.

The comparison between a company's management and municipal control requires to be very carefully made to show the exact differences. So long ago as 1895 Mr. J. S. Raworth made the statement that "the municipal undertakings, which have a monopoly of supply in perpetuity, write off a larger percentage for sinking fund than the private companies which have a limited tenure without monopoly."* With a local authority the difference between the total assets and the total liabilities is a sum which represents the net profit and provision for redemption of debt made by the undertaking since the commencement. Municipal accountants occasionally argue that the amount of debt redeemed is equivalent to depreciation, and that in the case of a company the amount provided for redemption of debt by the local authority would be represented by cash in hand, because, they aver, a company, unlike a local authority, is not under any obligation to redeem its capital, and this view, they claim, should not be overlooked when comparisons are made between undertakings managed by municipalities and companies. Mr. Hammond is more precise in his analogy. He likens a local authority's undertaking to one owned by a statutory company consisting of seven original shareholders who put up the sum necessary to obtain their parliamentary powers, and who, having obtained these powers, raised the *whole* of the capital necessary to carry out the undertaking in the form of debentures repayable at the end of 25 years, the interest and repayment in respect of the same being personally guaranteed by the original shareholders. It must be added that the shareholders, either wholly or in part, form the customer purchasing the commodity produced by the undertaking. Then the shareholders are analogous to the ratepayers in a municipality operating electricity works. Any losses in working would fall upon themselves, and any profits remaining over, after paying debenture interest and sinking fund contributions, would be at their disposal. But if such profits accrued from the charging of prices for the commodity in excess of its market value, the shareholders in their capacity of consumers would certainly disprove of the policy of management, and as directors would take steps to effect a change for the better.

Provided the undertaking was maintained in working order and in a position to earn dividends to the end of its life, it is unlikely the shareholders would do more than create a reserve fund as an insurance against losses which might be incurred at some period during its working. At the end of the life period, on expiration of the statutory powers or of the useful duration of the machinery employed, there would remain in the former case the residual value of the machinery, and in the latter in addition the goodwill built up by years of services rendered by the supply of the commodity.

Does a company usually pay off its debentures on their termination, and reduce its capital by the amount wiped out? This hardly seems the practice, and those who claim that a company's debentures are on all fours with a corporation loan should be called up to explain why in so many instances one set of debentures is cleared off by the creation of another. Indeed, in the model form of accounts for electric lighting companies no mention whatever is made of any sinking fund for this purpose.

The writing down of company's capital is too often effected at the expense of the shareholders, who, willy-nilly, have to suffer the loss consequent upon the re-establishment of a sound commercial position. Depreciation has been defined as "the diminution of the intrinsic value of anything,"† or "that loss, or shrinkage in value, which inevitably occurs from time to time in the assets which represent the capital equipment of a business, as a result of their employment therein, such loss being attributable to wear and tear, to lapse of time, to the march of modern invention, or to any or all of these causes combined."* There is an admitted diminution of value of small dynamos and alternators purchased eight, ten, or more years ago, to say nothing of the minor portions of plant equipment. Where such plant has been removed to make room for large and efficient sets of modern design, it has invariably been sold at a residual value but little above scrap or breaking-up price. In the days when many of our present successful undertakings were established, day-load sets of under 50 kw. were quite common; occasionally such things as 15-kw. generators were put down, and these have given place to larger because they became useless with a minimum load many times their capacity well within their expectation of life. Utility and durability were shown to have different periods, yet where similar sets remain to-day they appear in the balance-sheets at full value, and against this there is only half the purchase price in the sinking fund. "At Taunton their plant became somewhat obsolete—not worn out, but not as economical as modern plant, and consequently they were advised to change it for new. When they came to do it their alternating plant stood on their books at a certain price, and they were able to get their price for it, but the arc lighting plant did not realise the amount at which it stood in the books, and the difference the Local Government Board would not allow them to borrow, so this they took from the depreciation fund."†

The assertion is then made that the accounts have been audited and found correct. The accuracy of the entries on a cash basis may be proved by audit, but "the professional audit goes beyond mere questions of payment. It looks to see if the accounts submitted are really true and proper statements of accounts to submit to a community, that capital and revenue are properly apportioned, *that reserves are provided*, and, in short, that general experience and a large commercial view are applied in the audit of accounts in our municipal trading, so that we can stand up in the face of the world and say that we are presenting an honest and straightforward statement to the community.‡ Auditors frequently bring this question forward in their reports. In one case the following expressions were used: "I would bring before your notice that while there is no legal necessity to charge against profits more than interest charges and sinking fund instalments, yet I think the burgesses should have brought before them most clearly that, in my opinion, the depreciation is very much greater than the amount of the sinking fund."

Electrical machinery is no exception to the general rule, and the words applied to workshop plant bear with equal force where central-station apparatus is concerned. "Although some undertakings keep their plant in first-class order and effect such repairs from time to time as to maintain it in good working condition, still it cannot be denied that all machinery is constantly being superseded by something more efficient, and that it is only a question of time in any case when it would be more economical to put some of it on the scrap heap—in fact, necessary to the very existence of the undertaking to do so. To only repair plant to make good depreciation cannot, therefore, be wise or sufficient. And yet to buy new plant (out of revenue) regularly, or even at all in the early stages of a new concern would, in order to comply with the requirements of depreciation, be absurd."§ The amount of depreciation which should be allowed is fairly definite. The Income Tax Commissioners allow 4 to 5 per cent. in calculating income tax upon industrial undertakings. For purposes of extreme accuracy a professional valuer may be called in and his opinion taken, say triennially, depreciation for the ensuing three years being allowed upon the rate at which the assets are diminishing in value according to such valuations. The engineer of an undertaking can usually give a figure sufficiently accurate for the purpose, and in the most prominent case of accounts made out in this way that was the course followed.‖ The five instances where depreciation is debited in the accounts are Aberdeen, Bolton, Darlington, Devonport, and Glasgow, while Bristol has now followed suit.

The figures for the last complete year published are given in Tables A and B, together with the various opinions expressed

* *Lightning*, April 4, 1895.

† The late Mr. Arthur Towers, F.S.A.A., borough treasurer of Islington, Inst. Mun. Treas. and Accountants, Kensington, 1901, added that electrical supply machinery cannot appreciate in value, and that maintenance in a high state of efficiency out of revenue should be held to dispense with the necessity for providing a depreciation fund, merely proved that the object of such a fund had not been grasped.

* Prof. L. Dicksee, 1907.

† Alderman Potter, M.E.A. Convention, 1899.

‡ Mr. Harmood-Banner's Presidential Address, Association of Municipal Corporations, April, 1907.

§ Mr. J. Slater Lewis, "Commercial Organisation of Factories," Chapter 38.

‖ "Mr. Chamen had put down a period for the various portions of the electrical undertaking at Glasgow. One-third of the equipment at from 50 to 100 years, and others at 10 years. They had written off their depreciation according to this list."—Bailie Willock, M.E.A. Convention, 1906. "The Corporation of Glasgow would be sadly wanting in ordinary business methods if they allowed either their gas or electricity accounts to be stated without an adequate amount for depreciation and renewal of all wasting or wasted assets being debited against revenues."—Bailie Maclay, M.E.A. Convention, 1899.

"Your sinking fund pays what you borrow,
But does not write down your assets;
Depreciate or, to your sorrow,
Renewals will add to your debts."
Mr. Donald McColl (Glasgow), "Tramway Book-keeping."

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TABLE A.—CAPITAL AND DEPRECIATION CHARGES AT GLASGOW. ELECTRICITY WORKS ACCOUNTS.

Year.	Gross capital.	Depreciation for year.	Per unit.	Sinking fund for year.	Per unit.	Total depreciation and sinking fund.	Depreciation and sinking fund to gross capital. For year.	Total.
May, 31	£ s. d.	£ s. d.	d.	£ s. d.	d.	£ s. d.	Per cent.	Per cent.
1893	98,025 14 9	1,328 13 8	1·11	800 0 0	·67	2,128 13 8	14·12	14·12
1894	122,307 3 1	4,393 0 11	1·50	1,214 3 9	·41	7,735 18 4	5·72	6·84
1895	142,638 2 9	5,151 13 6	1·39	1,369 10 10	·35	14,257 2 10	5·33	6·06
1896	149,164 8 0	6,329 8 8	1·39	1,392 15 2	·29	21,979 6 8	5·41	5·81
1897	169,559 6 10	10,705 10 0	1·71	1,585 11 11	·23	34,270 8 7	8·25	6·50
1898	224,887 4 9	8,945 1 9	1·01	1,717 13 3	·17	44,933 3 7	6·28	6·45
1899	384,156 15 11	7,520 18 0	·64	3,456 19 0	·27	55,911 0 7	4·88	6·06
1900	657,040 15 9	3,181 10 11	·18	6,633 12 10	·35	65,726 4 4	2·55	5·03
1901	883,702 9 3	—	—	9,196 1 10	·31	74,922 6 2	1·39	3·82
1902	1,021,713 13 0	11,430 16 3	·29	9,402 3 4	·22	95,755 5 9	2·35	3·37
1903	1,137,917 18 6	37,185 10 6	·78	12,924 8 8	·25	145,865 4 11	4·90	3·77
1904	1,247,400 11 5	32,180 13 1	·51	16,688 15 5	·24	194,734 13 5	4·29	3·88
1905	1,414,356 7 6	41,840 17 3	·55	17,286 2 2	·20	253,861 12 10	4·74	4·06
1906	1,576,317 14 3	37,989 10 6	·42	22,325 14 7	·22	314,176 17 11	4·26	4·10
	Total	£208,183 5 2		£105,993 12 9				

TABLE B.—Estimated Life of Electrical Appliances for Loan Purposes.

—	Mr. Robert Hammond, April, 1907	L.G.B.	L.C.C.	Mr. J. F. C. Snell, M.E.A., 1905.
Land	60	—	60	100
Buildings	60	30	50	60
Boilers	20	15	20	20
Engines	20-25	15-25	20	25
Electrical generators	25	20	20	25
Accumulators	15	5-7	20	10
Static transformers	15	15	20	20
Rotary converters, switches, and instruments	20	15	20	20-25
Mains	25-30	12-15	mains, 30; services, 12	ducts, 60; solid mains, 25; cables, 15
Meters	10	5	10	15
Arc lamps	10	7-10	Not granted	15

as to duration of life of plant, etc., and a summary of the amounts set aside at Glasgow. The sinking fund may be regarded as a depreciation fund for capital and the "depreciation" proper as a similar provision for plant and mains. If, in addition to sinking fund, from 1 to 2 per cent. on the whole capital be set aside annually for the latter purpose and either invested or (what is the same thing) employed in the business as working capital, thus saving the payment of bank interest which should be credited to this fund, the minimum considered desirable would be available. Out of this regular renewals on change of old plant for new could be made. The amount of depreciation desirable to allow in America was considered at the Boston meeting of the U.S.A. Institute of Electrical Engineers in 1899, and the general feeling was that 10 per cent. on the cost of any electrical plant was a fair allowance annually. The New York Edison Company allowed 8 per cent., this amount covering the wearing out of machinery, its profitable replacement by other forms, and the limitation of the useful life due to greater competition of the central-station companies. The life of electricity generating plant constructed at this date is considerably greater than that turned out, say, 10 years ago. But the useful life depends upon more than the possible working life. It must be borne in mind that not only has diminished value by reason of wear and tear to be provided for, but the probability of an expensive machine becoming obsolete and requiring replacement well within its expectation of life has also to be taken into account. Having regard to this and to the absolute necessity of economy in face of increasing competition, the financial support required to keep their plant up to date is being asked for by many municipal electrical engineers.

From the engineer's point of view, having the best interests of the consumers and ratepayers before him, depreciation allowances should cover antiquation, obsolescence, and ineffectiveness enabling machinery which may be in good working order to be scrapped and replaced when it has become ineffective as an industrial tool for the production of a commodity called for by the public at a price not exceeding what is charged in the neighbourhood, or for what it can be made by private plants. Objection is sometimes taken to the word "obsolete." There are rope-driven generating sets still at work. They are admittedly obsolete, although the objection to them is not that they are out of fashion, but that they are wasteful in steam consumption, in oil, and in the repair bill. They have, in short, become obsolete owing to improvements introduced in the methods of generation. What applies to them also has some force in connection with many works laid down quite recently. It is by no means the exception to find the first sets of less size than 100 kw. The serve admirably to keep down the initial expense, to show good running costs whilst an output of a hundred thousand units or less is recorded as the annual sale, but in a few years the load has grown far beyond their capacity to cope with at any time, and space being valuable they are displaced by larger, thus avoiding building extensions. The Local Government Board require the local authority to write off the capital expended on them and not by that time repaid. Where it can come from, save out of revenue or from a reserve fund of some kind, is a mystery to those who have to face the responsibilities of management at the time. In a recent report the sentence occurs: "Should the life of an asset be shorter than the period covered by the loan, the outstanding portion of the loan will be written off out of reserve."

To apply this statement to municipal electrical undertakings generally would be out of the question, inasmuch as comparatively few possess any reserve. Even this statement was not regarded as commercially sound by a firm of accountants, who recommended "a further charge in respect of renewals." The local authority then termed their reserve fund a "renewal reserve," and the amount placed to it will in no case be less than the actual "profits" earned until the reserve fund represents the difference between the *actual* value of the plant (*after* depreciation has been deducted) and the net sum represented by plant as an asset in the balance-sheet. This is an exceedingly good example of the principle working out in practice. The plant starts at purchase value and ends with none (or nominal residual value). Conversely, the reserve fund starts at zero and ends with sufficient to buy a renewal plant, the sum of the plant value and "renewal reserve" being a constant quantity throughout. If the evidence of Mr. J. N. Kershaw, an assistant secretary of the Local Government Board, before the 1902 House of Commons Select Committee is to be accepted, the intention of the Board in granting sanctions to loans that the loan period shall not exceed the life—presumably *actual* life—of the works, while, on the other hand, the ratepayers and consumers of the future shall not be unduly burdened.

It has been said that the Local Government Board is adverse to the specific provision for depreciation.* This can hardly be the case, as the tendency of the Board is to shorten, and not to lengthen, the period of loans, thus tacitly admitting that the former periods granted are too long. Yet it is found that several corporations have, by majorities against the building up of a depreciation fund, shown that they consider their undertakings "on a sound financial basis" without it, and prefer "to leave things as they were." Supposing that a depreciation allowance is made and charged annually against revenue, it is quite conceivable that in one particular year the surplus balance may be insufficient to meet this charge. What has then to be done? The case arose at Glasgow on the annual accounts up to May 31, 1903, when the receipts amounted to £127,004, working expenses to £58,668, and interest with repayment to £45,045, leaving a surplus of £23,291. But depreciation on the sca'e in force required £29,360, and, in addition, plant had been sold (on change of voltage) representing £7,826, or a total of £37,186, making a debit balance "which, in terms of the Glasgow Corporation Electric Lighting Order, 1890, was in the meantime transferred to the debit of the gas account." Doubts have been expressed as to the legality of supporting a depreciation charge by the equivalent of a call on the rates. On the

* Treasurer Brown, Edinburgh Council, June 12, 1906.

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other hand, it would appear that a company cannot legally pay dividends even in subsequent years until capital previously reduced by depreciation has been made good out of earnings,* and this is supported by the inclusion of depreciation in the revenue (or "profit and loss" account) of the model form of accounts for companies, whereas debenture interest for companies and all charges for mortgage debt for local authorities appear in the net revenue (or "revenue") accounts in the model form for local authorities. In addition to providing adequately for depreciation, a local authority owning electricity works may have to face special unforeseen or extraordinary expenditure, the result of accident, change of system, or brought about by some natural cause, such as settlement of the ground due to undermining. These expenses would in the ordinary way fall upon repairs and maintenance account, but to meet them in any one year might, and probably would, entail a call upon the rates for aid should the average price received per unit be only slightly in excess of the inclusive cost (taking total cost and capital charges together). The method sometimes adopted to avoid a call on the rates—*i.e.*, to create a (deficit) suspense account and wipe it out by payments thereto from revenue over a period of years—is undoubtedly not in accordance with the Electric Lighting Acts. A reserve fund built up beforehand from surplus revenue acts as an equalisation fund. It is on all fours with the now much favoured hire-purchase system, whereby a large expense is avoided and a costly article obtained by a series of regular small payments. It partakes of the nature of self-insurance and gives a cover on every portion of the work equal to the full amount of the reserve.

There is yet another reason why surplus balances should be retained in hand or readily realisable investments until the reserve has reached the full amount of 10 per cent. on capital permitted by the Electric Lighting Acts. The fact must not be lost sight of that when the annual accounts are made up to the end of a financial year the charges for the fourth quarter of that year have only just been rendered to the consumers, and the surplus shown in the net revenue account is, therefore, not really available in cash, but is represented principally by book debts. As loans are not granted for working capital even the stock of stores which is credited against the purchases during the year have been paid for by a bank over or appear in the adverse balance by the bank against the corporation. Wages and other expenses have to be paid in the same way until the receipts come in from consumers. Even then local authorities are dependent upon their bankers for trading capital until a reserve is accumulated at least equal to the total of the consumers' accounts for one quarter plus any amount required for stores in hand. If an electricity department were dissociated from the corporation, would this be regarded as good business finance? The fact that borough accountants are often able by combining the balances on different accounts to finance the current electricity account at no or only a small interest does not lessen the desirability of strengthening the municipal position in this respect. There is very little real disagreement on the question of depreciation, and the necessity for providing annually such sums as will meet it, between engineers and accountants. A perusal of the report of Alderman Ewing Matheson, chairman of the Leeds Committee, of Sir A. B. W. Kennedy† to the Edinburgh Corporation, and of Prof. L. Dicksee to the City Council of Bristol, shows that on all the main points there is a remarkable unanimity of opinion.

After the foregoing was drafted, Mr. Robert Hammond read his paper on the same subject at the Institution of Electrical Engineers, and, consequently the writer eliminated certain sections to avoid repetition. Mr. Hammond introduced his subject by the remark that "in arriving at the net profits earned during any given period by an industrial undertaking, it is obvious that a determination should be made of the extent to which the assets of the undertaking have depreciated in value during that period." It would appear that instead of the permissive "should" the imperative "must" might well be substituted, with a prefixing of *true* before "net profits." But the *obvious* desirability—or necessity, more likely—of determining the depreciation in value was made the subject of an assumption, and this assumed acceptance of the premise was shown by the discussion, and by the action of local authorities in many instances since, to have been only partially justified. Accordingly the writer has very briefly endeavoured to assert the fundamental importance of acknowledging, rather than ignoring, the existence of depreciation, if the future financial stability of electricity supply enterprises in the hands of local authorities is to be assured. To the accountant is left the precise calculations necessary to properly deal with every given case, and no attempt has been made to stretch the argument by hypothetical calculations.

* Neufchatel Asphalt Company, 41 Ch. D. 1.

† "Provision for payment of interest and sinking fund on municipal undertakings should not be considered as in any way superseding the necessity for the establishment of a reserve or depreciation fund, which could be used for the same purpose as a depreciation fund in any ordinary commercial undertaking." May, 1906.

Mr. ROBERT HAMMOND said he disagreed entirely with the principle that municipal electrical undertakings should be called upon first to set aside an amount annually which represented the gradual wearing away of the plant, and also a further amount which represented the gradual antiquation of the plant. This would impose a very onerous duty upon any undertaking, and would make the carrying on of new undertakings almost impossible. He ridiculed the idea of building up a fund immediately a new business was started, simply with the idea of providing against the possibility of better plant being evolved before the existing plant was worn out. That would burden the present ratepayers with a most unjust charge. At the same time, he most strongly urged the setting aside of adequate sums towards sinking funds, and instanced the case of many London local authorities which had borrowed money for 42 years for electrical purposes. They seemed perfectly satisfied as long as they put aside the exact proportion of the sinking fund based on 42 years, irrespective of the life of the plant. If engineers worked strictly according to the life of their plant, a depreciation fund was unnecessary.

Bailie STEVENSON, of Edinburgh, rejoiced in the fact that in Scotland money was granted to local authorities at 30 years, and they were allowed to spend it in their own way. In England money was granted for different periods for different purposes.

Alderman PEARSON, of Bristol, held the view that it was the duty of an electrical committee to hold the balance, first, as between the users and non-users of electricity, and, secondly, as between the ratepayers of the present and the ratepayers of the future. He could not conceive it logical that the ratepayer of the future should be handed over a revenue-earning works and at the same time a sufficient sum of money to purchase new plant if that were desired. The provision of a depreciation fund as well as paying off capital and keeping the plant in repair would create this position.

The Value of Photometry in Central-Station Practice.*

BY ROBERT MCCOURT, ASSOCIATE, MAINS SUPERINTENDENT, HARROGATE.

It is a remarkable fact that the subject of photometry has not received the attention it deserves from electrical supply station engineers. For instance, during the 11 years the Municipal Electrical Association has been in existence there has never yet been read a paper on photometry. While no amount of investigation and experimental research has been thought too great to undertake in the other departments of central-station work, the study of photometry has been left entirely to the staffs of the university and technical school laboratories. And yet, from the point of view of the outside public, the principal reason for the existence of the profession of electrical engineering is that

* This paper was submitted in competition for the I.M.E.A. travelling studentship, value £10, which has been awarded to the author.

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the members of that profession should provide light, or, as the American technical Press puts it, that profession should understudy the sun. It is a matter of supreme indifference to the ordinary consumer of electricity whether the pressure of supply at his lamp terminals is within the limits prescribed by the Board of Trade if the light which he gets from his lamps is less than that obtained by his competitors from some other source of illumination. This being so, electrical engineers ought to be well up in all the details of photometry, and have instruments and appliances at hand to demonstrate the candle-power of different electric lamps, and also to compare the illumination of electric lamps with gas lamps and other forms of lighting. This point has been brought prominently to our notice in recent papers read before the Institution of Electrical Engineers. We are, however, not so conversant with the study and practice of photometry as gas engineers are, but they have been compelled to devote attention to it, as various Acts of Parliament impose upon gas companies the *obligation* of providing apparatus for testing the candle-power of the gas supplied, and impose upon the local authorities the *duty* of carrying out these tests through a gas examiner appointed under the Gasworks Clauses Act.

While it is difficult to conceive Acts of Parliament regulating the number of watts per candle-power of electric lamps, and still more difficult to imagine such Acts of Parliament being enforced, there is no doubt that in the past too little attention has been given to this subject. It is the case that until recently the equipment of central stations in regard to photometry was of a very meagre nature, and even now a very large proportion of central-station test-rooms do not possess a photometer. This is still more to be deplored when one remembers that nowadays the tendency of local authorities is to buy and sell light for the public streets by candle-power, and not by cubic feet of gas or watts of electricity, so that it is most important that the staffs of municipal electric supply authorities should be in touch with photometry and the use of the photometer.

In this paper the author does not propose to go deeply into the scientific aspects of the subject, but to deal with it in such a way as to show what can be done with a few simple instruments with a fair degree of accuracy. The phrase "a fair degree of accuracy" is used advisedly, because, in the words of Mr. A. P. Trotter, "after all, photometry is largely a matter of individual judgment; it is not really a physical measurement, because the physical measurement is indirectly based upon the judgment of the eye," and the users of electricity are not likely to grumble if their 16-c.p. lamps are giving their rated candle-power within 10 per cent.—viz., ranging from 14·4 to 17·6 candles.

Photometrical Laws.—It may not be out of place to state briefly the laws which govern the principles of photometry and which apply to all types of photometers. They are so well known that an apology is, perhaps, necessary for introducing them here, but first principles are such important factors in the consideration of such a subject that, if for no other reason than refreshing our memories, the enumeration of them at this point may be useful: (1) Kepler's law of inverse squares—the quantity of light falling directly upon a given surface varies inversely as the square of the distance from the source; (2) Lambert's cosine law—the intensity of illumination which is received obliquely is proportional to the cosine of the angle which the luminous rays make with the normal to the illuminated surface. It follows, therefore, that if the two lights which are to be compared are at different angles to the screen, the law of inverse squares must be modified and a correction must be made for the cosine of the different angles to the normal. Of course, the obvious thing to do for the sake of simplicity is to take steps to ensure that the two lights are presented at the same angle to the screen. This is easily done in the case of a room specially adapted for such photometric purposes as testing large quantities of incandescent lamps, but in the case of street-lighting and the testing of the candle-power of various types of lamps in the streets and in consumers' premises the angle of incidence of the two lights cannot be made similar without a great deal of trouble and inconvenience. Further on is given a description of a portable photometer which is constructed in such a way as to allow for the cosine law.

(3) There is a tendency at the present time to measure the light effect in foot-candles on a given surface without reference to the power of the source of light which illuminates that surface, and the law is a combined or generalised law deduced from (1) and (2). The equation is:

$$e = \frac{I \cos a}{B^2},$$

where e is light effect;
I is source of light;
a is angle of incidence;
B is distance of the source of light from the surface illuminated.

If I is given in candles and B in feet, then e will be in candle-feet. *Note.*—One candle-foot is the amount of illumination received on any surface from a source of light of 1 c.p. at a distance of 1ft. from it, or from a light of 4 c.p. at 2ft. distance, and so on.

Light Standard.—Having thus outlined the physical laws on which the study of photometry is founded, we now come to the consideration of the question of a standard of light against which to compare our commercial lamps. Round this section of the subject of photometry has raged a long and exhaustive controversy. Until recently the discussion on papers on photometry has nearly always resolved itself into a debate on this matter of a standard or unit of light. In Dr. Fleming's paper on "The Photometry of Electric Lamps," read before the Institution of Electrical Engineers in December, 1902, no fewer than 18 pages of the journal were devoted to this important point. Fortunately the matter is now settled as far as British electrical engineers are concerned, because in the standard specification for electric incandescent lamps, published by the Engineering Standards Committee, occurs the following definition of a British standard of light: "The British standard of light shall be the 10-c.p. Vernon Harcourt pentane lamp in the custody of the National Physical Laboratory." And also that the secondary standards of light to be employed in the testing of incandescent glow lamps shall be: "suitable carbon-filament incandescent lamps which have been certified to be in accordance with the standard of light at the National Physical Laboratory and which are in agreement with it at the time of use." The procedure which gives best results is to obtain from the National Physical Laboratory standardised carbon-filament lamps and from these to calibrate carefully sub-standards. It is most important that both standards and sub-standards should be carefully-selected incandescent lamps, preferably large bulb type which have been "aged"—*i.e.*, have been on circuit for a sufficient number of hours to have got over that rise in candle-power which is noticed in all incandescent lamps during the first 100 or 200 hours' life, and have thus arrived at that stable condition indicated by the straight portion of the curve in their life chart. Another point to note is that these standards must be marked on the bulb or cap showing the exact position in which they must be placed with reference to the photometer head to give the actual candle-power at which they are standardised. These sub-standards are used in the photometer, and can be checked regularly against the original standards. These original standards being thus only used for a short time can do duty for a very long period and seldom require restandardising. It is a very great help towards accuracy to have original standards in each of the more common sizes of lamps—viz., 8, 16, 32, and 50 candle-power—as, for obvious reasons, there is less likely chances of mistakes in testing a 50-c.p. lamp against a 50-c.p. than if the standard were an 8-c.p lamp and *vice versâ*.

Certification of Incandescent Lamps.—The object of this paper, as already stated, is to deal with the subject of photometry, not from the purely scientific point of view, so there is no need to describe in detail the various elaborate types of photometers on the market which have been designed to enable the user to make tests on the candle-power of lamps accurate within half of 1 per cent. This side of the subject has been dealt with by Dr. Fleming in the paper already referred to, and also more recently by Mr. Hadyn Harrison in his paper on "Practical Photometry and its Value," read before the Leeds Local Section of the Institution of Electrical Engineers in December last year. But to describe the methods adopted in a central-station test-room to deal with the testing and certification of large quantities of incandescent lamps. It will be remembered that in 1905 it was decided by Mr. Wilkinson, in view of the great harm done to the electric lighting business by the large number of inefficient and wrongly graded lamps on the market and as a measure of protection to the consumer, to institute with the assistance of the local contractors a system of testing and certification of all incandescent lamps. For this purpose a lamp specification was prepared and sent out to all lamp manufacturers, and they were informed that only lamps complying with the terms of that specification would be certified for use in Harrogate. The local contractors have worked loyally with the department in this matter, and no lamps are sold by them now other than those which have been tested and certified. The consequence is that we now have passing through our hands from 20,000 to 30,000 lamps per annum. The procedure adopted is in two steps: (1) wattage tests; (2) candle-power tests.

Wattage Tests.—The instruments employed are a standard voltmeter, a hand-regulated booster by which the pressure on the testing circuit can be maintained constant, and a standardised dead-beat wattmeter. When the pressure on the testing circuit has been exactly adjusted to the declared pressure, each lamp is in turn inserted in a lamp-holder connected with the wattmeter, the watts taken are read off and marked in pencil on the brass cap of the lamp. The lamps are then placed in light baskets and passed on to the photometer room. Any lamps which do not come within the specified limit for wattage are not certified, and no further tests are made. This test is simple and can be very expeditiously carried out;

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it is found that in ordinary working a rate of 200 lamps per hour can easily be maintained.

Candle-Power Tests.—The walls of the room in which the photometric tests are made are dead black, all daylight is carefully excluded, and the lighting of the room proper is controlled by a switch on the photometer bench, so that the operator can ensure that no light is allowed to fall on the photometer head except that of the standard lamp and the lamp under test. The photometer head used is of the well-known Bunsen disc type. It contains what is known as a compound screen in place of two screens. This compound screen is made of white blotting paper, part of which is made translucent by saturating it with paraffin or stearine. The part which is not translucent is a disc in the centre, and mirrors are arranged on each side of the screen at about an angle of 60deg., so that both sides can be examined at one time (see Fig. 1). The scale is set on edge on a horizontal base which forms a run-way for the standard lampholder, the lampholder for lamp under test, and the photometer head, all of which are mounted on wheels and are furnished with screw clamps, so that they can be secured in any required position on the scale. This scale is 86in. long, is graded directly in candle values up to 70 candles on each side of a zero line in the centre of the bar, so that the illuminating power of any lamp can be read off at once without any calculation. An illuminated dial voltmeter with very open scale is placed just above the photometer head, and a small booster adjusted by a screw motion is fixed under the photometer head, so that the operator can easily maintain the exact pressure. Of course, both the standard lamp and the lamp under test are on the boostable circuit. The procedure is as follows: The photometer head, which is screened to protect the operator's eyes, is fixed and clamped at the zero point on the scale. The light standard is fixed and clamped on the left hand of the spot box on the point of the scale corresponding to the known calibrated candle-power. The lamp under test is placed in a lampholder on a moving carriage on the other side

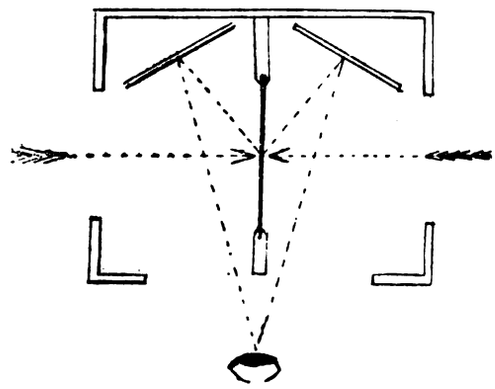

FIG. 1.

of the scale, this holder being rotated at about 200 r.p.m. by means of a small motor and worm gear carried on the moving carriage and controlled by a switch near the operator. The pressure is carefully adjusted, and the photometer reading taken. We find that with a little practice a youth with ordinary intelligence can easily maintain a rate of testing of 150 lamps per hour. At this point particular attention is directed to the enormous importance of having an accurate standard voltmeter in use, and also to the equally important necessity of having the voltage of the circuit maintained at the exact pressure marked on the lamps. In this connection it is interesting to note that in the discussion on Mr. Swinburne's recent paper on "New Incandescent Lamps," read in London, Prof. Kapp, of Birmingham University, stated that a 4 per cent. increase of pressure caused a 25 per cent. increase in the candle-power of carbon-filament lamps. Of course, by arranging that the standard lamp and the lamp under test are on the same circuit this effect is minimised, but still it is important that accuracy and close regulation should be observed. The equipment here described can also be, and is, readily used for the comparison of lights of different spectra—such as Nernst lamps, metallic-filament lamps, and gas lamps—by the substitution of a flicker photometer head in place of the Bunsen grease-spot head. The following table gives the limits within which the lamps must come to ensure being passed and certified. The certification is completed by stamping on the glass bulb with etching fluid the words "Certified," and the initials of the electricity department.

	—100 volts.—		—200 volts.—		
	Total watts.	Watts per c.p.	Total watts.	Watts per c.p.	Limits of c.p.
5 c.p.	26	4·2	28	4·5	from 4–6·5
8 c.p.	34	4	36	4·25	,, 7–9
16 c.p.	66	3·75	68	4	,, 14–18
25 c.p.	100	3·75	108	4	,, 22–28
32 c.p.	130	3·75	140	4	,, 28–36

As an evidence of the beneficial effect upon the class of lamps supplied to our consumers since the introduction of the system of testing and certification of lamps, the following figures are significant. They show the number of lamps received to be tested, the number passed, and the percentage of passed lamps in the month of January, 1906 and 1907:

	January, 1906.	January, 1907.
Lamps received	2,704	1,746
,, passed	2,320	1,595
Per cent. of passes	85·7 %	91·3 %

Before leaving this part of the subject a point worthy of attention in the design of photometer benches was brought forward in a recent paper—viz., the advisability of replacing the straight photometer bench by two benches set at an

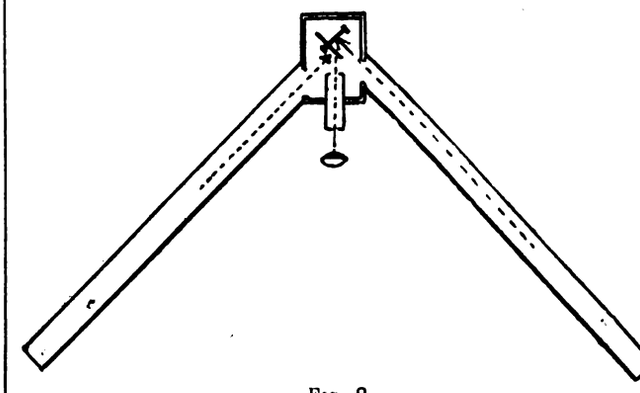

FIG. 2.

angle, the photometer head being fixed at the apex, and the angle of the benches being such that the rays from both lamps would fall directly on their respective screens, thus eliminating error. The operator would sit between the benches, thus not only would each bench be nearer his hands, but the lamps would be behind him (see Fig. 2). There is no doubt that this arrangement would be most suitable and convenient for rapidly testing large quantities of incandescent lamps.

Outdoor Photometry.—Every distribution engineer has at some time felt what a great advantage it would be to him in his work if he had a light portable photometer with which he could make fairly accurate tests in the streets on the photometry of arc lamps (flame, enclosed, etc.), incandescent glow lamps, and gas lamps. Again, in dealing with a dissatisfied customer who has had installed one of the latest types of inverted gas mantles and is holding forth on the fact of having a 70-c.p. gas lamp at about the same cost as a 16-c.p. electric incandescent lamp, how much more satisfactory it would be to take his portable photometer and demonstrate that even if it was giving 70 c.p. when new, after 20 or 30 hours' use the candle-power is nearer 30, instead of having simply to express his opinion that such is the case, and, of course, be scoffed at as prejudiced. Unfortunately in the past it has not been possible to obtain an instrument sufficiently portable, accurate, reasonable in price, and suitable for testing lamps of different colour values which could

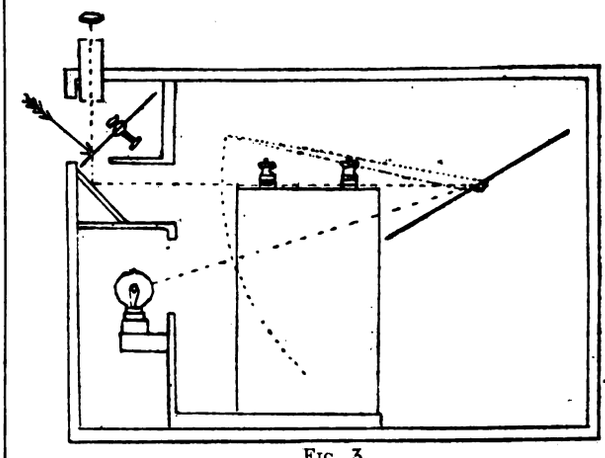

FIG. 3.

be used in the circumstances indicated. The instruments were heavy, clumsy, awkward, and cumbersome to set up. At the beginning of this year there was placed on the market a portable photometer in which the inventor has most successfully overcome these difficulties. It is of the boxed-in pattern, having as a light standard a low-voltage Osram lamp supplied from a small secondary battery of comparatively large capacity. The various parts are as follows: A flicker head consisting of a double sector cut out of a disc which is actuated by an air blast from a pneumatic ball under the control of the operator. This makes the instrument suitable for measuring the candle-power

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of all types of lamps even if the spectrum varies considerably, and is a light and convenient arrangement. The photometer bar and sliding lamp is replaced by a reflecting screen with an angular adjustment. This is operated by a pointer attached to it, which thus also indicates the angle of incidence. This enables the instrument to measure the candle-power of any lamp *in situ*. There is also, of course, a mirror by which the degree of illumination of the screen can be observed through the telescope. The instrument is supplied fitted with a tripod, and is light and portable, only weighing 15lb. to 18lb., and, what is of special importance, reasonable in price. The operation is simple. Having set up the instrument, rotate the sector disc by means of the air-pressure bulb. Insert the plug which lights up the standard lamp, and then move the pointer until the position is arrived at, when the operator, looking through the telescope can see no flicker. The pointer will then read the illumination in candle-feet at that distance from the light and at that angle of incidence indicated by the lens and sector on the edge of the instrument. If the candle-power of the source of light is required, it can be calculated from the formula

$$\text{Candle-power} = \frac{r \times d^2}{k},$$

where r is reading on instrument;
d is distance of instrument from source of light;
k is constant for the angle of incidence.

The general arrangement of the parts is shown in Fig. 3. Undoubtedly this instrument should prove to be most useful to all distribution engineers, and probable circumstances will readily rise in the minds of all where its use would be most helpful in central-station practice. In conclusion, the author desires to thank Mr. George Wilkinson, borough electrical engineer, Harrogate, for so readily granting facilities for the preparation of this paper, and to Mr. Haydn Harrison for details of his portable photometer.

Mr. WILKINSON, of Harrogate, said he was exceedingly pleased that Mr. McCourt had gained the premium for his paper. He (the speaker) had given him no assistance beyond permission to use the records from the test-room at Harrogate. He hoped that assistants would compete keenly each year for the travelling studentship, and that the first prize paper would be read each year at the convention. The importance of testing lamps was found at Harrogate, where the gas competition was very keen. He recognised that it was useless to economise in the station when so much was wasted by inefficient lamps. The result had been most successful, and certified lamps were almost universally employed now. With the portable photometer described in the paper they had found considerable difference in the readings obtained by different operators. He thought that this was due to the standard illumination not being high enough.

Prof. CRAPPER said that with the cheap gas in Sheffield it was of the utmost importance that they should keep a high standard for the electric lamps in order to meet competition. A photometric equipment such as had been described was an important adjunct to a lighting standard.

Mr. A. J. CRIDGE, of Sheffield, went into details as to the limits within which lamps should be accepted. He suggested that, instead of the target diagram in the Engineering Standard Committee's report, an elliptical diagram should be used. With the flicker head he had found that there was a critical speed which affected the accuracy of results. With the portable photometer described the method of driving the flicker head by means of a rubber ball did not conduce to accuracy.

Mr. FRANK AYTON, of Ipswich, said he was testing lamps at Ipswich, and had found Mr. Wilkinson's paper read last year of great service when working out the arrangements. They had had many complaints of bad light before starting this department, and found that they were usually due to inefficient lamps. This kind of complaint was now very rare. They had a large number of lamps on maintenance, and found that the photometric equipment was very valuable when pairing lamps with metallic filaments. These were seldom properly paired by the makers. It was well to keep a record of the effect of various shades, so that definite advice could be given to consumers as to the light absorbed. Some people liked to cover up the lights, and had not any idea how much they lost by so doing. He asked the author how best to maintain a regular voltage for testing. He had found it necessary to use the battery for this purpose, and to disconnect it temporarily from the mains.

Mr. A. B. MOUNTAIN, of Huddersfield, spoke as to the influence of colour on photometric tests.

Mr. ROBT. HAMMOND questioned the legality of Mr. Wilkinson dictating to consumers as to what lamps he should use and what lamps he should not. He thought that the limits permitted of 12½ per cent. up and down were too much.

Mr. C. C. ATCHISON, of Rochdale, spoke of the value of lamp testing commercially, as it helped to retain consumers who were dissatisfied with their lighting. He had found instances of 32-c.p. lamps which gave only 18 c.p, and one 16-c.p. lamp which gave 6 c.p. He had adopted the limits of the Engineering Standards Committee. For marking lamps etching fluid was unsatisfactory, and he found it necessary to use a sand blast.

Mr. HAYDN HARRISON said that it was an American plan to sell light rather than energy, but they were not so hampered on that side with regulations. The cost of testing depended on the degree of accuracy required. He thought that Mr. Trotter's remark as to the accuracy being affected by the judgment of the eye was too often quoted, as all physical testing was more or less subject to personal error. He had found the flicker photometer more accurate than others, and described recent improvements introduced into his portable apparatus.

Mr. C. FURNESS, of Blackpool, said that only 10 to 12 per cent. of their consumers accepted the free testing of lamps he had provided. They had a rule to smash all lamps consuming over 5½ watts per candle-power. He thought they should sell electricity, not light. He quickly settled the disputed accounts by testing the lamps. He advocated the testing by electrical engineers of all forms of new gas lamps as well as electric lamps.

Mr. J. K. BRYDGES, of Eastbourne, had found the flicker head better than the grease-spot photometer. He had found that in the disputed accounts the meters were more often wrong than the lamps. He thought it was a drastic step to smash lamps and to prevent consumers from returning them to the manufacturers.

Mr. MCCOURT, in reply, said that the permissible limits given in his paper were much the same as those given in the engineering standards specification. He had compared recently a 50-c.p. Osram lamp with an incandescent gas-burner taking 3ft. per hour. Actual measurement showed the electrical lamp on one occasion gave 50 c.p. as against 36·1 c.p for the gas-burners. A previous test showed 54·5 c.p. for the electric lamp and 25·2 c.p. for the gas. With gas at 2s. 10d. per thousand the result was 17·6 per cent. in favour of electricity. They did not deal with the consumers direct, but tested all lamps for the local contractors. The householders were asked by circular to see that they got only certified lamps.

FORTHCOMING EVENTS.

SATURDAY, JULY 13.

Civil and Mechanical Engineers' Society.—At 3 p.m., visit to the Rotherhithe Tunnel Works, Shadwell.

TUESDAY, JULY 16.

Dynamicables.—Welcome dinner to Lord Kelvin at the Trocadero Restaurant, at 7 p.m.

Liverpool and District Electrical Association.—First meeting at the Common Hall, Hackins Hey, Dale-street, at 8 p.m.

British Association.—July 31 to Aug. 7, seventy-seventh annual meeting at Leicester.

Iron and Steel Institute.—Sept. 23, 24, and 25, Vienna meeting.

APPOINTMENTS VACANT.

Lecturer in Electricity and Physics, Birmingham Municipal Technical School. Salary £140. Particulars from the Secretary. See advertisement.

Mains Superintendent for South Shields Corporation Electricity Department. Salary £150-£200 per annum. Applications by July 26 to the Borough Electrical Engineer.

Representative for Weak-Current Lines knowing the article for Great Britain. Apply to V L 500, care of Haasenstein & Vogler, A.G., Berlin, W. 8. See advertisement.

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THE

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

TO ADVERTISERS.

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United Kingdom	3s. 3d.	6s. 6d.	13s. 0d.
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PROFESSIONAL ETIQUETTE.

When in 1902 our Institution looked into the question of the etiquette to govern consulting engineers, six rules were drawn up as a general guide as to what should be and what must not be done by engineers acting as advisers to others. The value of such rules is only felt when the great majority accept them, and amongst the honourable men in our profession there is little need for a written code. Failure to conform might in extreme cases lead to expulsion from the Institution, but otherwise there is no penalty attached to a breach of the six rules then issued. In America they have gone more thoroughly into the question, and the committee who reported to the Niagara meeting of the American Institute of Electrical Engineers found forty-two rules necessary. We are reminded of some verses which appeared in our issue of Oct. 31, 1902, on the subject, one of which read:

> Six rules to point the narrow way.
> Will sixty score suffice
> To regulate the game they play
> Who are not over-nice?
> Though some who up to eyes in work
> Need half a hint or less,
> The touting crowd will not be cowed
> From neck or nothingness.

The forty-two rules in the American code cover the relations of the electrical engineer to his employers, customers, and clients; his relations to the general public, to the engineering fraternity, and to the standards of the profession. The scope is, perhaps, too wide, and it has led to the expression of opinions on subjects which can only be decided by the law courts. The questions which must arise on these may throw doubt on those simpler points on which uniformity is so desirable. Take, as an example, the three following rules:

15. The following general principles should be recognised. If in executing his work the electrical engineer uses data or information which are not common and public property, but which he receives, directly or indirectly, from his employer, or if the problem solved by the engineer is met in the pursuit of his work for his employer, and is not of such character that his attention would have been directed to it regardless of his relations to his employer, the product of his work, in the form of inventions, plans, designs, etc., are not his private property, but the property of his employer, though the engineer may be entitled to special remuneration for such inventions, etc.

16. If in the execution of the work the engineer uses only his own knowledge or data or information which are public property by prior publication, etc., and receives no engineering data from his employer or customer, except performance specifications, the results of the work, such as inventions, plans, designs, etc., are the private property of the engineer, and his employer or customer is entitled to their use only in the specified case.

17. All the work done by the engineer in the form of inventions, plans, designs, etc., which are outside of the field of engineering for which his employer has retained him, are the engineer's private property.

Rule 16 would touch the majority of consultants in this country, who after designing a station for a municipality do not get the commission to carry out extensions. To be of any service this rule must be binding on the employer, but there will be many legal battles before such a fine point can be maintained.

The other extreme is touched in Rule 8, which reads: "He can honourably accept compensation, financially or otherwise, from one side or party only, interested in the same matter The electrical engineer, whether consulting, designing, or operating, may, therefore, not accept commissions, either directly or indirectly, from other parties dealing with his principals." This surely does not need to be put in the code of ethics, as it falls under the law of corrupt practices in this country at least. One point, however, which is strongly emphasised in the code, is that an engineer should consider himself responsible for the legitimate character of the enterprises he is associated

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with. Thus, as the third rule states: "An electrical engineer permitting the use of his name in any enterprise or exploitation becomes morally responsible for the character of the latter." It is not enough for the engineer to write a general report on the engineering side of the project if he knows that commercially the undertaking is unsound. There have been too many wild-cat enterprises floated in this country by means of such reports, which, though true in letter, do not disclose the whole facts of the case. One clause in the American code we strongly concur with. This places the responsibility of defects in machinery or dangers in working the same on the engineer in charge, but states that if the remedies advised are not carried out by the employers the engineer should resign. Again, in the section devoted to the fraternal side of the code, it is provided that "An electrical engineer in responsible charge of work should not permit other engineers or non-technical persons to over-rule his electrical engineering decisions. If this is done and persisted in, he should as soon as is practicable withdraw." In conclusion, the American code has much to commend it. It goes rather too much into detail, but if loyally adhered to by the majority it should help to keep the profession clean.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TELEPHONE TARIFFS.

SIR,—On July 5 you were good enough to publish a letter from me which, I am glad to say, has been the means of attracting some attention to this very important subject. Some of the Hull municipal subscribers have supplemented the report of the city accountant as to the effect of replacing the municipal tariff by that now being imposed in non-competitive areas by the Post Office and National Telephone Company by calculating what would happen to themselves as telephone users in such an eventuality. One subscriber finds that, in lieu of the £12. 1s. per annum which he now pays to the Corporation for two direct business lines without limit as to the number of calls, he would have to pay £50—more than four times as much—for the same number of communications under the new tariff. And his case is a typical one. To those who make free use of the telephone the proposed increase is simply enormous. Only 25 calls per day—a very small number for a busy subscriber—means £22. 5s. 6d. per annum. In 1898 a Select Committee sat to consider the telephone situation, very much in consequence of the complaints of London subscribers, who then had to pay £20 per annum. But now that price and more is aimed at in the provinces for all but the smallest users. I perceive that some attempt is being made to palliate the charge, on the ground that it is to apply to new subscribers only. Let not people be led astray by this. There is no real intention of so limiting it, only policy requires that the cherry shall be consumed by nibbles and not swallowed all at once. It is the deliberate intention to make telephone users yield immense profits, and so increase the efficiency of the Post Office as a tax-levying department.—Yours, etc.,

A. R. BENNETT.

Queen Anne's-chambers,
Dean Farrar-street, Westminster, London, S W.
July 6, 1907.

ST. MARYLEBONE PUBLICITY DEPARTMENT.

Mr. F. A. Wilkinson, the energetic engineer and manager of the electricity undertaking of the metropolitan borough of St. Marylebone, has forwarded to us a collection of the publications issued by his publicity and canvassing department. These show that an effort is made to interest everyone in the success of the undertaking. The literature issued ranges from descriptive pamphlets down to leaflets and post-cards for enclosure with the quarterly accounts for electricity. The five larger publications deal respectively with charges for electricity, electric power, electric lighting, domestic electricity, and methods of obtaining economy with electric lighting. In the first of these the Wright maximum demand system of charging for electricity is explained clearly, and a promise made that further explanations or details will be given personally by a member of the staff if required. At St. Marylebone the charge for lighting is 8d. per unit for the first period and 1d. per unit after. Some interesting curves are given to show the average prices charged for a given use of the maximum demand in hours per day. For heating and lighting the maximum rate is reduced to 2d. per unit, at which price the first 500 hours' use per annum of the maximum demand is charged. After that 1d. per unit is charged for all in excess. We see that for basement lighting a flat rate of 2d. per unit is offered, and also to day consumers for lighting special parts of their premises and advertising signs.

In the publication B, which deals with electric power, a diagram is used to show how floor space is saved by using an electric motor instead of a gas-engine or oil-engine. This is shown both diagrammatically and by figures Thus a 10-h.p. motor only needs 6·3 square feet, as against 48 square feet for a 10-h.p. gas-engine and 62 square feet for an oil-engine. The pamphlet is illustrated by a number of interesting applications of electric motors, and contains good general advice to would-be consumers. Amongst these is a statement that, while motors vary in price according to the make, the best is always cheapest in the long run. The advantages of electric power as far as flexibility, reliability, and low cost of upkeep are concerned are fully emphasised. The pamphlet has the advantage that, while being short, it is likely to be read, and yet it contains the information likely to draw consumers and make them keen to obtain more details for their special requirements

In the pamphlet dealing with electric lighting a number of forms of electric lamps and electroliers are advertised, but we expect that more will be said about the metallic-filament lamps in the next issue.

The domestic electricity publication shows the very numerous adjuncts to the household comforts which can be obtained with advantage when electricity is supplied at as low a rate as in St. Marylebone. In these, figures of costs are not given, but they do appear on the leaflets which are sent round to consumers. This is a valuable feature, as everyone after hearing of something likely to be useful immediately wants to know approximately what the first cost will be. On the leaflet, for instance, of the motors for driving sewing machines the consumer is informed that the cost will be about £5, or less, and that with the smaller sizes the consumption is about equal to that of a 16-c.p. lamp. Again, for the fans, which are not required so much this summer as the electric radiators, both the first cost of the equipment and the cost of consumption are given. A new series of folders just being issued detail the advantages of electricity to various trades. Those to hand show the advantages to the butcher and to the licensed victualler.

On the whole, the St. Marylebone literature compares favourably with any we have seen, and should conduce to the healthy development of the undertaking.

AN INTERESTING FRENCH ELECTROLYTIC TRANSFORMER.

BY FRANK C. PERKINS.

It frequently happens that direct current is not available for charging storage batteries, and the only current which can be obtained for this purpose is an alternating current having a frequency of 25 or 50 periods per second. It is well known that by the use of aluminium electrodes in an electrolytic solution half of the alternating-current waves are cut off, and by the use of such an electrolytic cell, accumulators may be charged without difficulty. The accompanying illustration (Fig. 1) and drawings (Figs. 2 to 5) show the details of construction and the electrical con-

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struction of a unique "transformateur electrolytique" of the system O. de Faria as constructed by E. Ducretet, of Paris This four-cell equipment is designed for charging 44 accumulators from an alternating current of 110 volts pressure with an efficiency of 65 to 70 per cent. The

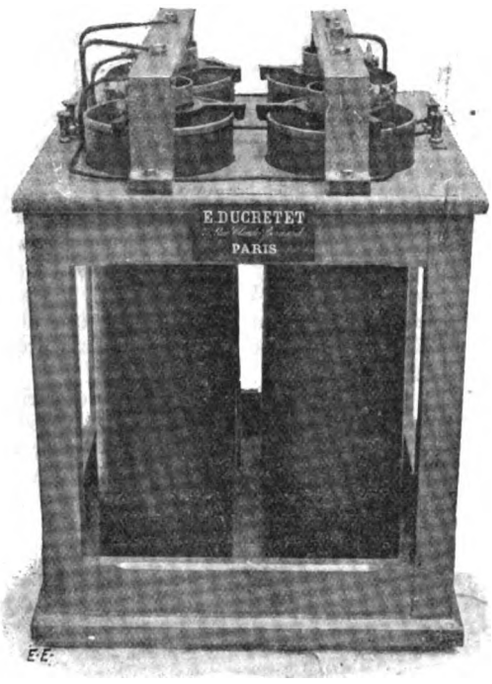

FIG. 1.

smaller sets may be utilised for charging with a current of from 5 to 10 amperes and larger outfits from 10 to 20 amperes and 20 to 30 amperes.

As noted in the accompanying drawing, each cell consists of a container holding the electrolyte of phosphate of soda with a cylindrical electrode, B, of lead and another

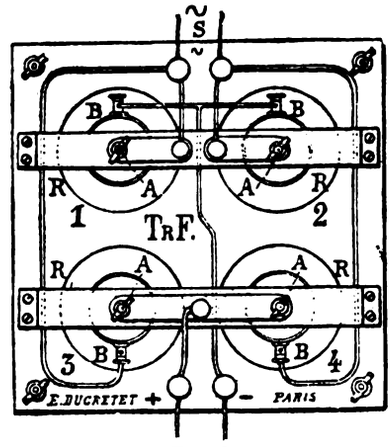

FIG. 2.

electrode of aluminium, A, in the centre. The aluminium electrodes and the lead electrodes are connected, as shown in the accompanying diagram, with a variable resistance, R, and an ammeter in series. The design of the switch-board and the current curves are shown in the accompanying drawings. The voltmeter, V, rheostat, R, and fuses

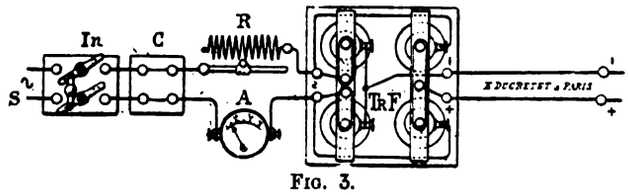

FIG. 3.

and switches are indicated, together with the electrical connections to the electrolytic transformer. In a single electrolytic cell used for charging 1 to 20 elements, about eight litres of electrolyte are required with 125 grammes of phosphate of soda per litre of water. A charging current of from 1 to 3 amperes is provided by this single cell, while the four-cell outfits shown in the accompanying illustration will pass from 1 to 30 amperes. In a test of 46 cells of storage battery being charged from one of these equipments, the electrolyte temperature ranged from 23·5deg. to 26·3deg. with a current of from 6·5 to 7 amperes

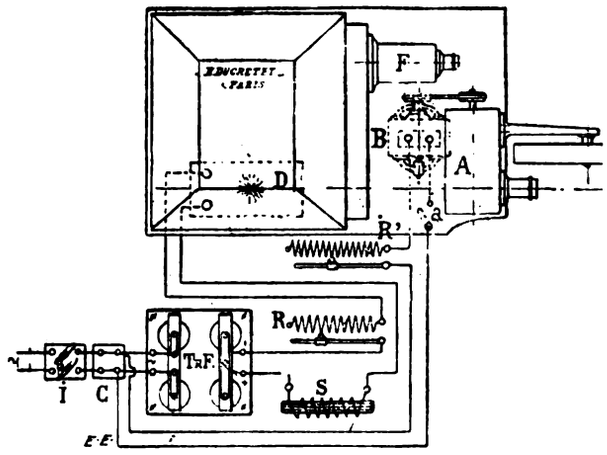

FIG. 4.

alternating, the voltage being from 107 to 110 and the charging current 5 to 5·2 amperes with a voltage of 104 to 106·5, the efficiency being 65 8 per cent. On a charging test of 29 elements for four hours with a similar current to that above mentioned, the alternating-current voltage being 107 to 108 and at the accumulators the pressure being 64 to 71 volts, the electrolyte varied in temperature from 15·5deg. to 28deg, and the efficiency about 70 per cent.

This apparatus is utilised to advantage in operating arc

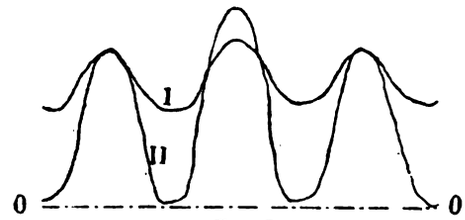

FIG. 5.

lights for stereoscopic work and also for moving-picture machines, as well as for the operation of oscillographs.

HOT-WIRE WATTMETERS AND OSCILLOGRAPHS.*

BY J. T. IRWIN, ASSOCIATE MEMBER.

The working of an ordinary hot-wire ammeter or voltmeter is well known. The commonest type is that shown in Fig. 1, in which a current passes through the wire A, B, C proportional to the current to be measured. The tension on the wire is sufficient to keep the two portions A B and B C comparatively straight. At B there is a wire or filament, B E, which in turn is pulled back at the centre by the flat spring, F G, acting by means of the silk fibre, G D. This silk fibre passes round a pulley, P. The pull of the flat spring keeps the wire A C in tension, and if A C is heated and expands, any increase of length in A C will

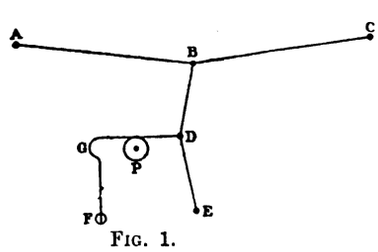

FIG. 1.

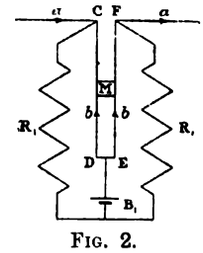

FIG. 2.

allow the spring, F G, to move back, and the pulley, P, will rotate. The disadvantages of this instrument are: (a) The zero is not very constant, owing to the wire having to be heated to a comparatively high temperature, say 100deg. C., while under

* Paper read before the Institution of Electrical Engineers.

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tension. The result is a certain fatigue, which may prevent the needle from going back to its original position. (*b*) The frame supporting the pillars which carry the wire A C, owing to its larger mass, will not attain to any normal temperature as quickly as the wire, and this may introduce uncertainty into the reading unless some means of compensation is provided in the instrument. For ascending readings this may be an advantage, as the wire creeps slowly to its final position. During the same time the frame is slowly heating, which tends to reduce the reading, and, therefore, these two creeps may neutralise each other. The final result depends on which of the two has the larger effect. On descending curves these effects are reversed, but they again tend to neutralise each other. The error due to the above causes is always greater near zero, as the

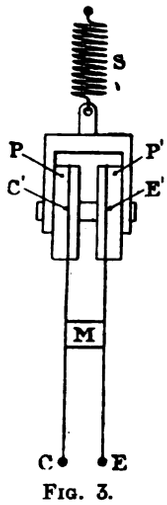

FIG. 3.

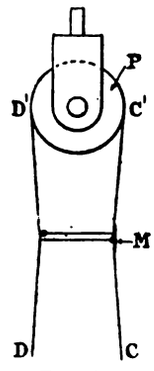

FIG. 4.

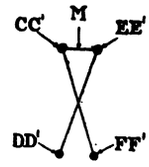

FIG. 5.

difference in temperature at high value on the scale is so large that any small variation of the frame from the normal does not make much difference to the reading, and, of course, the creep is proportionally less. Errors may also be introduced in this type of instrument by friction, by a gradual stretching of the wire, by a change in the resistance of the wire or in its emissivity of heat, or by a change in the strength of the controlling spring. To minimise the zero creep it is necessary (1) to make the tension on the wires small, and (2) to make the instrument independent of changes in the normal temperature and of the strength of the spring. The rate of heating of the wire—that is, the rate at which heat is being generated in the wire—is, of course, proportional to the square of the current flowing

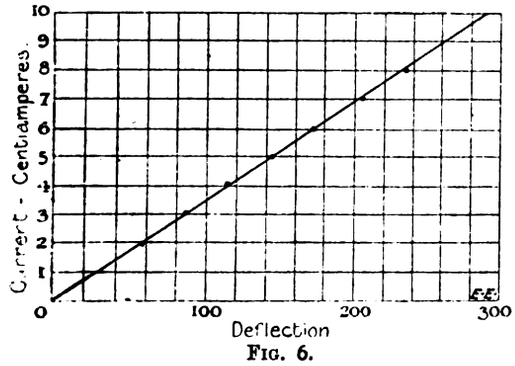

FIG. 6.

through it, and this means that when the current is small the readings are near together, in addition to being very uncertain. At the high readings the scale is open, and at these points the increase of deflection is nearly proportional to the increase of the current.

Up to the present, polarised hot-wire instruments have not been used, and herein the author describes a new type invented by him, and some of the uses to which it can be applied. In Fig. 2, C D and E F are two wires or strips of the same size; one pole of a battery, B_1, is applied to D E, and the other pole of the battery is connected through two resistances, R_1 R_1, to C and F. If the resistance of C D is equal to E F = *r* (say), then there will be a current, *b*, flowing in each wire. If another current, *a*, from any other source is sent from C to F through both the wires in series, the whole current, *a*, can be assumed to pass through the strips, C D, E F, owing to the resistances, R_1 R_1, being large compared with the resistance of the strips, then the rate of heating in the right-hand wire will be $(a+b)^2 r$, and the rate of heating in the left-hand wire will be $(a-b)^2 r$. The difference in the rate of heating will be equal to $4\,a\,b\,r$. In any case the difference in the rates of heating is proportional to $4\,a\,b\,r$. Therefore, if *b* and *r* are constant, the difference in the rates at which energy is given to the two strips is proportional to the current *a*, and if the current *a* reverses in sign, the difference will reverse in sign. If the wires, C D and F E, are each drawn back with equal and constant tension at their middle point, then a small mirror, M, placed across the two wires will be deflected through a certain angle proportional to the difference in temperature between the two wires, and this difference in temperature is proportional to $4\,a\,b\,r$, if the current *a* remains constant for some time; therefore one has a polarised instrument in which the deflection for small angles is practically proportional to the current.

Although it might seem an easy matter to arrange to draw back the two wires with equal and constant tension, it is difficult when one considers that the movement in some particular instruments may be of the order of $\frac{1}{10000}$ in.

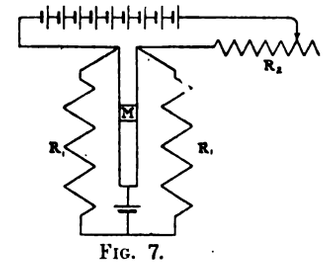

FIG. 7.

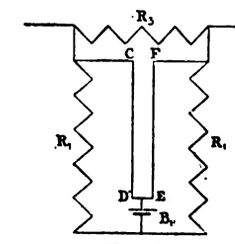

FIG. 8.

It is also necessary that the initial sag of the two wires should be the same, so that the sensibility shall be the same. The author spent some considerable time in trying to arrange two springs to draw the two wires back or push them forward with equal tension, and although he could get the deflection on each side equal to within about 10 per cent., this method was abandoned in favour of a better arrangement, shown in Fig. 3. The wires C D and C F in Fig. 2, instead of being pulled back at their middle point, pass over independent and insulated pulleys, P, P', and return almost parallel to each other and to their outgoing length, as shown in Fig. 4, where the wire C C' D' D corresponds to the wire C D in Fig. 2. A similar wire, E E' F' F, will pass over the pulley P'; these two systems of wires are tied together diagonally—that is,

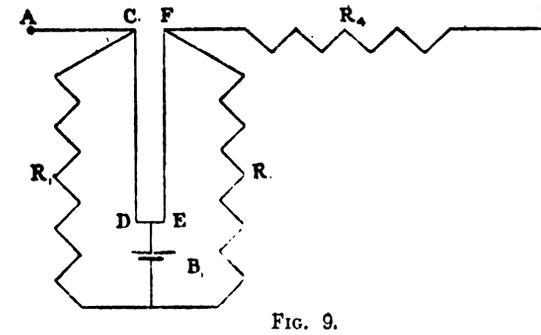

FIG. 9.

the wire C C' is tied at its middle point to the middle of the wire F' F, and the wire E E' is tied back at its middle point to the middle of D' D. This is shown in Fig. 5. Now, as the current passing through the wire C C' is the same as that passing through D' D, if they are of the same length and of the same size, the expansion of each wire will be the same since the rate of losing heat is the same. The pulley P will not rotate, and will only serve to ensure that there is equal tension on each wire. The pulleys, P P', are drawn up by the spring, S. If there is no current passing through C C' D' D or E E' F' F, and if the wires are exactly similar at the same temperature, then the sag of the wires C C', D' D, E E', and F' F will be equal in each case. If a current is sent through the four portions in series, then there

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will be an increase in length in all four wires, but there will be no deflection of the mirror. If the wire C C' D' D is heated it will sag more than the wire E F' F' F, and, therefore, the mirror will be tilted by an amount depending on the difference in the rates of heating in the two wires. This is very approximately correct for this type of instrument. Fig. 6 shows the curve connecting deflection with current passed through the two strips in series, when another constant current is sent through the two strips or wires in parallel as shown in Fig. 7. It will be seen that it is very nearly a straight line, any deviation from the straight-line law being almost within the limits of experimental error. The only objection to the instrument used in this way is that it requires a constant exciting current, and this would be a drawback to its general use. It could be used as an ammeter, voltmeter, or ballistic coulombmeter. Used as an ammeter,

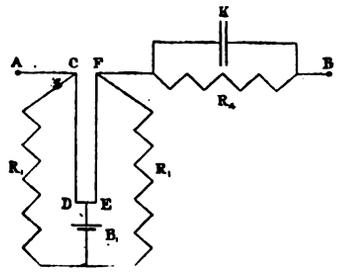

FIG. 10.

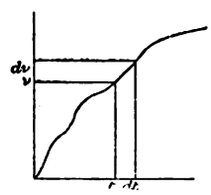

FIG. 11.

the main current or a current proportional to it would pass through the two strips in series, and a continuous current would be sent through the two strips in parallel as shown in Fig. 8. The instrument could only be used for continuous-current measurement. The chief advantage it would have over the same instrument used an ordinary hot-wire ammeter—that is, by passing the current through one wire only and putting no exciting current on—is that one could read small currents with greater accuracy, as the deflection would be proportional to the current. Used as a voltmeter, the two strips in series will be connected in series with a suitable resistance and put across the two points between which it is required to measure the potential difference.

There is a special case, however, where the instrument described has many advantages—namely, where it is required to measure the instantaneous voltage across two

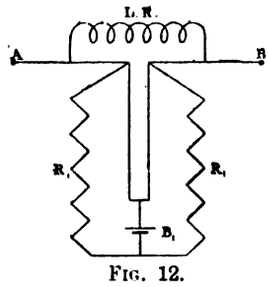

FIG. 12.

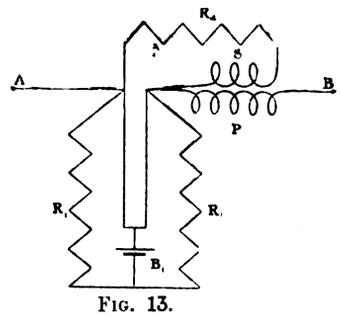

FIG. 13.

points or the instantaneous current flowing in a circuit. Suppose one wishes to measure the P.D. at every instant between two points, A B (Fig. 9). The instrument, C D E F, is placed in series with a non-inductive resistance, R_4. If the difference of potential across A B varies very slowly, the deflection of the instrument will be practically proportional to the potential difference at every instant. If the rate of change of potential difference across A B is rapid, the heat capacity of the wires will prevent the difference in temperature of the two wires being proportional to the actual difference of potential. The rate of change which the instrument will follow with any given degree of accuracy depends on the ratio of the quantity of heat stored in the wires for a given temperature rise to the increased rate of loss of heat for the same temperature rise. The smaller this ratio is, the quicker the instrument attains a constant temperature after a given current is switched on. The ratio can be made smaller by immersing the wires and mirror in oil, which enormously increases the rate of cooling, making it six to nine times the rate of cooling in air. But even by this method the rate of change the instrument could indicate accurately is so slow that it would be impossible to use it for frequencies much above five per second. To make the instrument practical for ordinary frequencies, the resistance R_4 in Fig. 9 is shunted by a condenser, K, as shown in Fig. 10. The resistance of the instrument itself is low compared with the resistance R_4 being about $\frac{1}{200}$th of it for a R.M S. voltage of 100 across A B. In this case there is a current flowing through the instrument at any instant proportional to the difference of potential across A B, plus a current proportional to the rate at which the potential across A B is varying, this last current flowing into the condenser. Suppose the curve in Fig. 11 shows how the potential difference across A B varies with reference to time. At any time t the voltage is v, and there

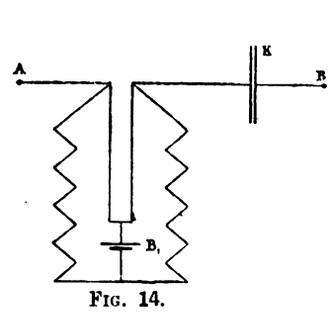

FIG. 14.

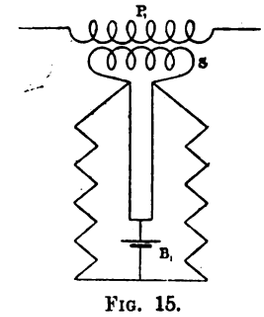

FIG. 15.

is a current flowing from A to B proportional to v, which will produce a difference in the rate of heating of the two wires proportional to v. Now there is also a current flowing through the instrument proportional to the rate of change of potential difference—that is, the current is proportional to $\frac{dv}{dt}$. Consider, first, the current flowing into the condenser—namely, $n\frac{dv}{dt}$, where n is a constant. This current multiplied by the time dt gives the increase in the quantity of electricity in the condenser

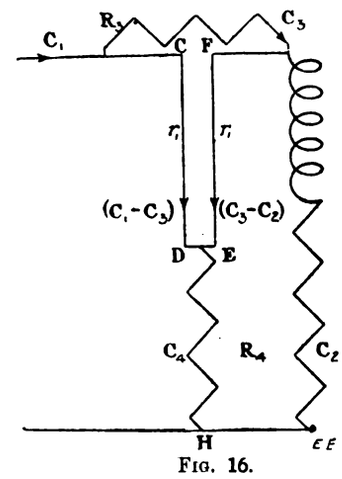

FIG. 16.

in the time dt. Now the difference in the rate of heating of the two wires due to this current is proportional to $n\frac{dv}{dt}$, and if there was no difference in the rates of radiation from the wires, the increase in the difference in temperature in time dt would be proportional to $n\frac{dv}{dt}dt$—that is, to the increase in the quantity. Therefore, the difference in the temperature of the wires would be proportional to the voltage and to the quantity of electricity that has passed through the wires. But so long as there is a difference in the temperature of the two wires, one will radiate heat at a greater rate than the other depending on this difference. To make the difference of temperature at every instant proportional to the quantity stored in the condenser—that is, proportional to the voltage—the condenser is shunted with a resistance, R_4, and the current through R_4 is proportional to the voltage—that is, a current, mv, flowing through the strip in series can be arranged to

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produce a difference in heating effect equal to the radiation losses, which are proportional to v. In fact, one may regard the strips as thermal condensers, which are very *leaky*, and to compensate for this leakage one makes the electric condenser equally leaky by shunting it with a resistance. When these conditions are fulfilled, the difference in temperature between the two sets of wires will at every instant be proportional to the voltage across the two points A B—that is, assuming the drop across the instrument itself is small compared with the voltage across R_4. Whether the deflection at every instant will be proportional to the voltage across the points A B depends upon the forces acting on the moving parts, on the inertia, and on the damping. This will be considered further on.

To use the instrument for indicating the instantaneous value of the current flowing in a circuit, the arrangement shown in Fig. 12 is used, where the current is comparatively large compared with that taken by the strips. A coil with self-induction, L, and resistance, R, is placed in the main circuit, A B. The potential difference across the two strips and the current that flows through them in series is proportional to $c\,R + L\frac{d\,c}{d\,t}$, and if R and L are chosen so that $\frac{R}{L}$ = the ratio of the difference in the rates of dissipating heat to the difference in the quantity of heat stored for a given difference in temperature, then the difference in temperature will be proportional to the instantaneous current in A B. To prove this, consider a steady current, c, flowing through the inductive resistance, L R, and that after a time it changes suddenly to another value, $c + \Delta c$. At first there is a voltage drop across L R equal to $c\,R$, and this sends a current proportional to $c\,R$ through the strips.

Then $k\,c\,R$ = the difference in the rates at which heat is being given to the wires,

and $p\,k\,c\,R$ = the steady difference in temperature corresponding to the steady current $c = T$.

Then
$$p = \frac{T}{k\,c\,R}.$$

If the current c now change rapidly to $c + \Delta c$, a quantity of electricity will pass through the strips. This will produce a difference in the quantities of heat given to the strips equal to $k\,L\,\Delta\,c$. This difference in the quantities of heat given to the two wires will produce an increased difference in their temperature $= \frac{k\,L\,\Delta\,c}{m\,s}$, where m is the mass of one wire and s its specific heat; and so that this temperature difference may remain constant as long as the current is constant at $c + \Delta\,c$, the increase in the difference in the temperatures of the wires $\frac{k\,L\,\Delta\,c}{m\,s}$ must be equal to the increased difference in temperature necessary to enable the wires to exactly radiate the heat due to the increased current $\Delta\,c$. When this is true—

$$\frac{k\,L\,\Delta\,c}{m\,s} = p\,k\,R\,(c - \Delta\,c) - p\,k\,R\,c$$
$$= p\,k\,R\,\Delta\,c.$$
$$\therefore \frac{L}{R} = m\,s\,p.$$

But
$$p = \frac{T}{k\,c\,R}.$$
$$\therefore \frac{L}{R} = \frac{m\,s\,T}{k\,c\,R}.$$

That is, the ratio $\frac{L}{R}$ must be equal to the difference in the quantity of heat stored in the two wires to the difference in the rates of radiation of heat from the wires due to the same temperature difference. If the current flowing in A B is very small, then the arrangement shown in Fig. 13 is more suitable, where practically all the current flows through the two strips in series and through the primary of a transformer, the flux in which is practically proportional to the current. The secondary of the transformer is of few turns, and the ampere-turns on the secondary are small compared with the ampere-turns on the primary. When this is so, the current flowing in the secondary is proportional at any instant to the rate of change of the primary current. The current through the strips in series is proportional to

$$c + k\frac{d\,c}{d\,t}.$$

Where the frequency is high or the rate of cooling slow, it is possible to have simply a current through the strips proportional to the rate of change of the voltage as shown in Fig. 14, or of current as shown in Figs. 14 and 15, since the heat gained or lost during a period is practically that due to the current through the strips, proportional to the rate of change of potential difference or current. This is particularly useful when measuring very high differences of potential, as it is possible (as shown in Fig. 14) to indicate the instantaneous potential difference on extra high-tension systems without the use of high, carefully-insulated, and, therefore, expensive resistances, especially as the curve can be corrected if the rate of cooling be known. This correction would be applied as follows: If the curve shown in Fig. 10 had been obtained by a hot-wire oscillograph, and if there had been no compensation for the difference in the rates at which heat was being radiated from the wires, the curve would have to be corrected to show the true value of the voltage at every instant. When there is a deflection δ, say, there must be a difference in the temperature of the two wires and a difference in the rates of losing heat proportional to δ. The heat lost in any time $d\,t$ is $p_1\,\delta\,d\,t$, where p_1 is a constant, and, therefore, the heat lost up to the time t is $\int_o^t p_1\,\delta\,d\,t$. If T is the difference in temperature corresponding to a deflection δ, then the deflection instead of being δ at time t should have been

$$\delta\left(\frac{T + \frac{\int^t p_1\,\delta\,d\,t}{m\,s}}{T}\right) = \delta + \frac{\delta}{T}\frac{\int_o^t p_1\,\delta\,d\,t}{m\,s},$$

where m is the mass of one wire and s its specific heat. That is, there has to be a second curve drawn which represents at any point the integral up to that point of $n\,\delta\,d\,t$ (where n is a factor which is constant for an instrument working under fixed conditions of cooling), and this curve has to be added to the original curve to give the true curve.

There is also another method of using a hot-wire instrument by which one could obtain a true voltage curve—viz., by allowing only a current proportional to the voltage to flow through the strips. In this case, if there was very little difference in the rates of cooling of the strips, the deflection at any time t would be proportional to $\int_o^t v\,d\,t$. If the difference in the rates of cooling was appreciable, the curve could be corrected as shown above, so as to be exactly proportional to $\int_o^t v\,d\,t$. To get the voltage wave the curve $\int_o^t v\,d\,t$ would have to be differentiated throughout. The current curve could be obtained in a similar way from the curve $\int_o^t c\,d\,t$. As the rate of change of the potential difference across the condenser is large, a small condenser of, say, one-hundredth to a thousandth of a microfarad capacity would be sufficient, or an idle feeder could be used as a condenser, the instrument being suitably shunted by a non-inductive resistance to prevent too large a current flowing through it. The current taken by the condenser necessary to work the instrument in all but very small machines will be too small to alter the wave shape of E.M.F. Resonance will be prevented by the resistance of the instrument itself in low-voltage systems, and on high-voltage systems the instrument can be short-circuited to start with to see if there is any tendency to resonance, and if there is, a resistance can be placed in series with the instruments. The arrangement shown in Fig. 15 is suitable for measuring very

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small high-frequency currents, say telephone currents. To enable the instrument to indicate the instantaneous power given to a circuit, from the proceeding consideration of the current and voltage arrangements it is seen that the difference in the rate of heating of the two strips should be equal to

$$v\,c + k_2 \frac{d\,(v\,c)}{d\,t},$$

which is equal to $$v\,c + v\frac{d\,c}{d\,t} + c\frac{d\,v}{d\,t}.$$

But before considering how to get a deflection proportional to the instantaneous watts given to a circuit, it is advisable to consider how the instrument could be used for indicating the mean power given to a circuit. Mr. M. B. Field has shown (Patent 15,168^{07}) that if a is the instantaneous value of the current flowing in a circuit, and b is the instantaneous value of the voltage, the instantaneous power given to the circuit is $a\,b$ watts; also as $(a+b)^2 - (a-b)^2 = 4\,a\,b$—that is, the power given to a circuit is proportional to the difference between the sum of the current and voltage squared and the difference of the current and voltage squared. Of course, a and b may be only proportional to the main current and main voltage respectively. Suppose a circuit arranged as shown in Fig. 16, where R_3 is a resistance in the main circuit and R_4 is a resistance in series with the strips, r_1 r_1, in parallel placed across the main circuit. Let C_1 be the instantaneous value of the current taken from the mains, C_2 that flowing in the circuit in which it is required to measure the power, C_4 that flowing through the resistance R_4, and C_3 the current through the resistance R_3. Then

$C_1 - C_3$ = current through one strip,

and $C_3 - C_2$ = current through other strip.

The difference in the heating of the two strips is equal to

$$(C_1 - C_3)^2\,r_1 - (C_3 - C_2)^2\,r_1.$$

But $$C_3\,R_3 + (C_3 - C_2)\,r_1 = r_1\,(C_4 - C_3 + C_2)$$

$$2\,C_2\,r_1 = C_3\,R_3 + 2\,C_3\,r_1 - C_4\,r_1$$

$$C_2 = \frac{C_3\,R_3 + 2\,C_3\,r_1 - C_4\,r_1}{2\,r_1}$$

$\therefore$ difference in the rate of heating

$$= r_1\{C_4 - C_3 + C_2\}^2 - r_1\{C_3 - C_2\}$$

$$= r_1\,C_4\left\{\frac{C_4\,r_1 - 2\,C_3\,r_1 + C_3\,R_3 + 2\,C_3\,r_1}{r_1} - C_4\,r_1\right\}$$

$$= C_4\,C_3\,R_3,$$

which is a very simple expression for the reading of the instrument. The current $C_4 = \frac{v}{R_4}$, when v is the potential difference between H and D E. If V is the voltage across the load, then

$$V = C_4\,R_4 + (C_3 - C_2)\,r_1.$$

$$C_4 = \frac{1}{R_4}\,[V - r_1\,(C_3 - C_2)].$$

The difference in the rate of heating

$$= \frac{1}{R_4}\,[V - (C_3 - C_2)\,r_1]\,C_3\,R_3.$$

When $(C_3 - C_2)\,r_1$ is very small compared with V, and when C_3 is nearly equal to C_2, the difference in heating is proportional to the product of C_2 V—that is, to the watts spent in the circuit. It is, therefore, essential that the actual power spent in the strips themselves shall be very small compared with the power to be measured, if the instrument is to read nearly correctly on low power factors. In order that the difference of heating shall be as high as possible compared with the total heating of the two strips, it should be arranged that the current shunted through the strips when the pressure current, C_4, is taken off, should be nearly equal to the pressure current flowing in the strips when the main current, C_2, is reduced to zero; then at full load and unity power factor there will be no current in the right-hand strip.

One of the many ways of using a hot-wire wattmeter in conjunction with a transformer is shown in Fig. 17, where P Q is the primary winding of a transformer, and S the secondary. The potential difference across the points P_1 and Q_1 is at every instant equal to Kx potential across P and Q = k_3 V, say, and the current which flows through the strips C D E F in series is equal to k_3 C, and is in phase with C, since the resistances R_3 and r_1 are non-inductive. The difference in heating in the two strips C D and E F is equal to 4 $k_3\,k_4$ V C, and, therefore, the mean difference of heating is equal to 4 $k_3\,k_4$ W. The difference of heating is proportional to the power spent in the portion of the circuit A B, plus the C^2 R losses in the resistance R_3 and r_1 r_1 due to the main current, C. Errors are introduced by this method due to the transformer winding P having resistance, and to the winding P and S having magnetic leakage; but as a closed iron transformer can be used, the errors due to these causes can be made negligible at all but very low power factors, say of the order of 0·01, and in this connection the author

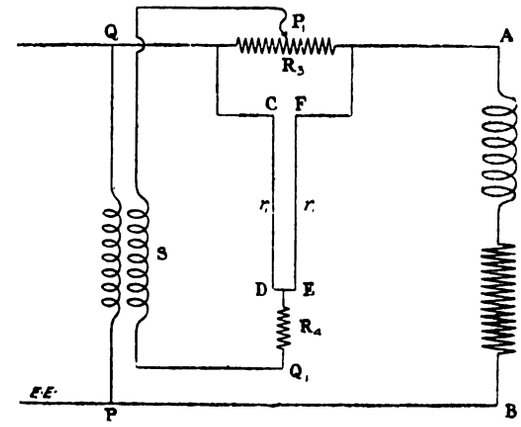

FIG. 17.

cannot do better than refer to Dr. Sumpner's original and valuable communication.

(To be continued.)

CONSTANT-CURRENT POWER TRANSMISSION.

It is difficult to place oneself in the position of a pioneer who has to move forward along new paths in the development of science, and it is interesting to read the records of the steps taken by such leaders in our branch of engineering. The following paper by Profs. Elihu Thomson and Edwin J. Houston is dated February, 1879. Thus 28 years ago we find a clear description of a constant-current system of power transmission on the lines since perfected by M. Thury. The arguments in the paper are perfectly sound and the limitations clearly recognised. The paper is "On the Transmission of Power by Means of Electricity," and reads as follows:

"The statements recently made as to the size and cost of the cable that would be needed to convey the power of Niagara Falls to a distance of several hundred miles by electricity have induced the authors to write the present paper, in the hope that it may throw light upon this interesting subject. As an example of some of the statements alluded to we may cite the following—viz., that made by a certain electrician who asserts that the thickness of the cable required to convey the current that could be produced by the power of Niagara would require more copper than exists in the enormous deposits in the region of Lake Superior. Another statement estimates the cost of the cable at about 60dol. per lineal foot. As a matter of fact, however, the thickness of the cable required to convey such power is of no particular moment. Indeed, it is possible, should it be deemed desirable, to convey the total power of Niagara *a distance of 500 miles or more by a*

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copper cable not exceeding one half of an inch in thickness. This, however, is an extreme case, and the exigencies of practical working would not require such restrictions as to size.

"The following considerations will elucidate this matter: Suppose two machines connected by a cable of, say, one mile in length. One of these machines, as, for example, A (Fig. 1), is producing current by the expenditure of power; the other machine, B, used as an electrical motor, is producing power, by the current transmitted to it from A, by the cable, C. The other terminals, *x* and *y*, are either put to earth or connected by a separate conductor. Let us suppose that the E.M.F. of the current which flows is unity. Since by the revolution of B a counter

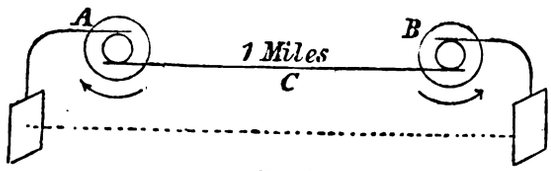

FIG. 1.

E.M.F. is produced to that of A, the E.M.F. of the current that flows is manifestly the difference of the two. Let the resistance of A and B together be equal to unity, and that of the mile of cable and connections between them the 0·01 of this unit. Then the current which flows will be

$$C = \frac{E}{R} = \frac{1}{1{\cdot}01}.$$

If now an additional machine, A′ (Fig. 2), an additional motor, B′, and an additional mile of cable, be introduced

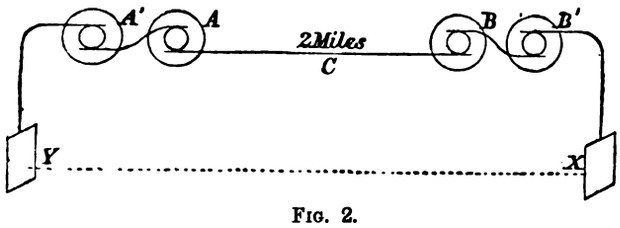

FIG. 2.

into the above circuit, the E.M.F. will be doubled, and the resistances will be doubled, the current strength remaining the same as

$$C = \frac{E}{R} = \frac{1 + 1}{1{\cdot}01 + 1{\cdot}01} = \frac{2}{2{\cdot}02}.$$

Here it will be seen that the introduction of the two additional machines, A′, B′, has permitted the length of the cable, *c*, to be doubled, without increasing the strength of the current which flows, and yet allowing the expenditure of double the power at A A′ and a double recovery at B B′ of power, *or, in other words, a double transmission of power without increase of current.* Increase, now, the number of machines at A to, say, 1,000, and of those at B in like proportion, and the distance between them, or the length of the cable, 1,000, or in the case we have supposed, make it 1,000 miles, its diameter remaining the same. Then although the same current will flow, yet *we have a thousand times the expenditure of power at one end of the cable, and a thousandfold recovery at the other end, without increase of current.* And the same would be true for any other proportion.

"Since the E.M.F. is increased in proportion to the increase of power transmission, the insulation of the cable and machines would require to be proportionally increased. As an example, it may be mentioned that a dynamo-electric machine used for the purpose of A in the figure may have a resistance of, say, 40 ohms, and produce an E.M.F. of, say, 40 volts. Such a machine might require from 3 h.p. to 5 h.p. when used in connection with a suitable motor, B, for recovery of the power transmitted. If the resistance of the motor B be, say, 60 ohms, and the cable transmitting the currents a distance of one mile be one ohm, then the current

$$C = \frac{400}{60 + 40 + 1} = \frac{400}{101}.$$

If, now, 1,000 machines and 1,000 motors and 1,000 miles of cable, each of the same relative resistances, be used, the current

$$C = \frac{1{,}000 \times 400}{1{,}000 \times 101},$$

which has manifestly the same value as before. If our supposition of the power used to drive one machine be correct, then from 3,000 h.p. to 5,000 h.p. would be expended in driving the machines, and possibly about 50 per cent. of this amount recovered. Then we have from 1,500 h.p. to 2,000 h.p. conveyed a distance of 1,000 miles. What diameter of copper cable will be required for such transmission? Since this cable is supposed to have the resistance of one ohm to the mile, calculation would place the requisite thickness at about ¼in. If, however, the distance be only 500 miles, then the resistance per mile may be doubled, or the section of the cable be decreased one-half, or its diameter would be less than one-fifth of an inch.

"For the consumption of 1,000,000 h.p. a cable of about 3in. in diameter would suffice under the same conditions. However, by producing a much higher E.M.F., the section of the cable could be proportionally reduced, until the theoretical estimates which we have given in the first part of this paper might be fulfilled. The enormous E.M.F. required in the above calculation would, however, necessitate such perfect insulation of the cable that the practical limits might soon be reached. The amount of power required to be conveyed in any one direction would, of course, be dependent upon the uses that could be found for it, and it is hardly conceivable that any one locality could advantageously use the enormous supposed power we have referred to.

"Stripped of its theoretical considerations, the important fact still remains that with a cable of very limited size an enormous quantity of power may be transferred to considerable distances. The burning of coal in the mines, and the conveyance of the power generated by the flow of rivers, may therefore be regarded as practicable, always, however, remembering that a loss of about 50 per cent. will be almost unavoidable.

"It may be mentioned that Dr. C. W. Siemens and Sir William Thomson have recently made statements that are in general accordance with the views here expressed."

PARLIAMENT.

Telegraph (Money) Bill.

Standing Committee B of the House of Commons met on Monday, under the chairmanship of Sir D. Brynmor Jones, to consider the Telegraph (Money) Bill, which was introduced by Mr. Sydney Buxton, Postmaster-General, to enable the Post Office to raise six millions sterling under the Telegraph Acts. Mr. Buxton moved the insertion of words to make it clear that the money was to be spent entirely on the development of the Post Office telephone system, and not on telegraphs. In 1911 the Post Office would purchase the National Telephone Company's system, and as that would involve a new policy, Parliament would have an opportunity of reconsidering the whole question of capital expenditure.

The words proposed were agreed to, and the Bill as amended was reported to the House.

London United Tramways Bill.

This Bill, which has for its object the extension by two years the period granted in 1904 for the construction of certain tramways authorised in 1901, and to provide for a similar extension for the purchase of lands for tramway purposes in East Bedfont-with-Hatton, Stanwell, Staines, Hanworth, Twickenham, Sunbury, Heston, and East and West Molesey, has passed a committee of the House of Lords, and has been ordered for third reading.

Aberdeen Electricity Bill.

The Aberdeen Corporation's Electricity Bill, already passed by the House of Lords, came on Monday before a committee of the House of Commons, over which Major Seely presided. The Corporation of the city of Aberdeen already possess power to supply gas in an area of Aberdeenshire outside the city borders. They seek power to supply electricity also in this area.

The committee adjourned in order to give the parties who are opposing the Bill an opportunity of coming to some arrangement with the promoters.

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LEGAL INTELLIGENCE.

RAILWAY COMPANY AS 'BUS OWNERS.

The House of Lords heard the appeal on Tuesday of the Attorney-General, at the instance of the Mayor and Corporation of Birkenhead, from an order of the Court of Appeal which, upon the respondents (the Mersey Railway Co.) giving certain undertakings, discharged an order of Mr. Justice Warrington, who held that it was beyond the powers of the railway company to carry on the business of omnibus proprietors in any of the streets of the borough, and granted an injunction.

The LORD CHANCELLOR moved that the order of Mr. Justice Warrington, appealed against, should be restored. In this case the running of the omnibuses was not fairly incidental or consequential to the railway company.

Lord MACNAGHTEN was of the same opinion. He thought the railway company had transgressed the line. If they wished to extend their undertaking beyond the limits authorised by their charter, the proper course was to apply to Parliament for further powers.

Lords JAMES OF HEREFORD, ASHBOURNE, and ATKINSON concurred and the order appealed against was sustained.

SMOKE NUISANCE.

Underground Electric Railways Co. Summoned.

An important case affecting electric power stations was tried by Mr. Curtis Bennett at the Westminster Police Court on the 4th inst. The Underground Electric Railways Co. of London were summoned, under the 24th section of the Public Health Act, 1891 (London), for permitting dense black smoke in such quantity as to be a nuisance to issue from the chimneys of the electric current generating station at Lots-road, Chelsea.

Counsel for the prosecution said the Chelsea Borough Council were anxious not to do anything which was vexatious, but they felt that they were bound to take action after continuous complaints about a nuisance which had become a scandal and which was injurious to health. This generating station—one of the largest in the world—supplied many railways with current, and it would no doubt be contended that under statutory powers the company had authority to carry on their business as they were doing. His point would be that no private Act could over-ride, remove, or modify a public statute.

Mr. JAMES R. CHAPMAN, chief engineer to the company, in his evidence said the power-house contained 64 boilers and 128 furnaces. Four hundred and fifty tons of coal were consumed daily. The coal was of the best quality, approved only after two analyses, one as the basis of purchase and another as the basis of delivery. Each of the four chimneys was 19ft. in diameter, and each was calculated to equal 504 domestic chimneys. The smoke from these chimneys was dissipated in a few hundred yards. He was prepared to admit that occasionally brown smoke emanated from the chimneys.

The proceedings were adjourned.

TRAMCAR FARE.

In the Manchester Police Court last week a tramcar passenger was summoned before the stipendiary magistrate for attempting to avoid payment of his car fare.

It appears that on June 9, 10, and 11 the defendant boarded a car. On two occasions he said he had no money with him, and on the third that he had no change. He was given a ticket, and gave in return a card with his name and address on. He owed the tramway authorities 5½d. in car fares. He rode on a car on June 5 under similar circumstances, and he paid for that on June 14. For the company it was argued that this fact alone was evidence that the defendant intended to avoid payment, for when he paid on June 14 for a ride on the 5th he knew that he was owing the authorities 5½d. in car fares only a day or two before that.

The STIPENDIARY MAGISTRATE did not think the section under which the case was brought was sufficient to prove an offence in this instance. "I quite agree," he said, "that it ought not to be allowed, but if you have not a clause which does not cover this, you must get a by-law. The guard could have asked him to get out of the car, but he did not. He said all right, I will trust you, and he gave him a ticket. He does not avoid payment."

The DEFENDANT said he had travelled in the same way on the cars at Salford, and he paid them a few days later. They had never summoned him. He had also paid for his car fares at the Manchester tramway offices in Piccadilly in times past.

The STIPENDIARY MAGISTRATE did not think there had been any attempt to avoid payment, and dismissed the three summonses.

FROST v. LONDON COUNTY COUNCIL.

In the Westminster County Court last week the case of Frost *v.* the London County Council was tried by his Honour Judge Woodfall and a jury, and was a claim by James Frost for damages for assault. The plaintiff was refused admission to one of the defendants' electric cars at New Cross, and the conductor pushed him off after starting the car. He suffered from bruises and shock, and his clothes were damaged. It was denied that the plaintiff was drunk, and a police constable declared he was quite sober. Evidence for the defence tended to show that the plaintiff was under the influence of drink, and it was denied that he was pushed off the car. The jury awarded the plaintiff £50, and judgment was given accordingly, with costs.

COMPANIES' MEETINGS AND REPORTS.

NEW GENERAL TRACTION.

The eleventh annual general meeting of the New General Traction Co. was held last week at the offices, 20, Bishopsgate-street Within, E.C., Baron Emile B. d'Erlanger (chairman of the Company) presiding.

In moving the adoption of the report (*Electrical Engineer*, July 5), the CHAIRMAN said that the Company had had to face a loss of £18,740 to carry through the very satisfactory arrangements between the Philadelphia undertaking and the Rapid Transit Co. of Philadelphi. The amount of loss mentioned had been reduced by the transfer of £3,574 from the special reserve account, so that it now stood at £15,166. The dividends the Company had received from the undertakings in which they were interested amounted to £14,767—an increase as compared with last year's figures of £2,851. The Philadelphia undertaking was now leased to the Philadelphia Rapid Transit Co. Under this arrangement the whole of the bonds which the Company held in the Philadelphia undertaking were guaranteed at the rate of 4½ per cent., and the shares were also guaranteed a dividend, which, rising from 1 per cent., would reach in the next four years 5 per cent., at which rate it would stand. The Coventry tramways, in which the Company had an interest amounting to about £170,000, were doing extremely well. The only concern which caused the directors anxiety was the Norwich tramways, which, owing to the great depression in that part of the country, showed an appreciable decrease in their takings. The Douglas Southern Tramway Co. was doing well, notwithstanding the unfavourable weather. In the current year the loss involved in the Philadelphia transaction would not recur, so that the Company's profit and loss would be absolutely determined by the amount received from the various undertakings.

The Hon. A. G. BRAND seconded the motion, which was adopted.

CHILI TELEPHONE.

The report of the Chili Telephone Co. for the year ended March 31, 1907, to be presented at the meeting on the 18th inst., states that the Company's plant suffered severely in the earthquake disaster last August, and the necessary repairs and reconstruction incurred in consequence have greatly increased the expenditure The aggregate number of subscribers at all centres at the end of the year was 7,115, as compared with 7,270 at the beginning, or a loss of 155 for the year. The gross revenue in Chili from all sources was 1,169,488dol., an increase of 78,919dol. The expenditure in Chili was 648,549dol., an increase of 147,517dol. The net income in Chili from all sources was 520,938dol., a decrease of 68,598dol. The average rate of exchange for the year was 14·01d., as compared with 15·24d. in the previous year, giving a decrease for the year of 1·23d. Converted into sterling at these rates the net income was £30,414, a decrease of £7,021. The liquid assets and liabilities in Chili on March 31, 1907, were valued at 12¾d., the current rate of exchange on that day, as compared with 15¼d. at which they were valued on the corresponding date of the previous year. The balance to credit of revenue account, including £2,653 brought from the previous year, is £29,892, of which £9,564 has been carried to reserve. An interim dividend of 3s. per share, free of income tax, was paid on Jan. 16 last, and the directors now recommend a final dividend of 5s. per share, free of income tax, leaving a balance of £2,727 to be carried forward.

ELECTRICAL POWER STORAGE.

The report of the directors shows that the profit for the year, including the balance of £425 brought forward, is £9,176. Out of this sum the directors have carried £1,000 to the contingent fund and have written off £2,000 in respect of patents, goodwill, etc. They recommend the payment of a dividend of 6 per cent. on the paid-up ordinary share capital, which will absorb £5,389 and leave £786 to be carried forward. The buildings, plant, tools, etc., have been maintained in thorough repair and condition at a cost of £3,597, which has been provided out of revenue. Notwithstanding the continuance of the severe competition, as well as the unprecedented rise in the price of raw materials, the directors state that the Company's business has increased during the year.

NEW COMPANIES REGISTERED.

Missenden and District Electric Light and Power Co.—Registered June 29. Capital, £1,000 in £1 shares. Objects: to supply electricity in Great Missenden, Little Missenden, and Lee, Buckinghamshire. Registered without articles. First directors: G. Carrington, S. F. Beck, and W. Clay. Registered office: High-street, Amersham.

British Carbide Factories. — Registered July 3. Capital, £15,000 in £1 shares. Objects: to exploit any chemical and electro-chemical processes, etc. No initial public issue. First directors (not less than three nor more than five): H. Compton, A. Howard, and A. Akers. £200. As fixed by company. Registered office: 170, Tower Bridge-road, S.E.

British Electric Detonator Co.—Registered July 3. Capital, £6,000 in £1 shares. Objects: to acquire certain benefits, rights, property, and effects connected with the business of manufacturers of fuse heads in connection with detonators as applied to explosives, and to adopt an agreement with the Lancashire Explosives Co., A. J. Jordan, and G. A. Jordan. No initial public issue. S. Salisbury is

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governing director for life, remuneration as fixed by company. Registered office: 2, Albert-street, Manchester.

John Hands and Sons, Limited.—Registered June 29. Capital, £25,000 in £1 shares. Objects: to acquire the business carried on at Cardigan Works, Birmingham, as John Hands and Sons, and to carry on the business of founders, engineers, manufacturers of wire drawing, rolling, and other machinery, tool makers, etc. No initial public issue. Registered office: Cardigan Works, A. B. Row, Birmingham.

Birmingham Electrical Case Co.—Registered July 3. Capital, £1,000 in £1 shares. Objects: to acquire the business carried on by E. Bennett as an electrical case maker and cabinet-maker at Birmingham. No initial public issue. First directors (not less than two nor more than five): P. T. Thompson, F. E. Bill, and E. Bennett (all permanent). £25 (E. Bennett, as managing director, £100 shares). Registered office: 109, Unett-street, Birmingham.

Simplex Industrial Producer-Gas Plants.—Registered July 1. Capital, £600 in £1 shares. Objects: to acquire from C. H. Schill the benefit of certain existing inventions and processes relating to gas-producer, hydrogen gas, and suction gas plants, and the working thereof, and to adopt an agreement with C. H. Schill, G. S. Aveyard, A. Denton, and B. R. Rowland. No initial public issue. First directors (not less than three nor more than five): B. R. Rowland, A. Denton, and G. S. Aveyard. £50. As fixed by company. Registered office: 78, King-street, Manchester.

Golconda Malay Rubber Co.—Registered July 2. Capital, £80,000 in £1 shares. Objects: to acquire the Golconda estate, district of Klang, Selangor, and all or any of the assets and liabilities of the Golconda Rubber Co. (incorporated under the Ceylon Joint Stock Companies' Ordinances, 1861, 1888, and 1893) in connection therewith. No initial public issue. First directors (not less than three nor more than five): J. N. Campbell, W. D. Bosanquet, J. Iuch, and G. F. Traill. £250. Till end of 1908 at rate of £50 each per annum, afterwards as fixed by company. Registered office: 2, Fenchurch-street, E.C.

Platinum Corporation, Limited.—Registered June 26 by Burn and Berridge, 11, Old Broad-street, E.C. Capital, £300,000 in 297,500 ordinary shares of £1 each and 50,000 deferred shares of 1s. each. Objects: to acquire platinum, platinum gold, and gold concessions in any part of the world and for the purpose of working the same to vest them in the Anglo-Russian Platinum Mining Co., or any other limited or other company formed to work or capable of working the same, under such terms as to the issue to this company of all or part of the shares of such company or its nominees or otherwise as may be thought fit; to explore, work, develop, and turn to account any of the company's properties; to search for, win, crush, extract, calcine, refine, dress, make merchantable, and deal in platinum, gold, and other minerals, and to adopt certain agreements. Minimum cash subscription, 50,000 ordinary shares. The number of directors (other than local directors) is not to be less than two nor more than six; the first are Sir Ernest Clarke, Kt., R. Hewitt, H. Claudius Ash, A. E. Ash, and J. Seed. Qualification, £200. Remuneration, £200 each per annum (chairman £100 extra). The directors may not borrow beyond the amount of the issued capital for the time being without the sanction of a general meeting. Secretary and registered office: H. Gunter, 4 and 6, Copthall-avenue, E.C.

Liens Registered.

Mevagissey Electric Supply Co., Limited, Mevagissey, Cornwall.—Lien registered June 29 for £1,300 5 per cent. debentures. No trustees. Charged on the general assets, present and future.

Frank Suter and Co., Limited (Electrical Engineers, London). £1,000 5 per cent. debentures, created and dated June 26, 1907. Charged on the company's undertaking and property, present and future, including uncalled capital, have been registered. No trustees.

Burgess Hill and District Electric Supply Co., Limited.—A debenture dated June 17, 1907, to secure £1,200, charged on the company's undertaking and property, present and future, including uncalled capital, has been registered. Holder: Mrs. E. L. Burrows, View Down, Burgess Hill, Sussex.

J. H. Street, Limited (Electrical Engineers, Redditch).—Issue on Feb. 7 of £400 7 per cent. debentures, part of series created same date, to secure £1,000. Charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Registered June 24, pursuant to order of court.

Electrical Power Storage Co., Limited.—Issue on July 1 of £1,600 5 per cent. debentures, part of series created Feb. 14, 1907, to secure £30,000. Charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £8,400.

Supplies, Limited (Electricians, Liverpool).—Issue on June 17 of £200 5 per cent. debentures, part of series created April 17, 1907, to secure £5,000. Charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £800.

D. Santoni and Co. (1906), Limited (Electrical Engineers, London).—Issue on June 22 of £440 debentures, part of series created May 31, 1907, to secure £2,750. Charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £1,650.

Uxbridge and District Electric Supply Co., Limited.—Issue on July 1 of £1,000 6 per cent. second debentures, part of series created July 10, 1906, to secure £15,000. Charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £14,000.

Newcastle-upon-Tyne Electric Supply Co., Limited.—Issue on June 20 of £2,200 4½ per cent. second mortgage debentures, part of series created Feb. 15, 1906, to secure £250,000. Charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £185,300.

Lancashire Dynamo and Motor Co., Limited.—A trust deed dated June 24, 1907 (supplemental to a trust deed dated March 4, 1907, securing £75,000 debentures and increasing the interest from 4½ per cent. to 5 per cent.), has been registered. Property charged by original deed: certain land in Trafford Park, Stretford, near Manchester, with all works, erections, and buildings thereon, and fixed plant and machinery therein, and the company's undertaking and other assets, present and future, except uncalled capital. Trustees: E. F. Sheppard, 55, King-street, Manchester; and A. Tongue, 86, King-street, Manchester.

OPENINGS FOR CONTRACTORS.

ACKWORTH—School for the West Riding Education Committee. County architect, Mr. J. Vickers Edwards, Wakefield.

BLACKPOOL—Library on the Old Raike's Hall Estate.

BOLLINGTON—Conservative club. Architect, Messrs. Whittaker and Bradbourne, 19, King Edward-street, Macclesfield.

BRIERFIELD—School. County architect, Mr. H. Littler, 16, Ribblesdale-place, Preston.

BROUGHTON (FLINTSHIRE)—Church schools. Architects, Messrs. Willink and Thicknesse, 14, Castle-street, Liverpool.

BURMANTOFTS—Extension of shoe works for Messrs. C. Davison and Sons, Compton-road. Architect, Mr. W. M. Coggill, 4, Airedale-terrace, Stourton, Hunslet.

CASTLE EDEN—Police court. County surveyor, Mr. Wm. Crozier, Shirehall, Durham.

CAUCASUS—An hydro-electric power station is to be constructed for the Municipal Authorities of Kontais. Particulars may be obtained from Radjia Datéchitze Lohrstrasse.

CHATBURN (NEAR CLITHEROE)—Erection of and extension to weaving shed and 17 dwelling houses for the Chatburn Manufacturing Co. Architect, Mr. W. H. Atkinson, Shaw-street, Colne.

CWMBRAN—Lighting and ventilation to St. Dial's School for the Monmouthshire Education Committee. Secretary, Mr. C. Dauncey, County Council Offices, Newport, Mon.

DALTON—Private residence. Architect, Mr. Douglas Hall, Fartown, Huddersfield.

DARLINGTON—Extension of factory for the Darlington Wireworks.

EXMOUTH—Destructor shed (including electrical installation) for the Urban District Council. Engineer and surveyor, Mr. Samuel Hutton, Council Offices, Exmouth.

FARNWORTH—Council offices (£11,450). Surveyor, Mr. J. Lomax. These offices to be lighted by electricity.

GATESHEAD-ON-TYNE—Motor-repairing shop for North-Eastern Railway Co. Architect, Mr. William Bell, Central Station, Newcastle-on-Tyne.

GELLI (WALES)—Manager's house for Messrs. Cory Bros. and Co. Architect, Mr. W. D. Morgan, Post Office-chambers, Pentre, Rhondda Valley.

HAMMERSMITH—Fitting up swimming-bath for use as public hall for the Corporation.

KEIGHLEY—Fireproof mill with boiler-house, etc. Architects, Messrs. Moore and Crabtree, York-chambers, Keighley.

LEEDS—Drapery warehouse for Messrs. Hatton and Whiting in Wellington-street. Architect, Mr. W. H. Thorpe, Leeds

LEEDS—Business premises in Meadow-lane. Architect, Mr. C. S. Nelson, Sun-buildings, 15, Park-row, Leeds.

LINTHORPE—Wesleyan church and schools (£6,200). Architect, Mr. R. Forester.

LLWYCOED (ABERDARE)—Villa for Mr. E. Moses. Architect, Mr L. Smith, Aberdare.

NEWTON BANK—Shop and cottages for the Winsford Industrial Co-operative Society, 21, High-street, Winsford.

PORTH—Hotel for Mr. T. Morgan. Architect, Mr. J. T. Jenkins, Porth, Rhondda.

RADLETT (HERTS)—School for the County Council (£2,000).

ST. ALBANS (HERTS)—Salvation Army barracks (£5,000).

SILVERTOWN—Soapworks for the Wholesale Co-operative Society.

SILVERTOWN—Warehouses for Messrs. T. W. Ward and Co., Thames-road, Silvertown.

SPAIN—The town of Villcaston is to be lit by electricity. The Municipal Authorities are prepared to grant a concession for four years.

STAFFORD—Isolation hospital for the Health Committee. Mr. W. Blackshaw, borough engineer, Borough Hall, Stafford.

STRATFORD (ESSEX)—Factory for the manufacture of flooring for the Zeta Wood Flooring Co., Crispin's Wharf, Stratford, E.

TINSLEY—Methodist church (£4,500). Architect, Mr. J. Amory Teather, Sheffield.

TOWER HILL (DEVON)—Residence and workman's cottage, etc. Architect, Mr. E. Wise, Launceston.

WHITWORTH (NEAR ROCHDALE)—Bleachworks to be erected for the Whitworth Bleaching and Finishing Co. Architect, Mr. A. Winstanley, 6, Brown-street, Manchester.

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PERSONAL.

Mr. S. Pollitt, B.Sc., science master at the Tottenham County School, has been appointed head-master of the Southall County School.

The British Insulated and Helsby Cables inform us that they have opened a branch office at 17, Crow-street, Dublin, in charge of Mr. F. H. Jones.

The Ayr Corporation have decided to grant an increase of £50 per annum to their electrical engineer, Mr. R. Marshall, making his salary £350 per annum.

Mr. F. A. Plenderleith, assistant engineer at the Harrogate Corporation electricity works, was last week presented by his colleagues with a case of cutlery on the occasion of his marriage.

The Electricity Committee have again recommended to the Bury Town Council that the salary of the electrical engineer (Mr. S. J. Watson) be increased from £400 to £450 per annum.

We are informed by Messrs. Merz and McLellan that Mr. Charles Merz will be leaving England for a short visit to Australia on Sept. 13 to report upon the proposed electrification of the Victorian Suburban Railways.

Messrs. T. Harding Churton and Co., Atlas Works, Leeds, have appointed Messrs. Andrews and Co., of 198A, St. Vincent-street, Glasgow, to be their agents in Scotland for the sale of their alternating-current motors.

Mr. A. G. Cuthbert, who formerly represented Messrs. Crompton and Co. in Ireland, has been placed in charge of the same company's Manchester district, the office for which is situated at Woodall's-buildings, 42, Deansgate.

Mr. Percy H. Buzza, who has for the past five years been engaged at the Leeds electric lighting station, has received an appointment at the Colchester electricity station at a salary of £2 per week, increasing 5s. per week per annum to a maximum of £3, in accordance with scale.

The council of the Institution of Civil Engineers have appointed Sir William Matthews, K.C.M.G., president of that institution, to succeed the late Sir Benjamin Baker, K.C.B., K.C.M.G., as one of their representatives on the main committee of the Engineering Standards Committee.

Messrs. J. C. Lyell and Co., 55, Victoria-street, Westminster, have been appointed sole buying agents by Messrs. C. and T. T. Pattison, torpedo-boat builders, motorcar builders, and general mechanical and electrical engineers, of Naples, Italy. They invite catalogues and price-lists (in duplicate) from manufacturers and agents for tools, plant, boiler plates, machinery, materials, etc., together with their best export discounts. They have now opened an office at 84, Rue de Richelieu, Paris.

The governing body of the Battersea Polytechnic have appointed Mr. S. G. Rawson, D.Sc. (London), F.I.C., principal of the Polytechnic in succession to Mr. Sidney H. Wells, who has been principal since the foundation of the institute in 1893, and is resigning to take up the position of director-general of the department of agriculture and technical education for Egypt. Dr. Rawson is at present director of education for Worcestershire, and was formerly principal of the technical college, Huddersfield, and lecturer at Liverpool University.

The annual excursion of the Silvertown employés of the India Rubber, Gutta Percha, and Telegraph Works Co. took place last Saturday, when upwards of 850 persons journeyed to Clacton-on-Sea. The day was most enjoyably spent, and arrangements had been made so that the visitors could enter the various places of amusements either free of charge or at greatly reduced prices. The success of the excursion depended altogether upon the excellent organisation by the committee, of which Messrs. A. Cheetham, T. Lockwood, and J. Hipwell discharged the duties of chairman, treasurer, and secretary respectively.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Salford.—Tenders are invited for 14 cars and four salt wagons for the Corporation Tramways Department. Tenders by Aug. 12.

Madrid.—The Public Works Department invite tenders for the construction of electric tramways in Valencia. Tenders by Aug. 12.

Madrid.—Tenders are invited by the Public Works Department for the construction of an electric tramway at San Sebastian. Tenders by July 30.

Kilkenny.—The Committee of Management of the District Asylum invite tenders for the electric lighting of the District Asylum. Tenders by July 15.

Beckenham.—The Urban District Council invite tenders for the supply of meters for the electricity generating station. Tenders by July 22. See advertisement in last issue.

Warrington.—Tenders are invited for extensions to the electricity station. Particulars from the Borough Electrical and Tramways Engineer, Warrington. Tenders by July 16.

Brisbane.—The Postmaster-General invites tenders for the supply and delivery at Brisbane of four sections of a common battery switchboard and 650 subscribers' telephones to specification No. 145. Tenders by Sept. 2.

Maidenhead.—The Borough Council invite tenders for the supply of coal to the generating station to March 31, 1908. Specifications, etc., from Mr. C. O. Milton, borough electrical engineer, Maidenhead. Tenders by July 19.

Wednesbury.—The Corporation invite tenders for (Section C) balancer boosters; (D) accumulators (alterations and extensions), in connection with the extensions to the electricity works. Tenders by July 23. See advertisement.

London.—The Metropolitan Water Board invite tenders for plant, including electric generator, boilers, piping, pumps, coal conveyor, moters, etc. Tenders by July 24.

Stepney.—The Electricity Committee invite tenders for the supply of a testing switchboard, motor-generator, and transformer, also a three-pole distribution board and earthing panel. Tenders by July 22. See advertisement in last issue.

Wallasey.—The Tramways Committee invite tenders for the supply of tramway points and crossings. Particulars, etc., from Mr. W. H. Travers, engineer and surveyor, Public Offices, Egremont, Cheshire. Tenders to Mr. H. W. Cook, clerk, by July 15.

Wednesbury.—The Corporation invite tenders for the erection of a new building for a generating station, and for certain extensions and alterations to existing buildings at the electricity sub-station, Camp-street. Tenders to the Town Clerk by July 17.

Wednesbury.—The Corporation invite tenders for the supply of balancer boosters and alterations and extensions to accumulators for the electricity department. Particulars from Mr. W. Fennell, Camp-street, Wednesbury. Tenders by July 23.

Devonport.—The Corporation invite tenders for the supply of general stores for a period of 12 months to the electricity department. Particulars from the Borough Electrical Engineer, Newport-street, East Stonehouse. Tenders to the Town Clerk by July 18.

Grimsby.—The Public Lighting Committee invite tenders for 5,000 tons of fine slack coal required during the 12 months ending Aug. 30, 1908. Particulars from Mr. W. A. Vignoles, borough electrical engineer, Corporation Electricity Works, Grimsby. Tenders by July 15.

Winnipeg.—The Point du Bois Hydro-Electric Development invite tenders for an electrical equipment and for constructional work. Specifications, etc., from the Power Engineer's Office, Carnegie Library Buildings, Winnipeg, or at 35-36, Bedford-street, Strand, W.C. Tenders by Sept. 3.

Cardiff.—The Guardians invite tenders for the provision of telephones, necessary wiring, switchboard, etc., and alteration of present telephone service at their Cardiff and Ely Workhouses. Particulars and forms of tender may be obtained from Mr. Arthur J. Harris, clerk, Union Offices, Queen's-chambers, Cardiff. Tenders by July 16.

Newcastle-upon-Tyne.—The Tramways Committee invite tenders for the supply of the various, points, crossings, rails, and other materials in connection with the renewal and extension of a three-road double turn-out junction of tramways at Market-street and Pilgrim-street, Newcastle-upon-Tyne. Tenders by Aug. 3. See advertisement.

Birmingham Tame and Rea District Drainage Board.—The Board invite tenders for the supply and erection, at their Saltney outfall works, of electrical pumping machinery for the pumping of storm water, comprising three-phase induction motors and electrically-controlled sluice valves, with all the necessary switchgear. Tenders by July 26. See advertisement.

New South Wales.—The Postmaster-General at Sydney invites tenders for the supply and delivery at the departmental stores, Sydney, of telegraph, telephone, and electric light material. Specifications, general conditions, and tender forms may be obtained at the General Post Offices, Sydney, Melbourne, Brisbane, Adelaide, Hobart, and Perth. Tenders by Aug. 14.

New South Wales.—The Postmaster-General, Sydney, invites tenders for the supply and delivery at the Department's Stores, Sydney, of 180 quantity and intensity detectors, wound with two circuits of about 150 ohms and 0·22 ohm respectively, the quantity coil fitted with a fifth shunt, in accordance with scaled pattern Q. No. 317. Tenders by Aug. 21.

Manchester.—Tenders are invited for the supply of (*a*) steel girder tramway rails and fishplates; (*b*) tie bars and bolts and nuts; (*c*) steel tramway poles; (*d*) span wire brackets; (*e*) tramway rail bonds, for the Tramways Committee. Specifications, etc., from Mr. J. M. M'Elroy, general manager, Tramways Department, 55, Piccadilly, Manchester. Tenders by July 15.

London.—The London County Council invite tenders for (*a*) supply and erection of 78 tramway feeder pillars for the Council's tramways, and (*b*) the supply, delivery, and erection of overhead electrical equipment for 2,400 yards of double tracks for the Council's tramways in the borough of Woolwich. Tenders to the Clerk of the Council, County Hall, Spring-gardens, S.W., by July 16.

Edinburgh.—The Corporation invite tenders for the supply of lead-covered paper-insulated copper cables for electricity supply conductors for the year ending May 15, 1908. Specification, etc., from Mr. Frank A. Newington, engineer, Electricity Supply Station, Dewar-place, Edinburgh, on payment of a deposit of £2. 2s., which will be returned on receipt of a *bona fide* tender. Tenders by July 15.

Wakefield.—Tenders are invited for the following contracts in connection with the second portion of the main institution of the Storthes Hall Asylum, for the West Riding County Council: (1) two engines and dynamos, electric light installation, including wiring, fittings, lamps, etc.; (2) electric bells, telephones, fire-alarms, recording clocks, etc.; (3) heating and ventilation; (4) farm buildings and residence. Full particulars may be obtained on application to the County Architect. Tenders by July 22.

Leeds.—Tenders are invited for the supply, delivery, and erection at their Knostrop sewage works of one new small combined electric lighting set, engine to be of compound enclosed condensing type, direct-coupled to one continuous-current generator, capable under normal conditions of producing an output of 45 e.h.p. at 110 volts, for the Sewerage Committee. Further particulars can be obtained on application at the office of Mr. Geo. A. Hart, sewerage engineer, Municipal Buildings, Leeds. Tenders to the Town Clerk by July 15.

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Walton-on-Thames. — The Metropolitan Water Board invite tenders for the provision of four high-class triple-expansion marine type steam-engines, seven centrifugal pumps, three hydraulic turbines, sluice valves, steel mains and cast-iron branch pipes, two 25-kw. electric generators, 10 water-tube boilers, mechanical stokers, two economisers, steam-pipes, feed pumps, coal conveyor, ash hoist, motors, etc., to be erected at the new pumping station at Walton-on-Thames. Tenders to the Clerk, Metropolitan Water Board, Savoy-court, Strand, W.C., by July 24.

Bristol.—Tenders are invited for the construction, delivery, erecting in place, fitting, testing, and maintenance for 12 months after completion, of 10 electric two-ton wagon capstans, to be erected at the Royal Edward Dock now in course of construction at Avonmouth, in the port of Bristol, for the Docks Committee. Specification, etc., can be obtained from Mr. W. W. Squire, engineer, Engineer's Office, Cumberland Basin, Bristol, on payment of a deposit of £3, which will be returned to *bona fide* tenderers after receipt of a tender accompanied by all the prescribed documents and drawings. Tenders to the Secretary of the Docks Committee, Dock Offices, 19, Queen-square, Bristol, by July 26.

Bristol.—Tenders are invited for the construction, delivery, erecting in place, fitting, testing, and maintenance for 12 months after completion, of the following electric jib cranes to be erected at the Royal Edward Dock now in course of construction at Avonmouth, in the port of Bristol, for the Docks Committee of the Council: (Schedule No. 1) 12 30cwt. movable electric jib cranes to be erected on the roofs of sheds No. 1 and No. 2 in course of construction on the east side of the dock; (No. 2) two 10-ton movable electric jib cranes on high pedestals, to be erected on the wharf on the south side of the dock; (No. 3A) three 30cwt. movable electric jib cranes on high pedestals, to be erected on the wharf on the south side of the dock; (No. 3B, as an alternative to Schedule 3A) one 30cwt. movable electric jib crane, two 3-ton movable electric jib cranes. Tenders to the Secretary of the Docks Committee, Dock Offices, 19, Queen-square, Bristol, by July 26.

Calcutta.—Tenders are invited for lighting by gas, oil, electricity, or other illuminant of the streets, thoroughfares, and public resorts of the city of Calcutta, as vested in the Corporation of Calcutta. The city comprises approximately an area of 20 square miles, containing about 170 miles of main thoroughfares and 130 miles of smaller streets and lanes, besides several squares, markets, latrines, slaughter-houses, and other public resorts, the whole being lighted at present by 9,225 gas lamps of 24 c.p., 84 higher power lamps equivalent to 2,074 lamps of 24 c.p., and 2,400 oil lamps. The new contract is timed to commence on May 1, 1911, and the successful tenderer or tenderers will be required to have all arrangements completed and ready to begin and continue the lighting with effect from that date. Tenders should be for 10, 15, or 20 years. It is left to tenderers to propose their own plans for carrying out the project, the end in view being to considerably improve the present lighting of the city, and, to this end, it is suggested that representatives should be deputed to personally inspect the area to be lighted and the system now in force, in order that they may be in a position to judge for themselves as to the best means to be adopted for attaining the desired object. Mr. P. N. Mookerjee, secretary to the Corporation. Tenders to the Vice-Chairman by Jan. 2 1908.

RESULTS OF TENDERS.

West Ham.—The Electricity Committee recommend the acceptance of the tender of the Fuller Electrical Co. for the supply of slow-speed and squirrel-cage two-phase motors.

Derby.—The Electric Lighting Committee have accepted the tender of Messrs. Cowans, Limited, for the enlargement and remodelling of the high-tension switchboard for £133. 10s.

Taunton.—The Somerset Joint Committee have accepted the tender of the Taunton Corporation Electric Works at £37. 15s. for electrical work at the Shirehall, about to be built in Taunton.

Glasgow.—Messrs. Bruce Peebles and Co. have received from the Glasgow Corporation an order for a 1,000-kw. Peebles-LaCour motor-converter. This machine is to operate on a 25-cycle circuit.

London.—Mr. F. E. Slatter, 56, Farm-street, London, E.C., has been awarded the contract for stage lighting at the Working Men's Club, Clerkenwell-road, London, recently advertised in these columns.

Belfast.—The Electricity and Tramways Committee of the Belfast Corporation have accepted the tender of J. and W. Stewart, of Belfast, for the supply of coal storage bunkers and electric crane for the sum of £2,059.

London County Council.—The Highways Committee recommend that the offer of Wm. Cory and Son to supply and deliver about 75,000 tons of coal for the Greenwich electricity generating station at the rate of 14s. 5d. a ton, with demurrage at the rate of 2d. a ton for each day after two days, be accepted.

Canada.—An electric line is to be built from Tacoma to Vancouver by Messrs. Stone and Webster, of Boston, who have purchased the franchises of the Everitt Electric Co. This will give a line from Vancouver to Seattle. Sir Thomas Shaughnessy announces that the company is considering the substitution of electric for steam locomotives for use on the heavy grades in British Columbia. Several tests that have been made of late have proved entirely successful, and the company's engineers are satisfied with the plan. Mr. James Milne, general superintendent of the British Columbia Electric Railway Co., states that the company contemplates building during the next two years about 60 miles of road from Westminster to Chilliwack, B.C. This does not include extensions to the lines in Vancover, Westminster, and Victoria.

BUSINESS NOTES.

TRACTION.

Lincoln.—The tramways have now been taken over from the contractors. The trams are said to have been working satisfactorily.

India.—The Benares tramway and electric licence, have now been finally granted, and it is expected that the constructional work will commence soon.

Greenwich.—The Borough Council has been asked to give its consent to the construction by the London County Council of a tramway along Blackheath-road.

Sunbury.—The District Council dissent to an application by the London United Tramways Co. to the Board of Trade for an extension of time for the construction of tramways.

Skipton.—The Rural District Council have decided to conditionally support the scheme of the proposed light railway commencing at the existing railway terminus at Grassington Station and proceeding to Buckden.

Leeds.—A meeting of the Leeds Corporation Tramways Traffic Sub-Committee was held to consider the question of adopting the system of carrying parcels on the tramcars. After considerable discussion it was decided not to recommend the adoption of the system.

Islington.—The Highgate-hill Tramways Co. having applied to the Board of Trade for a renewal for seven years of their licence to use cable traction on Highgate-hill, the Board asked the Islington Borough Council whether they had any objection to offer to the application, and the latter have referred the matter to their Works Committee.

Rail Corrugation.—Councillor Kidd, who is deputy chairman of the Tramways and Electricity Committee of the Cardiff Corporation, is said to have introduced a method for dealing with corrugation on tramrails. He has adopted the plane principle of rail grinding by means of a carborundum wheel. One advantage which this method is said to possess is that of economy.

Middlesbrough.—Owing to the brakes refusing to act in consequence of the rails being greasy, an electric tramcar proceeding down a steep bank at Thornaby-on-Tees could not be pulled up at a loop line, and ran into a car from Middlesbrough. Both drivers had fortunate escapes. The fronts of the cars were knocked in, and about a dozen passengers suffered from shock, cuts, and bruises.

Light Railways.—The Light Railways Committee held an inquiry last Friday into the application of the Barton and Immingham Light Railway Co. for powers to acquire land and construct a railway linking Barton-on-Humber with the Immingham deep-water dock. The Board of Trade have recently confirmed the undermentioned order made by the Light Railway Commissioners: East Sussex Light Railway (Extension of Time and Amendment) Order, 1907, amending the East Sussex Light Railway Orders, 1901 and 1905.

Glasgow.—A serious collision occurred recently between a tramway car and a lorry near the junction of Garscube-road and Cowcaddens-street, Glasgow, resulting in the death of a carter. The car was proceeding from Barracks Gate along Garscube-road on its way to Battlefield, and when near the Normal Training College the lorry emerged from Stewart-street and crossed the rails in front of the car. The motorman of the car at once applied his brakes and shouted out, but before he could pull up the car crashed into the front part of the lorry.

Paisley.—Mr. Jeune, one of the examiners of Bills, has reported to the Secretary for Scotland that in the case of the Paisley District Tramways' draft provisional order the General Orders have not been complied with, inasmuch as the promoters have not obtained the consent of the provost, magistrates, and councillors of the burgh of Barrhead, who are the local and road authority of the district through which it is proposed to construct tramway No. 1, nor of the County Council of the county of Renfrew, who are the local and road authority in respect of tramways Nos. 2 and 3.

London Transportation.—The *Tribune* states that at a meeting of the passenger transportation companies of London, including the omnibus companies, summoned by Sir George Gibb, and held at the offices of the Underground Electric Railways of London, it was decided that it is desirable to establish a traffic conference for the purpose of dealing with matters affecting the mutual interests of the various undertakings. A revision of omnibus fares will probably be one of the results of this movement, and the rearrangement of routes so as to avoid overlapping and wasteful and unnecessary competition is also likely to be dealt with.

Liverpool-Manchester.—In view of the rapid development of Irlam and Cadishead, and the isolation of the district, the General Purposes Committee of the local authority have discussed a proposal for providing connections with Manchester and Warrington by electric car. It was reported that there was a movement on foot for introducing motor 'buses, but the members were of the opinion that the provision of electric cars ought to be encouraged. The clerk was instructed to communicate with the corporations affected and the South Lancashire Electric Tramways Co. to ascertain if they were willing to join at an electric tramcar service through the district, and thus bring direct communication between Manchester and Liverpool along the main roads between the two cities.

Wandsworth.—The clerk to the London County Council has informed the local authority that, owing to the additional street widenings asked for by the Wandsworth and Battersea Borough Councils, the clauses relating to the proposed reconstruction for electric traction of the Wandsworth-road, Lavender-hill, St. John's-hill, and East-hill tramways had to be withdrawn from the County Council's Tramways and Improvements Bill of the present session. The High

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ways Committee of the County Council was impressed with the desirability of reconstructing these lines at an early date, and hoped that the Wandsworth Council would be willing to consider some modification of the proposals previously put forward. They suggested that, with the view of arriving at an agreement, representatives of the two borough councils should meet a few members of the Highways Committee to discuss the matter. This has been agreed to.

Morecambe.—A special meeting of the Morecambe Town Council was held on Monday to consider the question of the purchase of the tramways at present owned by the Morecambe Tramways Co., and run by horse traction within the borough. The company's authority expired on June 4, and notice of the intention of the local authority to purchase must be given within six months of that date. The Finance and General Purposes Committee, therefore, recommend the necessary notice be given that the system be electrified, and parliamentary powers obtained. Mr. Gardner, manager of the Chester Corporation tramways, estimates the cost of purchase and reconstruction for electrification at £46,093. After allowing for the fluctuations between summer and winter traffic at Morecambe, he estimates an annual income of £10,390, and a balance of £3,689 for reserve and renewals. It would be necessary to spend a sum of £10,000 in additional plant at the electricity works. The report of the committee was approved by 14 votes to 4.

London County Council.—The traffic receipts on the tramways owned and worked by the London County Council for the week ended June 29 last amounted to £31,596, against £26,248 in the corresponding week of the previous year. The total traffic receipts from April 1 last, the beginning of the financial year, to June 29 amounted to £401,397, against £342,493 in the same period of the preceding year. The Highways Committee's report upon the question of providing adequate accommodation for the repair and overhauling of the electric cars used on the Council's tramways, and are recommending the Council to vote £51,400 in respect of the erection of the first section of buildings, etc., required in connection with the establishment of a central car-repairing depôt for the London County Council tramways and in respect of incidental expenses. They are also asking for £16,000 in respect of the provision of plant, tools, machinery, etc., for the first section of the central car-repairing depôt proposed to be established. A report was also presented at Tuesday's meeting of the Council on the subject of some whisky advertisements which the Highways Committee propose to accept for display on the tramcars.

Derby.—The receipts from the Derby Corporation tramways during the month ended June 22, 1907, were £2,963, being a decrease of £699 as compared with the corresponding period of last year. The time for the completion of the tramways authorised by the Derby Corporation Act, 1901, will expire in August next year. As it is not proposed to proceed with the construction of the whole of the lines before that date, the Council is recommended to pass resolutions in favour of an application to Parliament for an extension of the time. The committee have decided to apply the sum of £5,000, part of the balance on revenue account, in reduction of the loan borrowed for the acquisition of the undertaking of the Derby Tramways Co. The Council is recommended to grant the sum of £1,774. 17s. 10d., representing the excess between the amount previously granted and the amount of the tender accepted by the Council at their last meeting for the construction of the Nottingham-road route, and to direct the borrowing of the amount under the provisions of the Derby Corporation Act, 1901, this excess being caused by the doubling of the line to the racecourse. The committee have now ascertained that the cost of the three double-deck cars substituted for three single-deck cars is £653. 10s. per car instead of £592 per car, as reported to the Council at the last meeting. The Council is therefore recommended to grant the additional sum of £184 required, and to direct the borrowing of the amount under the provisions of the Derby Corporation Act, 1901. The committee have visited and inspected various sites for the erection of car-sheds, and have decided to accept the offer of the Estates Committee with respect to land on the Nottingham-road, and have given instructions for the preparation of plans and estimates for the construction of car-sheds thereon.

West Ham.—The Tramways Committee have agreed to the addition of the following by-law suggested by the Board of Trade: "Provided that, on cars run for artisans, mechanics, and daily labourers, no person shall be prevented from entering or remaining in or upon a car under the provisions of this by-law on the ground of the condition of his dress or clothing, if such condition is solely due to the nature of his employment." The tramways manager has presented a report on the apportionment of street widenings. He says that it has been practically adopted as a precedent in connection with street widenings for tramway purposes that one-third is rightfully chargeable against the tramways undertaking, one-third against the local authority, and one-third against the county road authority. In West Ham the latter two are both vested in the Corporation, so that, acting in accordance with precedents which have been adopted in all parts of England, the apportionment of these street widenings would have been as follows: tramways, £53,630. 12s. 3d., being 33⅓ per cent.; street improvements and highways, £107,262. 4s. 6d., being 66⅔ per cent.—total, £160,892. 16s. 9d. The present suggested apportionment debits against tramways a sum of £71,509. 3s. 8d., or 44·44 per cent. This is a sum greater than that which, acting on precedent, would be so debited, to the extent of £17,878. 11s. 5d. He recommends the adoption of this, firstly, because in adopting the apportionment drafted by the borough engineer, the officer of the Highways Committee, it cannot be suggested with any reasonableness by any critic that he could be in any way biassed in favour of the tramways as against highways; and, secondly, because, having regard to the strong and oftentimes unfair and illogical criticism to which municipal trading is subjected, the committee has always adopted the policy of charging against tramways account any payment which, on any ground of justice or reasonableness, could fairly be charged against it.

Tramway Extensions in Yorkshire.—Official notice has been given of an intended application to the Board of Trade for the transfer of the undertaking authorised by the Morley and District Light Railways Order, 1901, and such portion of the undertaking authorised by the Spen Valley and Morley Light Railways (Extension) Order, 1902, as have not been constructed, from the British Electric Traction Co. to a new company to be known as the Leeds and Bradford District Tramways. It is proposed that the new company should have tramway running powers over lines of the Yorkshire (Woollen District) Co. from Cleckheaton and Hightown to Heckmondwike, and through Gomersal to Birkenshaw, so as to enable the company to connect the unconstructed portion of the railways authorised by the Spen Valley Light Railways Extension Order, 1901, proposed to be transferred to them. The intention is to proceed with the construction of the lines from Leeds to Morley, and from thence to Gildersome and Drighlington in the first instance. It is further proposed that the new company should apply for an extension of the authorised Morley tramway through Birstall by a line joining the authorised Hartshead Moor line, and thence by another extension to Brighouse. The question of the proposed transfer has been considered by the Morley Light Railways Committee, and by the District Councils of East and West Ardsley, Gildersome, and Drighlington. While the Morley Corporation have not arrived at a definite decision as yet, the Ardsley District Council have decided not to offer any objections providing certain conditions are met. The Drighlington and Gildersome District Councils have held a conference with a view to approaching Leeds City Corporation and ask them to continue their tramways from the city boundary along Whitehall and Gelderd roads to Drighlington and Gildersome, but after discussion it was resolved to oppose any extension of time for the construction of the new tramways by the company unless such extension was short and final.

LIGHTING AND GENERAL.

Grimsby.—A loan of £3,825 is being applied for by the Corporation for their electricity undertaking.

Lowestoft.—Sanction is being sought by the Corporation for a loan of £18,150 for electric lighting purposes.

West Bromwich.—The Corporation are applying to the Local Government Board for sanction to borrow £4,925 for the electricity undertaking.

Pontypool.—The Pontypool Electric Lighting Co. is being asked by the Urban District Council to submit a scheme and estimate of lighting the whole market.

Essex.—The County Council have referred back a wayleave agreement with the National Telephone Co. in respect of poles and wires at Chigwell, Harlow, Burnt Mill, Epping, and Ingatestone.

Notice of Intended Dividend.—According to the *London Gazette* the last day for receiving proofs in the estate of Francis Williams electrician, 17, Orchard-road, Bemerton, Salisbury, is July 22.

Northallerton.—The Northallerton Electric Lighting Co. have informed the Urban District Council that they would be pleased to consider an offer to purchase their undertaking. The Council are considering the matter.

Longton.—Mr. H. Shelford Bidwell, an inspector of the Local Government Board, held an inquiry last week into an application by the Town Council for sanction to borrow £2,000 required for extensions at the electricity works.

Bournemouth and Poole Electricity Co.—The directors of the Bournemouth and Poole Electricity Supply Co. have declared an interim dividend at the rate of 5 per cent. per annum on the ordinary shares, less income tax, for the half-year ended 30th ultimo.

Calverley.—The Calverley District Council have decided to lease their electrical lighting powers to the Electrical Distribution of Yorkshire; the powers to be transferred for a number of years, and the company to find the capital required for the necessary works.

Partnership.—The *London Gazette* announces that the partnership between C. Willis, H. Willis, and W. James, carrying on business as electrical engineers at 4, Ryleys-gardens and at Manchester-buildings, Tithebarn-street, Liverpool, has been dissolved by mutual consent.

West Ham.—The Electricity Committee recommend for the approval of the Highways and Parks Committee the adoption of a single-light 50-c.p. Osram lamp at an inclusive charge of £2. 12s. 6d. per annum, the Highways Committee to provide the column and lantern.

Felixstowe.—The Town Council have received offers from two makers of new flame lamps to fix up five each of their lamps for a month's free trial, and replace the present ones at the end of that period if requested. It has been agreed to accept the offers and to have the lamps.

Finsbury Technical College.—The drawings executed by the students of this college during last session will be on view each afternoon from Monday, July 15, until Friday, July 19, from 2 to 5 o'clock. This exhibition should prove of extreme interest, and we consider it is worthy of a visit.

Darlington.—There has been a steady increase in the demand for electricity for power purposes. The electricity department of the Corporation have already 120 motors connected or on order, which altogether represents over 900 h.p. Enquiries have been made for the supply of no less than 1,100 h.p.

Spennymoor (Durham).—The Urban District Council have accepted the tender of the Northern Counties Electricity Supply Co. of 42s. per lamp for the term of 10 months' lighting. They had also decided to ask the electricity company to state the terms upon which they will fix an arc lamp in High-street as an experiment.

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Acton.—The scale of charges to consumers of electricity has been revised as follows: For light—private consumers, 5d. per unit; shops and public buildings (including places of worship), 4d. per unit. A flat rate of 1d. for heating, and for power a maximum demand system of 2½d. for one hour and 1d. per hour after, with the alternative of 1½d. flat rate.

Derby.—The Electricity Committee have decided to extend the mains in Wood's-lane to meet the Boyer-street mains at an estimated cost of £190, and have also decided to lay a new feeder main from the Wardwick to the deaf and dumb institution at an estimated cost of £150. These amounts are included in the sum of £6,350 granted by the Council on April 3, 1907.

Hinckley.—The Rural District Council have been informed by Mr. C. S. V. Brown, of Newcastle-on-Tyne, that in November he will apply to the Board of Trade for provisional orders to supply electricity for lighting and other purposes in the urban and rural districts of Hinckley, including, Barwell, Burbage, Earl Shilton, Stoke Golding, Stoney Stanton, and Sapcote.

Llansamlet (Glamorgan).—A meeting in connection with a suggested scheme to light Llansamlet with electricity has been held. It took the form of a conference between the members of the Parish Council and the local members of the Swansea Rural District Council. It was agreed that a provisional order should be applied for and that an expert should be employed.

National Telephone Co.—The directors of the National Telephone Co. announce the following dividends for the half-year ended June 30 last, after payment of the dividends on the preference shares: at the rate of 6 per cent. per annum on the preferred stock, at the rate of 6 per cent. per annum on the deferred stock, carrying £130,000 to reserve and about £10,000 forward.

Leeds.—The present engine used at Knostrop sewage works for electrical lighting purposes is to be replaced by a modern small compound electric lighting set, the engine to be of compound condensing type, direct coupled to one continuous-current generator, capable under normal conditions of producing an output of 45 e.h.p. at 111 volts.

Bermondsey.—The General Purposes Committee are recommending the Council to dispose of the Rotherhithe destructor. The electrical engineer can find no room for the machinery except the two Workington pumps, which might be useful, but they would have to be dismantled to see what condition they are in. The committee recommend, therefore, that tenders be obtained for the disposal of the whole of the machinery.

Bath.—The Electric Lighting Committee have recommended, in connection with the proposed acquisition of the electric light undertaking by a company, that the town clerk should notify Mr. Schenk that if the agreement for the sale of the undertaking were not executed before July 22 next steps will be taken at the following meeting of the Council to rescind the resolution adopted on Feb. 26 last, authorising the agreement to be entered into.

Edinburgh-Glasgow Underground Cable.—The Streets and Buildings Committee of the Edinburgh Town Council have had under consideration the question of the route of the telegraph cable between Edinburgh and Glasgow. They decline, however, to consent to its going through either Princes-street-gardens or Princes-street, and suggest the route recommended by the road surveyor, which is by the Low Calton, Leith-street, and Queen-street.

Gravesend.—Some time ago the Gravesend Town Council took over a provisional electric lighting order secured by the Urban District Council of Northfleet, and both bodies sealed an agreement that a supply of electric light should be given within a specified time. Gravesend is now declining to extend the supply to Northfleet. Gravesend has now been informed by Northfleet that the latter will hold Gravesend strictly to the terms of the agreement.

Holywood (co. Down).—Messrs. Maclean and Sons, of Belfast, on behalf of the Holywood Tramways Co., have informed the Urban District Council of their intention to apply for a provisional order for supplying electrical energy in portions of the urban district of Holywood and the rural district of Castlereagh, near Belfast. The Council have decided to form a committee to go thoroughly into the matter with regard to the lighting of the town and the tramways.

Stafford.—The Town Council's electricity department is managed by Mr. Langford, the gas engineer, whose report for the past year shows that there has been a great increase in the quantity of current sold for motive power. Prices have been so reduced that those who take considerable quantities during the day can obtain it at a very low rate. The gross profits (made by the electricity department) were £1,077, and the interest and sinking fund charges £1,278, showing a loss of £201.

Yarmouth.—In reference to the application of the Yarmouth Town Council for sanction to borrow money for purposes of their electricity undertaking, an inquiry was held by Mr. H. R. Hooper, M.I.C.E., on behalf of the Local Government Board last week. The application was for two loans of £7,000 and £1,235, and there was no opposition. The first amount was made up as follows: £3,000 for additional steam plant for tramway purposes only, £2,800 for mains, and £1,200 for meters. The inspector suggested that the last-named should be paid for out of revenue.

Watford.—The Local Government Board have sanctioned a loan of £8,151 for additions and extensions to the electric light plant. The original sum applied for by the Council was £13,500, which was afterwards reduced to £9,032. The Board pointed out that the Council had made an imprudent agreement with one firm to supply power at as low a price as 1d. per unit, and asked the Council to "carefully compare the cost and advantages of lighting by electricity and gas before proceeding with any further extensions of the system of lighting streets by electric incandescent lamps."

St. Annes.—The gross profit for the past year of the District Council's electricity undertaking was £4,534, to which was added £25 for bank interest; the loan instalments amounted to £1,436, and the interest on loans to £1,358, leaving a net profit of £1,765, which has been apportioned as follows: £700 to the general district fund, £50 to the library fund, and the balance (£1.015. 13s. 6d.) to reserve, which now stands at £4,136. 0s. 10½d. The actual cash in hand at the bank was as follows: capital, £1,417; depositors, £404; reserve fund, £4,136, less overdrawn on revenue account £2,680, leaving a net cash balance of £3,276.

Voluntary Liquidation.—The Brockie-Pell Arc Lamp, Ltd., have issued to their creditors a circular informing them that the present company will immediately go into liquidation voluntarily, with a view to reconstruction for the purpose of paying all the debts of the company and raising further capital for development and extension of the company's business. The directors and the receivers of the company believe that the assets are ample to pay the whole of the debentures and debts of the company in full, and to leave a fair surplus for the shareholders. The receivers appointed are Mr. Robert Warner, F.C.A., and Mr. Duncan Watson, M.I.E.E.

Aston (Birmingham).—The Electricity Committee have had under consideration the question of providing suitable sites for the substations in connection with the Erdington lighting scheme, and have arranged to take an outbuilding attached to the house at the corner of Wheelwright-road and Gravelly-hill, on a lease for a period of 21 years, at an annual rental determined by the committee, with the option of extending the lease for a further 21 years. The committee will report upon further sites at present the subject of negotiations. The committee has been informed that the confirming Act has passed Standing Orders of the House of Commons and been read twice in that House.

Camberwell.—Some difficulty has arisen between the Borough Council and the London Electric Supply Co. as to the placing of a transformer box in Blenheim-grove. The box is intended to be used for the purpose of transforming 2,000 volts high-pressure supply to 200 volts low pressure for use in neighbouring consumers' premises, the mains being suited accordingly. The Works Committee are recommending the Council (*a*) to object to the position of the proposed transformer box, and (*b*) in the event of the Board of Trade sanctioning the placing of the box in the proposed position the company be informed that such box shall be used exclusively for the company's purposes under the Camberwell Electric Lighting Order, 1896.

Gainsborough.—The Gainsborough Urban Council last week considered three schemes submitted by Mr. Parker, the Council's engineer, for placing a refuse destructor on the land which has been secured on the Trent bank for this purpose, and also for providing for future requirements in the matters of sewage treatment and electricity. The first scheme, estimated to cost £4,250, was the one chiefly discussed. It proposed to commence with two cells, each capable of dealing with 10 tons of refuse every 18 hours, which, it was estimated, would be sufficient to meet all requirements during the next 10 years. There was not much difference in the cost of the three schemes, but that described was adopted, and it was decided to at once invite tenders.

Electricity in Mining.—At the annual meeting of the New Hillgrove Proprietary Mines the chairman stated that the company's engineer has for some time had under consideration the question of an electrical installation, and on his recommendation the Board had authorised the construction of a transmission line from the Styx River, a distance of about 19 miles from the mine. Every effort was being made to get the installation completed and the production of electric energy for power purposes available at the mine at the earliest possible date. They were assured that the water supply from the Styx River, even at a record dry summer, is more than sufficient to generate all power that will be required for the company's purposes.

Middlesbrough.—A coroner's inquest was held last week into the circumstances attending the death of a workman who had been killed whilst working in an electrical power station at Messrs. Samuelson and Co.'s ironworks. An electrical fitter, in his evidence, said he pointed out to deceased the "live" and "dead" switches, and warned him of the danger of touching any "live" switch. Deceased was left to cement a tube, and, after finishing, he started to paint the "dead" switches, which he was not ordered to do, and accidentally touching a "live" switch he received a shock. Medical evidence showed that death was due to electrocution, and a verdict to that effect was returned, with the rider that no one was to blame for the occurrence.

Canada.—Mr. T. Moran, of Arnprior, has secured a franchise to develop water power at Galetta, and will supply light and power. The Dominion Power and Transmission Co., of Ontario, intend building a third transmission line from De Cew Falls to Hamilton to supply Toronto, Hamilton, Niagara Falls, and Brantford, and other towns in this vicinity. The British Columbia Power and Electric Co., of Port Moody, B.C., and the Port Haney Lumber Co., Port Haney, B.C., have been given permission to develop water powers. The Stave Lake Power Co.'s original scheme, which was to supply power to Vancouver only, has been greatly extended. Power is to be supplied to the Great Northern Railway between Vancouver and Seattle, and it will be used for industrial purposes in Washington.

Manufacturers' Lists.—Messrs. J. H. Heathman and Co., Parson's Green, Fulham, S.W., are sending out a price-list and catalogue of their self-supporting steps and extending ladder combined, and other of their noted specialities. This well-known firm of fire-protection engineers are also sending out a list of precautions against fire, together with a number of useful regulations which should be observed when a fire occurs. Both the price-list and the list of regulations should be in the possession of every engineer.—Messrs. Monte Callow and Co., of Ipswich, have sent us a catalogue of their "H. P." electric capstans for direct and alternating (one, two, and three phase) current.—"Matters of Moment" is the title of a little pamphlet which the Simplex Conduits, Limited, are sending out.

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Dudley.—Several matters relating to the electricity undertaking were discussed at the last meeting of the Town Council. Complaint was made that the balance on the undertaking was small, but the chairman of the committee contended that it was the duty of the Corporation to supply the electricity at the lowest possible rate, and not, as some appeared to think, to make a large profit. If the average selling price at Dudley were increased by only one farthing per unit, it would make a difference in the income of about £2,000. He alluded to the heavy rate of interest on the bank overdraft, amounting to £966, due to the outlay in obtaining the sanction of the Local Government Board for further loans. He said that, although for the first time £100 had had to be set apart for depreciation of motors let out on hire, the total increase in expenditure was more than counterbalanced by an increase in the income of £636, leaving as a result an increase in the gross profit of £145.

Sunderland.—An inquiry was held on Tuesday by Mr. H. R. Hooper, M.I.C.E., of the Local Government Board, into an application by the Sunderland Corporation for sanction to borrow sums amounting to £58,967 for the purpose of their electricity undertaking, and the further sum of £11,500 in respect of the provision of quarter sessions and police court buildings, fire brigade station, etc. The electricity extensions referred to consist of the installation of four Babcock and Wilcox boilers, with superheaters, each arranged to evaporate 25,000lb. of water per hour; Green's economiser, Hall's compound pumps, Babcock coal and ash conveyor plant, and coal bunkers; one 2,000-kw. normal rating Willans-Dick-Kerr turbo-alternator for generating three phase current at 5,000 volts. This will work in conjunction with a Klein barometric condenser, extensions to the extra high-tension switchgear, additional buildings, together with a provisional sum for mains extensions generally.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to Shawinigan Water and Power Co.'s scrip (fully and partly paid) for £200,000 4½ per cent. perpetual consolidated mortgage debenture stock. The committee has also been asked to appoint a special settling day in Electric Traction Co. of Hong Kong 325,000 shares of £1 each, fully paid, Nos. 1 to 325,000; Highlands and Lowlands Para Rubber Co.'s 181,464 vendors' shares of £1 each, fully paid, Nos. 8 to 181,461, and 60,000 vendors' shares of £1 each, 7s. 6d. paid, Nos. 181,462 to 241,461; Pena Copper Mines further issue of 114,600 shares of £1 each, fully paid, Nos. 400,001 to 514,600. The committee has further been asked to allow the following securities to be quoted in the official list: Kent Electric Power Co.'s 75,000 4½ per cent. irrodeemable debenture stock (special application); British Aluminium Co.'s 2,000 additional ordinary shares of £5 each, fully paid, Nos. 1 to 2,000.

Hammersmith.—For some time past the Council have been in communication with Mr. Mulholland, the proprietor of the King's Theatre, with reference to an action in dispute as to the supply of electricity to the theatre. It has now been arranged that the present agreement with Mr. Mulholland be given up and a new agreement be entered into for the supply of both alternating and continuous current for a period of four years from July 1, 1907, at the price of 2d. per unit. The Electricity Committee, taking advantage of the high price of copper, have obtained tenders as follows for the purchase from the Council of about 30cwt. of scrap copper, cable ends, etc., which were in stock—viz., Messrs. White, Jacoby, and Co., £82 per ton, delivered at works; Mr. J. Read, £94 per ton, delivered at works; Messrs. Pearce, Brownsmith, and Co., £95 per ton delivered at works; British Insulated and Helsby Cables, £96. 10s. per ton delivered at Prescot. They recommend that the copper be sold to Mr. J. Read at the above rate.

Battersea.—The assessor has fixed the fees to be charged by the Thames Conservancy Board in respect of suction and discharge pipes in the River Thames, used in connection with the water-condensing plant at the central electric generating station, at £50 per annum as from Sept. 29, 1907, until 1911. It has been decided to extend the electric mains from a point in Queen's-road to the Longhedge Railway Works, Silverthorne-road, at an estimated cost of £140. The Electricity Committee are recommending the immediate carrying out of the necessary alterations in connection with the coal-conveying plant at an estimated cost of £150. The electrical engineer originally proposed to replace the elevator by a jib crane, fitted with grab feeding by means of a hopper to the conveyor, and strengthening the gantry, and to alter the present tray of the conveyor in the coal store to one having tipping trays discharging the whole of the coal where the trays tipped, at an estimated cost of £790, but the committee did not see their way to consent to this at present.

Sutton Coldfield.—The annual report on the working of the electric lighting department has just been issued by the engineer, Mr. Trevor Ducsbury. The consumers show an increase of 38 on the year. The total number of units sold was 322,901, as against 292,427 last year. The increase of 30,474 units compares with an increase of 37,390 in 1906, and of the total output 109,864 units were sold for public lighting and 213,037 for private supply. The last-named produced £3,642, as against £3,089 the previous year. The revenue derived from public lighting was £807, or, deducting from this the cost of labour, supervision, maintenance, and renewals, the actual amount was £592. The cost of production, including generation, distribution, rates, taxes, management expenses, etc., was 1·43d., as against 1·62d. in 1906, and 2·18d. in 1903. The gross profit on the year was £2,518, as against £1,824 last year, and £472 in 1903. The capital expended during the past year was £950, bringing the total up to £40,104, of which £5,134 has been repaid.

Hereford.—The Electric Light Committee's report shows the financial results of the year's working as compared with 1905-6 to be as follows: 1906-7, surplus after paying interest £1,444. 12s., repayment of principal £1,079. 8s. 3d., surplus towards rates £365. 3s. 9d.; 1905-6, surplus profits £1,058. 4s. 2d., repayment of principal £1,050, surplus towards rates £8. 4s. 2d. The financial results for the year ended March 25, 1907, were: total units sold 214,621, as compared with 178,583 for the previous year. Income—receipts for current £3,704. 3s. 9d., meter rents £177. 7s. 2d., charging batteries £43. 6s., premiums for pupils £157. 10s., fittings, lamps, etc., sold and supplied to other departments £143. 5s. 11d., sundries £4. 14s. 5d.—£4,230. 7s. 3d.; less discounts and allowances, £157. 15s. 7d.—total, £4,072. 11s. 8d. The expenditure included: wages, salaries, oil, stores, coal, repairs, taxes, moiety of pupils' premiums paid to engineer, etc., £1,860. 4s. 7d.; interest, £767. 15s. 1d.; repayment of principal, £1,079. 8s. 3d.; surplus profit for the year, £365. 3s. 9d. The estimate of income and expenditure on the electric light works for the current year is as follows: estimated income, £4,069; estimated expenditure, £3,865; estimated surplus revenue, £204.

Pendlebury Spinning Mill.—At the invitation of the directors of the Acme Cotton Spinning Co. last week a large party of members of the Lancashire section of the British Association of Managers of Textile Works visited the firm's mill at Pendlebury. The chief interest lay in the electrical motive power, which was explained by Mr. C. D. Taite, the manager of the Lancashire Electric Power Co. Current is obtained from the company's generating station at a sub-station in the building, and the voltage reduced from 10,000 to 400 by means of transformers. Throughout the mill the power is distributed, in each instance being controlled separately on each shafting by an independent motor. An exhibition was given of the ease and rapidity with which full power can be obtained. One thing noted in the mill was the lightness of the shaftings and the flexible couplings to the electrical motors. In the transformation of the current 98 per cent. of efficiency is obtained, Mr. C. D. Taite said, the 2 per cent. being loss. A centrifugal pump electrically controlled, stated to be the only one of its kind erected in the country to maintain fire-sprinklers, had proved admirable under stringent fire insurance tests. The question of electrical *v.* steam driving was mentioned, but no information as to the cost of the electrical running was given.

Morley.—The borough electrical engineer (Mr. J. E. Ellis) reports that the output from the electricity works for the month of April was 12,554 units, as compared with 8,005 units the same month last year, being an increase of 4,549 units. The quantity sold to consumers by meter was 11,647 units, as compared with 5,561 the same month last year, being an increase of 6,086. There were now 29 motors connected, with an aggregate of 94 h.p. The following additional report has also been presented by Mr. Ellis: "I am pleased to report that we have had during the past two months a 6-h.p. motor coupled up and driving a milling machine at the Quarry Mills. Although the motor is rather too large for its work, they have no difficulty in getting on to the ½d. scale of charges. At this rate the cost per hour when they are milling their heaviest pieces works out at 1·94d. per hour. I feel confident that a 10-h.p. motor would drive two milling machines without any difficulty. Arrangements have been made between the owners of Quarry Mills and Messrs. E. Brook, of Huddersfield, motor makers, to supply a 15-h.p. motor to drive a rag-grinding machine on a three months' trial. As this will not incur any expense on the Corporation, I have given them permission to proceed with the work. Of course, it is understood that all current used is to be paid for at the ordinary rates."

Industrial and Business Exhibition.—The exhibition now being held at Olympia is the first of its kind in this country. It is well worth a visit from those responsible for the commercial management of electrical undertakings, whether manufacturing or for the supply of electricity. Every refinement in the furnishing of offices can be inspected, but in the present state of trade more attention will, perhaps, be paid to the facilities for keeping records and for book-keeping. The machines of the Elliott-Fisher Co. for writing invoices and simultaneously entering the same in the ledger, writing the order, shipping, and forwarding records, and addressing the envelope are time and labour saving. A further refinement to one of these machines adds up the items on the invoice at the same time that they are typed. A good part of the exhibits deal with advertising, and amongst these electricity plays a prominent part. There are not so many electrical firms represented as we had expected, but Messrs. Armstrong, Power, and Co., of 118-122, Holborn, have a splendid show of advertising signs. These are shown in a darkened room, which enables the full advantage of this form of advertising to be appreciated. The flash signs made by this firm are artistic and effective. Messrs. C. Larkins and Co., of Bush-lane House, have a general electrical exhibit. On their stand many types of electric lamps are on view, and there is a good display of Linolite and Tubolite fittings. The telewriters distributed about the exhibition are shown writing messages from an operator in the gallery. The instrument is evidently a development of the "telautograph," which has been described several times in our columns. The "telewriter" messages, while proving that handwriting could be accurately transmitted, did not flatter the writer. The dictaphone is another old friend reappearing under a new name. At this stand a number of phonographs are shown with special adaptations for taking down correspondence, etc. The cylinders are driven through a clutch which can be released by the foot pressing a rubber ball. This device allows for the necessary intervals in dictation without wasting a portion of the wax cylinder. After the letters have been taken off by the typist the wax cylinders are shaved to remove the record, and can then be used again. The Synchronome Co. have a good exhibit of their standard time clocks, which are driven from two master clocks on the same stand. The list shown of the users of this system indicates that the advantage of having uniform time throughout large works or buildings is greatly appreciated. Dey time recorders, which are used at so many engineering works, are also well represented.

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Leyton.—An inquiry was held by Mr. R. H. Bicknell, C.E., on Tuesday into an application by the District Council for permission to borrow the sum of £5,770 for their electricity undertaking. Objection was made by the inspector to the wages of permanent officials being paid out of loan for special work. A sum of £3,000 of the amount asked for was for the purposes of mains and cable junctions, and Mr. Lewis, the engineer, declared that a large part of the money would be absorbed in wages, which it was intended to pay out of the loan. The inspector said that where men were specially employed in laying the mains their wages could properly be apportioned out of the loan, but if permanent officials were to be engaged on the work then their wages must come out of revenue. Mr. Lewis replied that in the case of men who laid "services" their work was of a continuous character, and they came under the category of permanent servants. The clerk said it appeared to him that if the work was advertised and carried out by a contractor the wages could come out of the loan, but if the work were carried out by the permanent staff of the Council their wages must come out of revenue. The only way out of the difficulty was for those who were used to the work to be discharged and re-engaged for the special work, and after its completion reappointed to the staff again. The clerk added that he could not see why the Local Government Board could not obviate such a formula.

Dunfermline.—There was circulated among the members of Dunfermline Town Council on Saturday a report prepared by Mr. Matthew Buchan, Rutland-square, Edinburgh, who was employed by the Corporation to advise as to whether it would be better to generate electricity or to purchase it in bulk from the Fife Electric Power Co. Mr. Buchan's conclusion is that the requirements of the individual cannot be satisfactorily met by a service obtained from the Fife Power Co.'s power mains without the individual resorting to the use of a motor-generator or converter. If the Corporation are to have a satisfactory supply of electricity for lighting purposes in the burgh, they must either take the current in bulk from the company, convert it in a sub-station, and distribute it as direct current over their own mains, or generate the current themselves by means of steam or gas and distribute it over their own mains in exactly the same way. To a certain extent the improved supply would assist the Corporation in obtaining a higher unit rate, but unless they could get the company to withdraw their active opposition for both lighting and power there is, he fears, no hope of their ever successfully fighting against the company. He thinks it is of vital importance that a state of harmony should exist between the Corporation and the company, and a friendly working agreement be entered into, and this, so far as he foresees, can only be obtained by taking a supply in bulk from the company. By so doing substantially less capital expenditure would be involved, and the best financial results would be obtained.

PROVISIONAL PATENTS, 1907.

JULY 1.

15079. Improvements in electrical heating apparatus for use in applying heat to liquids or substances in heating water and in boiling, cooking, sterilising, and other operations, and for heating smoothing irons, and for other purposes. Walter Scott Adlard, 18, St. Ann-street, Manchester.

15100. Improvements in or relating to electric clocks and the like. Arthur Charles Stray, 111, Hatton-garden, London. (Complete specification.)

15136. Improved contact-breaker for electrical ignition apparatus for internal-combustion engines. Robert Bosch, Birkbeck Bank-chambers, Southampton-buildings, London. (Complete specification.)

15147. Improvements in primary galvanic batteries. William Thompson, 6, Lord-street, Liverpool.

15151. Improvements in or connected with dynamo-electric machines of the neutralised conduction type. Valere Alfred Fynn, 70, Chancery-lane, London.

15156. New or improved method of and means for electrically transmitting images and rendering them distinctly visible. Robert Thorn Haines, Chancery-lane Station-chambers, London.

15169. Improvements relating to combined telegraph and telephone apparatus. William Kennedy Laurie Dickson, 18, Southampton-buildings, London. (Complete specification.)

15171. Improvements in methods of insulating sheet metal and other electric conductors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

JULY 2.

15219. Improvements in and connected with the driving gear of electric tramcars. Vittoria Giovanni Lironi, 18, Southampton-buildings, London. (Complete specification.)

15234. Improvements relating to electrical signalling apparatus for use with guns. Arthur Trevor Dawson and George Thomas Buckham, 7, Southampton-buildings, London.

15262. Improvements in controlling mechanism for electric circuits. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

JULY 3.

15288. Improvements in electric hoists. Hans von Kramer, 41, Newbridge-hill, Lower Weston, Bath.

15290. Appliance for rapidly making and breaking an electrical circuit automatically, and preventing it being made and broken slowly or left in an intermediate position. John Stevenson, 6, Marlborough-gardens, Cathcart, Glasgow.

15291. Improvements in electrical signalling apparatus for railways. James Rushworth Halliwell, 5, John Dalton-street, Manchester.

15302. Improvements in starting devices for alternating-current electric motors. August Eckstein, Arthur Cecil Heap, and David Barclay Mellis, Waverley Mills, St. Simon-street, Salford.

15335. Improvements in equalising devices for alternating-current circuits. John Sedgwick Peck, Westinghouse Building, Norfolk-street, Strand, London.

15338. Improvement relating to electrodes for searchlights. Gebrüder Siemens und Co., Birkbeck Bank-chambers, Chancery-lane, London. (Date applied for under Patents Act, 1901, Dec. 17, 1906, being date of application in Germany.) (Complete specification.)

15357. New or improved method of and means for electrically transmitting images, pictures, and like representations, and reproducing same. Robert Thorn Haines, Chancery-lane Station-chambers, London.

15363. Improvements in electrically-driven pulley blocks. Alfred August Conradin Gere, Southampton-buildings, London. (Complete specification.)

15367. Improvements in and relating to methods of producing refractory electric conductors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

JULY 4.

15394. Improved wall-box for electric switches. George Ernest Frederick Finch, "Wroxton," Rowan-road, Bexleyheath, Kent.

15412. Improvements in receivers for wireless telegraphy. Louis Heathcote Walter, 92, Victoria-street, London.

15418. Improvement in current distributing systems. Siemens-Schuckert-Werke G. m. b. H., York Mansion, York-street, Westminster, London. (Date applied for under Patents Act, 1901, July 5, 1906, being date of application in Germany.) (Complete specification.)

15441. Improvements in or relating to voltage regulators. Frank Conrad, Westinghouse Building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, July 9, 1906, being date of application in United States.) (Complete specification.)

15442. Improvements in or relating to voltage regulators. Frank Conrad, Westinghouse Building, Norfolk-street, Strand, London. Date applied for under Patents Act, 1901, July 9, 1906, being date of application in United States.) (Complete specification.)

15450. Improvements in and relating to electric telegraphy. Alexander Muirhead, 323, High Holborn, London.

15451. Improvements in and relating to the manufacture of refractory electrical conductors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

15452. Improvements in and relating to dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

15453. Improvements in and relating to single-phase electric motors. Marius Latour, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, July 5, 1906, being date of application in France.) (Complete specification.)

JULY 5.

15505. Folding electric light bath cabinet. Carl Magnus Holmquist, 52, Regent-street, London.

15510. Improved process for the manufacture of illuminating bodies for electric incandescence lamps. Deutsche Gasglühlicht Akt.-Ges. (Auergesellschaft), 55, Chancery-lane, London. (Date applied for under Patents Act, 1901, July 11, 1906, being date of application in Germany. (Complete specification.)

15514. Improvements in signalling and electric searchlight apparatus. Sherard Osborn Cowper-Coles, 82, Victoria-street, Westminster, London.

15515. Improvements in electrical conductors and resistances. Sherard Osborn Cowper-Coles, 82, Victoria-street, Westminster, London.

15522. Improved means for operating gas taps, electric light switches, and the like. John Nevil Maskelyne, 6, Breams-buildings, Chancery-lane, London.

15532. Improved telegraph or signalling system and apparatus. Philip Middleton Justice, 55, Chancery-lane, London. (Sub-Target Company, United States. (Complete specification.)

15549. Improvements in and relating to alternating-current dynamo-electric machines. The British Thomson-Houston Company, Limited, and Frederic Horton Clough 83, Cannon-street, London.

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15551. Improvements in electricity meters for use with alternating currents. Herbert John Haddan, 31, Bedford-street, Strand, London. (Bergmann Elektricitäts Werke Aktiengesellschaft, Germany.) (Complete specification.)

JULY 6.

15579. Improvements in boxes, cells, or electrolyte containers for electric accumulators and the like. Bryan Cookson, 11, Southampton-buildings, London.

15580. Improvements in apparatus for use in cleaning the interior of accumulater cells and for like purposes. Bryan Cookson, 11, Southampton-buildings, London.

15594. Improved armature for magneto-induction machines. George Cecil Dymond, 6, Lord-street, Liverpool. (Ernst Eisemann und Co., Germany.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on July 25.)

1906.

7920. Dynamo-electric machines. Johnson. (Felten und Guilleaume Lahmeyerwerke Akt.-Ges.)

8039. Continuous electrolysis. Rambaldini. (Date applied for under International Convention, April 3, 1905.)

10218. Party-line telephone systems. Roberts. (Date applied for under International Convention, May 1, 1905.)

14809. Electric arc lamps. Davy.

14922. Electrolytic diaphragms. Roberts.

15178. Electrical connections of motor road vehicles having electro-mechanical propulsion. Pieper.

15180. Electro-mechanically propelled vehicles having electric storage. Pieper.

15499. Electric vulcanising apparatus. Binko and Phœnix Electric Heating Company.

15988. Regulation of electric currents subject to large fluctuations of load. Tilney.

16342. Magnetic control appliances. Stothert and Pitt, Limited, and Heath.

17617. Process for the rapid production of electrotypes. Cowper-Coles.

17946. Rotatory bar electrical ignition for internal-combustion engines. George Anderson and Co. (1905), Limited, and Ross.

18156. Means for the regulation of electrical machines. Johnson. (Felten und Guilleaume Lahmeyerwerke Akt.-Ges.)

18279. Electric railway systems. British Thomson-Houston Company. (Kintner.)

18343. Cores of dynamo-electric machines, transformers, and the like, having ventilating spaces therein. Mavor, and Mavor and Coulson, Limited.

18889. Electric switches for telephones. Weman.

20395. Electric transformers and the like. British Thomson-Houston Company. (General Electric Company.)

21002. Dynamo-electric machines. Noeggerath. (Date applied for under International Convention, Sept. 22, 1905.)

21053. Electric switches. Hirst and Harrison.

21391. Wall connections and the like for electric lighting, heating, and power purposes. Lundberg, Lundberg, and Lundberg.

22132. Electrical cells. Gersabeck.

22625. Dynamo-electric machines. British Thomson-Houston Company. (General Electric Company.)

22795. Electric current collecting devices for railway or other vehicles. British Thomson-Houston Company. (General Electric Company.)

23413. Active materials for electric accumulators. Leitner.

23427. Electric lighting devices for theatres and the like. Thompson. (Firm of Schwabe und Co.)

24270. Electric vent sealing tubes or primers. King's Norton Metal Company, Bayliss, and Smith.

29394. Electric arc lamps. Jaburg.

29498. Friction couplings or clutches. Felten und Guilleaume Lahmeyerwerke Akt.-Ges. (Date applied for under International Convention, Jan. 26, 1906.)

1907.

210. Apparatus for magnetic separation of ore. Metallurgiska Patentaktiebolaget. (Date applied for under International Convention, Jan. 9, 1906.)

1082. Electrical bell-ringing apparatus. Fluckinger.

2377. Process of improving the magnetic qualities of a magnetic body. Hadfield. (Date applied for under International Convention, July 5, 1906.)

3008. Guards or fenders for electric tramcars. Lhotta, Lhotta, and Lhotta.

4045. Compensating or commutation poles of dynamo-electric machines. Felten und Lahmeyerwerke Akt.-Ges. (Date applied for under International Convention, Feb. 17, 1906.)

5654. Cooling or ventilating of alternating electric current transformers. Berry.

7033. Locking device for magneto-electric machines for igniting purposes. Unterberg and Helmle.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	–	½-⅝
—— Ord., 1 125,000	1	..	½-¼
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	⅝-¾
British Aluminium Co, Ordinary, 2,001-40,000	5	..	5-5½
—— 7 per cent. Cum. Pref., 1-40,000	5	..	5¼-5¾
—— "A" 6 per cent. Cum. Pref., 1-20,000	5	..	5¼-5¾
—— 4 per cent. Funding Certificates, 1-20,000	5	..	3¾ 4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	100-103
—— 5½ per cent Loch Leven Deb (Reg.), Red., 1-3,000	100	..	98-101
British Insulated and Helsby Cables, Ord., 1-100,000	5	–	6¼-6¾
—— 6 per cent. Cum. Pref., 1-100,000	5	–	6¾-6¾
—— 4½ per cent. Mortgage Debentures	100	–	101-104 xd
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	–	81-83
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	5	..	1-1½
—— 4 per cent. Mortgage Debenture Stock	100	..	55 60 xd
Brush Electrical Engineering, Ordinary, Nos. 1-106,731	2	..	½-¾
—— Non. Cum., 6 per cent. Pref.	2	..	¾-1¼
—— 4½ per cent. 1st Debenture Stock	100	..	88-91
—— 4½ per cent. 2nd Debenture Stock	100	..	75-78
Callender's Cable, Debentures	100	..	105½-107½ xd
—— Ordinary	5	–	9½-10½
—— 5 per cent. Pref.	5	..	5 3 5 5⅝ xd
Consolidated Electrical Co., Ordinary, 1-110,000	1	..	7/16-9/16
Crompton and Co.	5	..	1 1⅛-1⅜ 1/16
—— 5 per cent. Debentures	100	–	96 99
Dick, Kerr, and Co., Ordinary, 1 260,000	1	..	1⅛-1⅜
—— 6 per cent. Cum. Pref., 1-305,000	1	..	1-1½
—— 4½ per cent. Debenture Stock, Red.	100	..	100-105 xd
Edison and Swan United, "A" Shares, 1-99,261	5	–	1⅛-1⅜
—— "A" Shares, 01-017,139	5	–	2¼-2⅝
—— 5 per cent. Debentures	100	–	84-92
—— 4 per cent. Deb. Stock, Red.	100	–	83 85 xd
Electric Construction, Nos. 1 to 112,100	2	–	¾-⅞
—— 7 per cent. Cumulative Pref.	2	–	1¼ 1⅜
—— 4 per cent. Perp. 1st Mort Deb.	100	–	78 83
Electrolytic Alkali Co., Ordinary, 1-202,218	1	..	¾-⅞
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	—
General Electric Company (1900), 5 per cent. Cum. Pref.	10	–	8-8½ xd
—— 4 per cent. 1st Mort. Deb. Stock	100	–	92 95
W. T. Henley's Telegraph Works, Ordinary	5	–	11½-12½
—— 4½ per cent. Preference	5	–	5-5½
—— 4½ per cent. Debentures	100	–	105½ 107½
India Rubber, Gutta Percha, and Telegraph Works	10	–	14 15
—— 4 per cent. Debentures	100	–	97-99
National Electric Construction Co., 1-170,000	1	..	27/32-31/32
Parker, Thos., Limited, Ordinary	10	–	10-10¼
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5	..	3¾-4¼
Telegraph Construction and Maintenance	10	–	31-33
—— 5 per cent. Bonds	100	–	99-102 xd
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	..	9½ 10

Electric Lighting and Supply.—

Name.	Amount paid.		Last price
	£		£
Adelaide Electric Supply Co., 6 p. c. Cum. Pref., 1-10,000		..	4¾-5
Bournemouth and Poole, Ordinary	10	–	10 1
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	–	9¾ 10¼
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	–	10¼ 0¾
—— 4½ per cent. Debenture Stock, Red.	100	–	99-102 xd
Bromley (Kent) Electric Light and Power Co.	5	–	4¾ ¼
—— 4½ per cent. 1st Debenture Stock, Red.	100	–	98 100
Brompton and Kensington, Ordinary	5	–	7¾ 8¾
—— 7 per cent. Preference	5	–	7½ 8½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	–	6¾-7¾
—— Nos. 80,001-100,000	4	–	6¼ 7¼
Cambridge Electric Supply Company, £10 Ord.	8	–	1 1-16
Canadian General Electric Co., Common Shares	$100	..	120-125 xd
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	–	99 102
Charing Cross, West End, and City Electric Supply, Ord., 1-81,000	5	–	3 4
—— 4½ per cent. Cum. Pref., 1-80,000	5	–	3¼ 4¼
—— 4 per cent. Debenture Stock, Red.	100	–	96-98
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	3¾ 4¼ xd
—— ditto (1903) 40,001-80,000	5	..	3¾-4¼
Chelsea Electricity Supply	5	–	3¼ 4¼
—— 4½ per cent. Debentures	100	..	101 104 xd
Chicago Edison Co., 1st Mt. 5 p. c. 30-yr. Gld. Bds., Red., 1-1,200	$1000	..	98-101
City of London, Ordinary	10	–	9-10
—— 6 per cent. Cumulative Pref.	10	–	11½-12½
—— 5 per cent. Debenture Stock	100	–	120½ 123¼ x i
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	–	95 98 x i
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1,631	50	–	50 53 xd
Cordoba Light and Power Co., 1st Mt Stl. 5 per cent Bds., Red., 1-1,000	100	–	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-70,000	5	–	4¼-5
—— 5 per cent. Preference, 1 50,000	5	–	4¼-5
County of London Electric Supply, Ordinary	10	–	7¾ 8¼
—— 6 per cent. Cum. Pref.	10	–	10½ 11½
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100	–	106 109 x i
—— 4½ per cent. 2nd Debentures Prov. Certs	100	–	93-95
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5	–	¼-1
—— 6 per cent. Cum. Pref.	5	–	1-2
—— 4½ per cent First Mort. Deb	100	–	78 83
Electrical Development Co of Ontario, 5 per cent 1st Mort. 30-year Gold Bonds, 10,751-16,75	—	–	79-81 p.c.
Electric Lt & Traction Co of Aust., 6 p c Cm Pf 1 30,000	5	–	8¼ 2⅜
5 per cent Debenture Stock Red	100	–	85½ 89½ xd
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red	100	–	91½ 95½ xd
Folkestone Electric Supply, Ord. Nos. 1-10,000	5	–	4¼-4⅝
—— 4½ per cent. First Deb. Stock, Red.	100	–	98 101
Hove Electric Lighting, Ord., 1-13,000	5	–	6¾-7¼
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100	–	103-106 xd
Isle of Wight Elec. Lt. and Pwr., 4½ p. c. Deb. Stk. Red.	100	–	94-97
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	–	25/32-29/32
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5	–	8¼-8½
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	–	96-99
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9¾-10¼
London Electric, Ordinary	5	–	1¾-2¼
—— 6 per cent. Pref.	5	–	4¾-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	–	93-96

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Name.	Amount paid. £	Last price £
Madras Electric Supply Corporation, 5 per cent. Construction Deb. Stock., Red. (Prov. Certs.), all paid	— ..	94-97
Metropolitan Ordinary, 100,001-300,000	5 —	5⅜ 6⅜
—— 4½ per cent. First Mortgage Debenture Stock	100 —	103 107 xd
—— 4½ per cent. Cum. Pref.	5 —	4½ 5¼ xd
—— 3½ per cent. Mortgage Debenture, Red.	100 —	86 91 xd
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds., 1935, C 1-1,000 ($100), D 1-5,000 ($500), M 1-4,400 ($1,000)	— ..	74½ 76 p c xd
Mexican Light and Power Co., Capital Stock	$100 ..	46 48
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14,000 ($1,000)	— ..	84 86
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	— —	95-98
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,000	5 ..	7⅛ 7⅜
—— do., 57,001-75,000	5 ..	7¼-7⅜
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid)	4 —	5-5½
—— 5 per cent. Pref., 1-57,000	5 ..	5 5⅛
—— do., 75,001-87,500 (issued at 10s. prem., 4s. paid)	4 ..	4-4¼
Notting Hill Electric Lighting	10 —	12 13
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100 —	96 99
Oxford Electric, Ordinary, 1-96 and 40-14,310	5 ..	5⅜ 5¾
—— 4 per cent. Debenture Stock	100 —	96 98
River Plate Electricity Co., Ord., 1-119,687 & 120,501-120,507	1 ..	⅞-1
—— 6 per cent. Non-Cum. Pref., 1-100,000	1 ..	⅞-1
—— 4 per cent. Debenture Stock, Red.	100 ..	95-98 xd
Rosario Electric Co., 6 per cent Cum Pref., 1-20,000	5 ..	5-5½
—— 6 per cent. Cum. 2nd Pref., 1-15,000	4 .	5-5½
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 —	96 98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	— ..	99 101 p.c. xd
Smithfield Markets Electric Supply, Ord. 1-12,000	5 —	1-2
—— 4 per cent. Debenture Stock	100 —	73-77
South London, Ordinary	5 —	1⅜ 1¾
South Metropolitan Electric Light and Power, Ord.	1 —	⅞ ⅞
—— 7 per cent. Cum. Pref.	1 —	1⅛-1⅜
—— 4½ per cent. 1st Mort. Deb.	100 —	100-103
St. James's and Pall Mall, Ordinary, 101-20,080	5 —	8 9
—— 7 per cent. Pref.	5 —	6½ 7½
—— 3½ per cent. Deb.	100 —	86 91 x d
Urban Electric Supply Co., Ordinary, 8-30,007	5 —	1-2
—— 5 per cent. Cumulative Preference, 50,001-80,000	5 —	2 3
Westminster, Ordinary	5 —	9 10
—— 4½ per cent. Cum. Pref., 110,101-138,251	5 —	5⅛-5⅝ x d

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine, 5½ per cent. Cum. Pref., 1-260,007	5 —	6 6⅛ x d
—— Ord.	5 —	8 8½
—— Permanent 6 per cent. Debenture Stock, 1888	100 —	131 134 x d
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100 —	102-105 xd
Barcelona Tramways, Ord., 1-20,000	10 —	—
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10 —	—
—— 5 per cent. Deb., Red., 1-600	100 —	—
—— 4½ per cent. Red. Deb. Stock	100 —	—
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1 ..	⅜ ⅞
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1 —	27/32-31/32 xd
Birmingham and Midland Trams., 4½ p c. 1st Db. Stk., Red.	100 ..	94-97 x d
Blackpool and Fleetwood Tramroad	10 ..	13⅜ 15⅜
Bombay Elec. Supply & Trams. Co., 6 per cent. Cum. Pref.	8 ..	7½-8⅛
—— 4½ per cent. Deb Stock, Red.	100 ..	96-97 xd
Brisbane Tramway Invest., Ord., 1-75,000	5 —	2 15/16 3 3/16
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 —	4⅜ 5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 —	96 100 x d
British Columbia Electric Railway Co., Ord. Def.	100 —	120-125
—— Ord. Pref.	100 —	107 111
—— 5 per cent. Cum. Perpetual Pref. Stock	100 —	103 107
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 —	99-102
—— 4½ per cent. Vancouver Power Deb.	100 —	103 106
British Electric Traction, Ord. 1-300,000 & 60,001-80,000	10 —	2⅛ 2⅜
—— 6 per cent. Cm. Pf., 30,001-60,000	10 —	7 7⅛
—— 5 per cent. Perpetual Debenture Stock	100 —	103-106
—— 4½ per cent. 2nd Deb. Stock	100 —	78-81
Buenos Ayres and Belgrano Trams.	5 —	4 1/16 4 5/16
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 —	4⅜ 4⅝
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 —	4⅜ 4⅝
—— 5 per cent. Deb. Stock, Red.	100 —	105 108 xd
—— Prov. Cert., all paid	100 —	100 103 xd
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100 —	93 98 xd
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb. Bonds, Red., 1-1,500	100 ..	99-103 xd
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100 ..	100-105
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	93-98
Calcutta Tramways, 1-105,000	5 —	7¼-7⅜
—— 105,001-137,610	5 —	5⅛ 5⅜ xd
—— 4½ per cent. 1st Deb. Stock, Red.	100 —	102 106 x d
Cape Electric Tramways, Nos. 1-480,000	1 —	5/16-7/16
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5 —	4⅝ 5
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100 —	98 101
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5 ..	5⅛-5⅜
—— 4 per cent. Deb. Stock, Red. 1905	100 ..	95 99 xd
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	00 —	96-100
Cork Electric Tramway and Lighting Co., Ordinary	10 —	13⅛-1 ¼
—— 6 per cent. Cum. Pref.	10 —	13-14
—— 4 per cent. Debentures	100 —	99-100
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 —	13⅛- 4¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 —	13 14
—— 3½ per cent. Mort. Debs., 1-3,000 Red.	100 —	94-96
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100 ..	98-101
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6,957	$1,000 —	85-90
Imperial Tramways, Ordinary	all —	18-19
—— 6 per cent. Cum. Pref.	all —	14-14½
—— 4½ per cent. Deb. Stock	100 —	102-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5 —	1 1¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 —	66-71 xd
Kalgoorlie Electric Tramways, 1-250,000	1 ..	5/32- /32
—— 5 per cent. "A" Deb. Stock	100 ..	88-93
—— 6 per cent. "B" Deb. Stock	100 ..	78-82
Kidderminster and District Lighting and Traction, Pref.	5 —	3-5
Lancashire United Tramways Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100 —	93 96 xd
—— £296,500 2nd Mort. Deb. Stock	— —	—
—— £83,330 Deferred Deb. Stock (all fully paid)	— —	—
Lisbon Electric Tramways Limited, Ord., Nos. 1-594,188	1 ..	1 1/16-1 5/16 xd
—— 6 per cent. Cum. Pref., Nos. 1-425,553	1 .	1 1/16-1 3/16
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100 ..	95 93 xd
London United Trys. (1901), 5 per cent. Cum. Pref.	10 —	7⅛ 8⅜ xd
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 —	84 88 xd
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Rd.	100 —	96 99 xd

Name.	Amount paid. £	Last price. £
Manila Elec. R R. and Lghtg. Corp., 5 p c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4 635	$1,000 ..	93-95
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 23,436-25,000	5 ..	4⅜-5⅛
—— 4½ per cent. 1st Mort Deb. Stock, Red.	100 ..	97-100
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1 —	3/32 5/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1 —	27 32 31 32
—— 4½ per cent. Deb. Stock, Red.	100 —	84 87 xd
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	— ..	84-85 p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000 —	103 105
Montreal Street Rail., 4½ per cent. Sterling Deb., 601-2,000 (1922)	100 —	103-105
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5 —	⅜-½
Oldham, Ashton, and Hyde Tramway, Ordinary	10 —	12
—— 5 per cent. Cum. Pref.	10 —	8-9
Perth Elec. Tramways (W. Aus.), 5 per cent. 1 Mrt. Deb. Stk.	100 —	100 104 xd
Potteries Electric Traction, Ordinary, 1-245,000	1 —	⅜-½
—— 5 per cent. Cum. Pref., 300,001-545,000	1 —	⅜-½
—— 4½ per cent. Debenture Stock	100 —	95 98
Provincial Tramways Co., Ordinary, 1-24,912	10 —	4⅛-5¼ xd
— 6 per cent Cum. Pref., 1-10,000	10 ..	10¼ 11¼ xd
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-30,000	5 ..	5⅛-5⅜ xd
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	96½-98½ xd
Sao Paulo Tramway Light, and Power Co.	$100 ..	117-121 xd
—— 5 per cent. 1st Mort. Deb., Red 1929, 1-11,000	$500 ..	92-94 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1 ..	29 32-1 1/32
—— 4 per cent Deb. Stock, Red. 1940	100 ..	80 84 xd
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Deus, Red., 1-1,600	100 ..	84-88 xd
Yorkshire (West Riding) Elec. Tram Co., Ord., 70,001-110,000	5 ..	1-1⅛
—— 6 per cent. Cum. Pref., 246,261	5 ..	3⅛-3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	88-91 xd

Electric Railways.—

Name	Amount paid. £	Last price £
Central London, Ordinary	100 ..	73-75
—— 4 per cent. Pref.	100 —	92-94
—— " " deferred	100 ..	53-56
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)]	100 —	103-106
City and South London, Consolidated Ordinary	100 ...	47-49
—— 4 per cent. Debenture Stock	100	102-106
—— 5 per cent. Pref. Stock '91	100 —	117-121
—— " " " '95	100 —	115-118
—— " " " '01	100 —	1 0-113
Liverpool Overhead, 5 per cent. Pref.	10 —	10-10¼
—— Ordinary, 1 50,000	10 —	3⅜-4¼
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— —	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	— ...	62 65

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price. £
Amazon Telegraph Co., 1-25,000	10 ..	3-3½
—— 5 per cent. Debs., Red., within 1-1,069	100 ..	86-89 xd
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000	$1,000 ..	90-92 xd
Anglo-American Telegraph Co., Ordinary	100 ..	6⅛-6⅝
—— 6 per cent Preferred Ordinary	100 ...	10¼-10⅝
—— Deferred Ordinary	100 ...	21¼ 22⅛
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort Deb. Stock, Red.	100 ...	100-103
Chili Telephone Co., 1-44,000	5 ...	6⅛-7⅛
Commercial Cable Co., Ster. 500-year 4 p.c. Deb stk., Red.	100 ...	9⅜-9¾ xd
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10 ...	7⅜-8⅛
—— 10 per cent. Preference, 1-6,000	10 ...	15⅜-16⅜
Direct Spanish Telegraph Co., Ordinary	5 ...	3⅛-3⅜
—— 10 per cent Cum Preference	5 ...	8⅜-9⅛
—— 4½ per cent. Debs., 1-600	50 ...	98-101 xd
Direct United States Cable Co.	20 ...	15⅛-16⅛
Direct West India Cable Co., 4½ per cent. Debs., Reg. within 1-1,200, Red.	100 ...	98 100 xd
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100 ...	98-101
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8,000, 1913	25 ...	97-100
Eastern Extension, Australasia and China, 1-300,000	10 ...	12-13⅛
—— 4 per cent Mort. Deb. Stock, Perp.	100 ...	104-106
Eastern Telegraph Co., Ordinary Stock	100 ...	135-140
—— 3½ per cent. Preference Stock	100 ...	89-91
—— 4 per cent. Mortgage Debenture stock	100 ...	103-105
Great Northern Telegraph Co. (of Copenhagen)	10 ...	34-36
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1,200, Red.	100 ...	98-100 xd
Indo-European Telegraph Co.	25 ...	56-58
Marconi's Wireless Telegraph Co., 1-256,127	1 ...	⅛-¼
—— 256,128-384,190	1 ...	⅛-¼
Monte Video Telephone Co., Ordinary, 1-72,680	1 ..	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492	...	⅛-1
National Telephone, Preferred	100 ...	109-111
—— Deferred Stock	100 —	108-110
—— 6 per cent. Cum. First Pref.	10 —	11⅛-13⅛
—— 6 per cent. Cum. Second Pref.	10 —	10-12
—— 5 per cent. Non. Cum. Third Pref.	5 ..	5 7/16-5 11/16
—— 3½ per cent. Deb. Stock, Red.	100 —	84½-86½ xd
—— 4 per cent Deb. Stock, Red.	100 —	100½-102½ xd
Oriental Telephone and Electric Company	1 ..	1⅛-1⅜
— 6 per cent. Cum. Pref.	1 ..	1 3/16 1 5/16
Pacific and European Tel., 4 p c. Guar. Debs., Red., 1-1,000	100 ...	93-96 xd
United River Plate Tele. Co., Ordinary, 1-100,000	5 ...	6⅜-7⅛
—— 5 per cent. Cum. Pref., 1-40,000	5 ...	6-6⅛
—— 5 per cent. Debenture Stock, Red.	100 ...	—
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100 ...	98-101 xd
West African Telegraph Co.	10 ...	10-10½
West Coast of America, 1-30,000 and 53,001-53,003	2½ ...	14-14⅜
—— 4 p c. Debs., 1-1,500, Gua. by Western Telegraph	100 ...	97-100 xd
West India and Panama Telegraph Co., Ordinary	10 ...	⅛ ⅜
—— 6 per cent. Cum 1st Preference	10 ...	7⅛-7⅜
—— 6 per cent. Cum. 2nd Preference	10 ...	6⅛-7⅛
—— 5 per cent. Debs., Red., 1-800	100 ...	100-103 xd
Western Telegraph Co., 1-207 930	10 ...	13⅜-14⅛ xd
—— 4 per cent. Debenture Stock, Red.	100 ...	100-103 xd

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.							Cost per car mile.
	Ending	1907.	1906	Week.	Current year.	1907.	1906.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pass'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	July 3	1,571	1,474	+ 95	- 160	25½	25	May 31	64 071	15,530.351	1,379 723	0 93	11·14	2,512	6·45
Ayr Corporation	,, 6	351	412	- 61	—	8	8	,, 15	14,828	3,316,380	353,945	1	9·71	1,830	5 16
Baker Street and Waterloo Ry.	,, 6	2,783	1,446	+1,339	—	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 7	1,079	1,108	- 29	- 563	23 53	3·53	March 31	55,025	11,145,531	1,309 903	1·18	10 08	2,338	6·03
Birmingham Corporation	,, 6	6 056	—	—	—	56½	—	,, 31	17,133	4,709.738	266 526	86	14·5	8 855	—
Blackburn Corporation	,, 3	1,080	1,131	- 51	+ 580	21	21	,, 25	48,875	8,661,720	986 953	1·35	11 29	2,035	7·44
Blackpool Corporation	,, 4	1 409	1,303	+ 100	- 1,577	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	,, 6	885	950	- 65	- 289	16½	16½	Dec. 31	31,846	2,125,677	573,264	3·28	13 19	—	7·27
Bolton Corporation	,, 7	2 293	2,267	+ 26	+ 893	42	40	March 31	95 766	20,205 196	2,161,130	1·13	10 63	2.394	6·14
Bournemouth Corporation	,, 3	1,591	1,676	- 85	- 209	17·41	16·82	,, 31	55,276	10,058,288	1,121,623	1·32	11 83	3 226	7·19
Bradford Corporation	,, 6	4,691	4,709	- 18	- 337	95	95	,, 31	230,085	47,108,000	5,053,392	1·172	10 927	2,391	—
Brighton Corporation	,, 7	937	1,109	- 172	- 1,328	9½	9½	,, 31	50,339	11,321 160	1,152,828	1 06	10·48	2,914·8	8·0 4
Bristol Tramway Company	,, 5	5 122	5,612	- 490	—	51½	51½	Dec. 31	259,799	45,312,373	6 127,135	—	—	—	—
Burnley Corporation	,, 6	1,352	1 326	+ 26	—	40	40	March 31	57,942	11,092,704	1,197,772	1·31	11 61	5,388	8 17
Burton Corporation	,, 7	291	331	- 40	- 302	8½	8½	,, 31	17 950	3,878,269	454 082	1·07	9·21	2,0 8	6·76
Cardiff Corporation	—	—	—	—	—	32 62	† 32·26	,, 31	112,209	24,134,363	2,770 049	1·12	9 72	3,782	9 44
Carlisle Tramways Company	,, 6	251	273	- 22	- 372	8·5	8·5	Dec 31	10,713	2,935 002	359,756	—	7 14	—	5 18
Central London Railway	,, 6	5,816	6,131	- 295	—	6	6	,, 31	347,588	4,875,547	1,261,214	1 86	65·10	57,931	35 80
Charing X, Euston, & Hamp. Ry.	,, 6	2,660	—	—	—	8	—	—	—	—	—	—	—	—	—
City and South London Railway.	,, 7	3,260	2 470	+ 790	—	6½	6½	,, 31	—	—	—	—	—	—	—
Colchester Corporation	May 8	195	195	—	—	8	8	March 31	10,588	2 457,553	320,788	·97	7·47	1,401	6 12
Cork E. T. and L. Company	July 4	610	615	- 5	- 410	15½	15½	Dec 31	24,895	5,814.376	882,256	1 01	6 64	—	4 69
Darwen Corporation	June 14	268	261	+ 7	- 41	7 23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	July 6	242	304	- 62	- 428	4½	4½	,, 31	11,250	2,853,200	284,343	·94	9·43	2,500	—
Dublin and Lucan Electric Ry.	,, 5	75	97	- 22	— h	6¾	6¾	Dec 31	6,358	402,611	110,738	3·79	13·78	942	7·33
Dublin U.T.	,, 5	4,370	3,713	+ 657	—	48½	48½	,, 31	267,489	50,050,949	7 077,372	1·8	9·07	691	5 55
Dundee City Tramways	,, 3	1,145	1,087	+ 58	+ 375	22	22	May 15	60,154	13 086 396	1,005 911	·906	11·96	2,187	7·43
East Ham Corporation	,, 6	943	981	- 38	- 445	14	14	March 31	36,652	3,689,658	865,816	·61	10 18	2 94	6 70
Glasgow Corporation	,, 6	17,205	17,025	+ 180	- 2,738 h	79½	79½	May 31	756,490	195,767,519	17,945 595	—	10 12	—	—
Gloucester Corporation	,, 3	292	295	— 3	—	15	15	March 31	15,465	3,802,077	563,595	·50	6·58	939	5·32
G.N., Piccadilly, and Brompton	,, 6	4,440	—	—	—	9	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	37	37	,, 31	74 019	17,849,642	1,540 707	—	11 53	2,085	8·56
Huddersfield Corporation	,, 4	1 532	1,541	- 12	+ 699	35	35	,, 31	69,938	12 838,150	1,661,262	1·24	9 71	1,823	—
Hull Corporation	,, 6	2,478	2,334	+ 143	+ 1,879	26	26	,, 31	112,651	27,104,921	2,910,698	1	9 29	—	—
Ilford Corporation	—	—	—	—	—	10½	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 3	136	143	- 7	+ 140	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	11,586	3,626,656	419,800	·737	6 62	1 480	5·22
Lancashire United Tramways	,, 3	1,320	1,066	+ 254	+ 8,677	38½	28	—	—	—	—	—	—	—	—
Leeds Corporation	,, 6	6,960	6 896	+ 64	+ 3,698	83½	89½	March 25	298,233	64,223,666	7,121,038	1 10	10 02	351	—
Leicester Corporation	,, 6	2,192	2 325	- 132	—	42	42	Dec. 31	26,011	12 039,252	1,229,507	1	9·79	—	4 83
Liverpool Corporation	June 29	11,296	11,150	+ 106	+ 3,685	104	104	,, 31	547 625	116,642 663	12 166 419	—	—	—	—
Liverpool Overhead Railway	July 7	1,611	1,563	+ 48	— h	6·65	6 65	June 30	81,302	11,171,865	1,024 275	—	—	—	—
London County Council	June 29	31,596	25,248	+5,348	+58,504	98	88	—	—	—	—	—	—	—	—
Lowestoft Corporation	—	—	—	—	—	6	6	Sept. 30	14,511	3,128 857	359,435	1 08	9 68	2 630	6 48
Maidstone Corporation	—	—	—	—	—	2	2	March 31	4,740	850,121	112,227	1 33	10 13	2,370	—
Manchester Corporation	July 6	14,936	14,391	+ 545	+15,856	149	149	,, 31	631,956	125,900,875	14,123,124	1 19	10 73	4,299	6 99
Metropolitan District Railway	,, 7	8,214	8,110	+ 104	—	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 7	16,360	15,343	+1,017	—	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 6	123	168	- 43	—	2¾	2¾	,, 31	6.159	1,992,647	206,358	82	7 14	2.239	—
Newcastle-on-Tyne Corporation	,, 6	3,809	3,794	+ 15	+ 1,451	50	50	,, 31	197,849	43,06 ,934	4,326,152	1 07	10 98	3,957	7·0
Newport (Mon) Corporation	June 29	639	628	+ 11	+ 1,197	15½	15½	,, 31	30,356	7,252,535	783 435	—	9 23	—	6·4
Oldham Corporation	—	—	—	—	—	34	34	,, 25	65,553	13,466,245	1,504,740	1 16	10 45	1,885	—
Portsmouth Corporation	May 25	2,330	1 578	+ 752	+ 632	28½	28½	,, 31	95,702	19,625,329	197,499	1·17	11 63	—	—
Reading Corporation	July 4	610	678	- 68	- 336	33½	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	11·29	21·29	,, 31	14,881	2,837,110	386,547	1·24	9·24	1,102	7 98
Rotherham Corporation	—	—	—	—	—	9½	9½	,, 31	23,564	5 251,472	593,054	1 07	9·53	2,612	7·49
Salford Corporation	,, 8	4,690	4,848	- 158	+ 875	70½	70½	,, 31	214,111	39,213,560	4,894,530	1·28	10 29	—	—
Scarborough Tramways Co.	—	—	—	—	—	4½	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 7	5 537	5,495	+ 42	+ 3 310	35½	35½	,, 25	240,555	63 952,283	6,049,899	903	9 543	3,653	6 477
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,365	9 294,771	1,108,369	1·27	11·02	—	7 83
Southend-on-Sea Corporation	,, 3	441	457	- 16	- 269	9	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	,, 31	39,550	6,766,031	1,027 730	—	9 23	—	4·75
Sunderland Corporation	,, 7	1,409	1,557	- 148	- 86	20	20	,, 31	64,858	15,364 463	1 495 785	1·004	10·35	—	6·37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	4,937	1,315,757	102,751	0·87	11 53	1,371	—
Torquay Tramways	July 6	159	—	—	—	5 16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 6	854	907	- 53	+ 155	11 85	11·85	,, 31	38,762	7,412,881	778,851	1·30	11 94	3,271	7·54
Warrington Corporation	—	—	—	—	—	9	9	,, 31	17,057	4,418 225	403 363	—	9 83	—	6·33
West Ham Corporation	,, 4	2,393	2,453	- 60	+ 939	14·7	14 7	,, 31	—	15,773,742	1,257,165	—	—	—	—
Wolverhampton Corporation	June 31	853	851	+ 2	+ 188	20	20	,, 31	41,905	8,847,066	950,338	—	10 583	2,062	6·13

† And 98 miles of interlacing track. a Train mile. b Per mile of single track. h Half-year's figures. Double track

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NOTES.

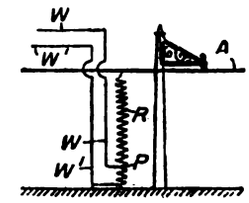
Institution of Mechanical Engineers. — The summer meeting of this institution will be held at Aberdeen from Tuesday, July 30, to Friday, Aug. 2. The following papers have been offered for reading and discussion: "Aberdeen Harbour," by Mr. R. Gordon Nicol, of Aberdeen; "Cableways used on Shipbuilding Berths," by Mr. J. M. Henderson, of Aberdeen; "Portable Pneumatic Tools," by Mr. H. Bing, of Fraserburgh; "Granite Quarrying in Aberdeenshire," by Mr. W. Simpson, of Aberdeen; "An Electrically-Controlled Single-Lever Testing Machine," by Mr. C. E. Larard, of London; "Observations on Present-Day Practice in Jute Preparing and Spinning," by Mr. D. J. MacDonald, of Dundee.

American Tools.—It is stated in a consular report from Philadelphia that the American manufacturers of shoes and dies for standard pipe threading propose to adopt the British thread for the future. This is being done chiefly to gain the Australian market, from which they are practically excluded because of their price and quality. The latest German quotation on shoes and dies made of Krupp steel to the Australian market was £17. 10s, while the price of American shoes and dies made of hematite iron was £23. Under these conditions American dealers assert that it is impossible to compete with the German article. According to the importers and mining experts of Australia the British thread is preferred for its tighter fit, and it is also asserted that in the purchase of spares or renewals of parts of machinery buyers are not in favour of the American standard.

Electrical Manufacturing.—The Board of Trade returns should be read in conjunction with the past year's report of the Electric Construction Company, appearing in another column, when, perhaps, readers will be reminded that the various branches of the electrical industry are not "booming" so loudly as the figures would have us believe. The affairs of the company do not appear to improve. Since 1904 the profits have steadily dwindled, dropping to £3,900 in 1905 and £2,700 in 1906. Now they have reached the vanishing point, the accounts for the 12 months ended May last showing an actual loss of £1,442. The loss is entirely on manufacturing and contracting, the receipts from investments being some £700 more than in the preceding year, and it is ascribed by the directors to "severe competition," and also to the higher cost of materials. They add, however, that they are enabled to take a more hopeful view of the future. But which electrical company is not suffering depression from causes that are artificial, and how many can show the same results as, say, the German companies mentioned in this issue.

British Association.—Not the least important of the sections of the British Association for the Advancement of Science is that devoted to economic science and statistics (Section F). The officials of this section for the annual meeting at Leicester, which commences on the 31st inst., are: president—Prof. W. J. Ashley; vice-presidents—Dr. James Bonar and Prof. F. V. Edgeworth; secretaries—Prof. S. J. Chapman (recorder), Mr. H. O. Meredith, Mr. D. H. Macgregor, and Mr. T. S. Taylor. The chief subjects for discussion will be the encouragement of agriculture, co-operation, trusts, Australian labour legislation, and German colonial policy. On the last-named subject Prof. Ernst von Halle (Berlin) will read a paper. The effect of Australian labour legislation is to be treated by the Hon. R. B. Wise and Mr. J. Ramsay Macdonald. The readers on co-operation will be Mr. Tweddell (vice-chairman of the Co-operative Wholesale Society), Mr. Amos Mann, and Mr. Fay, and on trusts Mr. Macrosty and Mr. Macgregor. Papers will also be read by Archdeacon Cunningham and Prof. Gonner.

Electrical Measurements.—Mr. A. B. Holmes, the resident electrical engineer of the Liverpool Corporation, has patented a device which has for its object the measuring of E.M.F. in a distant circuit. This is effected by means of a wire, W, connecting the indicating instrument to a point, P, in the resistance, R, connecting the conductor, A, to earth, such that the pressure in the connecting wire differs only slightly from that of the earth. The connecting wire may thus be carried overhead and uninsulated, though it may in special cases be insulated or underground. In the



case illustrated the resistance is connected to the return rail of an electric traction system, and an additional connecting wire, W^1, affording a complete metallic circuit for the instrument is connected close to the rail. The system may be applied to multiple-wire circuits. The instrument, which may be electrostatic, may be calibrated to indicate the actual pressure in the conductor, A. A fuse, cut-out, or other device may be placed near the resistance to disconnect the connecting wire in the event of the earth connection breaking.

The Mutual Inductance of Coaxial Solenoids.—In a paper recently read before the American Physical Society, Messrs. E. B. Rosa and Louis Cohen presented a number of formulæ which they had collected for the calculation of the mutual inductance of coaxial solenoids. Various formulæ have been given from time to time, and, although few of them are exact, several of the approximate formulæ permit inductances to be calculated with very great accuracy by using a sufficient number of terms of the series by which they are expressed. The authors have collected a number of the formulæ, extended some of them to improve the accuracy, and have compared and tested them by numerical calculations. The following are the more important of the formulæ given in the paper: (1) Maxwell's formula (extended) for coaxial solenoids of equal length, the inner having a radius considerably smaller than the outer, the length being several times the diameter for accurate results. (2) Roiti's formula (extended) for coaxial coils, the inner being considerably shorter than the outer This is a very convenient and accurate formula. (3) Gray's formula for coaxial coils, the length being $\sqrt{3}$ times the radius for both coils. (4) Searle and Airey's formula for coaxial coils in general, which is used as a test for some of the others. The numerical examples given show what degree of accuracy is attainable, and what form of coils can be computed by the various formulæ. This paper is to be published later in the *Bulletin* of the Bureau of Standards.

Obituary.—About this time last year the scientific world was celebrating, with much rejoicing, the jubilee of the discovery of the first of the now marvellous series of the analine dyes by that honoured savant, Sir William H. Perkin. Now the whole scientific and no small part of the industrial worlds are lamenting, with the same deep sincerity that characterised their happier feelings, the death of the founder of the coal-tar colour industry, which occurred at his residence, Sudbury, on Sunday last. By a cruel irony, memories of the happy rejoicings of last year

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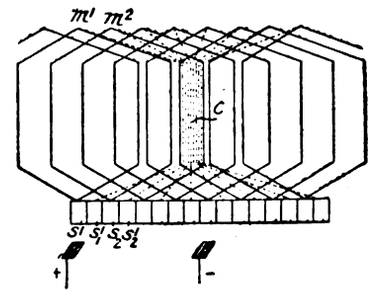
crowd on the mind in close juxtaposition with the sadness occasioned by the death of the hero of these rejoicings. But it is at least consoling to know that he received due recognition during his lifetime. The record of Sir William Perkin's career—from the time when, as a boy of 14, he wrote to Faraday and received permission to attend his lectures on electricity at the Royal Institution, to the spontaneous recognition last year of his wonderful achievements in the world of science—must still be fresh in everyone's mind, and scarcely needs recalling. Sir William enjoyed the rare happiness of seeing his three sons distinguish themselves in the science which he did so much to advance. One of them, Prof. W. H. Perkin, F.R.S., was the first occupant of a chair of organic chemistry in this country. Mr. Arthur G. Perkin, F.R.S., is a lecturer at the Yorkshire College, Leeds; while Dr. F. Mollwo Perkin is head of the chemistry department of the Borough Polytechnic. Our sympathy goes out to Lady Perkin and her family in their bereavement.

Centralising Electric Supply in Sydney.—The advent of a municipal supply in the city of Sydney has developed in a wonderful way the demand for electricity, due no doubt to the reduced rates introduced; for though the City Council is doing a business this year of over three million units, the private companies are selling more than they ever did before. There are five such companies operating, all with overhead wires in separate districts, and having an aggregate of about 2,500 kw. of plant. The Council, considering that the city would be better served by a centralisation of the electricity supply business being placed under its own control, have concluded an agreement with the Empire Electric Light Company, Limited, by which the latter agrees to transfer all its customers to the Council's mains. This company has been most successful during the past 10 years, and the transference of its business will add another million units to the Council's output. The method of the deal is novel and probably unique; the company might be said to have absorbed itself, returning the shareholders their capital back, and the Council obtaining the load without any actual outlay. Briefly this is to be accomplished as follows: the company transfers its customers to the Council's mains, all these customers are then considered a bulk customer, and the difference between the revenue from these customers and the bulk price charged of 1d. per unit to the Empire Company is paid to the reduction of the purchase price and interest on the unpaid portion. It is estimated that four years will accomplish this. The other companies may be dealt with in a similar manner later on.

Niagara Falls.—There was a singular appropriateness in the choice of meeting place for the annual conference of the American Institute of Electrical Engineers, which was held during the last week of June in the region of the Niagara Falls. The electrical industries owe much to the utilisation of the famous falls, which is really a precursor of hydroelectric works, and which, besides being the means of introducing an entirely new phase of electrical engineering, has permitted a great deal of valuable experimental work in connection with electrical distribution to be brought about. Under the circumstances, these annual conventions will later possess some historical importance, while at present they serve a very practical purpose. The Niagara convention recalls the controversy which has been carried on for some time between those who think that the natural beauty of the region will be impaired by the great engineering works involved in the harnessing of the falls, and those who, on the other hand, may be regarded as unrelenting utilitarians. There is certainly some ground for the fears entertained by the former, but their view is altogether exaggerated. Our esteemed contemporary, the *Electrical World* of New York, gives its impressions on Niagara after a personal visit: "Most gratifying to everyone after all the loose talk in the papers about the destruction of Niagara by its partial diversion, was the spectacle of a river of rapids and of plunging cataracts as brimful, as greenly translucent, and as obviously inexhaustible as at any previous stage in its history. Before the power era began Niagara was horridly unkempt at many points, but the stately new power-houses by day and night add a dignified frame and setting to the picture, and it is easy to see that in a very few years, even with utilisation pushed to its legitimate limits, the intrinsic wildness of Niagara and the beauty of the necessary environment will be enhanced rather than marred. The engineers have spoiled nothing, and have conserved a great deal for the present and the future." So the engineering works have improved the appearance of Niagara!

Armature Sparking.—A patent recently granted to the Phœnix Dynamo Company describes means for preventing sparking in armatures. In commutating machines, especially high-speed machines, special connectors, joining intermediate points in the armature winding to additional segments in the commutator, are arranged in groups or bundles, connectors of opposite polarity being brought into the same bundle in order to neutralise their self-induction. Additional commutator segments, S^1_1, S^1_2, etc., are inserted between the original segments, S_1, S_2, etc., and are joined to the mid-points, m^1, m^2, etc., of the armature coils connected to adjacent main segments. The connectors, c, are brought together in bundles which contain corresponding connectors of opposite polarity, and which may be disposed in tunnels in the armature iron, or in the



slots containing the armature bars, or in special slots, or in other ways. According to the provisional specification, the connectors may be brought back over the armature and beneath commutating poles; each armature coil may be divided into more than two parts; the machine may have two commutators connected to the same winding, each commutator having the increased number of segments, and each segment being connected to one or the other commutator; equalisers may be used in combination with the connecting conductors; the invention may be used for single-phase commutating machines as well as direct-current machines.

Motor 'Buses and Electric Tramways.—The House of Lords, on appeal, have reversed the decision of the Court of Appeal granting the Mersey Railway Company the right to run a service of motor 'buses in the streets of Birkenhead (subject to certain undertakings), and have restored Mr. Justice Warrington's injunction. It was clear that the running of motor omnibuses was not incidental to the railway enterprise, and Lord MacNaughton very properly pointed out, the company should apply to Parliament for such powers if they desired them. The case raised several important points, but the chief one from our point of view has been satisfactorily settled. Indeed,

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if the result had gone the other way, it is difficult to see what would prevent railway companies setting up motor-'bus services in direct competition with the tramways in any town, if they desired to do so. But the railway companies may yet have reason to thank the law for saving them from the evil effects of their own folly and imprudence. Running motor 'buses in competition with well-equipped and well-managed electric tramways is by no means the lucrative business some would have us suppose. An instance of this is furnished in the third annual report of the West Ham Corporation tramways department: "In the second annual report," says the tramways manager, Mr. H. E. Blain, "reference was made to the fact that the tramways undertaking had begun to face motor-'bus opposition on one of its routes, and the statement was made that there was no doubt as to the tramways holding their own in the competition, increasingly so as through-runnning facilities were extended and multiplied. The motor-'bus opposition then referred to was speedily run off the road, and on the opening of through traffic with Leyton the same result was achieved with the Bakers' Arms motor-'bus service, despite the fact that fares even lower than ours were charged. Motor-'bus services have been commenced on another route, and the expedient again tried of cutting fares." The experience of motor-'bus running both in the London area and in the provinces, show that the working costs are enormously higher than in connection with electric traction.

Foreign Trade.—The trading returns for the month of June are of unusual interest, inasmuch as they close the record for the half-year, and a comparison of the results of this longer period gives a truer indication of the trend of trade. The sum total of the imports of telegraph cable and apparatus for the month of June is valued at £85,280, an increase of £4,635 compared with the same month of the previous year, while the exports for the same period are valued at £364,987, which is no less than £262,377, or 255·7 per cent. increase compared with June, 1906. The imports of wire (including telegraph and telephone wire) reach a total of 5,216 tons, valued at £54,611, compared with 5,172 tons, valued at £53,521, for June, 1906 The export of the same commodity during last month amounts to 4,111 tons, valued at £75,312, compared with 3,740 tons, valued at £63,621, for the corresponding period of 1906. Of electrical goods (of all kinds) 636 tons were imported last month, the value being £48,382, as against 427 tons, valued at £39,283. The exports of the same commodities amounted for June, 1907, to 974 tons, valued at £71,857; June, 1906, to 992 tons, valued at £77,675. Turning from the results of June to the figures for the half-year, we find that imports and exports have maintained a steady advance. The imports of telegraph cables and apparatus advanced during that period by £51,244 to £632,232, while the exports advanced by £71,868 to £1,132,966. Wire (including telegraph and telephone wire) was imported to the amount of £336,883, as against £324,200 last year, and exported to the amount of £458,353, against £368,405 last year. The imports of electrical goods and apparatus have risen from £272,384 to £293,458, while exports also show an advance, in this case from £438,261 to £452,933. Under the heading of foreign and Colonial merchandise we find that the exports of electrical goods, etc. (not including machinery, telegraph and telephone wire), amounted during June, 1907, to £16,855, and during June, 1906, to £8,115. For the half-year the value had increased from £43,397 for the first half-year of 1906 to £71,139 for the six months that have just elapsed. Thus, in spite of the depression in electrical engineering, no sign of it is traceable in the international trade.

Sunderland Corporation and Mr. Snell.—The relations between corporations and their officials are not always of the happiest, and it all the more pleasing, therefore, to read of the little ceremony that took place in the mayor's parlour of the Sunderland Town Hall on Wednesday, the 10th inst. There assembled there many councillors and friends to witness the presentation by the Corporation of an address on parchment to Mr. J. F. C. Snell on the termination of his services to the borough as electrical and tramways engineer, and a solid silver tea and coffee set and tray to Mrs. Snell. The address spoke of the Council's high appreciation of the personal character and professional qualities of Mr. John Francis Cleverton Snell, and continued as follows: "Mr. Snell was appointed by the Council as electrical engineer on Aug. 28, 1896, and as tramways engineer on Dec. 14, 1898. At the time of the first of these appointments the electrical undertaking of the Council was in its infancy, the capital invested in it being not more than £30,000. Since then Mr. Snell has been responsible for the introduction of the three-phase extra high-tension system into the borough, with distribution by means of the continuous-current system for static transformer chambers. This has been accompanied by the carrying out of additional generating plant and main extensions, involving the expenditure by the Council, under the advice and guidance of Mr. Snell, of £320,000. As tramways engineer at Sunderland Mr. Snell has been entrusted with the designing and establishment of the entire undertaking, which is an overhead system, and he has constructed it to the complete satisfaction of the Council with a capital cost of £280,000. The Council deem Mr. Snell to be a gentleman of personal worth and great engineering ability, eminently reliable as an adviser in his profession. Given under the common corporate seal this 12th day of June, 1907.—Stephen M. Swan, mayor; Fras. M. Bowey, town clerk; William Bruce, chairman of the Electricity Committee; George New, chairman of the Tramways Committee." The speeches made at the ceremony breathed sentiments of warmth and affection for the recipient of the address, and all dwelt upon the high personal qualities of Mr. Snell and upon the happy relations which existed between him and the Council. These amenities form a pleasant interlude in the busy life of a corporation official, and Sunderland in honouring Mr. Snell honoured itself too.

Protection of Transmission Lines.—At the annual convention of the American Institute of Electrical Engineers held last month at Niagara Falls, Mr. Norman Rowe described certain experiences with lightning rods and grounded cables as a means of protecting transmission lines against lightning. The paper, an abstract of which appeared in the *Electrical World*, gave a summary of lightning trouble during the last three years on a steel-tower, long-span transmission line in the states of Michoacan and Guanajuato, Mexico. The transmission line towers are of standard type, the height being 40ft. from the top of the cross-arm to the ground. When the wires were first installed they were placed upon the towers at the vertices of an equilateral triangle, the upper wire being supported upon a 3in. extra heavy pipe, which forms the continuation of the tower, the other two being placed at the ends of a double-channel iron cross-arm approximately 7ft. in length, the sides of the triangle being 6ft. Throughout the rainy season of 1904 the only protection against any high voltage due to lightning discharges was afforded by the line insulators. During 1905, however, lightning rods were placed in pairs on the pole tops. During 1906 the transmission wire was removed from the top of the tower, and for it was substituted a steel cable grounded at each tower.

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over the entire line. The transmission line was placed on a special bracket located at a proper distance below the other two transmission lines. During the season of 1904 there was considerable trouble with lightning; during the next season there was less, and during the season of 1906 comparatively little trouble was experienced. On the strength of the experience during the three seasons, Mr. Rowe offered the following suggestions: First, insulators should not be disposed upon poles or towers so that they will be in the path of bolts of lightning going to ground by way of the supporting structure. Second, a grounded cable, strung above the transmission wires at the highest point of the tower, is certainly more effective than lightning rods in protecting the insulators and conductors from direct bolts of lightning. Third, lightning arresters for discharging the line in case very high voltages are present on the wires would be of some value if located along the line at frequent intervals. Fourth, on steel construction the insulator should have a margin of safety against puncture and arcing over.

Publications Received.—The Manchester Section of the Institution of Electrical Engineers have issued in volume form the papers read at the meeting in connection with the local section during the session 1906-7, together with a report of the discussions thereon. We understand that this is the first occasion on which a bound volume of the session's work has been compiled, and the committee of the Manchester Local Section are to be congratulated on their courageous venture. The volume contains much valuable and interesting information, and is to be heartily commended to the members of the section, to whom the possession of a copy will be very useful as a means of reference. It is published at 6s., and is procurable from the assistant secretary, Mr. A. L. Green, 2, Churchill-avenue, Manley Park, Manchester.—The July issue of the *Journal* of the Institution of Electrical Engineers (vol. 39, No. 184) has come to hand from the publishers, Messrs. E. F. and N. Spon, Limited, 57, Haymarket, London, S.W. Price 5s. Among the contents are contributions by Mr. J. A. Panton and Prof. A. Schwartz on "Rail Corrugation" and "Flexibles, with Notes on the Testing of Rubber" respectively, together with a report of the discussions on the papers when read before the Institution There appears also some of the papers read before local sections—viz.: "Electric Lighting of Trains," Mr. J. Denham (Cape Town); "Train Lighting, Mr. H. Henderson (Newcastle); "Stores and Cost Keeping for Electricity Supply Undertakings," Mr. D. Denholm, and "The Pay-Sheet," Mr. R. B. Maccall (Glasgow); and "Magnetic Oscillations in Alternators," Mr. G. W. Worrall. Dr. Gisbert Kapp has an original paper "On a Method of Plotting the Hysteresis Loop for Iron with an Application to a Transformer." The wiring rules are also given.—The American *Physical Review* for June (vol. xxiv., No. 6) contains the following communications: "On the Magnetic Properties of Heusler's Alloys," Mr. J. C. McLennan; "Some Newly Observed Manifestations of Forces in the Interior of an Electric Conductor," Edwin F. Northrup; "The Determination of Potential by Carbon Pencils," C. D. Child; "The High-Resistance Contact Thermo-Electric Detector for Electric Waves," L. W. Austin; "Upon the Chemical Nature of the Radium Emanation," L. M. Dennis and L. F. Hawley; "The Scientific Work of DeWitt Bristol Brace," Edward L. Nichols.—The *Official Circular* of the Tramways and Light Railways Association for July deals chiefly with matters relating to the association: the progress made by the special committee on brakes is reviewed; the final report presented to the council by the special committee on income tax assessment, and adopted by the council is given in full, together with six appendices; also copy of a reply received from the Board of Inland Revenue intimating that Sir Henry Primrose, chairman of the Board, would consent to receive a deputation from the association to discuss this report; further mention of the Postmaster-General's clause in regard to the use of tramway poles; a circular letter of the association to its members inquiring whether they would agree to be bound by arbitration on the question as to who shall bear the cost of inserting fuses and heat coils into the Postmaster-General's telegraphs, the arbitrator to be appointed by the Board of Trade, etc.; a copy of Major Pringle's report to the Board of Trade on the accident which occurred on April 2 last on the Croydon and district tramways.

Industrial Applications of Electricity.—Perhaps one of the most important features in modern industrial history, besides the displacement of manual labour in the more drudgery work, is the tendency to adopt mechanical power. This modern departure has acted as a wonderful stimulus to the manufacturing world where power-driven machinery is now to be found in huge mills and factories down to the modest workshop. As has been repeatedly pointed out in these columns, there is an exceptional opening for "pushing" motors for driving purposes in small workshops, for the economic and general advantages of this form of power are so obvious that it only requires that they should be brought prominently to the notice of the small manufacturer in order to secure his adoption of electric driving. No more reliable evidence as to developments in the industrial world need be sought for than in the annual report of the chief inspector of factories, whose divisional inspectors' reports present to the view a complete record of all that is going on in different parts of the country. One of the salient features of the sectional reports which are embodied in the chief inspector's report for 1906 is the increasing introduction of electric power into factories and workshops. So marked, indeed, is this tendency, that the chief inspector is forced to admit that "a final stage is by no means reached, for," he adds, "in factories themselves the moving force might be said to be undergoing a process of evolution. Electric motors, with their comparatively high degree of cleanliness, noiselessness, safety, and convenience, are frequently superseding steam and other engines." And when we turn to the sectional reports themselves we find one of the outstanding features to be the attention which is called to the very great increase of electricity. Thus the Plymouth representative says: "Electricity is being utilised in Royal dockyards for many of the large machines, driving direct, and, therefore, displacing not only the steam-engine but also a lot of the mill gearing that was formerly necessary to connect the machines with it." Another representative from the same centre says also: "The use of electricity as a motive power steadily gains in favour. During the year the Lords of the Admiralty had a generating station erected in this district, and motive power will now be used for many processes carried on by manual labour." From Southampton we learn that "in one fair-sized paper mill separate electric motors are being used to drive each machine, and with great success," while in South London "instances were again to be found of occupiers of small workshops installing power and thus converting their premises into factories. This was most noticeable in the boot and shoe repairing trade and in motor-repairing works connected with garages. In most cases electricity was the motive power used." In the Midland division "the use of electric power is spreading, and the introduction of motors into small shops" is noticeable in

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the Wolverhampton and Worcester districts. The demand for installations in South Wales has been described as "exceeding the power of supply." On Tyneside "electrical energy is now being utilised to a certain extent for furnace work and chemical processes," while in Sheffield, "during the past year many electric travelling cranes have been installed in the steelworks. Most of them are new, but some are converted from steam cranes." Several inspectors draw attention to the still increasing use of electricity for power purposes, but comparatively few occupiers of works now generate their own, preferring to obtain their supplies from the public mains. Indeed, the report abounds with references to the industrial applications of electricity, and so wide is the range that we may return to this subject later.

Costs in Relation to Selling Prices in Germany.—The report of Mr. Consul-General Schwabach on the German electrical industry, which was recently noted in these columns, has now been followed by another from Mr. Consul-General Oppenheimer on the electrical trade of the Frankfort consular district for 1906. Like its predecessor, the report is of great importance, and how admirably it surveys the state of the industry may be gathered from the following extracts: "In the electrical industry the figures for 1905 had been a record, exceeding the figures of the boom of 1900. In 1906 a turnover was achieved which constituted a fresh record, and went beyond the most sanguine expectations. Some of the largest firms have reported that the orders booked during 1906 totalled an amount which was 50 per cent. higher than that of the previous year. At the beginning of 1907 the orders in hand and in sight were alone enough to secure another busy year." The report goes on to show, however, that the prices of finished articles did not correspond to the increased cost of manufacture. "The increase of wages and salaries, by an advance of 10 per cent., was unavoidable; the prices of almost all raw materials in the course of the year advanced from 20 to 30 per cent. (copper about 35 per cent.); but the selling price of the finished article increased only by about 15 per cent., and did not offer anything like former profits, which were more in keeping with Germany's reputation for electro-technical products. Raw copper rose steadily from £88, at which it stood in August, to £115 per ton at the end of the year. This advance was due partly to speculation, partly to increased consumption, which was not accompanied by a corresponding increased production. As a result of the advance of the price of copper, products such as covered and uncovered wires, dynamo wires, etc., rose 33 per cent. in cost during the year. The average increase in the cost of brass articles was 25 per cent., and in the case of iron and steel articles 10 per cent. Lighting appliances, which had increased in cost by 10 per cent. in 1905, were increased in cost by 15 per cent. in 1906. Weak-current apparatus advanced in cost from 10 per cent. in 1905 to 20 per cent. in 1906. Switchboards, indicators, arc lamps, incandescent lamps, and insulating wire with rubber covering increased from 5 to 10 per cent. in their cost of production. Already, during the middle of the year 1906, the Union of German Electrical Firms (Verband Deutscher Electricitäts Firmen) had increased its selling prices by 10 per cent. In 1906 the price was increased by 15 per cent, and at the end of the year, after repeated conferences, an advance of 20 per cent. for 1907 was fixed. This should bring the selling price of the large machines into a fair relationship with their cost, but the selling prices of small machines still remain unsatisfactory, due to the competition of a large number of smaller special factories, which are restricted in their scope and are not members of the union." Thus it is seen that, while the output in the electrical trade in Germany is of record dimensions, the prices are not at all satisfactory, and Germany suffers in common with us from the exceedingly high prices of raw raterials. But where they hold a great advantage over us is in the existence of a Union of German Electrical Firms, which is able to regulate selling prices proportionately to fluctuations in the cost of labour and raw materials. The report also gives interesting statistics as to the paths along which the German electrical trade develops, the value of the shares of the principal manufacturing companies, and the workpeople employed, which we deal with below.

German Electrical Trade.—In another note we have given abstracts from the annual report on the trade of the consular district of Frankfort, which relate principally to the selling prices of German electrical products, and we have pointed to, what seems to us, one of the most reliable safeguards against the evil effects of the cutting of prices wrought by uncontrolled competition—viz., in the establishment of a Union of German Electrical Firms. We now give other references from the same report, which rather show the directions in which the electrical industry is expanding and the confidence of the public in electrical enterprises, as is gathered from the value of the shares in the principal companies. To return to the report, it states: "From a technical point of view the year brought no great novelties; the general aim seems rather to have been development and perfection in the paths that had been already opened. Thus, *e.g.*, great progress has been made in the employment of electric power in winding and hauling machinery, and especially in machinery used in mines and foundries. The progress of electricity for use in industrial enterprise continued steadily. High-speed motors were also developed and further introduced, and the output of turbo-generators increased materially. Exports increased during the year, but German electrical firms complain that the commercial treaties do anything but assist them in foreign dealings, and that the increased export was chiefly due to the world boom. The electrical industry employed about 72,500 workpeople in 1904, and increased this figure to about 82,000 in 1905. It may be assumed that about 95,000 were employed in 1906. The prosperity of German electrical concerns—that is to say, their money-earning capacity—will be gathered from the figures shown as dividends paid in the following table. The confidence of the country is also shown in the following table at which their shares are quoted on the Stock Exchange:

	Last dividend. Per cent.	Approximate market quotation.
Akkumulatoren Fabrik	12	201
Allgemeine Electricitäts Gesellschaft...	11	200
Bergmann's Electricitäts Gesellschaft...	18	270
Berliner Electricitäts-Werke	10	170
Brown-Boveri	11	189
Lahmeyer Electricitäts-Werke	7	128
Siemens-Schuckert-Werke	5	113
Siemens ú Halske	10	170

The par value of the shares in all cases is 100." Taking averages of the above figures, we find that the average of the last dividend paid by eight of the principal German electrical firms amounted to 11·6 per cent., and that the approximate market quotations of the same companies shares average 180, or no less than 80 above par. These figures invite comparison with those of English companies, but we refrain from again illustrating the fact that we have been so greatly outstripped by our Teutonic neighbours. It is clear that we are not participating in the alleged "world boom."

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THE IMPROVEMENT OF THE INCANDESCENT LAMP.

BY R. MILWARD ELLIS.

Until the invention of the gas mantle by Welsbach there was very little progress in the electrical world towards an improved electric lamp. The 3½-watt-a-candle carbon-filament lamp and the costlier, but more efficient, Nernst lamp more than enabled electrical engineers to hold their own against the gas companies, and necessity compelled the latter to find some means of improving the illuminating power of their gas. The consequent invention was the gas mantle, which for the time effectively checked the triumph of electricity. The necessity is now with the electrical engineers, and it is the increasing success of the gas mantle which we have chiefly to thank for the improvements now rapidly being made in the electric incandescent lamp. These improvements are divisible into two groups: those directed to the improvement of the carbon filament and those directed to its usurpation. The first group trends towards the production of a more efficient high-voltage lamp of low candle-power, and the second to the production of a much more efficient lamp of smaller voltage and higher candle-power.

The original carbon-filament lamps of Edison required from 4½ to 5 watts per candle, and this efficiency was gradually improved until now for many years it has stood at 3½. At least, that seems to be the general belief. As a matter of fact, this is only true for new lamps, but for those that have been in use a few hundred hours the watts per candle-power are nearer four. This increase is due to alterations in the filament, for though carbon is ideal as an infusible substance, it has an unfortunate propensity for disintegrating while at a high temperature, and this leads to blackening of the lamp bulb and consequent reduced candle-power and efficiency. In conjunction with the disintegration there is also an alteration in the structure of the filament, which still further reduces the efficiency.

Recent types of carbon-filament lamps manufactured by improved methods, and having spherical bulbs 3in. in diameter, consume from 2½ to 3 watts per candle-power. The bulb does not blacken appreciably, and the candle-power, consequently, remains practically constant. The life of these lamps is about 500 hours, as compared with 1,000 hours for the ordinary carbon-filament lamp. They can be obtained for 2s 3d. each, so that over the same period their cost is five or six times that of the ordinary lamp. Owing to its high specific resistance, the carbon filament is at present the only practical means of making a high-voltage, low-candle-power lamp. The ordinary carbon filament is prepared by electrically heating a carbonised thread of cellulose to incandescence in hydro-carbon vapour. The carbon from this vapour deposits on to the cellulose most thickly where the thread is thinnest, and *vice versâ*, thus producing a uniform, but not homogeneous, filament of graphite embedded in soot. Mr. Howell, an American, has recently discovered that if the ordinary carbon filament be subjected to the intense heat of a suitable electric furnace, it appears fused by the high temperature, and its resistance is much decreased. The ratio of the resistance of a filament thus treated to that of one treated in the normal manner is about 1 : 5 at ordinary temperatures. The new filament, moreover, becomes much more metallic in its properties than the original. The negative temperature coefficient of the original carbon filament changes to positive. The new filament resembles graphite in its chemical composition, and hence the name of the lamp—the *Graphite lamp*. Lamps made by this process have an efficiency of 2½ watts per candle-power They can be obtained suitable for giving 16 c.p. on 110 volts, the candle-power falling 20 per cent. in 1,000 hours, and are, in this, similar to the normal carbon-filament lamp.

Auer von Welsbach, the inventor of the Welsbach gas mantle, towards the end of 1890 turned his attention to the consideration of the utility of metals for the filaments of electric incandescent lamps. He discovered a suitable metal, after many failures, in the form of osmium. This metal is only fusible in the electric arc; it is exceedingly brittle, and cannot be drawn into wire. Welsbach had, therefore, to surmount this difficulty before he could utilise the results of his research. He did so in the following manner: Finely-powdered osmium metal was mixed with an organic binding substance—*e.g.*, paraffin oil—into a paste. By means of a press very thin threads were then produced. These threads were dried, and then heated *in vacuo* until the organic matter carbonised and the filaments became conductive. The filaments, which then contained carbon and osmium in very fine state of sub-division, were now heated to a white heat for a long time in an atmosphere of reducing gases—*e.g.*, hydrogen saturated with steam. By this means the carbon was eliminated and the osmium united into a metallic wire. Having accomplished this, Welsbach had still to consider the question of cost. Osmium at that time was only procurable as a by-product in the manufacture of platinum. Welsbach, however, discovered mines from which the metal could be obtained, and before publishing particulars of his invention bought up all known sources of the metal. Osmium, which had hitherto had absolutely no commercial use whatever, rose in price to £7 per ounce.

The Auergesellschaft, the company developing this lamp, state that they have in their mines enough osmium to construct several million lamps, while they hope to recover a considerable proportion of the outgoing material by buying back the burnt-out lamps—9d. each is being offered for these. The first cost of the lamp is 7s. 6d. The efficiency of the *Osmium lamp* is 1½ watts per candle-power, and the highest voltage for which it is made is 55. Owing to the very soft condition of the filament at its working temperature, each of its three loops has to be supported at its extremity, and the lamp may only be used in a vertical position. An attempt was made by the manufacturers of this lamp to adapt it to 110 volts by supplying a special adaptor, by which two lamps could be connected in series to one lamp socket. This, of course, added to the cost of the installation. It does not now seem probable that there is much of a future before the osmium lamp, which, though the first really practical metallic-filament lamp invented, is heavily handicapped to struggle successfully against its cheaper, more efficient, higher-voltage, and longer-lived competitors. As a low-voltage lamp it may be a success, but then only by the sufferance of its rivals. In these circumstances it is a satisfaction, therefore, to find that Welsbach, the pioneer of the successful metal lamp, has been enabled, by adding tungsten to the osmium filament, to invent a lamp which, for efficiency, life, and voltage, ranks with the product of any of his followers.

There are two such modifications of the osmium lamp now being sold. The first, the *Osmin lamp*, is not easily obtainable in this country, but is in use in America. It may be obtained for 110 volts 40 c.p., 110 volts 60 c.p., and 220 volts 80 c.p. The 110-volt 60-c.p. lamp has an initial efficiency of 1·05 watts per candle-power, which after 2,000 hours only changes 5 per cent. The 110-volt 40-c.p and the 220-volt 80-c.p. lamps are made from the same filament, which has a diameter of ·03mm. — *i.e.*, 1·2 thousandths of an inch. The efficiency of some lamps tested in Vienna was 1·15 watts per candle-power, remaining unchanged for 2,000 hours, but ultimately rising to 1·4 after 4,000 hours, by which time the candle-power dropped 10 per cent. The second modified osmium lamp is called the *Osram lamp*. It differs probably from the "Osmin" lamp in that it contains more tungsten. There are other reasons for thinking this apart from a comparison of the names. The electric properties of the "Osram" lamp differ from those of its near relative in that the resistance of the filament is higher, the candle-power at equal voltage consequently lower, the watts per candle-power higher, and the life shorter. "Osram" lamps can be obtained at a cost of 3s. suitable for 110 volts 28 c.p., having an efficiency of 1·35 watts per candle-power. The life is over 1,000 hours, the candle-power and efficiency remaining nearly constant. Some tests on 16 "Osram" lamps show a drop in candle-power of 6 per cent. in 1,000 hours; 11 of the lamps survived the test. "Osram" lamps are soon to be obtainable at 220 volts. The lowest candle-power will be 36, the efficiency then being 1·35 watts per candle-power, or with larger candle-power lamps the consumption is to be reduced to 1·15 watts per candle-power. It was Kuzel, the Viennese chemist, who first suggested the possibility of

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using alloys for lamp filaments. They had previously been thought useless, owing to their usually low melting points.

Werner von Bolton, following Welsbach, discovered the suitableness of the metal tantalum for the filament of the electric lamp. Like osmium, tantalum has a very high melting point—namely, about 2,300deg. C. It can be fairly easily worked, and may be drawn directly into wire suitable for filaments. Tantalum mineral can be obtained cheaply and in any quantity, the chief sources of supply being at present some mining properties in Australia. What is greatly wanted, however, is a cheap and simple process for extracting the pure metal from the ore. At present, Messrs. Siemens and Halske, the sole makers of the *Tantalum lamp*, use, it is thought, the following: The natural ore is transformed into the amorphous—*i.e.*, non-crystalline—state, pulverised, and then pressed into discs, with or without binding substance, and fused in the electric arc in the presence of some inert gas. The fused metal which results is rolled into very thin sheets, and these are cut into strip from which the filament wire is drawn The diameter of the wire varies from ·035mm. to ·05mm.

The tantalum lamp formerly required 1 6 watts per candle-power, but in later types the consumption has been raised to nearly two watts per candle. This has been done to obtain a considerable increase in the life, which is now over 1,000 hours The life of the lamp as formerly supplied certainly admitted of improvement, consisting, with direct currents, of only 500 to 600 useful hours. On alternating currents it was much less. At 25 cycles it decreased to 325 and at 60 cycles to 150 hours (Clayton H. Sharp). The bulb became greatly discoloured and a deep-brown film deposited on the glass. At the same time the filament underwent remarkable alterations. When viewed under a microscope it appeared to have been cut up into very small pieces, and these pieces fitted together without proper alignment. The cause of the phenomenon is not absolutely definite. It may be due to the harmful effects of over-running the filament at the peaks of the alternating-current wave, or it may be due to mechanical strains occasioned by the alternate heating and cooling which the filament undergoes. Since the life decreases with increase in the rapidity of the alternations, the first possibility, excessive disintegration due to increased temperature, cannot have a great effect on the life, as increasing the frequency decreases the maximum temperature attained. Therefore, it is fairly certain that the injurious effect of alternating currents upon the tantalum filament is due to rapidly varying mechanical strains, which, in time, produce fatigue in the material. For this reason Prof. J. T. Morris has suggested that, in order to place the filament under less restraint, it should be wound into a very fine spiral before being zig-zagged round the supports. The filament of the later type tantalum lamp appears to have been treated in this manner, and Siemens and Halske now state that the performance of their lamp on alternating currents has been considerably improved, but they do not yet recommend its use with such. The tantalum lamp costs half-a-crown. So far, its highest voltage is 130, the corresponding candle-power being 20, and for 110 volts 16 or 23. It has the great advantage that it may be used in any position. A large-bulb pattern may be obtained under the name of the "Sun" lamp. Apart from incandescent lamps, there would seem to be a good field open for tantalum metal. It has 1½ times the tensile strength of good steel, does not corrode, and can be obtained in large quantities. It is now being used in Germany for the manufacture of tools, pens, toys, springs, etc. When properly prepared, tantalum sheet can be obtained as hard as diamond. Altogether this curious metal seems to have many unique and several desirable qualities.

Zirconium has for some time been looked upon as a likely metal for making lamp filaments. The first attempts in this direction were to coat the ordinary carbon filament with zirconium, and a lamp of this type working at 2½ watts per candle-power was, for a short time, placed upon the market by Dr. Hollefreund and Co., of Berlin. It was then withdrawn, apparently without explanation. It was shortly replaced by a *Zirconium Carbide lamp* by the same firm This lamp was very efficient, but could not be constructed for voltages above 37, and had, moreover, but a comparatively short life It was at this pass, when the zirconium lamp was almost abandoned as a practical article, that Dr. Zernig, of Berlin, came to its rescue. He found that by the addition of tungsten to the zirconium filament an enormous improvement could be made in the lamp. The new lamp is called the *Zircon-Wolfram* or "*Z*" *lamp*, and is being exploited by the Zircon Syndicate, an amalgamation of the original Hollefreund Company with Dr. Zernig. The process by which the filament is made is some form of paste process, but a detailed account is not obtainable. The filaments are squirted into shape, and can consequently be obtained of fairly small diameter. The lamp has an efficiency of 1·4 watts per candle-power. It can be obtained for from 100 volts 20 c.p. to 200 volts 40 c.p. at a cost of 3s. to 4s. There is one great disadvantage that the Zircon-Wolfram lamp has, and that is fragility. All metallic filaments seem to be fragile, but the filament of this lamp is known from experience to be abnormally so. Quite recently an ingenious device has been introduced into these lamps with the object of permitting them to be used in any position. Excepting the tantalum lamp (the manufacturers of which control a master patent for winding filaments on supporting frameworks), none of these new metallic-filament lamps have been capable of working in any but a vertical position, owing to the soft condition of the filament when hot. This latest device consists of a small spring which is connected to the extremities of the filaments and to the glass bulb, so that when held horizontally the filaments are not permitted to sag, but are kept taut by the spring. Should further trial prove its capabilities, this innovation should do much to popularise the Zircon lamp.

(To be continued.)

ON A METHOD OF PLOTTING THE HYSTERESIS LOOP FOR IRON WITH AN APPLICATION TO A TRANSFORMER.*

BY DR. GISBERT KAPP, MEMBER OF COUNCIL.

Let ϕ_o be the flux in megalines produced by a continuous current of I_o amperes through n turns of winding under an E M.F. of e volts, then

$$e = R I_o.$$

If now e be suddenly reversed, then I will pass from its initial value $-I_o$ through zero to the final value $+I_o$. Any

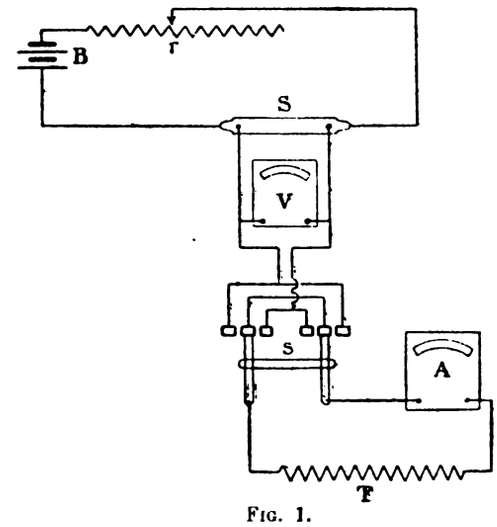

FIG. 1.

intermediate value of the current must obviously satisfy the equation

$$e = \frac{n}{100}\frac{d\phi}{dt} + R I \quad . \quad . \quad . \quad . \quad (1)$$

By observing t and I a time-current curve may be plotted, and from this curve and the known values of e and n the hysteresis loop giving ϕ as a function of I may be drawn. The arrangement of the test is shown in Fig. 1.

* Original communication to the *Proceedings* of the Institution of Electrical Engineers.

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B is a source of current capable of giving from 50 to 100 times the magnetising current, I_o, which is passed through the transformer coil, T. This current is taken off on the heavy shunt resistance, S, between whose terminals the E.M.F., e, is maintained and indicated on the voltmeter, V. A is an ampere-meter with central zero and s a reversing switch. Care must be taken to have the contacts of this switch in good order, so that its resistance may be exactly the same in either position. S may conveniently be the shunt belonging to V, so that this instrumental so indicates the main current given by B. All connections should be of sufficiently stout wire, and A should be of sufficiently low resistance to reduce the loss of E.M.F. between S and T as much as possible.

To make the test, regulate r so that A indicates the desired magnetising current, I_o, and note the E.M.F., e. Then knock s sharply over, starting at the same time a stop-watch and noting the current indicated by A as a function of the time The movement of the needle for values of I lying between $-I_o$ and zero is fairly quick, so that in this region single observations can only be taken by stopping the watch at the moment that the pointer passes a predetermined point on the scale. After the zero has been passed the movement becomes sufficiently slow for a continuous series of co-ordinate values of current and time to be noted. For transformers of similar type the speed of the needle is approximately proportional to the two-thirds power of the output. Thus, if with a 10-kw. transformer zero is reached in four seconds, it would be reached in about 6½ seconds with a 20-kw. and in about 16 seconds with a 80-kw. transformer. The shape of the time-current curve is of the character shown in Fig. 2.

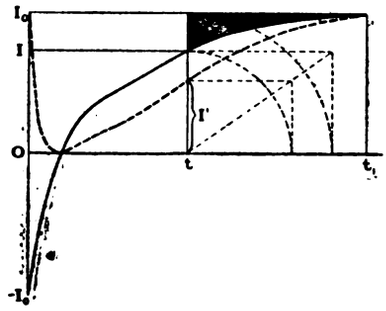

FIG. 2.

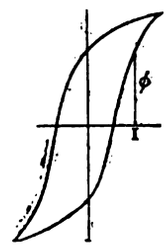

FIG. 3.

If there were no hysteresis loss, it would be a true logarithmic curve, but owing to the influence of hysteresis there is a depression in the upper part as shown. From (1) we have

$$\frac{100}{n}(e - \mathrm{R\,I}) = \frac{d\,\phi}{d\,t}$$

$$\frac{100\,\mathrm{R}}{n}(\mathrm{I}_o\,d\,t - \mathrm{I}\,d\,t) = d\,\phi$$

$$\frac{100\,\mathrm{R}}{n}(\mathrm{I}_o - \mathrm{I})\,d\,t = d\,\phi.$$

Now $I_o - I$ is the length of the ordinate between the curve and the $+I_o$ line, so that $\int (I_o - I)\,d\,t$ is the area enclosed between the curve and this line. Integrating between the limits $-\phi_o$ and $+\phi_o$, to which correspond the times 0 and t_1, we find

$$2\,\phi_o = \frac{100\,\mathrm{R}}{n}\,\mathrm{Q}_o \quad . \quad . \quad . \quad . \quad . \quad (2)$$

if by Q_o we devote the whole area between the curve and its asymptote. Integrating between the limits $-\phi_o$ and $+\phi$, to which correspond the times 0 and t, we find

$$\phi_o + \phi = \frac{100\,\mathrm{R}}{n}(\mathrm{Q}_o - \mathrm{Q}) \quad . \quad . \quad . \quad . \quad (3)$$

By combining (2) and (3) we get

$$\phi = \frac{100\,\mathrm{R}}{n}\left(\frac{\mathrm{Q}_o}{2} - \mathrm{Q}\right)$$

$$\phi = \frac{100\,e}{n\,\mathrm{I}_o}\left(\frac{\mathrm{Q}_o}{2} - \mathrm{Q}\right) \quad . \quad . \quad . \quad . \quad (4)$$

Q is the shaded area in Fig. 2. Having fixed on a value of I, we find by planimeter the corresponding area Q, and from (4) the corresponding value of the flux ϕ. It is thus easy to find by means of a planimeter corresponding values of I and ϕ, and to plot these as shown in Fig. 3. The hysteretic energy per cycle is obviously

$$\mathrm{E} = \frac{n}{100} \times \text{area of loop.}$$

If there are no joints in the carcase, and its cross-sectional dimensions are such as to make the induction the same in any part, the true B-H loop can, of course, be plotted, and the permeability as a function of the induction may also be found. In most cases, however, a knowledge of the

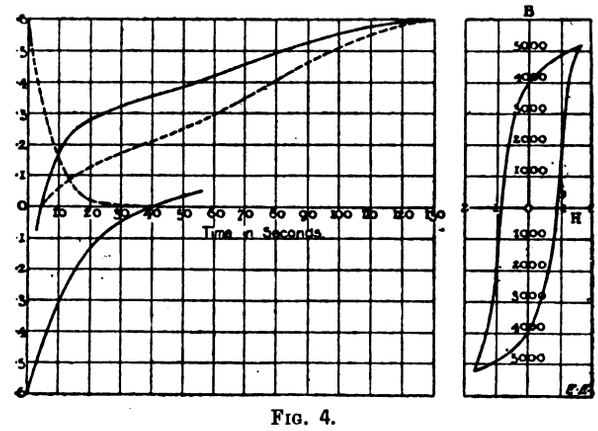

FIG. 4.

exact shape of the B-H loop and of the permeability is of secondary importance; what we require is a knowledge of the hysteretic loss in the whole transformer, and this may be found graphically from Fig. 2 without even drawing Fig. 3.

The hysteretic energy absorbed by the carcase in one half-cycle is obviously the difference between

$$e\int_o^{t_1} \mathrm{I}\,d\,t,$$

the total energy supplied, and

$$\mathrm{R}\int_o^{t_1} \mathrm{I}^2\,d\,t,$$

the energy lost in copper heat. The latter quantity may be expressed in the form

$$\mathrm{R\,I}_o\int_o^{t_1} \mathrm{I}\frac{\mathrm{I}}{\mathrm{I}_o}d\,t \text{ or } e\int_o^{t_1} \mathrm{I}'\,d\,t,$$

where $\mathrm{I}' = \mathrm{I}\,\frac{\mathrm{I}}{\mathrm{I}_o}$ can be determined graphically by the construction shown by dotted lines in Fig. 2. The hysteretic energy for one-half cycle is, therefore,

$$\frac{\mathrm{E}}{2} = e\int_o^{t_1}(\mathrm{I} - \mathrm{I}')\,d\,t \text{ watt-seconds.}$$

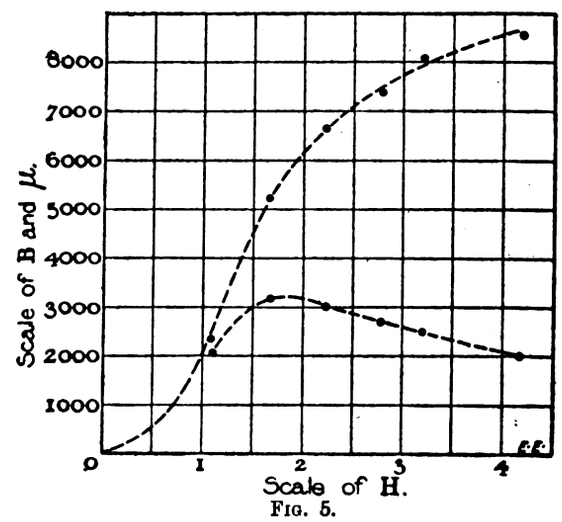

FIG. 5.

The integral is the area (expressed in coulombs) between the original time-current curve and the new I' curve shown in a dotted line. The area is to be taken with reference to the sign of the current—that is to say, negative up to the point $I = o$, and positive for $I > o$. By

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planimetering the two areas, and deducting that which is negative, we find

$$Q_h = \int_o^{t_1} (I - I')\, dt,$$

$$E = 2_1\, e\, Q_h.$$

This construction applies to any transformer, whether it has joints or not, and whether the induction is the same throughout the magnetic path or not.

By way of illustration, I give in Fig. 4 one of the time-current curves taken on a Westinghouse transformer of the shell type. The cross-sectional area of magnetic circuits is, in this case, constant throughout the path—namely, 200 square centimetres—its length is 53·8cm., and as there are no butt joints (the carcase is built up with overlapping plates) it was possible in this case to find the true shape of the hysteretic loop. This is drawn to the right of the time-current curve. In the test to which Fig. 4 refers n was 120, $R = 0{\cdot}1$, $e = 0{\cdot}06$, $I_o = 0{\cdot}6$.

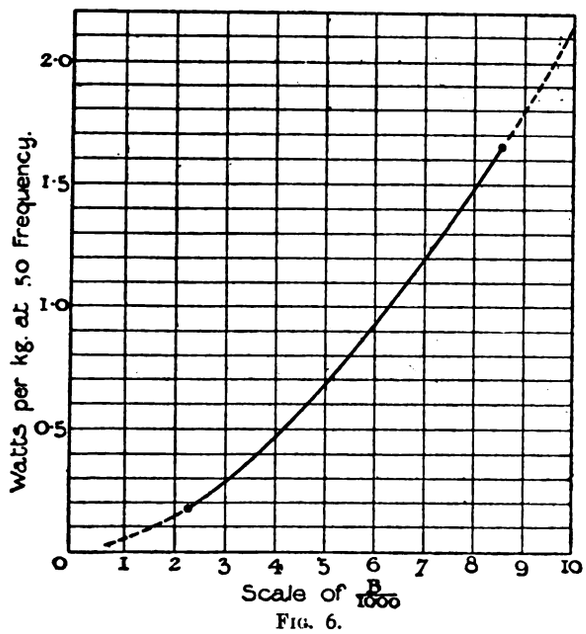

FIG. 6.

To obtain greater accuracy in the planimetric measurements, the I and I′ curves up to zero are drawn to a time scale magnified tenfold. Tests were also made with values of I_o ranging from 0·4 to 1·5, A corresponding to values of B from 2,300 to 8,600 respectively. From these tests the conjugate values of H, B, and μ are plotted in Fig. 5, whilst Fig. 6 gives the curve of hysteretic loss per kilogramme of iron at 50 frequency.

THE FAILURE OF THE PRODUCER GAS-DRIVEN CENTRAL STATION (AND A SUGGESTION).

BY W. T. WARDALE.

From the earliest days of public electricity supply from central stations, the high fuel economy and small stand-by losses of the producer gas-driven generator have had a great attraction for central-station engineers, and in various towns and at different periods gas-driven stations have been put down; but in spite of the fact that every possible chance has been afforded the interested parties in order to help them over their difficulties, there is not at the present date a successful public electricity supply of any magnitude which depends solely on gas-driven plant.

In many private plants of some magnitude in works in various parts of the country there are reported to be gas-driven sets of sizes up to 800 kw. which have been running successfully (and continuously in some cases) for fairly long periods. On making private inquiries from the engineers in charge of some of these plants, and of inspectors having them under supervision for various insurance companies, the writer finds that in many of the most often quoted cases there is a great deal of trouble and anxiety in keeping the plant running, caused chiefly by pre-ignitions, and that the term "giving every satisfaction" can only be taken as the usual contractors' formula in most of these cases—the greatest fault being that the plant *may* run for six months on end without a stop if carefully and constantly tended and nursed, or it may pull up (and often does so) at any minute.

In the public supply of electricity, the most important point is to maintain continuity of supply; therefore ability to work day in day out, whether in first-class or tenth-class condition, is a necessary attribute of the prime mover used in central stations, whilst economical working comes afterwards. Now, in order to get very high fuel economy, gas-engine makers have pushed the compression higher and higher, and this—and excessive speed in some cases—in the opinion of the writer, is the cause of most of the trouble with gas-driven sets—the reason being as follows: in the majority of stations anthracite is out of the question as a fuel, and bituminous or semi-bituminous coal must be used in the producer. Now one set of producer makers claim to turn the tar in the coal into a fixed gas, whilst the rest of the producer makers and their chemists deny that it is possible to do this, and so attempt to wash out all the tar. In practice what happens is that by neither process is all the tar and foreign matter taken out of the gas, with the result that the tar and other impurities are gradually deposited on the back of the piston and in handy spots in the combustion chamber; in a short time lumps of this tarry matter become formed, having a more or less pointed end. When the engine has been working for some time they gradually become heated, and not being of the correct shape, or having enough surface to dissipate this heat during the cooler parts of the working cycle, a time soon arrives when they have reached such a temperature that, when the compression stroke is taking place, the rapid rise in pressure, due to the compression, heats them to glowing point and ignites the mixture before the compression stroke is finished, thus causing the engine to pull up and throwing tremendous strains on all its working parts. Now if the engine was worked with a somewhat lower compression, it would follow that these lumps of tarry dirt would not be as likely to reach a temperature sufficiently high to fire the charge. That this is so is amply proved by the number of gas-engines of moderate powers which were built to work at a lower compression than is in use to-day, and which have rarely given serious trouble, pre-ignition being quite rare, if not altogether absent, in these engines. The question is at once asked, But what of the fuel economy? This would at once send up the amount of coal necessary per unit generated. The contention of the writer is that the gas-engine can increase its full consumption by 10 or 15 per cent. and then be a long way ahead of the best steam-engines, whilst the extra reliability and freedom from stoppage thus obtained would more than compensate for the extra fuel used. At the present date the gas-engine starts its life with a very high fuel economy, which, after a few months' working, is found to have increased somewhat considerably, and to involve a very high maintenance and depreciation charge. Overhauling must be very frequent if anything like constant work at fair economy is to be obtained, and at the end of two or three years' working it is found that the plant, in spite of the best care and attention, has depreciated far more than a steam plant of equal capacity; that its economy is less than that of the steam plant and its charges for upkeep considerably higher, while it cannot be relied on for constant hard work at or near its full load to nearly the same extent as the steam plant.

In conclusion, it should be borne in mind that the writer is referring to plant used in public electric supply stations of some size—say not below 2,000 kw. capacity, and using units not smaller than 300 kw. to 400 kw. Further fuel economy should be sought by expanding the flaming gas further than is done at present, and although clever brains have been, and are still, at work on this problem of expanding the flaming gas to lower pressures before exhausting it, the matter seems exceptionally difficult. That it will be ultimately and shortly accomplished is the wish of every central-station engineer, and the firm who can build gas-engines with the high fuel economy which is the great point of the gas-engine, and the reliability and low cost of upkeep of the steam-engine, will find a wide market awaiting them.

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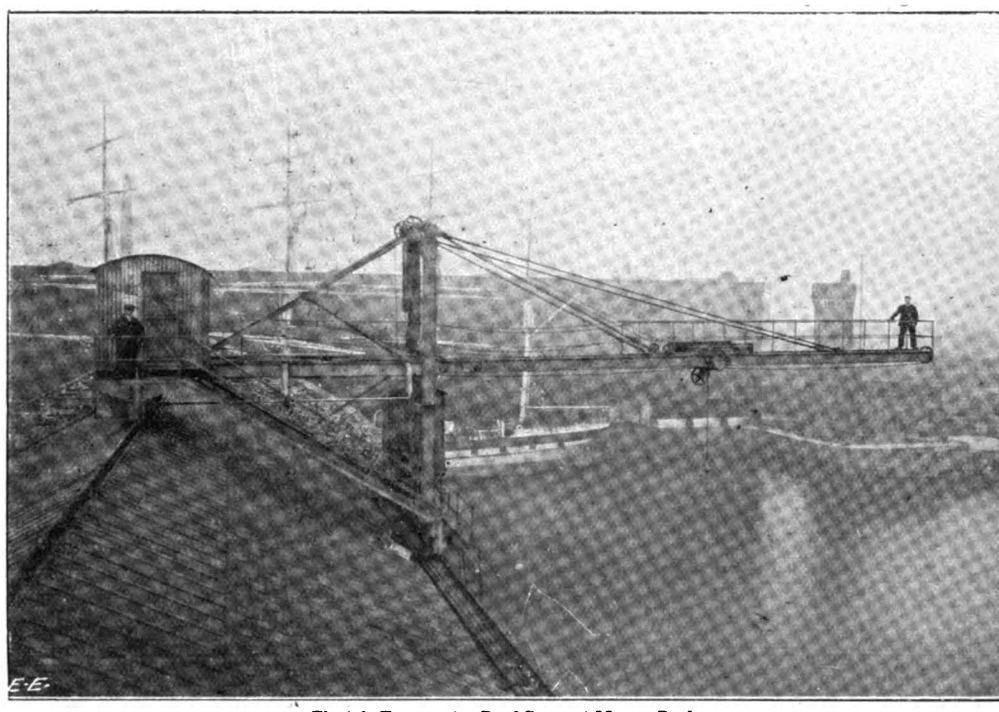
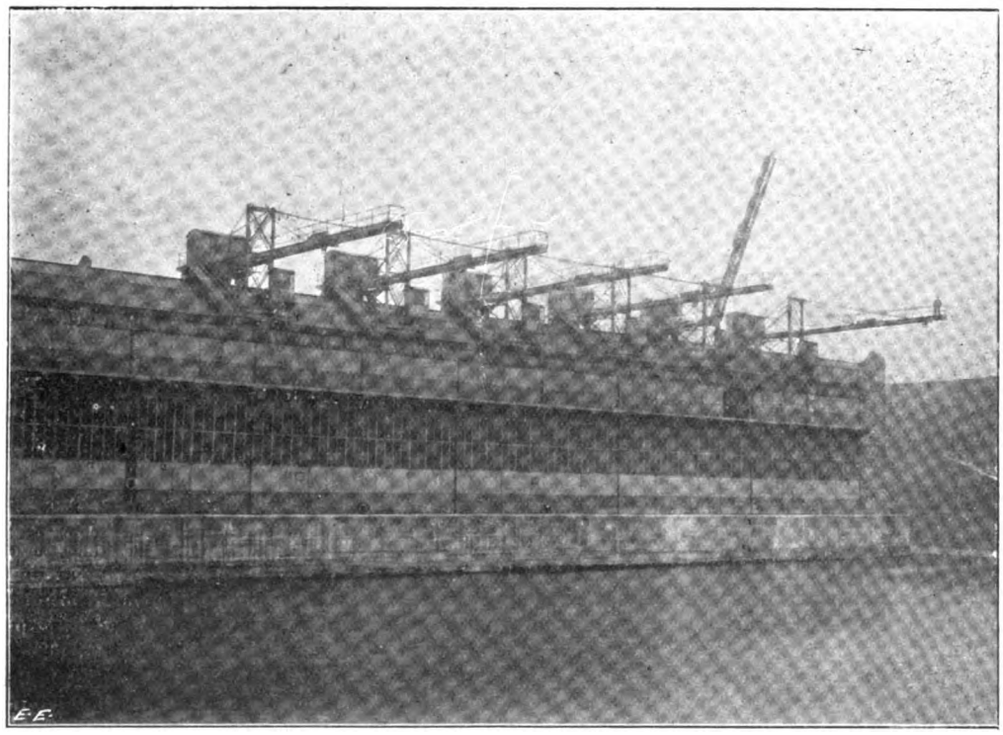
TRANSPORTER ROOF CRANES AT THE LIVERPOOL DOCKS.

The Mersey Dock Board are noted for the progressive policy which has enabled the trade of Liverpool to withstand outside competition. Amongst the latest improvements adopted are the cranes described below. These 30cwt. electric transporter roof cranes (Fig. 1) are fitted on the top of a shed adjoining King's Dock No. 1 North. They were constructed by Messrs. Applebys, Limited (an amalgamation of Jessop and Appleby Bros., Leicester and London, Limited, and the Glasgow Electric Crane and Hoist Company, Limited), London, Glasgow, and Leicester, to the order of the Mersey Dock and Harbour Board. They are in constant use for the rapid discharging of cargo vessels, and are constructed for running along the roof of the shed, having special carriages arranged respectively at the foot of the mast and underneath the rear end of the tail girder. In unloading a vessel the arrangement is such that, when the load has been raised to the requisite height, a motion of a lever will cause it to rack inward without the necessity of stopping the motor first, and when a load is being racked outward, it can be lowered by a motion of the lever directly the requisite distance out is attained.



Electric Transporter Roof Crane at Mersey Docks.

The cranes (Fig. 2) are each constructed to lift a working load of 1½ tons at a maximum outreach of 47ft. from the centre of the lower rail, variable to a minimum outreach of 3ft. 6in.; to run on rails distanced about 19ft. $9\frac{1}{16}$in. from centre to centre in a horizontal plane, and about 10ft. $3\frac{13}{16}$in. from the top of one rail to the top of the other rail in a vertical plane; and to have a vertical lifting range of 76ft. Each crane has four motions—viz., lifting, racking, travelling, and hinging up the jib. The lifting and racking gears are connected together by a coil friction clutch and driven by one motor in such a manner that when the clutch is out of gear the lifting motion is performed, and when the clutch is in gear the racking motion



Group of Electric Transporter Roof Cranes at Mersey Docks.

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is performed either backwards or forwards in accordance with the direction in which the motor is run. The hinging up of the jib can be performed alternatively by a small motor or by hand. The motors are of Messrs. Vickers, Sons, and Maxim's make, being of their enclosed, watertight, multipolar, reversible, series-wound type, fitted with radial carbon brushes. The lifting and racking motor gives 32 b.h.p. running at about 500 r.p.m., the travelling motor 5 b.h.p. running at about 600 r.p.m., and the jib hinging motor 3 b.h.p. running at about 1,000 r.p.m. The controllers are three in number, one for each motor, of the barrel type, similar to those used on tramways, totally enclosed and fitted with magnetic blow-outs, and of the Electric and Ordnance Accessories Company's manufacture. The resistances are of the cast grid type, of the same make as the controllers, and connected to them by means of insulated cables. These resistances are rated so that the full current can pass through them for five minutes without injurious heating. The lifting and travelling controllers are connected by means of universal gearing in such a manner that one hand lever only will be used for both motions. The arrangement is such that an up-and-down motion is given to the lever for lifting and lowering the load, and a right-hand and left-hand motion for travelling the crane backwards and forwards. A separate controller with ordinary crank handle is provided for jib hinging.

The working speeds of the cranes are as follows:

Lifting with 30cwt. load about 250ft per minute.
Lifting with no load about 700ft. per minute.
Racking with 30cwt. load about 300ft. per minute.
Racking with no load about 400ft. per minute.
Travelling with no load about 60ft. per minute.
Jib hinging with no load in about two minutes.

The lifting and racking gears each consist of a cast-iron barrel 16in. diameter, grooved in the lathe, the lifting barrel being fixed and the racking barrel being loose on the shaft, and a single reduction of steel machine-cut spur gearing, totally enclosed in a cast-iron case. The pinion in each case is a solid forging, and both spur wheel and pinion have bearings on either side. The ropes are of extra special flexible quality, 2in. in circumference, with a breaking strain of 16¾ tons.

The brake strap is of steel with wood blocks, being weighted to keep the brake on, the release being effected by a solenoid in series with the motor, so that when current is applied to the motor the solenoid releases the brake. The brake can also be released by a hand lever not affected by the solenoid. Lowering is effected normally by simply releasing the brake band by means of the hand lever, and in the case of the empty hook a slight impetus may be required, which can be given by starting the motor with current. The fact that the motor revolves when lowering is, in this case, no objection on account of the slow speed at which the motor runs. This brake is at once very simple and highly efficient, and has been applied to more than a hundred cranes of the type with the most satisfactory results. The hinging gear consists of a cast-iron barrel, 8in. in diameter, grooved in the lathe right hand and left hand, and one reduction of worm and one of spur gearing. The worm wheel is of phosphor bronze, machine-cut, and the worm of best mild steel, cut from a solid blank, double-threaded and fitted with ball thrust bearings; the whole gearing being enclosed in a cast-iron case and run in an oil bath. The spur wheel and pinion are of steel, machine-cut. The hinging brake is a mechanical device operated by the axial thrust on the worm, and consists of laminated gunmetal discs and steel ratchet wheels fitted with ball thrust bearings. The arrangement is such that when lifting the worm revolves on the ball thrust bearings, and the ratchet wheels are out of action and noiseless, but when lowering the ratchet wheels are in action and held stationary by the pawls, so that the gunmetal discs only revolve, and have thereby to overcome the friction between the discs and ratchet wheels. This mechanism is totally enclosed in an oil bath, and revolves with great smoothness and exactitude. The mast is built up of 12in. by 3½in. steel channels well stiffened throughout and cross braced on both sides, the top of the mast being arranged for carrying the rope guide pulley used in raising the jib. This jib consists of two 12in. by 3½in. steel channels hinged to the middle of the mast, and connected to the top of the latter by means of two flexible wire ropes 2¾in. in circumference. The two main channels are connected rigidly together at the centre by means of angle bracing and gussets. On this bracing wood planks are arranged, forming a footway, to enable a man to walk along the jib, protected by a suitable handrailing on both sides. The end of the handrailing nearest the mast consists of wire rope, to enable the jib to be raised to the requisite height. The tail girder consists of two channels of the same section as the mast and the jib, the girder being connected to the mast by means of strong gusset plates, both mast and girder being stiffened top and bottom by means of angle bracing. Suitable framed undercarriages are provided, consisting of strong steel channels, one carriage being arranged at the bottom of the mast and one underneath the rear end of the tail girder, both being firmly secured by means of steel channels and distance pieces. Each of the carriages is fitted with two cast-steel travelling wheels with machined treads. All shafts are of mild steel, and the bearings of cast iron fitted with caps and gunmetal bushes. Screw-jacks and rail-clips are fitted on both carriages. The travelling gear consists of three reductions of spur gearing, all steel and machine-cut, the second and third reduction being in duplicate, while the motion is transmitted to the travelling wheels of the rear carriage by means of mitre gearing arranged on a vertical and horizontal shaft, and driven by the travelling motor fixed in a convenient position on the front carriage. A suitable house is provided enclosing the lifting, racking, and hinging machinery, and a house is also provided on the top of the front carriage to contain the operator, controlling gear, and the necessary tools, etc.

In conclusion, we have to thank Mr. Anthony George Lyster, engineer-in-chief to the Dock Board, for the facilities extended to us in connection with the preparation of this article.

HOT-WIRE WATTMETERS AND OSCILLOGRAPHS.*

BY J. T. IRWIN, ASSOCIATE MEMBER.

(*Continued from page 60.*)

The arrangement shown in Fig. 18, where an auto-transformer is used, has some advantages over that shown in Fig. 17, especially where the voltage is small across the load, and where the main current is large.

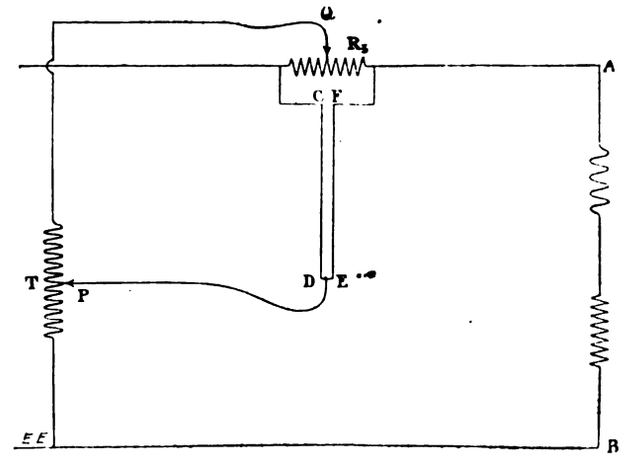

FIG. 18.

In the first place, the C R drop in the auto transformer does not introduce such a large error, as part of it is now useful in giving a current through the strips, and the leakage coefficient between the whole winding, T, and the portion, P Q, across which the strips are connected in parallel, is reduced. It is evident, however, that the magnetising current of the auto-transformer must be very small compared with the main current flowing in the circuit A B. When this is the case, the deflection of the instrument will be proportional to the power spent in the circuit Q A B,

* Paper read before the Institution of Electrical Engineers.

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and, since the point Q is the middle point of the resistance R_3, the power spent in the circuit A B = K deflection $= \frac{C^2 R_3}{2}$, where C is the R.M.S. value of the current in the circuit. It is known that a hot-wire instrument arranged to measure watts can be used as an ammeter or voltmeter. Thus suppose in the arrangement shown in Fig. 16 the strip E F is not connected at F to the resistance R_3, then there will be a current through C D proportional to the main voltage across the load, V, and, therefore, the deflection is equal to $k_5 V^2$. If, instead of this arrangement, the point D is connected to R_3 so that the strip C D shunts the resistance R_3, and if the circuit, D H, is broken, then there will be a current in C D proportional to the main current, C, and, therefore, deflection $= k_6 C^2$. By the use of suitable constants it is, therefore, possible to use the same instrument and the same scale for current, pressure, and power.

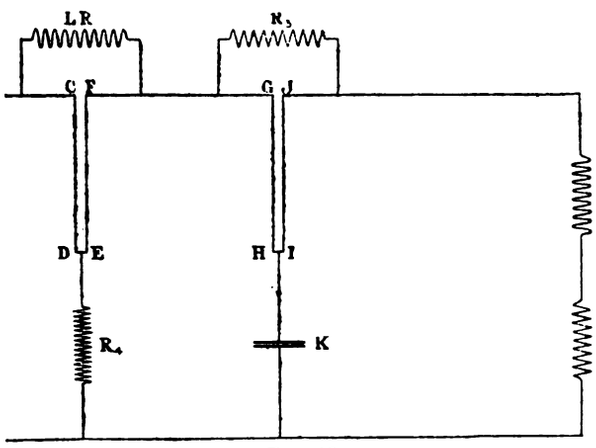


FIG. 19.

To enable the instrument to indicate instantaneous watts it is necessary, as was seen above, to have the rate of heating at every instant equal to $V C + k_7 V \dot{C} + k_7 C \dot{V}$. A method of arriving at this is shown diagrammatically in Fig. 19, where L R is an inductive resistance and R_3 a non-inductive resistance placed in series with the load, A B. The two strips, C D and E F, are placed in series across L R. The resistance R_4 connects the points D and E to the opposite main. The strips G H and I J are connected in series across the resistance R_3, and the points H and I joined to one terminal of the condenser, K, the

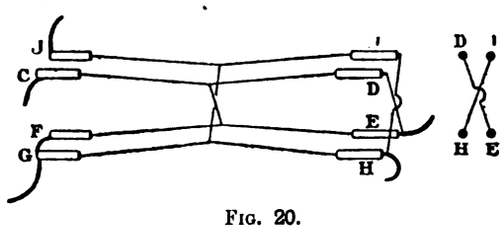


FIG. 20.

other terminal being connected to the opposite main In the strip C D there will be a current practically proportional to $V + k_8 C + k_9 \dot{C}$. In the strip E F there will be a current proportional to $V - k_8 C - k_9 C$. The difference in the rate of heating of the strips will be proportional to

$$(V + k_9 \dot{C} + k_8 C)^2 - (V - k_9 \dot{C} - k_8 C)^2$$
$$= 2 V (2 k_9 \dot{C} + 2 k_8 C)$$
$$= 4 k_8 V C + 4 k_9 V \dot{C}.$$

In the strip G H there will be a current proportional to $C + k_3 \dot{V}$, and in I J a current proportional to $k_3 \dot{V} - C$. The difference in the rate of heating of these two strips will be proportional to

$$(C + k_3 \dot{V})^2 - (k_3 \dot{V} - C)$$
$$= 4 k_3 C \dot{V}.$$

It is easy to arrange, as shown in Fig. 20, that the instrument itself shall have a deflection depending on the sum of the lengths of the strips C D and G H, minus the sum of the lengths E F and I J—that is, the strips C D and G H really form one strip, and the strips F E and I J another strip. In Fig. 20 the pulleys are replaced by a block which is pulled back in the same manner as the pulleys by a spring. The four connections, D H I E, instead of being connected D to H and I to E as in the case of the ammeter and voltmeter, are now connected diagonally D to E and I to H, and the wires are still tied together diagonally at the middle point. The letters used in Figs. 19 and 20 refer to similar parts. Now the difference in the heating of these two strips is proportional to

$$4 k_8 V C + 4 k_9 V \dot{C} + 4 k_3 C \dot{V},$$

and if the values of k_8, k_9, and k_3 are properly chosen, the instantaneous difference in the temperature of the two strips will be proportional to the instantaneous power. If the instrument has a high enough natural period and is properly damped, the deflection will be at every instant proportional to the power. The author generally mounts three instruments together to show at the same time three waves—say, current, P.D., and power. Three P.D. waves can be shown at once—say, the P.D. across a resistance and inductance in series, and the P.D. across the resistance, and the P.D. across the inductance separately.

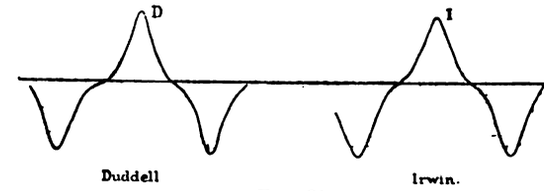
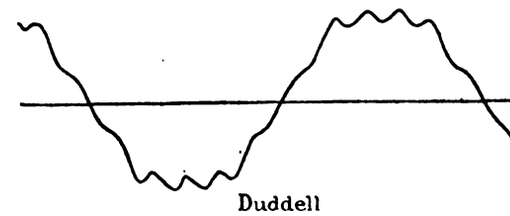


FIG. 21.

As the instruments can quite easily have independent exciting circuits, say a small four-volt battery for each, and as the wires for each instrument can be easily insulated from the others and from the case, it is possible to have a potential of 200 volts or more between the various instruments, as long as care is taken in making the connections.

The instrument is made with three elements and is very compact, weighing complete with its levelling screws only 1¾lb. The mirrors are fairly large, being 4m. by 1·5 mm. for projection purposes; the natural period is about $\frac{1}{4000}$th of a second, but it can be made much less by using a smaller mirror and tying back the wires more at the centre—in fact, if necessary, any natural frequency up to 20,000 per second is quite possible. Altering the tension with which the wires are stretched does not alter the natural period



Duddell

FIG. 22.

very much, the amount the wires are tied back having a greater influence than the tension. In a particular case, altering the tension on one instrument from 10oz. to 6·6oz. only increased the natural period from $\frac{1}{3200}$th of a second to $\frac{1}{2900}$th of a second. It is, of course, true of this instrument, as of all other instruments which are damped in oil or any liquid, that the damped period is longer than the undamped, owing to the oil put in motion by the vibration of the mirror and wires. An oscillograph with a natural frequency of 3,200 in air had a frequency of 2,360 in paraffin oil. This oil was not quite sufficient to damp out the vibrations caused by sending a square wave through the strips, and so the natural period under these conditions could be observed by means of a falling sensitised plate. The ratio of the period in oil to that in air depends on the specific gravity of the oil, on the mass of oil that has to be moved when the strip vibrates, and to a certain extent of the viscosity on the oil.

The sensibility of a hot-wire polarised instrument can only be given for a steady current through it and for a given exciting current. Thus the instrument of the size

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shown in Fig. 20, when the strips are immersed in castor oil and are excited with 0 5 of an ampere in each, will give a scale deflection of about 30mm. at a metre scale distance when another current of 0·10 of an ampere is sent through the two strips in series. The deflection it will give when an alternating current of constant R.M.S. value and wave-form is passed through depends on the frequency; thus the instrument would give a wave of approximately 100mm. amplitude at a metre scale distance, when excited with 0·5 of an ampere and a simple sine wave of alternating current of 40 ~ and a R.M.S. value of 0 35 of an ampere is sent through it, but at double the frequency for the same deflection the current would have to be doubled, except for the smaller radiation of heat that takes place from the wires in the shorter time of a complete period. The fusing current is four amperes in this oil. As shown, however, earlier in the paper, the deflection can be made proportional at every instant to the instantaneous voltage across two points, or to the instantaneous current flowing in a circuit independent of the frequency, and this although the instantaneous deflection is not proportional by any means to the current flowing through the instrument itself. Since the difference in rate of heating of the wires is equal to $4\,a\,b\,r$, where b and r are constant, the difference in the rate of heating of the two wires is proportional to a and the temperature difference to $a\,t$ or quantity of electricity that has passed through them. Then, if there is comparatively little difference in the rate of radiation compared with the difference in the amount of heat stored in the strips in a given cycle, or if the difference in the heat radiated can be compensated for, the deflection of the instrument will be proportional to the quantity of electricity that has passed through it, and can be used to indicate the instantaneous flux linking with a circuit. This is very useful for drawing hysteresis loops for iron or showing the instantaneous value of the quantity of electricity stored in a condenser.

Experimental Results.

Voltage Curves.—One of the first machines for which the voltage curve was obtained was the Pyke and Harris inductor alternator at the Central Technical College. This machine was the one from which Mr. Duddell obtained a curve by his oscillograph in its early stages and compared it with that obtained by the point-by-point method. He showed that the two curves were practically identical, so that the author had only to compare a curve obtained by his oscillograph with one obtained by a Duddell instrument. This is shown in Fig. 21, D being the curve obtained on a Duddell projection oscillograph and I the curve obtained on the author's instrument. The two curves are so nearly alike that it is almost impossible to detect any difference even when two tracings of the curves are superimposed. In this case the author's instrument was damped in paraffin

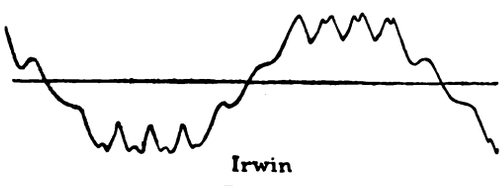

Fig. 23.

oil, which was found afterwards not to give quite enough damping. This want of damping is shown more clearly in Fig. 23, which represents a wave having ripples of a much higher frequency taken on a falling sensitised plate. Fig. 22 shows the same wave as recorded by a Duddell oscillograph having a natural frequency of 10,000 per second. It was found by sending a square wave of current through it that the Duddell was slightly over-damped. Fig. 24 shows two curves for current and P.D. on a non-inductive load, and it will be seen that they are practically in phase with each other and of the same wave-form. In this case the wires were properly damped in castor oil. The drop of potential across the inductive resistance, L R, was only about 1·5 volts, and, therefore, did not alter the current or the angle of lag much, as the voltage across the non-inductive resistance, R, was about 150. Fig. 25 shows the current and P.D. curves on a partially inductive load, Fig. 26 the current, P.D., and power curves on a non-inductive load, and Fig. 27 the current, P.D., and power curves on an inductive load. It is evident that the power curves are incorrect, but it is not easy to adjust the currents in the wattmeter wires to the theoretical values they ought to have. The author has developed a new method of damping by which it is possible to dispense with the damping oil altogether, or else to have a damping liquid much less viscous than castor oil and not affected by variation in temperature. The method consists in so damping the electric current through the instrument that the deflection is proportional to the quantity it is desired to record. Suppose in Fig. 9 a resistance, R_6, is inserted in series with the condenser, K, and the resist-

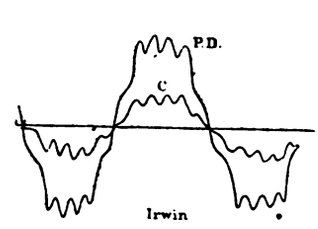

Fig. 24.

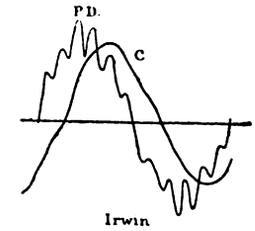

Fig. 25.

ance R_4 is now placed across both the condenser and R_6. Then when a nearly square wave of P.D. is applied across the points A B the current flowing into the condenser when the P.D. changes suddenly is proportional to $\frac{d\,V}{d\,t}\,\frac{1}{R_6}$. The quantity of electricity that flows into the condenser in a very small time $d\,t$ is proportional to $\frac{d\,V}{R_6}$. This quantity flowing through the strips will produce a difference in their temperature proportional to $\frac{d\,V}{R_6}$, and, therefore, the initial force acting on the moving parts is reduced as the resistance is increased. This initial diminution of the force acting on the moving parts is to be depreciated, inasmuch as it reduces the steepness of the curve P.D. If the resistance R_6 was very large, the quantity of electricity in the condenser would increase comparatively slowly and the oscillograph would indicate this accurately, and would, therefore, show the P.D. curve rounded off; just as with ordinary oil damping the steepness of the curve is reduced and the curve rounded off as the viscosity of the oil is increased. As the resistance R_6 is decreased the rounding off of the curve diminishes, and the mirror would eventually have a throw greater than that corresponding to the impressed voltage across A B. The critical resistance is that which limits the deflection of the instrument when a

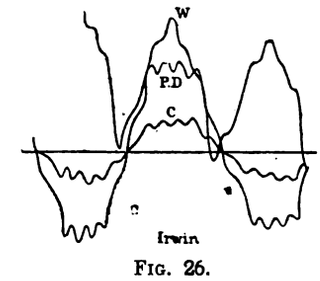

Fig. 26.

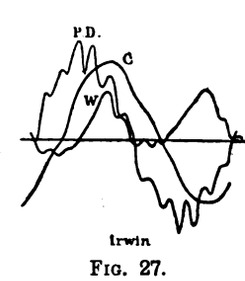

Fig. 27.

sudden P.D. is applied to what it would have if a steady P.D. of the same value were applied across A B. It is possible to damp the current wave by putting a resistance in parallel with the self-induction across which the strips are placed. This is necessary when the damping due to the strips themselves is not sufficient. When a transformer is used, it is only necessary to increase the secondary ampere-turns compared with the primary ampere-turns to secure increased damping. The hysteresis curve shown in Fig. 28 is from the iron in a transformer. At this point it would be well to describe the arrangement of drawing rectilinear curves adopted by the author. There have been rectilinear curves drawn by a moving spot of light for hysteresis and other curves, by having, say, two oscillographs, one indicating flux and the other P.D., with the plane of the mirrors normally parallel and their axis of rotation at right angles, or the equivalent of this obtained by rotating the plane in which a beam of light reflected

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from the mirrors would vibrate by a reflecting prism as shown by Morris and Catterson-Smith and by Witteman. There is, however, no necessity to go to the trouble of fitting up this special arrangement, as by the simple arrangement shown in Fig. 29 the curve can be drawn. A is a source which gives a beam of light on M_1, the mirror on the oscillograph. This mirror, which has a deflection proportional, say, to the magnetising current of a transformer, reflects the beam on to the mirror M_2, which has

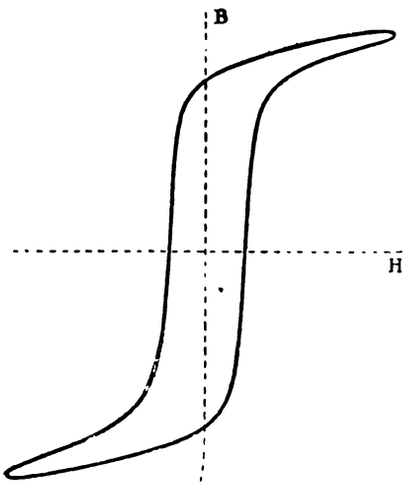

FIG. 28.

its axis of rotation at right angles to M_1. If the mirror M_2 is oscillated by a synchronous motor, and if the phase of the displacement is exactly in phase with the flux in the transformer, then the beam of light will draw out a L (which oscillates the mirror M_2 about its centre), is kept pressed against it. The lever is fairly long in comparison with the throw of the eccentric, so the motion of the mirror is nearly simple harmonic. A sine wave P.D. is impressed on the transformer, then the back E.M.F. must be also a sine wave and the flux a sine wave; therefore if one can

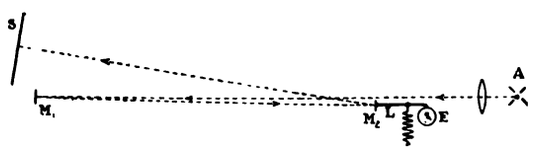

FIG. 29.

vary the position of the eccentric on the shaft until its maximum throw corresponds with the maximum flux in the transformer, and if the mirror M_1 has a deflection proportional to the magnetising current, then the beam of light will draw out the hysteresis curve. There is another method of drawing hysteresis loops where the E.M.F. wave does not compel the magnetising current to be nearly a sine wave—namely, by putting a large self-induction without hysteresis curve on the screen, S. To effect this, an eccentric, E, is placed on the shaft of a two-pole synchronous motor of the type shown diagrammatically in Fig. 30, and a lever,

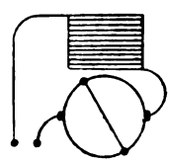

FIG. 30.

iron in the core in series with a small magnetising coil wound on the test piece of iron. A hot-wire oscillograph is connected across this magnetising coil or across a secondary. Since the deflection of the oscillograph is proportional, if the frequency is high, to the quantity, it will be proportional to the flux: therefore, one has only to make the deflection of mirror M_2 proportional to the magnetising current and the hysteresis loop will be drawn out. The objection to this method is that there is no exact method of compensating the strips for their difference in rate of losing heat, since to secure compensation would require a current proportional to the flux as well as to the rate of change of flux to be flowing through the instrument a every instant.

(To be continued.)

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

TWELFTH ANNUAL CONVENTION.

(Concluded from page 53.)

Some Notes on Alternating-Current Distribution.

BY A. J. CRIDGE, ASSISTANT ELECTRICAL ENGINEER, SHEFFIELD.

It is proposed to draw the attention of the association to some points connected with the distribution of alternating currents, especially where the supply of electricity for power is undertaken, and to show in the form of curves and concise tables a few of the results obtained in the course of the last three or four months on the Sheffield system. The number of electric motors connected to the mains is 831, aggregating 7,000 h.p., or 5,250 kw., and the supply is alternating current, single and two phase, 50 periods, 200, 400, and 2,000 volts.

Theoretical Considerations.—It is well known that the amount of power in a direct-current circuit is found by multiplying together the pressure and the current, but the matter is not so simple when alternating current is used. If we assume that the E.M.F. of the generators conforms to a simple sine law, then, if there be no disturbing element in the circuit, the current will also alternate according to a sine curve, and it will be exactly in step with the pressure. The virtual current—that is to say, the direct current which would exercise the same heating effect—is the square root of the mean square of the instantaneous values of the current taken over a complete period. When the current flowing is in phase with the pressure, then the power in the circuit is equal to the product of those two quantities. When an E.M.F. is impressed on an inductive circuit, the resulting current builds up a magnetic field, which induces a back E.M.F., so that the current does not instantly rise to its full value. The impressed E.M.F. has to overcome the ordinary ohmic resistance of the circuit, and, in addition, the induced E.M.F. referred to, and the pressure, V, required to drive a virtual current, C, through a circuit of resistance, R, and self-induction, L, is found from the expression $V = R C + L \frac{d C}{d t}$ where $\frac{d C}{d t}$ is the rate of change of the current. In a direct-current circuit, where the voltage acts in one direction only, the rate of change of the current becomes practically zero in a very short time, but with alternating current the voltage goes through a complete cycle of operations many times in a second, the resulting current goes through the same number of cycles, the magnetic field is built up and destroyed as a result of the current, and the back E.M.F. induced by the magnetic field passes through the same number. The rate of change of the current is large, and the item $L \frac{d C}{d t}$ becomes more important in the above expression than the item R C. The greater L is, the greater is the back E.M.F., and, consequently, the current is forced more out of phase with the impressed voltage, and it

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is seen from Fig. 1 that during a certain fraction of every half-period it is actually flowing against the pressure. The power, W, is at any instant the product of the current, C, and the voltage, V, at that instant, and it follows that when the pressure and current curves are of opposite sign the power will be a negative quantity, and the effective value of the power will not be the same as the product of the virtual values of the pressure and the current.

An alternator working on an inductive load generates during one part of the half-period, but during the remaining part, when the power is a negative quantity, it absorbs power from the circuit, or acts as a motor. The ratio between the true watts, W, and the apparent watts, V C, is called the power factor of the circuit, and it is numerically equal to the cosine of

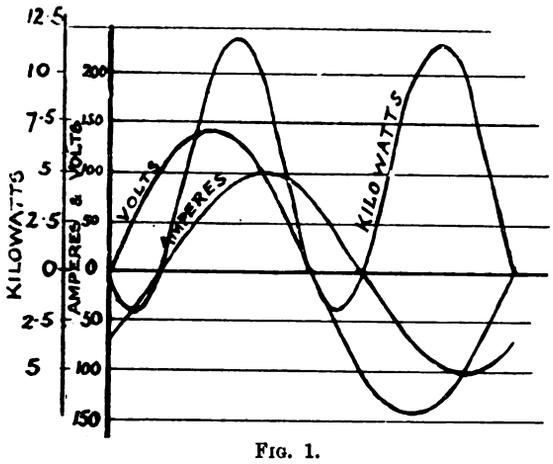

FIG. 1.

the angle by which the current curve lags behind the pressure curve. If, instead of self-induction, capacity be present in the circuit, similar reasoning holds good, but the symbol K, capacity, must be substituted for the symbol L, self-induction. The important difference is that the presence of capacity causes the current to be in advance of the pressure, while self-induction causes it to lag behind. Self-induction is much more frequently found than capacity in supply work, and for the remainder of this paper it will be spoken of as the cause of a low power factor, although it must be borne in mind that a circuit of high capacity is no better, from the distribution point of view, than a circuit having high self-induction. The current flowing in an inductive circuit is partly useful and partly idle, and the idle current is flowing in the machine windings and in the mains, to the disadvantage of the supply. The idle current may be considered to be lagging 90deg. behind the impressed E.M.F.; it is, of

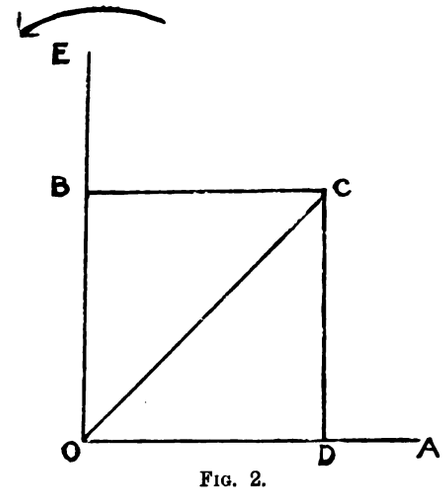

FIG. 2.

course, in phase with the induced or back E.M.F. The useful current may be considered to be in phase with the pressure. The current actually flowing in the circuit is the resultant of these two quantities. In Fig. 2 O E is a rotating vector representing the pressure, and O C represents the current, lagging by the angle whose cosine is the power factor of the circuit—in this case 45deg., for the cosine of 45deg. is $\frac{1}{2}\sqrt{2} = \cdot 707$, and a power factor in the neighbourhood of this number has frequently been obtained. From O draw O A at right angles to O E; from C let fall a perpendicular C D on to O A, and a perpendicular C B on to O E. The line O B represents the useful component of the current, and O D the idle current. The vectors are supposed to revolve in a counter clockwise direction about O. In any alternating-current motor the part O B depends on the work the motor is doing, but O D depends solely on the pressure. Provided that the voltage is sufficient to drive the motor, the lower it can be kept the less will O D be, to the improvement of the power factor and the gain of economy.

There are three sources of loss of power in an electric motor—viz., friction, copper loss, and iron loss. The friction is practically a constant quantity whatever be the load on the motor. Copper losses are proportional to the square of the current and to the resistance of the windings. Iron losses consist of the work required to overcome hysteresis and eddy currents in the magnetic circuits of the stator and rotor. We have then

$$\text{Total loss} = f + c\,r + (W_h + W_e).$$

When the pressure is reduced, the term in brackets is reduced more quickly than the second term is increased.

Practical Considerations.—A motor-generator used to furnish the direct-current supply in the centre of Sheffield has a capacity of 120 h.p., but it is not loaded to more than 40 h.p. as a rule. Fig. 3 shows the connections of one phase of the motor. In order to obtain some comparisons, a wattmeter, ammeter, and

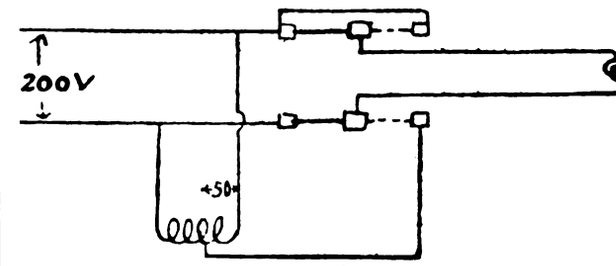

FIG. 3.

voltmeter were introduced into both phases, and readings were taken with the machine running at 200 volts in the ordinary way. The instruments were allowed to remain in the 200-volt circuit, and the machine was switched over on to the 50-volt winding of an auto-coil used for starting it. The figures given in Table I. show that the conditions were very greatly improved.

TABLE I.—Test of 120-h.p. Induction Motor Driving Direct-Current Generator in Sheaf-street Station, Monday, Feb. 18, 1907.

Volts.		Amperes.		Kilowatts		Kw. Total.	Power factor.	Time	Remarks.
A.	B.	A.	B.	A.	B.				
								a.m.	
210	209	33	32	6	6·1	12·1	·889	11.10	50 volts on stator.
210	209	55	55	10·4	10·2	20·6	·894	11.20	,,
209	210	130	130	10	9	19	·35	11.30	200 ,,
								p.m.	
210	212	48	48	9	9·2	18·2	·9	4.45	50 ,,
212	212	35	35	6·6	6·6	13·2	·89	4.55	,,

The power factor, which at 200 volts was ·35, at 50 volts became ·9, the kilowatts absorbed being the same. The output of the generator was not measured, but on adopting the system of running the machine on the low voltage a noticeable reduction in the number of units consumed each week was

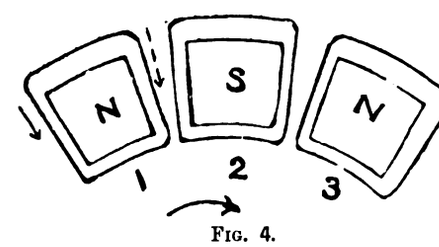

FIG. 4.

the result. It is convenient to consider here the effect of an out-of-phase current on the field of an alternator. In Fig. 4 let N S N be the poles of an alternator, and let 1, 2, 3 be three positions of one of the armature coils. The E.M.F. passes through its zero value in the positions shown, because then the rate of change of the magnetic flux through the coil is zero. Between 1 and 2 the direction of the current is that shown by the full-line arrow, between 2 and 3 that shown by the dotted arrow. When the coil is facing a pole, the current in the coil most readily affect the field. If the current be in phase with the E.M.F., then, being at zero in the positions shown, there will be no effect on the field. If the current be lagging behind the E.M.F., when the coil arrives at 1 there will be a current in it flowing in the direction indicated by the dotted arrow, and this will tend to weaken the field. Similarly, a leading current will tend to strengthen it. Any alternating-current generator will run as a motor if brought up to synchronous speed, but it will only run at that one speed, which depends on the frequency of the circuit. If an alternator be running as a synchronous motor, we see, by applying conversely the reasoning of the previous paragraph, that the current in the circuit may be caused to lag by weakening its field, and to lead

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by strengthening it, and that at a particular field strength the current will be exactly opposite in phase to the motor's back E.M.F. At this point the efficiency of working is greatest, but stability is gained by strengthening, or over-exciting, the field.

When a condenser is introduced into an inductive circuit, the lagging current is taken up by it, so that instead of flowing all the way between the inductive load and the generator it flows between the load and the condenser. The effect of running an over-excited synchronous motor in parallel with an induction motor is precisely similar—*i.e.*, the idle current flows between the synchronous motor and the induction motor. The power factor of the circuit is improved, and the carrying capacity of the generators and mains is increased by the amount of idle current of which they are relieved. If the power factor of the circuit under consideration be ·707, as indicated earlier in the paper, the wattless current is equal in amount to the useful current. It may be assumed that some 40 per cent. of the motors connected are running during the daytime when there is very little lighting in use, and these motors are situated in various parts of the distribution area. In one part of this area motors amounting to 2,500 h.p., or 1,875 kw., are installed. Assuming 40 per cent. as the proportion in use, we obtain 750 kw. of motor load. At 2,000 volts the useful current for this amount of power is 375 amperes, and with the power factor at ·707 the idle current is also 375 amperes ; the total current flowing in the mains is 531 amperes. To bring the power factor up from ·707 to unity it would be necessary to install a synchronous motor capable of dealing with 375 amperes of wattless current at 2,000 volts. This machine would require to be as near the source of trouble as possible, for the wattless current must be confined to the smallest possible portion of the network. It would be necessary to have some means of altering its field strength so as to increase or diminish its condensing effect according to the amount of idle current flowing, otherwise it might happen that the machine would actually cause a leading current to flow, and the power factor would still be low. At certain times of the day no remedial measures are necessary, because the power factor of the system is sufficiently high already. This is generally the case in the evening, when incandescent lighting constitutes the greater part of the load.

TABLE II.—Tests made on 1,500-kw. Parsons Turbo-Generator at Neepsend, Friday, March 8, and Saturday, March 16, 1907. (See Fig. 7.)

Time	Volts.		Amperes.		Kilowatts.		K.V.A.		Kw. Total.	K.V.A. Total.	Power factor.	Remarks.
	A.	B.	A.	B.	A.	B.	A.	B.				
a.m.												
11.20	2130	2120	345	360	530	520	735	763	1050	1498	·70	Friday 8-3-07
p.m.												
12.25	2130	2140	305	310	440	460	650	669	900	1319	·633	—
1.20	2120	2130	265	270	455	470	562	575	925	1137	·813	—
3.20	2190	2120	280	280	450	450	613	594	900	1107	·813	—
5.0	2200	2190	280	290	450	470	616	635	920	1251	·733	—
6.0	2230	2250	290	305	560	580	646	676	1140	1322	·864	—
6.10	2226	2228	320	335	625	700	723	763	1325	1486	·894	—
7.0	2228	2230	385	385	830	830	877	858	1660	1735	·957	—
9.0	2220	2220	75	80	155	160	167	177·5	315	344·5	·914	Machine out
p.m.												9.30 p.m.
6.5	2180	2190	85	70	180	140	185·3	153·3	320	338·6	·945	Saturday 16-3-07.
7.5	2290	2270	330	340	720	743	755	772	1463	1527	·955	—
8.5	2290	2270	340	355	732	800	780	806	1532	1586	·965	—
9.0	2270	2250	350	350	727	730	795	887	1457	1682	·923	—
10.0	2250	2230	360	367	760	780	810	818	1540	1628	·91	—
10.40	2150	2150	250	255	520	540	538	548	1060	1086	·975	—

In Table II., which gives some figures obtained during a test of one of the generators at Neepsend, it is shown that after 6 o'clock in the evening the power factor is well over ·9. Before that time it is in the neighbourhood of ·7, and sometimes less, so the improving device would be required to run during the day only. In the winter it would not be required for so many hours, and in the summer it might have to run for considerably longer. Fig. 6 shows the average daily power factors obtained during the year 1906. The results of tests given in the tables were obtained by means of the combination of instruments shown diagrammatically in Fig. 5. Multiple range series transformers for each phase, from 5 to 500 amperes, and two separate series transformers of 1,500 amperes capacity are provided, also shunt transformers for reducing the voltage from 2,000 to 200. One ammeter and one wattmeter for each phase are provided, and the current coil of the wattmeter is in series with the ammeter. The shunts of the wattmeters are connected independently of the series windings to the pressure terminals, and connections are also made from these terminals to a two-way switch, through which the voltmeter is supplied. Simultaneous readings can thus be taken of the current and the power in each of the two phases, and sufficiently close readings of the two pressures by means of the two-way switch. The product of the pressure and the current gives the apparent watts—the true watts are read directly—and the quotient of the true watts divided by the apparent watts gives the power factor. The power factors shown on the curve (Fig. 6) were obtained by the following means. The average of all the readings taken at intervals of 20 minutes during each day of the month is calculated and plotted on a curve. By calculating the area of this curve or measuring its area with a planimeter the apparent units generated during an average day of the month are found. The total units generated during the month, as measured by the station feeder or machine meters, divided by the number of days in the month, gives the number of true units generated during an average day

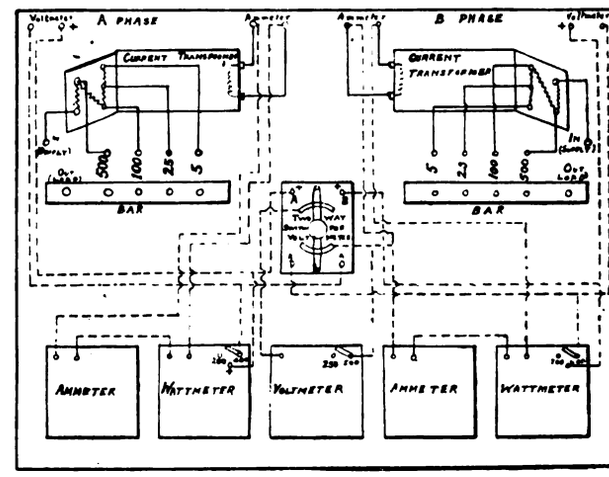

FIG. 5.

of the month. The quotient of the true units divided by the apparent units gives the average daily power factor. It may be of interest to notice, in passing, that in three-phase distribution, where the system is adopted of measuring the power by connecting the series coils of the instruments in two of the phase wires, and the two shunts to the third phase wire, the power factor is readily calculated from the readings of the instruments, for where

a = the reading on one wattmeter ;
b = the reading on the second wattmeter ;
θ = the angle whose cosine is the power factor of the circuit,

we have

$$\frac{a-b}{a+b}\sqrt{3}=\tan\theta.$$

Difference nearly always exists between the readings of two single-phase wattmeters connected in a two-phase power supply, and the difference is greater when the motor is running under light load, so that the circuit is rendered more inductive in character, and the power factor made low. There is no law similar to that given above which will apply generally to all all cases of two-phase working. It quite frequently happens that the readings of the meter in one phase are five or six times

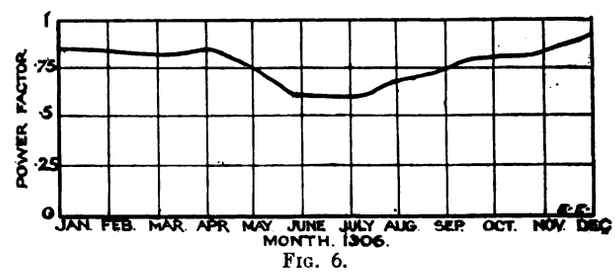

FIG. 6.

as great as the readings of the meter in the other phase, and sometimes one meter will go backwards, but it is always correct to take the algebraic sum of the readings of the two meters as the total consumption of power in the circuit. It might be possible that a law connecting the difference in the meter readings with the motor's power factor could be deduced for an individual motor, but it would not be general in its application, as the difference depends also on the windings of the motor and the supply voltage. Any inequality between the two phases in either would tend to render the readings unequal.

The machine about to be installed on the Sheffield system is required to relieve the plant and mains of the excessive amount of idle current which sometimes occupies them. It will be situated at the old generating station at Sheaf-street, and will serve to keep the trunk mains from Neepsend loaded at a power factor approximately equal to unity. It will be of 600 kilovolt-amperes capacity, and, in order to keep the starting current low, it will be started by a small induction motor, and switched

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into parallel on attaining synchronous speed in the same manner as an ordinary generator. A power-factor meter is to be provided so that the effect which the machine is producing may be read at intervals. The cost of the machine, with the necessary switchgear and accessories, will be about £800, and its consumption of electricity will be some 32 units per hour. This will be taken up in overcoming the friction, copper, and iron losses of the machine, as it will have no mechanical work to do. The cost of this power may be taken at ¼d. per unit—for distribution expenses are nil in the station—and, taking an average run of 15 hours a day for 300 days in the year, the amount will be £150 per annum. Cost of switching and attendance will be quite small, as no extra help will be needed beyond the present staff employed in the station. Capital charges at 6 per cent. are £48, and, with sundry amounts for exigencies, it would appear that the cost of running the machine for a year would not exceed £200. For this sum plant and mains to the extent of 420 kw. will be liberated. Extra plant to this amount would cost £5,000, without buildings or mains, and the capital charges alone would be £300. These approximate figures serve to give some idea of the improvement it is hoped to effect by the installation of the machine. The provision of another similar machine to be situated in a suitable sub-station in the power district previously mentioned was at first contemplated, but it was thought wiser to proceed with the motor at Sheaf-street as a commencement. There seems reason to hope that in the near future static condensers, energised by step-up transformers, will be available for the purpose indicated. These, although dearer in first cost, will absorb less power to a sufficient extent to make them commercially preferable, while the effect in respect of reducing the wattless current and of limiting the fall of pressure due to weakening of the fields of the alternators will be equally good. It is also claimed for this class of apparatus that the dangers which occasionally arise from resonance on opening the circuit, and from the presence of harmonics of a high order in the alternator wave, are practically eliminated, and that the wave-form is caused to be much more nearly sinusoidal. During the

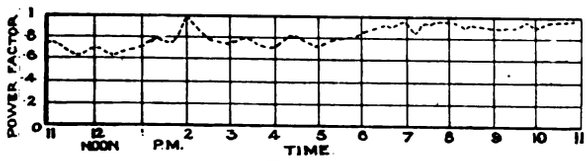

FIG. 7.

early part of last year the experiment was tried of running a 300-kw. Parsons turbo-generator at Sheaf-street as a synchronous motor, and over-exciting its field, and the greater carrying capacity gained for the mains was sufficiently marked to warrant the highest hopes for the success of the project which has been briefly outlined above.

It may seem to some that this paper is rather elementary in character in some of its parts, but as a rule central-station engineers have not the time to investigate these matters at first hand, and the theoretical knowledge gained through a technical college training is apt to become very rusty when exposed to the variable weather of practical experience.

Mr. LANGLEY, of Sheffield, considered that the author's statement of saving by using the over-excited generator was not carried far enough. He did not allow for the reduction in the copper losses in the cables. He advocated the use of the flywheels to prevent flickering due to the sudden changes of load.

Mr. C. H. YEAMAN, of Hanley, suggested that in many stations the small units could be converted into synchronous motors, and used for this purpose of correcting power factors. He had employed one or two of his original generators as motors for driving consumers' works.

Mr. C. TURNBULL, of Tynemouth, said that a flywheel could not have any effect when used with a synchronous machine.

Mr. S. L. PEARCE, of Manchester, said they distributed direct current as well as three-phase. The lowest recorded power factor at Manchester was 0·7. They compensated the idle current by using over-excited motor-generators for conversion purposes. He looked forward to the time when condensers connected through step-up transformers may be available for this purpose.

Mr. CRIDGE, in reply, said he had found a flywheel useful to keep the voltage more steady. He warned those present that the power factor could be over-corrected, as there was one system in London in which this was the case. The synchronous motor-generators more than compensated for the induction in the generators, etc.

TUNGSTEN ORES IN NEW SOUTH WALES.

If the exceptionally high efficiency which is promised by the tungsten lamp is eventually fulfilled, the popularity of the lamp will then become assured; and the question will turn upon the adequate production of tungsten ores. Tungsten and other minerals from which metal filaments for incandescent electric lamps are drawn occur plentifully in Australasia, and, as has been shown before in these columns, increasing attention is now being given to the winning of such minerals, with the result that the production of these minerals is higher now than ever. In the report of the Department of Mines for New South Wales for 1906, statistics relating to the production of tungsten ores appear. During the year the quantity of wolfram exported was 132·15 tons, valued at £9,057, as compared with 86·5 tons, valued at £7,361, for the year 1905, thus showing an increase in value of £1,696. In 1904, 89·05 tons, valued at £8,432, were exported, but in 1903 the quantity was only nine tons, valued at £608. The quantity of scheelite exported has also increased considerably since 1903, but the quantity exported during 1906, 109·45 tons, valued at £7,647, compared with 138·3 tons, valued at £10,122, during 1905, showed a decrease in value of £2,475. In 1904, 15·5 tons were exported, valued at £1,406, compared with nine tons, valued at £140, during 1903. The bulk of scheelite came from the Hillgrove Field, and the Torrington Ore Company, operating at Torrington, provided the bulk of the production of wolfram. But prospecting is being carried on at several places, though the results so far do not seem to be very important.

PERSONAL.

The annual outing of the employés of the London Electrical Fittings Co. took place at Tilehurst on July 6. There was a considerable attendance, and a most enjoyable day was spent.

On the recommendation of the Finance Committee, the Exeter City Council have decided to increase the salary of Mr. H. D. Munro, the electrical engineer, from £350 to £400 per annum.

Mr. F. E. Saunders has been appointed manager of the Maidstone Corporation light railways undertaking as from Aug. 1 next, at an annual salary of £160, rising by £10 a year to £200.

Mr. Alfred S. Mumme, 95, Leadenhall-street, London, E.C., has been appointed sole London representative for Messrs. R. S. Newall and Son, wire-rope manufacturers, Liverpool, also Messrs. Storry, Smithson, and Co., Hull, makers of the "Economic" anti-fouling compositions.

Mr. D. C. Bate, A.M.I.C.E., has severed his connection with the Electric and Ordnance Accessories Co., and has opened an office at 40, Brazennose-street, Manchester, as a manufacturers' agent for the whole of the various lines of goods in which he has hitherto dealt, as well as for artistic bronze fittings, insulation materials, wires and cables, soldering compounds, etc.

Mr. W. C. T. Goodman, who at one time held the position of electrical and mechanical engineer in the Tramway Construction Department of South Australia, has been appointed electrical engineer to the Adelaide Tramways Trust. Mr. Goodman had considerable experience in connection with electric tramways, not only in the Commonwealth and New Zealand, but also in England and Germany.

On Saturday last the University of Liverpool conferred the degree of doctor of engineering (D.Eng.) on Sir Alexander Kennedy, and that of master of engineering (M.Eng.) on Prof. Watkinson, Mr. J. A. F. Aspinall (general manager of the L. and Y. Railway), Mr. J. A. Brodie (city engineer of Liverpool), Mr. A. Bromley Holmes (consulting electrical engineer to the Liverpool Corporation), and Mr. J. Wemyss Anderson (dean of the faculty of engineering).

The following applicants will be requested to interview at an early date in England Mr. E. W. P. Foster, C.M.G., member of the Alexandrian Commission, who is delegated by the municipality to make the final appointment of chief temporary assistant sewerage engineer: A. G. Brandram, Portsmouth; Chas. S. Cole, London; W. H. A. Court, Leicester; S. Silver Davson, London; A. R. Galbraith, Portsmouth; T. W. Joyce, Dartmouth. For the four temporary assistant engineers for sewerage the following gentlemen have been appointed: J. Lockhart Elder, Nottingham; Ernest Wilson, Wolverhampton; W. K. Hoskins, Southampton; Adolf Ludin, Mannlien, Germany. Mr. W. Nicohosoff, of Alexandria, has been appointed assistant building surveyor. Mr. Charles Malaval, of Paris, has been appointed an assistant road surveyor. Mr. Vincenzo di Pasquale, Rome, and Mr. David Falik, Vienna, have been appointed as general engineers on the permanent staff. Mr. F. Pernet, of Alexandria, has been appointed assistant mechanical and electrical engineer. On the recommendation of the chief engineer, the municipality have decided to readvertise the appointment of chief electrical and mechanical engineer. The Selection Committee went to a considerable amount of trouble in examining the 500 applications received, and the appointments have been made with the greatest care. The delegation passed a resolution thanking all candidates for the trouble they have taken in submitting their applications.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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THE SOLE ARBITRATOR CLAUSE.

Perhaps one of the most far-reaching cases that the Courts have ever had to deal with is that just concluded between a contractor and the Westminster Corporation. We have not to deal with the case, but with one result that will certainly follow; nor does it matter for our purpose that judgment was given for the defendant. The sole arbitrator clause, as is well known, has gradually been extended in specifications relating to municipal work, and has been a fruitful source of dispute principally because its due significance has never been realised, and also because on the face of it the clause does not seem a bad one. Unless the matter be very carefully considered some of its weak points are overlooked. Assume for the moment that we only consider the case of an engineer who is a permanent official to an authority. He is duly authorised to prepare plans and specifications for work, and tenders are received and one is accepted. Assume the sole arbitrator clause to be agreed to, what is the position of the engineer? He certainly is the agent for his authority. It is his duty to see that work and materials accord with the terms of the specification, and, further, not only is he the author of the design, and so interested in the due carrying out of the work, but, being a permanent official, he has a continuing responsibility, and in face of this continuing maintenance and economic responsibility he naturally must be inclined to interpret the words of his specification in the strictest possible manner conformable with his views and responsibilities. On the other hand, another person may construe words and sentences somewhat differently, and may have tendered upon this construction. Both parties may be perfectly honest, but differences may arise and become crucial. In that case the sole arbitrator clause becomes operative, and the engineer who is agent and author and having preconceived notions as to what he himself meant is asked to act as a perfectly unbiassed arbitrator between two parties. He so acts, and according to the clause his "decision is final.' Suppose the decision not accepted, and the law appealed to. The only loophole the law provides to reconsider the decision is that the engineer has acted dishonestly, and it is litigation of this kind that every engineer subjects himself to when he puts in such a clause. The contractor has no other course open to him, and the most careful engineer, the one who realises his responsibilities to the full, the one who tries to be absolutely impartial, is the one who is tried for "bad faith," for dishonest procedure, and upon whose every action an interpretation is put that may be as wide from the reality as the poles are asunder. It is certain that the first feeling of every intelligent juryman must be that the difficulties of the engineer are very great, and that he must almost be superhuman to abstract himself wholly from his agency and become a dispassionate, unbiassed arbitrator between two contending parties. He knows what he intended to indicate, the other party knows what the words used in the specification in their ordinary meaning tell him; and those two positions constitute a real difficulty. That must stop. No matter how great the advantage of the engineer being the sole arbitrator, the position is untenable, and for all purposes it will be better to revert to a clause, which is preferred by many of the ablest among municipal engineers, providing in the face of a deadlock for an expert arbitrator not connected in any way with either party. No engineer ought to be put into the position of possibly having to defend a suit to prove his honesty of purpose in seeing the work properly done. The position of the con-

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tractor is under the sole arbitrator clause as bad or worse than that of the engineer. No business man likes to accuse of *mala fides*, and in many cases suffers when there may be a real grievance because of the difference of interpretation.

SURFACE-CONTACT SYSTEMS.

The problem of supplying tramcars with current by means of contacts placed on the surface of the streets has attracted the attention of engineers since the earliest days of electric traction. The money spent on model and trial lines has been thrown away in the majority of cases, and the inventors have seldom reaped any financial advantage from their labours. To-day one can count on the fingers of one hand the lines working in this country with surface contacts. The latest move of the London County Council in this direction has much to commend it. The business arrangements ensure a definite royalty to the inventors of the system adopted, and also that the equipment shall be supplied at competition prices. This enables a reliable comparison to be made as to the relative costs of the conduit, surface-contact, and overhead systems, which previously could not be done. The net result shows the advantages of the surface-contact system, as far as first cost is concerned, over the conduit system. The annual charges for maintenance will also be lower if the Lincoln figures are repeated. The figures in the report of the London County Council commiteee reproduced in this issue are convincing, and we trust that the report will be duly confirmed.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TELEPHONE TARIFFS.

SIR,—A letter signed "A. R. Bennett" has recently appeared condemning the measured-rate telephone tariff of the National Telephone Company and the Post Office, and quoting certain figures issued by the Hull Corporation telephone department. The Hull figures are worthless, because the Hull municipal telephone accounts show that a paper "profit" has been arrived at by the simple process of overloading the capital account. The calculations which purport to show what the Hull municipal telephone department would have earned had different rates been charged, simply demonstrate the ingenuousness of municipal officials. It would be just as sensible to calculate what the earnings of a penny steamer would be if Atlantic fares were charged! The one and only excuse for municipal telephony has been a cheap rate, and municipal telephony at cheap rates has been an admitted failure; so that municipal telephone figures have no bearing on the question. If any corporation could have made a success of municipal telephony, that of Glasgow, backed by immense resources and great prestige, would have done so; but the Glasgow municipal telephone department got into such deep water financially, after about four years' working on the lines laid down by Mr. Bennett, that the Glasgow Corporation gladly sold their telephone system at a reduced price and cut their losses. The only thing the municipal telephone experiment has shown us is—how not to do it.

On the general principle of telephone tariffs there is, however, a word to be said. A practical telephone tariff should be based, not on the "telephone," but on the service supplied. The telephone is no more the unit of the telephone business than the knife and fork the unit of the restaurant business; the telephone is merely the means of using the service.

What the telephone user wants is *telephone service*, and his requirements as to quality and quantity of service vary to an astonishing extent. One man needs to make or receive only one or two calls a day, or, perhaps, one or two a week, and he is content to share a line with others, so getting a cheap service which meets his needs. From this minimum demand the requirements of telephone service users range through a variegated scale up to those of the very large concern whose telephone traffic is measured in thousands of daily calls. To handle effectively this large daily traffic requires telephone equipment known technically as a "private branch exchange," consisting of a number of lines to the main exchange, a switchboard on the subscriber's premises, and branch telephones in all the offices or departments.

Very little consideration of the subject should convince the business man that the requirements of the customer for telephone service necessarily vary as widely as the circumstances of the people in any given community vary.

What possible argument can there be in favour of trying to meet many varying requirements by a uniform class of service, charged for at a flat rate arrived at by guesswork and applied rigidly to every customer, be he small user, medium user, or big user? It is obvious that the rate for telephone service should be based on the amount of telephone facilities and service supplied—just as a man's grocery bill depends on the quantity and quality of groceries he consumes.

The measured-rate telephone tariff is based on the equitable principle of payment in proportion to service rendered. The small user (of whom there are thousands and thousands in every town) gets the limited service he requires at a low rate; under the flat-rate scheme he pays—if he takes the service at all—the same rate as the large user, and really helps to pay for the large user's service. The large user gets under the measured-rate tariff the elaborate facilities he requires, and the large volume of service he requires, at a proportionate rate.

To put the case in a nutshell, flat rates restrict the development of the telephone service by shutting out the small user, and they impair the quality of the service by causing large users to restrict their telephone equipment and to overload their lines. Measured rates give low figures for moderate use and so open the doors to vast numbers of small users, thus increasing the development of the telephone; they make the price of telephone lines and equipment cheap (as each call pays its way), and so encourage large users to take adequate telephone equipment, thereby greatly improving the service for every user of it. The large users get their calls at a gradually descending rate, so getting the benefit which it is usual in every business to allow the wholesale customer.

The whole scheme is logical and practical. It is to the advantage of the whole of the community, as it cheapens the service to the small and moderate users, who are the great majority, and it raises the efficiency of the service. There are various other technical advantages in the measured-rate system which would require much space for explanation to the general reader.

Finally, the whole body of expert opinion is in favour of a measured-rate tariff for telephone service. On Friday last in the House of Commons, Mr. Sydney Buxton, the Postmaster-General, Mr. Austen Chamberlain, a former Post-Master General, and Mr. H. W. Forster, a former Lord of the Treasury (who had been chairman of a special committee to investigate telephone rates), all emphatically condemned the flat-rate system, and urged members of Parliament to resist agitation regarding the measured-rate tariff. Mr. Gaine, the late general manager of the National Telephone Company, whose lamentably sudden death we are all mourning, repeatedly stated before Select Committees that the flat rate was based on a wrong principle. The great development of the telephone service in America has been brought about mainly by the adoption of measured rates; under flat rates telephone development in America was very slow, under measured rates it has been prodigious. In Switzerland measured rates only have been in force for many years. In Scandinavia measured rates are largely used. In Germany measured rates were adopted a few years ago, and have largely increased telephone development. In Austria the Administration have lately completely changed their telephone tariff and adopted measured rates; under flat rates there had been almost no develop-

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ment of the telephone in Austria. In France high officials of the Administration have repeatedly urged the adoption of measured rates.

So on the broad question of the proper principle of telephone tariffs Mr. Bennett is in a minority of one against the rest of the telephone world.—Yours, etc.,

HERBERT LAWS WEBB.

35, Old Queen-street, Westminster, S.W.

SURFACE-CONTACT SYSTEM FOR LONDON.

The "G.B." System from Aldgate to Bow.

The report of the Highways Committee of the London County Council, reproduced below, is complimentary to the Griffiths-Beddell system of surface contacts for electric tramways, and the figures given are of general interest. The "G.B." system is at work in Lincoln, and a description of these tramways appeared in our issue of June 12, 1906 (*Electrical Engineer*, vol xxxvii., p. 42). There some three miles of track has been worked by surface contacts for the last 20 months with success. This has led to the adoption of the system for the London County Council, in competition with the other forms of surface contacts which are so actively pushed. The report of the Highways Committee is dated July 4 and 11, and reads:

We are considering what tramway works should be put in hand when those which are now being proceeded with shall have been completed, and in this connection the question of the system of electric traction to be adopted on the tramways remaining to be dealt with has received our most careful attention. Having regard to the very heavy cost involved by the adoption of the underground conduit system of electric traction, we are of opinion that, in view of the large amount of tramway work remaining to be done, and the necessity for economy owing to the heavy financial commitments of the Council at the present time, it is essential that a less expensive system should be adopted except in cases where special circumstances make it necessary to use conduit traction. We feel this very strongly, particularly in view of the facts which have recently come to light as to the difficulty of estimating before the works are put in hand what will be the precise cost of using the conduit system of traction, owing to the impossibility of ascertaining in advance exactly what works are necessary in relation to the removal or alteration of underground pipes and mains.

It will be remembered that on April 30, 1907, we had to ask the Council to approve a supplemental estimate of £53,000 in respect of the reconstruction of the Westminster-to-Wandsworth tramways, representing an increase of about 19 per cent. over the original estimate for trackwork. There are cases in which conduit traction has been laid down where the exigencies of the traffic will necessitate other and connecting lines being similarly constructed, as the possibility of a different system of traction being worked in conjunction was not considered when the lines were laid. We are, however, strongly of opinion, for the reasons above indicated, and also in order to secure the completion of the important work of reconstructing the tramways for electric traction with as little delay as possible, that a cheaper method should be adopted wherever practicable. By Section 23 of the London County Tramways (Electrical Power) Act, 1900, the Council is precluded from using the overhead trolley system of electric traction unless with the consent of the road authorities concerned. Every effort has been made with regard to certain of the tramway routes which it appeared would be suitable for this system of traction to secure the consent of the road authorities, but without success, and in these circumstances we have considered whether it would be possible to arrange for some system of traction other than conduit to be adopted. The only other methods of traction which have been adopted with any degree of success, other than conduit and overhead, are certain surface-contact systems of electric traction. In these systems the electrical energy for propelling the cars is obtained by the contact of skates fixed under the cars with studs on the surface of the road. These studs, which are placed in the centre of the tracks, are brought into contact with cables underneath by a mechanical device operated by magnetic action. These studs are only charged with electricity when a car is actually passing over them. Each of these systems very materially reduces the cost of the trackwork owing to the much less extensive excavation and amount of material which is required for its installation. Having had before us information with regard to the various types of surface-contact traction in use on other tramway undertakings, it appeared to us that, speaking generally, the most satisfactory results were secured from what is known as the "G.B." system. We ascertained that this system had been in operation in Lincoln for about a year, and on May 11, 1907, we visited that city and made a very careful inspection of the tramways there. We have since had before us very full reports upon the results obtained from the working of this system, and also upon its merits compared with other surface-contact systems, having regard to the particular requirements obtaining in London, including the necessity of providing a system which will work satisfactorily in conjunction with conduit and overhead traction. The electric cars used on the tramways can without difficulty be fitted with ploughs or with trolley arms, in addition to the contact skates, so that arrangements can readily be made for through services of cars between surface-contact and conduit tramways or between surface-contact lines and lines equipped on the overhead system.

As the result of our deliberations, we have come to the conclusion that it would be to the Council's interests to lay an experimental line of tramways on the "G.B." system with a view to ascertaining whether it could be satisfactorily used generally on the tramways in London. Under normal conditions the cost of trackwork (excluding cables, etc.) on this system of traction, compared with conduit and overhead traction, appears to be approximately per mile of single track as follows: underground conduit system, £17,000; "G.B." surface-contact system, £10,500; overhead trolley system, £9,500. These figures are exclusive of those items, such as cables and other equipment, which are common to all three systems. As regards working costs, it would appear probable that the "G.B." system would be not less economical in point of power consumption than either the conduit or overhead system, while there would, it is likely, be a saving in respect of maintenance over the former system, as the expenditure necessary for cleaning the conduits would be avoided.

In deciding on what line of tramways it would be advisable to make a trial of this system of traction, we have considered the importance of arranging for it to be used on a route where the conditions of traffic are characteristic of those obtaining on the Council's tramways generally, in order that the Council might be in a position to judge from the results of the experiment whether this system would be adaptable to other routes. We have come to the conclusion that the experiment should be made on the existing horse tramways from near Aldgate, *viâ* Whitechapel-road, Mile End-road, and Bow-road, to the county boundary at Bow Bridge. Another reason for selecting these tramways is the fact that the service between Aldgate and Bow Bridge is complete in itself, and, therefore, the working of the lines will not interfere with the running of any other existing electric route. Moreover, it should be pointed out that this route was one of the most successful on the whole of the northern system when it was worked by horse traction, and on financial grounds, therefore, it appears to us to be very desirable to arrange for the electrification of these tramways at an early date.

Owing to the small amount of cover between the roof of the Whitechapel and Bow Railway, which runs underneath the route of the Aldgate-to-Bow tramways, and the surface of the carriageway, it has been considered impracticable to adopt conduit traction on these tramways, in view of the great cost which would be involved. There is a bed of concrete between the roof of the railway and the surface of the road, which would have to be excavated for laying the conduits. In addition, the roof of the railway itself would have to be altered. The use of surface-contact traction, however, will involve interference to a much less extent with this concrete, and it will not be necessary to alter the roof of the railway. The Council decided to install conduit traction between Aldgate and Cambridge-road, on which part of the route these difficulties do not exist to so great an extent as on the remainder of the route, and to use overhead traction on the remainder of the route to the county boundary. Owing, however, to the refusal of the Stepney Metropolitan Borough Council to consent to the use of overhead traction on any portion of the tramways in its district, it has been impossible to take any action in the matter as regards those lines situated in Stepney. Only a small portion of the route—namely, that portion between Coborn-road and Bow Bridge, a distance of about three-quarters of a mile of route—is situated in the metropolitan borough of Poplar, and the Council of that borough gave its consent to the use of overhead traction on this short length of tramways. The Council on Jan. 22, 1907, accepted the tender of Dick, Kerr, and Co., Limited, to reconstruct this length of line for the overhead system of electric traction with a view to its being worked temporarily by the West Ham Corporation as part of the tramways system outside London. It has not, however, been possible to arrange satisfactory terms with the West Ham Corporation, and no further steps, therefore, have yet been taken with regard to the reconstruction of the tramways. We think that, in view of the importance of this route, it would be preferable that it should be reconstructed on the same system of traction throughout, as this will enable a more satisfactory service of cars to be run; moreover, it is preferable, if possible, for the Council to control the working of the lines. In all these circumstances, therefore, we are of opinion that for the purposes of making a satisfactory

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experiment the Aldgate-to-Bow route would be the best to select.

We have had an interview with representatives of the company owning the patents of the "G.B." system, and we have now received from them a definite offer of terms on which the company would be prepared to agree to the use of the system as an experiment on the Aldgate-to-Bow tramways, a total length of about three miles of double line. The details of such offer are embodied in a recommendation appended to this report, and are, shortly, as follows: (1) the Council to pay to the company a royalty at the rate of £500 a mile of single line in respect of the reconstruction and working on the "G.B." system of traction of the existing horse lines in Whitechapel-road, Mile-end-road, and Bow-road; (2) the same royalty to be paid in respect of tramways constructed or reconstructed for this system up to a total length of 30 miles, including the Aldgate-to-Bow lines; (3) a royalty at the rate of £250 a mile of single track to be paid in respect of tramways so constructed or reconstructed beyond 30 miles and up to a total of 50 miles; (4) a royalty at the rate of £150 a mile to be paid on all lines on which the system is used beyond a total of 50 miles; (5) the royalty in respect of the Aldgate-to-Bow tramways not to be payable by the Council until 12 months after the opening of the lines for public traffic, and then only if the system works satisfactorily and the Council decides to retain it.

We have been in communication with Dick, Kerr, and Co., Limited, whose tender, as above stated, was accepted on Jan. 22, 1907, for the roadwork and platelaying for the reconstruction of the tramways in Bow-road, between Coborn-road and Bow Bridge, as to the terms upon which they would be prepared to reconstruct the whole route from Aldgate to Bow on the "G.B." system. As a result this firm has submitted a tender amounting to £48,618. 6s. 11d., which includes a provisional sum of £5,000. In addition, there would be a sum of about £3,000 for royalties at the rate of £500 a mile of single line, which amount covers all patent rights involved in the use of the system, about £11,000 for rails, and £3,000 for the supply of special trackwork. This makes the total cost for the trackwork for the whole length of about six miles of line about £66,000, or £11,000 a mile of single track, compared with the cost of about £19,000 a mile which it is estimated would be involved by the adoption of the underground conduit system of traction from Aldgate to Coborn-road. It should, however, be borne in mind in considering these figures that, as already stated, the difficulties on this particular route are exceptional, whether conduit or surface-contact traction is adopted, and the figures above referred to, therefore, are not a fair comparison of the respective cost of these two systems under normal conditions. Such a comparison has been given earlier in this report. It was originally intended to reconstruct the tramways from Aldgate to Cambridge-road on the underground conduit system of traction, and from Cambridge-road to Bow Bridge on the overhead trolley system of traction. The cost of the trackwork and overhead equipment would on this mixed system have amounted to about £68,000, as compared with about £66,000 on the "G.B." surface-contact system. It should, however, in making this comparison, be borne in mind that the Stepney Metropolitan Borough Council has refused to consent to the overhead system between Cambridge-road and Coborn-road, and if the conduit system were also adopted on this part of the route and overhead traction from Coborn-road to Bow Bridge the figure of £68,000 above-mentioned would be increased to about £92,000, and the saving for the whole route by adopting surface-contact traction would be about £26,000.

We suggest that inclusive estimates should be approved for the electrification of the whole route from Aldgate to Bow, made up as follows: trackwork, etc. (exclusive of £11,000 for rails already provided for), with provision for royalties, etc., £55,000; special equipment of cars, £3,360; cables and cable ducts, £13,850; erection of Bow car-shed, £50,000—total, £122,210. It will be necessary to apply to the Board of Trade, under the London County Tramways (Electrical Power) Act, 1900, for approval of the adoption of the "G.B." system of traction.

The following figures and comments from the report of Mr. Stanley Clegg, the city electrical and tramway engineer of Lincoln, deal with the working of the "G.B." system for the year ending March 31, 1907. Mr. Clegg says:

As I have recently reported somewhat fully on the working of the tramways as a "G.B." system, it will not be necessary to do more than give an analysis of the costs, taken from the actual figures of the last 12 months, which are as follows:

	£	s.	d.		Per car mile run.
Traffic expenses	1,436	0	2	.....	2·512d.
Repairs and maintenance	521	19	11	.....	·913d.
Management and general expenses	843	19	7	.....	1·476d.
Power expenses	1,026	19	3	.....	1·797d.
	£3,828	18	11	.....	6·698d.

I have compared our costs with the average of those obtained in 70 other municipal undertakings, including all the largest in the country, and find that we are only ·35d. above the average, and when it is considered that we have run the least car miles of any municipal system, the only other under 200,000 being Maidstone with 156,000, and a cost per car mile of 6·82d., I think our position may be judged satisfactory. I am glad to be able to point out the fact that our consumption of electricity per car mile has been considerably reduced, and to prophesy that it will still further be reduced during the coming year; this is undoubtedly due to more careful driving on the part of our men, and that most of our cars are now fitted with meters, the presence of which has a beneficial effect on the driving. The somewhat large item which is debited to cars under the heading of repairs is mostly accounted for by the fact that all the skilled labour at the shed is debited to this item. As there is only one other surface-contact system in the country that has been working for a complete 12 months—viz., the Lorain, at Wolverhampton—it would be interesting to compare our figures with theirs. To do this, however, I have to take the figures for the year ending March, 1906, as this year's figures are not available:

	Lincoln. Per car mile run.		Wolverhampton. Per car mile run.
Traffic expenses	2·512d.	.....	2·54d.
Repairs and maintenance	·913d.	.....	·77d.
Management and general expenses	1·476d.	.....	·83d.
Power expenses	1·797d.	.....	1·99d.
	6·698d.	.....	6·13d.

It will be noticed that under the items of traffic and power expenses we are ahead of Wolverhampton, but worse under the others; these two items, particularly management and general, are largely dependent on the size of the system, and the car miles run, and seeing that Wolverhampton ran 950,000 car miles during the year, as against our 137,000, there is every reason to suppose that with an increased mileage we could do equally well, if not better.

The report referred to above on the working of the "G.B." system is a private one, but on the strength of it the committee decided to take over the line from the contractors.

FACTORIES AND WORKSHOPS.

Report of the Electrical Inspector.

The annual report of the chief inspector of factories and workshops for the year 1906 has just been issued. To the general report the usual sectional reports and statistical tables are appended. Chief interest will, of course, centre upon the report of the electrical inspector of factories, and the outstanding features in Mr. G. Scott Ram's report is that of the extending use of electricity. As evidencing the steady increase in the use of electricity, Mr. Ram mentions that up to January of this year the horse-power of motors connected to the mains amounted to 265,000. This figure does not, however, show the whole amount, as information continues to be withheld from the inspector in a number of instances. He presents tables dealing with 418 undertakings, 33 of which, including some of the largest, furnish no return. Of the remainder, 163 have less than 100 b.p. connected. The increase as shown by the figures in the tables is over 50,000 h.p., about the same as during the previous year. The first table gives the accidents at electrical stations of electricity supply companies or local authorities. Non-electrical accidents show a slight increase over the previous year, the numbers being 200 non-fatal and eight fatal. There were 37 non-fatal electrical accidents and two fatal. The accidents in this class show only a very slight increase over those of the previous year. Cleaning or repairing "live" switchboards, which was responsible for 13 non-fatal accidents, included also one fatality. In the fatal case the man was repairing switchgear close to other "live" and unprotected switchgear, against which he stumbled. The pressure was 10,000 volts. Two accidents from short-circuit occurred to persons when taking measurements of "live" switchboards with metal rules. Another befel a man when making a sketch of a sub-station by coming into contact with a "live" switch at 10,000 volts pressure. Fourteen non-fatal electrical accidents occurred at private electrical generating stations, and 43 non-electrical accidents, one of which proved fatal. The third table presented by Mr. Ram is of importance, as it deals with electrical accidents in factories, engineering works, etc.

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TABLE I.—Reported Electrical Accidents in Factories, Engineering Works, etc.

No.	Description.	Non-fatal.	Fatal.
1.	(*a*) Arcing of switches	28	—
	(*b*) Arcing of fuses	10	—
2.	Arcing at fuses when replacing fuse wires	14	—
3.	Unprotected conductors, switches, terminals, fuses, etc.	11	1
4.	Faulty apparatus (other than switches)	37	2
5.	Working on live conductors:		
	(*a*) Skilled persons	19	1
	(*b*) Unskilled persons	5	—
6.	Flashing at motor brushes when adjusting	9	—
7.	Electric travelling cranes:		
	(*a*) Unprotected electrical apparatus in driving cage	3	—
	(*b*) Faulty apparatus	3	—
	(*c*) Carelessness	9	—
8.	Miscellaneous accidents in testing electrical apparatus in course of manufacture	22	1
9.	Miscellaneous	21	3
	Total	191	8

The following observations are made by Mr. Ram on the above table:

The electrical accidents reported as having occurred in factories, engineering works, etc., show a considerable increase over those of the previous year, the number having risen from 122 to 199, or over 60 per cent., including eight fatalities as against four in the previous year. The increase is scarcely to be wondered at in view of the greatly extended use of electricity and to the fact that the necessity of proper precautions being taken is often not realised by the occupier, who accepts the lowest tender for his installation without being aware that the price is low because the apparatus is inferior and often without elementary safeguards.

Touching upon the nature of the accidents, Mr. Ram says that in this respect there is nothing new, and his remarks are necessarily in the nature of repetition of the remarks he has made in former reports. But here again inferior apparatus, together with careless handling, contribute largely to the list of accidents, as the following comments will show:

Burns from the arcing of switches in ordinary use are often due to faulty construction of the switches or to the absence of any cover or guard. Not infrequently the accident occurs at a motor starting panel. The double-pole switch is put on, and a flash burns the operator's hand, sometimes even when there is a cover, owing to the flash passing through the slot provided for the handle. This variety of the accident is nearly always due to the use of cheap and flimsy switchgear. It arises primarily from the starting switch being of inferior construction, generally much too small for the motor it has to control. The contacts are burnt up, the spring is weak, and the lever will stick in any position. The motor is stopped by turning off the double-pole switch, and the lever of the starting switch fails to automatically move back to the starting position. This failure is not noticed by the attendant; consequently, when he proceeds to start the motor on the next occasion, he turns on the double-pole switch on what is practically a short-circuit. . . Many switches are now designed with the handle attached to an extension of the spindle, so that no slot in the cover is required, and are, consequently, to be preferred.

The somewhat numerous accidents under the heading of faulty apparatus (4) attracts attention. These occurred with one or two exceptions in connection with the use of portable appliances, generally lamps. Mr. Ram explains the circumstances under which these accidents occurred, and concludes that:

The obvious precautions appear to be that the portable appliance should be connected to earth, or that no part of the metal of the appliance which can be touched can under any circumstances become charged by leakage.

Among the miscellaneous accidents were three fatal cases of shock. One of these occurred in a transforming sub-station. A fault had occurred, and some transformers had been disconnected by removing the ends of the high-pressure cables from the transformer terminals. The victim of the accident took hold of one of these "live" tail ends and was killed. This accident emphasises the necessity of having proper switchgear for disconnecting transformers. The system was three-phase at 5,000 volts. In another case a youth was killed while trimming an arc lamp. He had lowered the lamp to within a few feet of the ground, having previously turned it out by the double-pole switch. He was standing on wet ground. The switch was of faulty type, and, although the lamp was extinguished, the circuit was broken on one pole only, one blade of the switch remaining just in contact on the other pole. The lamp was, therefore, alive at 200 volts above earth, the system being three-phase, 350 volts per phase. The switch had no spring or other provision to prevent it remaining in partial contact, and hence the fatality.

The following extracts from the report describe a number of the various dangerous conditions of electrical plant which Mr. Ram has come across during the year, and which would appear to be none on other grounds than those of thoughtlessness or neglect:

Perhaps the most striking example is one which I found in an important generating station for public supply in regard to a switchboard for three-phase working at 6,000 volts pressure, which had recently been erected and put to work. This switchboard was apparently satisfactory so far as the working platform was concerned, but the various passageways in connection with it were a series of death-traps. One long passage had on one side rubber-covered cables of 6,000 volts without any protection by metallic sheathing or casing, and on the other exposed live terminals at the same pressure at frequent intervals. The floor of the passage was of iron, and 2ft. 4in. wide. The 'bus-bar galleries were even less inviting. In one of these there was on one side of the passageway sheet metal for protecting glass water resistances used in connection with the spark-gaps. On the other side, at about 1ft., 2ft., and 3ft. from the floor respectively, were the three bare and unprotected 'bus bars at 6,000 volts. The floor of this passageway was of iron, and the clear width was about 18in.! In another the passageway was a little wider on account of the absence of spark-gap resistances, and the edge of the iron flooring was fenced with an iron railing; there was, therefore, a passageway about 2ft. wide with the bare 6,000-volt 'bus bars on the one side and the iron railing on the other. One would naturally suppose that such passages were never intended for use when the 'bus bars should be alive, but such restriction did not appear to have been contemplated, as half-way along the gallery the 'bus bars were divided by means of plug switches with the idea that the two halves of the board might be run together or from independent generators. No means of access was, however, provided for getting to these plug switches other than along the passageway described. Even assuming that the attendant should safely reach the plug switches there was room for him to work them, the iron railing being less than 2ft. away. These plugs were heavy, and would necessarily have to work stiffly in the contacts in order to make a good connection, and would, therefore, require a strong effort to work them. There was exposed metal within 3in. or 4in. of the handles, and the 'bus bars were, of course, close to, the combined arrangement being such as to offer a great and totally unwarrantable risk in operation. The safeguards usually present in switchboards for extra high-pressure systems of this kind for preventing danger of accidental contact with live metal were conspicuous by their absence, whilst the narrowness of the passageways and the provision of earthed metal to stand on provided all that could be wanting to contribute to a maximum degree of danger. Other new switchboards in connection with the same undertaking exhibited a like disregard for safety. Thus, a single-phase 2,000-volt switchboard had a long passage at the back, 2ft. 10in. wide, with iron floor. On one side bare terminals and 'bus bars were exposed at intervals all along. An undesirable feature not unfrequently met with was also present here—namely, apparatus requiring occasional handling fixed on the wall of the other side of the passageway. Some high-pressure switch fuses for instrument transformers were fixed on the back wall at 6ft. from the iron floor. In order to handle them a man would have to stand with his back towards the live terminals of the main portion of the switchboard, one of which was so placed that he would almost certainly touch it with the back of his head when handling the switch fuses. It is difficult to account for the apparently reckless want of thought in cases such as this where the danger is so obvious and of such serious kind—*i.e.*, sudden death to the unwary attendant—particularly in view of the importance of the undertaking and the high standing of the makers of the apparatus. The risk of personal accident is closely associated with that of breakdown of the supply, and it is often a matter of surprise that it is not more carefully guarded against as a pure matter of business. Want of foresight is frequently apparent in the arrangement of switchboards. Thus, again, at the new generating station of an electrical power supply company, furnishing electrical energy for working tramways and for power purposes in collieries and for general supply in several townships, a class of supply which must necessarily be maintained night and day, the main high-pressure switchboard was so designed that it could not be made dead for adjustment or repairs in sections. Consequently, in order to carry out any work upon it in safety, the whole supply would have to be shut down. In practice it would probably not be shut down, and any repairs or other work would be carried out at a considerable risk to the

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workers—a risk which could have been entirely obviated by a proper design of switchboard in the first instance. I noticed various other points of greater or less importance which had been overlooked in new stations. For example, in a generating station of a local authority for providing continuous current at 440 volts, the switchboard was placed so that it might have had plenty of clear space behind, but the advantage was entirely lost on account of rods and cables being fixed across so as to completely block the passageway. In another case of new work in a large station a glass-tiled floor had been laid behind the switchboard. The glass floor was only 20in. wide, and at the sides the iron framework projected an inch above the glass, thereby nullifying to a great extent the safety, as regards insulation, provided by the glass. A person doing any work behind the board would be likely to have his foot against or upon the metal frame. The projecting edge of metal was no doubt provided to prevent him from slipping over the edge of the tiles, but this object could be easily attained with glass if the outer row of tiles were specially shaped for the purpose. In sub-stations, both new and old, I found many examples where safety had been insufficiently provided for, and some where the means intended to procure safety added considerably to the dangers. In some colliery sub-stations, where it was important that the supply should be available continuously, the high-pressure switchboards were arranged so that it would be impossible, without great danger, to carry out any repair or adjustment unless by completely shutting down the supply. In two others I found that the consumers' medium pressure switchboards were within the sub-stations, regardless of the Board of Trade regulation that the sub-stations should be in the sole occupation of the supply authority. These sub-stations were supplied at 10,000 volts pressure, three-phase. The 10,000-volt conductors were of bare copper. The transformers and high-pressure switchgear were on one side of the room, and the consumers' switchboard on the other, with only a few feet space between. The arrangement of exposed high-tension conductors was dangerous in any case, and particularly so in view of the consumers' employés having access. I made strong representations as to the dangers and as to the breach of the Board of Trade regulations, and it was agreed that the power company's men should alone have access until suitable screens had been erected to entirely shut off all the high-pressure side of the room.

In some less recent transforming sub-stations, I found a form of protection provided for the high-pressure switchgear which distinctly added to the danger. The switches and bus 'bars were of bare metal exposed, but the whole switchboard was surrounded by an iron cage with a door. When any switching or replacing of fuses became necessary the attendant would, therefore, have to go into the cage, which was so confined that he would inevitably be in contact with its iron bars, thereby being in contact with earth, and would besides have insufficient room to work in. In some other underground chambers, far too small, I found some survivals of a bygone age in the form of protection of the high-pressure terminals of the cables by metal covers or bells. The terminals were bare, and in order to get at them for any purpose, the bell, which was heavy, had to be lifted vertically with a very steady hand, or it would touch the terminals. An earth wire was attached to the bell, but in one case this wire proved to be very much alive!

In motor-generator sub-stations I found numerous cases of the high or extra-high pressure coils of the motors insufficiently protected. Adequate fencing of these machines is seldom provided. In those having a centre bearing, the lubrication of which has to be examined at intervals, there should be protection provided, so that the attendant can get to the bearing without danger of coming into contact with the revolving armature on one side or the rotor on the other side. A rail at least should be provided for him to hold on by, but whether this alone is sufficient depends on the construction of the machine. Accidents have occurred through men putting out their hands to steady themselves and touching the high-pressure stator coils when examining the lubrication of the bearings. In some continuous-current sub-stations I found the motor converters placed with a passageway between them of less than 20in. and having their exposed high-pressure terminals sticking out into the passageway on each side. The practice as to employment of persons in sub-stations is one which varies considerably. In large sub-stations having moving machinery it is customary for at least two persons to be employed simultaneously. There are, however, examples where from motives of economy only one person is employed at a time. Thus, in two large sub-stations I found one man employed alone in each. The incoming supply was three-phase at 6,000 volts. The one man had to attend to the working of the plant, consisting of two motor-generators, one for traction and one for general supply, and three switchboards for the high-pressure, traction, and general supply with secondary battery. The starting-up of the motor-generators was accomplished by barring them round with a plank. The question is whether, in view of the nature of the work and its attendant dangers, one man should be left entirely alone.

On factory premises I found the usual examples of exposed switches, terminals, etc., in dangerous positions—that is to say, in places where a person who might accidentally touch the live metal would be in connection with earth, either by standing on damp ground or iron floor-plates or otherwise, and would consequently obtain a severe shock. One particularly dangerous type of switch appears to be a universal favourite. It has two or more blades, hinged at one end, and held together at the other by a bar of insulating material, on the other side of which is the handle. The insulating bar is attached to the switch blades by studs or screws having heads or nuts on the handle side, and generally close to the handle. In the better makes of these switches these nuts or studs are covered by insulating caps, or are sunk in the bar and covered over with insulating material, but usually they project above the bar in such a way as to be naturally in contact with the hand of a person grasping the handle. The connections of the switch are variously arranged. In some the blades of the switches are only alive when the switches are in the "on" position, in others the connection is through the hinged ends, and the blades are always alive. The studs are, therefore, always alive when the switch is "on," and in some cases also when it is "off." The danger is obvious. When the studs are close to the handle, as is frequently the case, a person may touch both studs with his hand when working the switch. The switches are often used as motor switches with 440 or 500 volts across the studs, with the result that the operator is likely to get severely burned. When, as is often the case, such a switch is fixed over a damp floor or over iron floor plating, there is the additional danger of a serious shock to earth. In a previous report I described a fatal case of shock due to such a cause. The current was alternating, 250 volts. The victim was going to stop a motor. He touched one of the studs with his little finger in grasping the handle of the switch, and, although the latter was of insulating material, he could not release his hold or pull the switch "off" and was killed. I refer to this accident again as the particular type of switch is being constantly supplied. I found them in new installations in factories, on cranes in docks, in electrical stations, etc., in dangerous positions. I also found them in use as high-pressure switches in sub-stations, 2,000 volts across the studs, and placed in dangerous situations where the person using them would be in contact with an earthed transformer case. A more dangerous trap could hardly be devised.

Questions as to guarding overhead transmission wires occurred in connection with a large private installation. The supply was by a three-phase system at 3,000 volts. The wires ran alongside and over roadways and footpaths and places where people were working. Some system of protection against falling wires seems necessary at such points, but none had been provided.

All the fatal accidents reported as having occurred on factory premises were due to shock from alternating current at various pressures down to 200 volts, no less than four occurring at the latter pressure. It is customary when fatalities occur at such low pressures for people to say that the victims must have had weak hearts. This view, however, is seldom confirmed, the post-mortem examination often proving the contrary. The danger with low pressures depends upon the path of the current through the body and the kind of contact. People who are responsible for electrical installations do not sufficiently realise the hidden dangers of low-pressure currents, and hence the weak heart theory is brought out at every inquest, but until recently I had never heard of it being seriously put forward to account for a fatality where the pressure exceeded 5,000 volts.

I have reason to think that a number of accidents from shock do not get reported. I happened to come across a man recently who owned to having been in hospital for several weeks as the result of a shock received whilst working on a 10,000-volt switchboard. The accident had not been reported. It occurred in an electrical power company's generating station, but the man was working for a contractor. Possibly the contractor assumed that the power company would report it, and *vice versâ*. The question of the responsibility for the safety of contractors' workmen when working in an electrical station I have referred to in a previous report. It is certain that the contractor's workman is often required to do work of a hazardous nature without adequate supervision. It is probable that under the new Notice of Accidents Act many more electrical accidents will be in future reported, but at present the provisions of this Act seem to be very little known.

The following is a list of electrical fatalities occurring during the year, including those not reportable under the Factory Act, so far as I have been able to ascertain them:

TABLE II.

Place.	Voltage of system.	Probable voltage of shock.	System.
Reported under the Factory Act.			
Wednesbury	350	200	Alternating three-phase
Belvedere	8,000	8,000	Alternating single-phase
Blaina	440	250	Alternating three-phase
Wednesbury	5,000	3,000	Alternating three-phase

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Leeds	280	200	Alternating two-phase
Brimsdown	11,000	6,500	Alternating three-phase
Derby	200	200	Alternating single-phase
Ramsbottom	400	230	Alternating three-phase
Scotstoun	350	200	Alternating three-phase
Burnbank	11,000	6,500	Alternating three-phase
On Mains of Electrical Supply Undertakings. (Reportable to Board of Trade.)			
Near Glasgow	10,000	—	Three-phase.
Mining. (Reportable to H.M. Inspectors of Mines. Probably Incomplete.)			
Lower Duffryn Colliery	3,300	—	Alternating three-phase
Cadeby Colliery	500	—	(?)
Emily Mine	—	—	(?)
Cwmneol Colliery	3,000	—	Alternating three-phase
Cwmneol Colliery	3,000	—	Alternating three-phase
Dean and Chapter Colliery	500	—	(?)
Railways and Tramways. (Reportable to Board of Trade.)			
London—Notting-hill Gate (Central London Railway)	5,000	—	Alternating
Heywood	500	—	Continuous
East Ham — Metropolitan District Railway	600	—	Continuous
Byker — North - Eastern Railway	600	—	Continuous
London — Mansion House Station, District Railway	600	—	Continuous
Darlington	500	—	Continuous

PHYSICAL SOCIETY.

At the meeting on June 28 at the Central Technical College, Prof. W. E. Ayrton, past-president, in the chair,

Mr. J. T. Irwin gave a demonstration of the uses of his hot-wire oscillographs and hot-wire wattmeters. After giving an explanation of the principle of the hot-wire oscillograph, and pointing out how to obtain exact compensation for the heat capacity of the wires by means of electric capacity or self-induction, Mr. Irwin showed the following experiments with the oscillograph: (1) The potential difference from a rotary converter (*a*) with the ripples due to sparking damped out by resistance in the condenser circuit; (*b*) with the ripples shown at their proper size with critical damping; (*c*) with the ripples very much exaggerated owing to want of damping. (2) The periodic discharge of a condenser through a self-induction (*a*) with a small resistance in circuit and, therefore, an oscillatory discharge; (*b*) with a large resistance in circuit and the oscillations damped out. (3) The potential difference across the stator of an induction motor and the current in the rotor below, above, and at synchronous speed (*a*) as a two-phase machine; (*b*) as a single-phase machine. (4) The current through and the potential difference across the armature of a single-phase commutating compensated motor run up to and above synchronous speed, (*a*) with the auxiliary brushes short-circuited, showing the current and potential difference in phase with each other at synchronous speed; (*b*) with the auxiliary brushes open-circuited, showing the potential difference and current differing by nearly 90deg. in phase. (5) A circle and a straight line produced by combining, by means of a beam of light, the vertical harmonic motion of a mirror with the simple harmonic motion of the oscillograph due to a sine wave of current, the circle being produced when the two movements were at 90deg. difference in phase, and the straight line when the two movements were in phase. (6) A hysteresis loop for glass-hard steel wire, showing the rounding-off of the tips at a frequency of 40 per cent. Mr. Irwin also showed a new type of synchronous motor which he has invented, and which can be run easily at synchronous or half synchronous speed. This motor consists essentially of a series motor with laminated fields and with two points on the commutator 180 electrical degrees apart shorted. A hot-wire instrument to measure mean watts was also shown.

Mr. W. Duddell expressed his interest in the fact that Mr. Irwin had succeeded in designing an oscillograph depending for its action on thermal effects. Referring to the hysteresis loops shown by the author, he said it was important to know the form of these loops in actual work. He was doubtful, however, whether the blunted points were due to hysteresis effects or whether they were due to instrumental defects.

Mr. A. Russell congratulated the author on his extremely novel and interesting instruments. Apart from the practical utility of the invention, which the experiments shown amply demonstrated, there were many points in connection with the working of the instrument which elucidated physical laws. For instance, in his paper to the Institution of Electrical Engineers Mr. Irwin gave figures from which it could be deduced that Newton's law of cooling was very approximately true for the wire strips of his instrument slowly cooling in air. The practical working of his oscillograph proved that Newton's law of cooling was also very approximately true even when the periodic time of the temperature fluctuation of the strips was only a very small fraction of a second—a physical result of considerable importance.

Mr. J. S. Dow described a form of photometer in which the cosine law was utilised. It was, therefore, unnecessary to move either the photometer or the sources of light. The adjustment of the illumination of the photometrical surfaces was carried out in the photometer itself by the rotation of a Ritchie wedge about the boundary line between the photometrical surfaces as axis. The ratio of the candle-powers of the two sources of light compared could then be read off on a suitably calibrated scale attached to the photometer. This type of instrument is very convenient. Attention was drawn, however, to the possibility of "angle errors" and the means of avoiding them. This instrument could be used on the equality of brightness principle, or, by utilising an oscilating lens, as a flicker photometer. The results of using these two photometric methods were, in this case, in very good agreement. Yet this might not have been the case if a different portion of the retina had been utilised, especially at low illuminations. An experiment was then shown illustrating the behaviour of the "rods" and "cones" as regards flicker. At strong illuminations, when the cones are predominant, the perception of form and colour is most acute when the central portion of the retina is utilised, but at low illuminations, when the rods are in action, visual acuteness is best when the outer region of the retina is used. In the same way the perception of flicker was demonstrated to be only most acute over the portion of the retina removed from the centre of the eye when a weak illumination is employed. A distinction must be drawn between "rod flicker" and "cone flicker." Some experiments were then shown illustrating the detail-revealing powers of red and green light. A green or blue surface loses in luminosity as the image of it fades more and more towards the centre of the retina. But apart from the question of luminosity, the red end of the spectrum gives the best definition in the case of distant vision and the blue end in the case of very close vision. This arises from the want of achromatism of the eye. Two exactly similar patches of red and blue light were thrown upon a screen on which a black and white chessboard pattern had been traced. The black and white squares were then seen to be more sharply defined when illuminated by the red light, in spite of the fact that the illumination due to the blue light was much the brighter of the two. The red end of the spectrum is, therefore, in general, the most effectual portion for the illumination of clocks, shop signs, and objects which must be viewed from a distance.

Mr. Patterson complimented the author upon his paper and experiments. With reference to the cosine instrument, he asked if the cosine law was trustworthy at very acute incidence of the light. The unequal sensitiveness of different parts of the retina accounted for the fact that it was possible to obtain different balance points by fixing attention on the different sides of a Ritchie wedge.

Mr. J. S. Dow, in reply, said he had only worked with photometers with wedges of 90deg., but he was certain that the cosine law would not hold at acute incidence on account of the large amount of regular reflection.

APPOINTMENTS VACANT.

Chief Electrical and Mechanical Engineer. The Municipality of Alexandria have decided to readvertise this appointment.

Motor Fixer for West Ham Corporation electricity supply works. Wages, 9½d. per hour. Applications to the Engineer, 84, Romford-road, Stratford.

Lecturer in Electricity and Physics, Birmingham Municipal Technical School. Salary £140. Particulars from the Secretary. See advertisement in last issue.

Mains Superintendent for South Shields Corporation Electricity Department. Salary £150-£200 per annum. Applications by July 26 to the Borough Electrical Engineer.

Technical Assistant, Sunderland Corporation electricity department. Salary, £156 per annum. Applications to the Borough Electrical Engineer and Manager by July 26. See advertisement.

Assistant Superintendent of Telegraphs for service in Ceylon. Salary, £300 per annum, rising to £350 per annum by annual increments of £25. Applications to the Crown Agents for the Colonies, Whitehall-gardens, S.W., by July 29. See advertisement.

FORTHCOMING EVENTS.

Saturday, July 20.

Junior Institution of Engineers.—Visit R.M.S. "Oruba" and th Tilbury Dock pumping plant.

British Association.—July 31 to Aug. 7, seventy-seventh annual meeting at Leicester.

Iron and Steel Institute.—Sept. 23, 24, and 25, Vienna meeting.

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LEGAL INTELLIGENCE.

ELECTRICAL AND ENGINEERING MAINTENANCE CO. v. JOHNSTON.

Mr. Russell Clarke acted as arbitrator in an action brought by Messrs. Fraser and Mills, who carry on business as the Electrical and Engineering Maintenance Co., of Westminster, against Mr. L. Campbell Johnston, of Wodcote House, Coulsdon, Surrey.

The plaintiffs claimed from the defendant the sum of £32 due to them for running a Thorneycroft-Siemens petrol engine. This amount was not in dispute, but the defendant counterclaimed for the sum of £50 for damages, he alleging that his engine had broken down through the negligent treatment it had received from the plaintiffs' servants.

Mr. DRAKE, counsel for the defendant, stated that his client in the early part of last year was anxious to have an electric installation fitted up at his private house, and that he had paid upwards of £600 for this privilege. A petrol engine, which had been supplied by Messrs. John Thorneycroft and Co., formed part of the electric plant, and before it was fitted up at his house it had been thoroughly tested and had proved itself to be satisfactory in all respects. The defendant agreed that the plaintiffs should have the contract for running the engine and charging the batteries, and for a short time everything went smoothly. In the month of September the plaintiffs' men found the engine was not running very well, and from this time until December, when the engine completely broke down, there was constant trouble, and the defendant wrote to the plaintiffs complaining that the men they were sending to his house were not properly discharging their duties. In November one of the plaintiffs' men informed the defendant that the engine was hammering badly, and suggested certain repairs. These the defendant instructed him to carry out. For some reason the repairs were not done, and the men continued to run the engine, with the result that it broke down on Dec. 3, from which time the defendant, notwithstanding his heavy outlay, has been obliged to light his house with lamps.

Mr. CAMPBELL JOHNSTON bore out his counsel's statement. He said that he knew nothing about the management of electric plant, and left it entirely to the plaintiffs' men.

Counsel for the plaintiffs said that he was quite prepared to admit that the engine in question was a good engine, and that it had broken down through no fault of the makers. He pointed out that the plaintiffs only attended at the defendant's house on certain days, and he was going to contend that someone—possibly one of the defendant's servants, his gardener, or coachman—had tampered with the engine. Mr. Lever said that the defendant in his evidence had admitted that he was thinking of buying a motorcar, and it was, therefore, quite possible that the coachman had been trying to run this engine to get his hand in, so to speak.

The plaintiffs were called, and denied that they had received any instructions to do the repairs.

Mr. NICHOLSON, one of the engineers employed to run the engine, admitted that the defendant instructed him to do certain repairs, but he had asked the defendant to communicate with the plaintiffs as to this. Further, that the defendant had told him that he was to be sure to fully charge the batteries before any repairs were commenced, and that it was while he was carrying out these instructions that the engine broke down.

Expert evidence was called, but the ARBITRATOR, who had some of the damaged parts of the engine before him, stated that it was quite clear to him that there had been gross negligence somewhere. The crankshaft and piston were twisted and battered in a most alarming manner, and he did not think the question of whether it was a faulty engine or not need be gone into.

After a hearing lasting two days the arbitrator has now published his award, finding in favour of the plaintiffs on the claim and counterclaim.

UNITED INCANDESCENT LAMPS AND ELECTRICAL CO. v. TANQUERAY.

In the City of London Court, on Friday last, an action was brought by the United Incandescent Lamps and Electrical Co., Budapest, against Mr. J. T. Tanqueray, lately trading as the Wholesale Supply Co., Bond-street, to recover the sum of £24 for incandescent electric lamps supplied.

Plaintiffs, through their counsel, said that they were represented by Mr. H. G. Mayer, the company carrying on business in Hungary. The defendant endeavoured to carry on an electrical business in the West-end of London under the name of the Wholesale Supply Co. He commenced in the early part of last year, and he had an "electrical department" there, according to his note-paper. Within a few months the defendant had ceased to carry on the business. Defendant wrote to the plaintiffs and discussed the purchase of 50,000 electric lamps of the mushroom shape. It was the defendant's desire to obtain a large supply, as he was appointing agents and was sending travellers with them throughout the length and breadth of England. He was to sell them at a price which would reserve to the defendants a liberal profit. In the course of certain negotiations which went on the defendant asked if the lamps were the same as those certified by the Westminster Electrical Testing Laboratory. Mayer said he thought they were, but that he could not guarantee them without making inquiries. Considerable quantities of mushroom lamps were supplied, and they were sent to different parts of England. A large quantity of the lamps were returned because of the delay in the delivery. There was good ground for that complaint, because the time occupied in getting the lamps from Hungary was much longer than the plaintiffs imagined would have been the case. Plaintiffs took them back because other firms in Manchester were clamouring for them, and they had all since been sold. Defendant had complained that while the lamps were guaranteed to burn for a low voltage of 1,000 hours and high voltage of 600 hours, in many cases they only burned for a few hours. Defendant had said that he had many complaints. It was contemplated that the sale by the defendant would amount to 50,000 lamps for the first 12 months. A merchant at Hastings sent an order for 700 dozen lamps, and when they were delivered to the defendant's traveller in Hastings he had gone. One merchant had sold as many as 330,000 lamps.

Mr. H. G. MAYER, 67, Aldersgate-street, plaintiffs' representative in London, said that when he first discussed the matter he told the defendant that he had a certificate from the Westminster Electrical Testing Laboratory to the effect that specimens of the lamps had been burned for 500 hours, and that they had burned satisfactorily, according to the vouchers of Mr. Lancelot W. Wild, the chief electrician to the Electrical Testing Laboratories. That certificate referred to the pear-shaped lamps and not to the mushroom lamps. The plaintiff company employed 7,000 people making incandescent lamps, electric motors, and other electrical appliances. The mushroom-shaped lamps were a novelty, and he and the defendant were both anxious to push it. He guaranteed that the pear-shaped lamps would burn for 1,000 hours lower voltage and 600 hours higher voltage, but not the mushroom lamps. Defendant returned some of the lamps as bad, but one of them had been burning in his (witness's) office for 18 months, and was still good. They could not burn more current than 3½ volts, and there was no ground for the suggestion that his lamps burned an excessive amount of electric current.

The defence was a charge of fraud and misrepresentation, and that the orders for the lamps were only given because of the certificate.

Mr. TANQUERAY said that Mr. Mayer very distinctly told him that the certificate referred to the mushroom lamp, and not to the pear-shaped lamp. In consequence of the lamps being defective he had lost £75. He had raised a counter-claim for £112 for all the damage which he had suffered. Plaintiffs supplied him with hundreds of copies of the certificate, and he had sent them out to customers in all directions. That had brought him into great trouble in a business way. He employed 12 travellers, to one of whom he paid £4 a week.

Mr. NORMAN KNOWLES, an electrical expert, said he had examined the lamps supplied by the plaintiffs and he found them defective. Quite 50 per cent. of the lamps tried went out before they had burned 600 hours.

In answer to the counterclaim, Mr. MAX HACKER, of Manchester, said he had sold 300,000 of the mushroom lamps supplied by the plaintiffs, and he found them satisfactory, repeat orders following. None of them were faulty.

Mr. ALEX. DAWSON, electrical engineer, Rose-grove, Manchester, said he had also sold plaintiffs' mushroom lamps, for which he obtained a better price than any other.

The jury stopped the case, and said they could not see the defendant had suffered any damage. Judgment was accordingly given for the plaintiffs on their claim (subject to formal proof before the registrar of the delivery, etc.) and for the plaintiffs on the counterclaim, with costs.

UNITED MOTOR INDUSTRIES v. VANDERWELL AND CO.

In the King's Bench Division, London, last week, Mr. Justice Walton and a special jury concluded the hearing of the action brought by the United Motor Industries, dealers in motor accessories, carrying on business at Coventry, against Messrs. C. A. Vanderwell and Co., manufacturers of accumulators, of London, to recover damages for an alleged breach of an agreement under which plaintiffs said the defendants undertook not to disclose the fact that they were the manufacturers of the "Castle" ignition accumulators. Plaintiffs also asked for an injunction restraining the defendants from further advertising the fact. The defendants denied liability, contending that the agreement was only for the year 1903, and that their obligation ceased at the end of that year.

Mr. JUSTICE WALTON, in summing up the case to the jury, remarked that before they could find a verdict for the plaintiffs they must be satisfied that it was an implied term of the agreement between the parties that after 1903 the defendants would not at any time divulge that the accumulators in question were manufactured by them. If they were of opinion that the plaintiffs were entitled to a verdict, there was evidence upon which they could award them more than nominal damages.

The jury found a verdict for the plaintiffs, and assessed the damages at a farthing.

Mr. Justice Walton reserved the question of granting an injunction.

LEEDS CORPORATION v. HEY AND CO.

In the Leeds County Court last week the Leeds Corporation sued Hey and Co., brewers, of Manningham-lane, Bradford, for £8, damage to a tramcar caused by a collision between the car and a steam wagon belonging to the defendants.

His Honour held that the plaintiffs had failed to establish negligence, and found for the defendants.

SCOTT v. BLACKPOOL TRAMWAY CO.

At Kirkham County Court on Friday last before Judge Hans Hamilton, Walter Scott sued the Blackpool, St. Annes, and Lytham Tramway Co. for £100 damages arising out of a collision between a tramcar and a double-decker caravan on Easter Monday.

WILFRID HARTLEY, driver of the van, stated that on turning from Lytham Beach into St. Peter's-place to cross Clifton-street into Station-road an electric car struck him broadside, throwing him into

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the road, and causing injuries to the head. He tried to get out of the way, but the car was too quickly on top of him.

Corroborative evidence having been called, LEACH the driver of the tramcar, stated he made every endeavour to avert a collision. The force of the collision threw him through the window, and he sustained a severe shock. The accident was due to an erroneous estimate by the caravan driver of the time it would take to cross Clifton-street; therefore, as he took the risk, the defendant company was not responsible.

His Honour gave a verdict for the plaintiff for £63. 19s. 9d.

ANDREWS v. IMPERIAL TRAMWAYS CO.

At the West Riding Assizes on Wednesday Mrs. Hannah Andrews, of Linthorpe, near Middlesbrough, sought to recover damages from the Imperial Tramways Co. for damages for personal injuries sustained while travelling on Aug. 13, on the line worked by the defendant company.

The defence was a denial of negligence on the part of the defendants, on whose behalf it was suggested that the accident was due to contributory negligence.

The jury, however, found in favour of the plaintiff, and awarded her £500 damages.

FERGUSSON v. BROUGHTY FERRY TRAMWAY CO.

An interlocutor was issued by Sheriff Ferguson in Dundee Sheriff Court on Saturday last in an action in which Misses Fergusson, Tayside, Broughty Ferry, and their coachman, sought to recover damages from the Dundee and Broughty Ferry Tramway Co. for personal injuries and damage to a carriage as the result of a collision with a car belonging to defenders in October last. The defenders denied liability, and averred that the coachman was responsible for the mishap. Sheriff Campbell Smith allowed £50 for the carriage and horse damage, £40 to Miss Gertrude A. Fergusson for injuries, and £30 to the coachman for injuries. The defenders appealed, and the Sheriff-Principal has dismissed the appeal, with additional expenses, holding that a vehicle such as a tramcar, which could not deviate from the direct line in which it was travelling, should be constantly under control.

COMPANIES' MEETINGS AND REPORTS.

CONSOLIDATED ELECTRICAL.

The fifth ordinary general meeting of the Consolidated Electrical Co. was held on Monday at River Plate House, Finsbury-circus, E.C., Mr. Herbert Allen (chairman of the Company) presiding.

The directors' report of the Consolidated Electrical Co. for the year ended March 31 last, submitted at the meeting, stated that the ordinary income amounted to £7,532, in comparison with £3,851 for the previous year. The directors recommended a dividend of 3½ per cent. for the year, comparing with 3 per cent. for the previous year, on the ordinary shares, leaving £5,977 to be carried forward. The position of the Anglo-Portuguese Telephone Co. was entirely satisfactory. Considerable improvement had been effected in the position of the Private Wire and Telephone Installation Co. The unsecured liabilities of the Consolidated Supply Co. to this Company had been reduced during the year by the issue to this Company of a further amount of 5 per cent. debentures, and the item of "investments" had been increased correspondingly.

In moving the adoption of the above report, the CHAIRMAN said that the year under review was not a particularly eventful one, but after the immense improvement effected in the position of the Company in the previous two years, it was perhaps only natural that they should have moved a little more slowly of late. He hoped that it was merely a case of marking time preparatory to their next step forward. The balance-sheet, as a whole, scarcely did justice to the real position of the Company, and could easily be made to show the position in a much more favourable light, but, following their usual practice, the directors adopted a very conservative attitude in their treatment of all the figures.

Mr. C. WOOLLEY seconded the resolution, which was carried unanimously, as was also a resolution that a dividend be paid upon the ordinary shares at the rate of 3½ per cent. per annum, free of income tax, for the year ended March 31, 1907.

NATIONAL TELEPHONE.

The report of the National Telephone Co. for the half-year ended June 30, to be presented at the meeting on July 23, states that the income accrued in respect of the business amounts to £1,314,791, an increase of £119,639. The working expenses amount to £753,207, an increase of £61,470. The net results (after deducting the Post Office royalties, amounting to £125,312) is a profit balance of £436,271, an increase of £46,206. The rentals carried forward for unexpired terms of running contracts amount to £1,210,117, an increase of £103,478. Out of the available balance of £331,979 shown by the net revenue account the Board will recommend for the half-year a dividend at the rate of 6 per cent. per annum on the first and second preference shares, 5 per cent. per annum on the third preference shares, 6 per cent. per annum on the preferred stock and 5 per cent. per annum on the deferred stock and new shares, less income tax in all cases. The Board also proposes to transfer £130,000 to the reserve fund and to carry forward £9,662. The sum of £583,758 has been expended on capital account during the half-year in the erection of 20,967 additional exchange and private stations, and in the construction of underground works. The lamented death of the general manager, Mr. W. E. L. Gaine, on June 18 last, has deprived the Company of an officer whose conspicuous ability and devoted services have been of the highest value. The duties of general manager will in future be discharged by a managing director, and, at the unanimous request of his colleagues, Mr. George Franklin has consented to accept that position, in addition to his office of president.

ELECTRIC CONSTRUCTION.

The report of the Electric Construction Co. for the year ended May 31 last states that very severe competition has continued to prevail in the electrical manufacturing industry. The increased price of copper and other materials has also been prejudicial, a corresponding increase in the price of electrical plant not having been obtainable, particularly during the first half of the financial year. In consequence, the year's operations, after payment of £10,250 for debenture interest and crediting £5,000, as formerly, to depreciation account, show a loss of £1,442. This has been deducted from the surplus of £1,651 brought forward, leaving £208 to be carried forward. During the year several important contracts have been completed at home and abroad. The volume of business in hand is greater than at this time last year, and includes important orders from the Admiralty, London County Council, Wolverhampton Corporation, and others. Prices have also improved. The directors, therefore, take a hopeful view of the outlook, reasonable selling prices being alone necessary to restore the Company's prosperity. Mr. Walter S. B. McLaren has accepted a seat on the Board and has been appointed chairman.

BUENOS AYRES GRAND NATIONAL TRAMWAYS.

The report of the Buenos Ayres Grand National Tramways Co. for the year ended March 31 last, to be submitted at the meeting on July 24, states that the gross receipts of the line (consisting of the lines of this Company and those of the Buenos Ayres New Tramways Co.) have amounted to £321,256, as compared with £252,597 for the previous year. The working expenses amounted to £220,389, as compared with 192,893. The net receipts amounted to £100,867, as compared with £59,703. The Grand National Co.'s share of the above net receipts under the agreement has amounted to £68,405 as compared with £45,556. After payment of London administration expenses, interest on debentures, etc., there remained a balance of £27,230, from which the sum of £900 has been transferred to debenture reserve funds and £3,726 to income bond-holders' interest account, and there has been paid on Feb. 15, 1907, £9,000, being the interim dividend of 2 per cent. on the 5 per cent. cumulative preference shares, leaving £13,604, which the directors recommend should be appropriated—as to £13,500 to the payment of a further 3 per cent. on the preference shares (making 5 per cent. for the year), and as to £104 to the credit of the contingency fund, which will then stand at £6,955. Further progress has been made with the work of converting for electric operation the joint system of this Company and of the Buenos Ayres New Tramways Co., and at June 30, 1907, there had been converted a total length of 75¾ miles.

UNITED RIVER PLATE TELEPHONE.

The directors' report shows that the gross receipts in sterling for the year in the River Plate were £216,204, as against £181,085 for last year. Deducting debenture interests, dividend on preference shares, and interim dividend on ordinary shares, and adding interest on investments, transfer fees, etc., there remains a profit of £61,993, to which must be added £2,076 brought forward from the previous year, making an available balance of £64,070. After putting aside £25,000 for renewal of plant and transferring £10,000 to the reserve fund, the directors recommend that a final dividend of 5 per cent. be paid upon the ordinary share capital, making, with the interim dividend paid Dec. 31 last, a return of 8 per cent. for the year, free of income tax, and that the balance of £4,070 be carried forward. The directors have found it advisable to avail themselves of the powers for increasing the debenture capital granted by the shareholders. This necessitated the redemption of the 5 per cent. debenture stock, which was paid off on July 1 under the terms of the issue.

CITY OF LONDON ELECTRIC LIGHTING.

The report of the City of London Electric Lighting Co. for the half-year ending 30th ult. states that the number of customers being supplied was 12,233, number (equivalent) of 8-c.p. lamps connected was 946,986, an increase of 46,708. On the 26th ult., in addition to the lamps connected, there were 45,991 awaiting connection on completion of the consumers' wiring, delivery of motors, etc., as compared with 30,014 on June 27, 1906. The gross revenue from sale of electricity for public and private supply and meter rentals, excluding sundry receipts, was £135,776, an increase of £7,253. The net revenue (including sundry receipts) was £60,331, plus £20,621 brought forward, making £80,952. The gross revenue and net revenue are larger than for the same period in any previous year. This result is mainly attributable to the increase in the number of units sold, especially for power purposes, the total sale having been 11,856,427 units, as compared with 11,143,662 units. After payment of interest on the debenture stocks and loans, the net revenue (including £20,621 brought forward) is estimated to be about £80,952. A dividend of 5s. per share on the ordinary shares was announced last month.

SOUTH WALES ELECTRICAL POWER DISTRIBUTION.

The report of the South Wales Electrical Power Distribution Co. for the year ended Dec. 31, 1906, has just been issued. The report

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states that the annual meeting could not be held earlier owing to the protracted negotiations caused by the financial position of the Company. That position was fully explained to the shareholders at the extraordinary meeting held on July 2, 1906, when the shareholders approved the Bill for enabling the Company to raise £500,000 of prior lien debenture stock, which Bill received the Royal assent on Aug. 4, 1906. The undertaking has since June 1, 1906, been carried on by an arrangement with the consumers, under which they have paid prices for current supplied which have enabled the works to be kept going without loss. Every effort has been made to raise the further capital required to enable the Company to complete the part of the undertaking then in hand and to supply power to various collieries with which agreements had been made and to others with which negotiations were in progress. Certain financial firms largely interested in the Company were prepared, under the advice of the most experienced experts, to find the £500,000 thought necessary to put the undertaking on a sound footing, if 40,000 h.p. could be guaranteed under contracts for 15 years. After long negotiations with the consumers this was found to be impossible, and since then other schemes have been put forward in the interests of the shareholders, who will be asked to approve certain proposals at the extraordinary meeting to be held at the close of the ordinary meeting to be held in Cardiff on July 27. The directors who retire by rotation do not seek re-election, and the remaining directors have sent in their resignations. The revenue account shows that the total receipts were £20,540, and the expenditure £42,690, a loss of £22,150. The loss on the previous year amounted to £28,886, to which has to be added £10,000 interest on debenture stock and £10. 16s. interest on prior lien debenture stock. Deducting £69 interest received, the net debit balance is £60,978. The list of names of those who are willing to act as directors include several well-known South Wales gentlemen, and Mr. W. L. Madgen and Mr. T. O. Callender.

BOMBAY ELECTRIC SUPPLY AND TRAMWAYS.

The directors' report and statement of accounts for the year ended Dec. 31, 1906, shows that the capital expenditure at that date amounted to £1,229,349, and includes the payment of the balance of the purchase price of all the property, works and other assets acquired under the agreement of July 3, 1905. The gross receipts for the year amounted to £102,192; after deducting all expenses chargeable to revenue, including repairs and maintenance, there remains £41,900. Interest on loans and debenture interest absorbs £28,056; the balance of £13,843, added to the amount brought forward from last account (£3,163), leaves a total available of £17,006. From this has to be deducted the dividend on the 6 per cent. cumulative preference shares paid to Aug. 15, 1906, £9,014, and the dividend on the 6 per cent. cumulative preference shares accrued to Dec. 31 1906, £6,627, leaving a balance of £1,363, which the directors recommend should be carried forward to next account. The report further states that considerable progress has been made with the electrification of the tramways. The receipts per car mile for the period from May 7 to June 7 earned by electric cars averaged 13·85d., as compared with an average of 8·31d. per car mile with horses. In exercise of the powers conferred by the Indian Electricity Act of 1903, the Governor in Council sanctioned the issue to the Company of the Bombay electric traction licence for the supply of energy for electric traction in respect of the city, town, and island of Bombay. The local government have amended the provisions of the Bombay Tramways Act of 1874, to authorise the Company to run at a higher rate of speed than that prescribed under that Act. Both amendments were essential on the introduction of electric traction. The extended width of the electric cars has since been sanctioned by the Corporation. The electricity supply section of the business is stated to be developing satisfactorily, and many important installations have been completed, while others will be completed shortly. The profits from the working of the tramway were earned entirely with horse traction, and, having regard to the obstruction and dislocation of the running caused by the work of reconstruction, have been well maintained.

NEW COMPANIES REGISTERED.

North-Eastern Electrical Stores.—Registered July 5. Capital, £1,000 in £1 shares. Object: to acquire the business formerly carried on by the Northern Electrical Supply Stores, and recently by F. H. Potts at 92, Northumberland-street, Newcastle. No initial public issue.

British Motor and Engineering Co. (1907).—Registered July 10. Capital, £50,000 in £1 shares. Objects: to acquire the goodwill and assets of the British Motor and Engineering Co., now or lately carrying on business at Caversham-road, Reading. Registered office: 12-13, Henrietta-street, W.C.

Electrical Securities Trust, Limited.—Registered in Edinburgh July 3 by Guild and Shepherd, 63, Castle-street, Edinburgh. Capital, £200,000 in £1 shares. Object: to carry on the business of an investment trust company in all its branches, and in particular in the branch indicated by the title. Registered office: 43, Charlotte-square, Edinburgh.

Greystone Wood Manganese Syndicate, Limited.—Registered July 5. Capital, £15,000 in £1 shares. Objects: to acquire mines, mining rights, quarries, and metalliferous or other land in England or elsewhere, and in particular certain mining rights in the Greystone Wood Mine, Cornwall, and to carry on the business of manganese, copper, iron, coal, and general miners, etc. No initial public issue.

Western Electric Co. (Australia), Limited. — Registered July 11. Capital, £2,000 in £1 shares. Objects: to carry on in Australia or elsewhere the business of dealers in telephones, telephonic, telegraphic, and electric lighting apparatus, instruments, and machinery, electric cables and wires, etc. No initial public issue. Table "A" mainly applies. Registered office: 171, Queen Victoria-street, E.C.

United Serdang (Sumatra) Rubber Plantations.—Registered July 10. Capital, £170,000 in £1 shares. Objects: to adopt agreements with the partners in the firm of Harrison and Crosfield for the sale and purchase of the Begerpang Estate, Serdang, with Paul L. J. Francis Count de Guigné, C. J. de Guigné, and G. C. A. de Guigné, and with H. W. Brett, and to carry on the business of growers of rubber, cocoanuts, and other products, etc.

Naversberg Falun Copper Mines and Works, Limited.—Registered July 5 by R. W. Blackburn, 35, New Broad-street, E.C. Capital, £100,000 in £1 shares (20,000 "A" and 80,000 "B"). Objects: to acquire certain mines and properties in the province of Dalarne, Kopparbergs lan, Central Sweden, and to carry on the business of miners, smelters, refiners, etc. No initial public issue. Registered office: 25 35, New Broad-street, E.C.

Sunlight and Safety Lamp Co., Limited.—Registered July 11 by Sharpe Parker and Co., 12, New-court, Carey-street, W.C. Capital, £50,000 in £1 shares. Objects: to acquire from the Sunlight and Safety Lamp Co. and its liquidator the business of the said old company, and to carry on the business of manufacturers and exporters of and dealers in oil, gas, electric, and other lamps, lamp accessories, and heating and lighting appliances of all kinds. No initial public issue. Registered office: Roscar Works, Summer-hill, Birmingham.

Hudson Economiser Co. (1907), Limited.—Registered June 19. Capital, £5,000 in £1 shares. Objects: to take over the business and assets of the Hudson Economiser Co.; to adopt an agreement with Balmforth Co. and C. A. Hunton for the acquisition of the said business for a consideration of 4,000 shares; and to carry on the business of engineers, manufacturers of and dealers in machinery and engineering appliances, manufacturers' agents, dealers in engineering stores, etc. No initial public issue. Registered office: Gloucester House, 2, Bishopsgate-street Without, E.C.

Liens Registered.

Helis Cell and Accumulator Co., Limited, London, W.C.—Debenture registered July 3 for £650. Charged on the general assets.

Italian "Rapid" Motor Co., Limited, Kensington, S.W.—Lien registered July 4 for £2,500 6 per cent. debentures, part of £5,000 authorised. No trustees. Secured by a floating charge on the entire assets.

St. Austell and District Electric Lighting and Power Co., Limited, London, E.C.—Lien registered July 11 for £150 5 per cent. debentures, part of £2,000. Amount previously issued, £1,650. No trustees. Secured by a first charge on the assets.

Brockie-Pell Arc Lamp Co., Limited (London).—Issue on June 25 of £6,000 6 per cent. debentures, part of series created May 30, 1907, to secure £8,000. Charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. No previous issue of same series.

Marconi International Marine Communication Co., Limited. Issue on July 5 of £5,000 7 per cent. debentures, part of series created Nov. 20, 1905, to secure £25,000. Charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £20,000.

Ferranti Limited, Hollinwood, Lancashire. — Trust deed registered July 2 for securing an issue of £20,000 prior lien debentures. Trustees: J. M. Henderson and A. W. Tait. Charged on certain leasehold properties situated at Failsworth, Manchester, and on the undertaking, uncalled capital, and the other assets generally, present and future.

London United Tramways, Limited.—An agreement dated May 10, 1907, relating to the conditional issue of debentures for an indefinite amount has been registered. Property to be charged: the company's undertaking and property, including uncalled capital (except certain property at Brentford), subject to first debentures. Holders: Parr's Bank, Limited, and Speyer Bros., 7, Lothbury, E.C.

James Keith and Blackman Co., Limited (Ventilating Engineers, London and elsewhere).—Issue on July 2 of a 4½ per cent. debenture for £175, part of series created Aug. 9, 1901, to secure £30,000. Charged on the company's undertaking and property, present and future, including uncalled capital. Trustees: W. K. Macdonald, Arbroath, and H. G. Anderson, Park House, Wimbledon. Total amount previously outstanding of same series, £29,825.

Lancashire Light Railways Co., Limited.—A mortgage or charge dated June 29, 1907, to secure an indefinite amount, but stamped to cover £6,000, has been registered. Property charged: all moneys due or to become due under a working agreement with the St. Helens and District Tramways Co.; all moneys, shares, securities, or other consideration to which the company may become entitled as the purchase money in respect of any sale of its railway property or undertaking or part thereof; the company's railway and any extension thereof, with all tolls, rates, and charges for the time being authorised to be demanded or charged in respect thereof; and the company's undertaking and property, present and future, including uncalled capital (subject, as regards railways, etc., to any working agreement). Holder: J. Beecham, Ewanville, Huyton, Lancs.

Stepney.—The Electricity Committee invite tenders for the supply of a testing switchboard, motor-generator, and transformer, also a three-pole distribution board and earthing panel. Tenders by July 22.

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OPENINGS FOR CONTRACTORS.

ALRESFORD—Workhouse extensions (£3,600) for Board of Guardians.

BAKEWELL—Hospital (£5,000) for the Derbyshire County Council.

BARNSLEY—Erection of houses and cottages. Architects, Messrs. Crawshaw and Wilkinson, 13, Regent-street, Barnsley.

BASSINGBOURN (CAMBS)—Alterations at the mills. Estate agents, Messrs. Nash, Son, and Rowley, Royston.

BELFAST—Factory for the Belfast Mineral Water Co. Architects, Messrs. W. J. Moore, 35, Royal-avenue, Belfast.

BELPER—Higher elementary schools and pupil teachers' centre, including science rooms and laboratory. Architects, Messrs. Hunter and Woodhouse.

BOLTON—Electric driving at Messrs. Crooks's cotton mill. Supply from Bolton Corporation.

BOURNEMOUTH — Parish hall for St. Peter's Church (£6,500). Architects, Messrs. Hawker and Mitchell.

BURMANTOFTS—Extension of shoe works for Messrs. C. Davison and Sons, Compton-road. Architect, Mr. W. M. Coggill, 4, Airedale-terrace, Stourton, Hunslet.

BURNOPFIELD—Business premises and houses. Mr. J. W. Thompson, Bute House, The Fold, Burnopfield, Durham.

CARDIFF—Telephones, etc., at Cardiff and Ely Workhouses, for the Cardiff Guardians. Clerk, Mr. A. J. Harris, Union Offices, Queen's-chambers, Cardiff.

CASTLE EDEN—Police court. County surveyor, Mr. Wm. Crozier, Shirehall, Durham.

CHATBURN (NEAR CLITHEROE)—Erection of and extension to weaving shed and 17 dwelling houses for the Chatburn Manufacturing Co. Architect, Mr. W. H. Atkinson, Shaw-street, Colne.

CHELMSFORD—Hospital extension.

CLAYTON (SUSSEX)—Public lighting for the Parish Council. Clerk, Mr. E. F. Hope, Church-road, Burgess Hill

CROYDON—Flame arc lamps and gear are required by the Corporation Electricity Department. Borough Electrical Engineer, Electricity Works, Factory-lane, Croydon.

DEVONPORT—Music hall at Devonport for the directors of the Plymouth Palace Theatre (£20,000).

DUBLIN—Erection of blocks of dwellings, stores, offices, etc., for the Commissioners of Irish Lights. Engineer's office, D'Olier-street, Dublin.

EAST STONEHOUSE—Annexe at the Town Hall. Surveyor to the Urban District Council, Mr. C. H. Trounce.

ECCLES—Extensions to the works of Messrs. Broughton Lindley, Peel Green.

FRODINGHAM—Ironworks being erected at Frodingham for Messrs. John Lysart and Co.

GAINSBOROUGH—Market buildings for Urban District Council.

GREENOCK—Admiralty works at Fort Matilda, Greenock (£20,000).

GRIMSBY—Extension of electricity undertaking (£3 825).

HAPTON—Street lighting for the Parish Council. Clerk, Mr. G. Hayes.

HARWICH—Enlarging Guildhall (£6,000).

HEREFORD—Additions to Spread Eagle Hotel. Architects, Messrs. Groome and Bettington, Palace-chambers, Hereford.

HUDDERSFIELD—Two dwelling-houses at Crosland Moor. Architect and surveyor, Mr. J. Ainley, Chapel-street, Slaithwaite.

KEYMER (SUSSEX)—Public lighting for the Parish Council. Clerk, Mr. E. F. Hope, Church-road, Burgess Hill.

LONDON—Extension of smoke-room and lavatory accommodation at the Great Western Railway Hotel, Paddington.

LONDON, S.W.—Married quarters at Regency-street Police Barracks. Mr. J. Dixon Butler, surveyor, Metropolitan Police Force, London, S.W.

LONDON COUNTY COUNCIL—Southfield new school, Wandsworth. Contractor, Mr. E. J. Clayton, Aldine Works, Shepherd's Bush.

LONGTON—Electricity works extensions (£2,000).

LUTON—Works for Messrs. Charles Clay and Sons. Architects, Messrs. J. R. Brown and Sons, 9, Castle-street, Luton.

MANCHESTER—Corporation electricity undertaking. Proposed to spend £112,850.

MANCHESTER—Church extensions. Messrs. C. K. and L. C. Mayor, Dalton-chambers, 41, John Dalton-street, Manchester.

MANSFIELD (NOTTS)—Residence at the Park for Mr. R. H. Wiggins. Architect, Messrs. Vallance and Westwick, Mansfield.

MILNSBRIDGE (YORKS)—Premises for workmen's club and institute. Architect, Mr. G. Ainley, Chapel-street, Slaithwaite.

MERTHYR—Fifty houses at Twynrodyn for the Council (£8,060).

NELSON—New fire station (£3 300).

NEW BARNET—Two detached residences and a pair of semi-detached houses. Architect, Mr. W. Bennett, Broadway, Finchley, London, N.

PENBRIWCEIBER—Institute for Messrs. Nixon's workmen. Apply, Workmen's Institute, Mountain Ash.

PENTONVILLE (NEWPORT, MON.)—Offices for the Monmouthshire County Council. County surveyor, Mr. W. Tanner.

PLUMPTON—Church. Architect, Mr. R. S. Lorimer, Edinburgh.

RADCLIFFE—Supply of electrical power to the textile works of Tootal, Broadhurst, Lee, and Co. and Messrs. J. Young, Limited. Mains extension to the brewery of Messrs. R. Seed and Co., Spring-lane.

PORTH—Hotel for Mr. T. Morgan. Architect, Mr. J. T. Jenkins, Porth, Rhondda.

ROYTON—Spinning mill for the Park and Sandy-lane Spinning Mill Co.

SHEFFIELD—Head post office. Secretary, H.M. Office of Works, Storey's-gate, London, S.W.

SHEFFIELD—Post office for H.M. Works and Public Buildings Department, London, S.W.

SHORNCLIFFE — Wesleyan Soldiers' Home (£3,000). Architects, Messrs. Ruck and Smith, Maidstone.

SOUTHAMPTON—Central fire station for the Corporation. Estimated cost, £5.200.

SWINDON—Enlargement of workhouse.

WAKEFIELD—Generating plant and electric lighting installation at the asylum for the Storthes Hall Asylum Sub-Committee of the West Riding County Council. County architect, Mr. J. Vickers-Edwards, County Hall, Wakefield.

WALKDEN—Power supply to Messrs. Faulkner's cotton mill from the Lancashire Power Co.

WEST DIDSBURY (MANCHESTER)—Wiring two hospital pavilions at the Withington Workhouse. Clerk to Guardians, Mr. David S. Bloomfield, Union Offices, All Saints', Manchester.

WHITEHEAD—Church. Architect, Mr. W. D. R. Taggart, 2, Wellington-place, Whitehead.

WIDNES (LANCS.)—New premises for the Liberal Club. Architects, Messrs. E. L. Bower and T. F. Shepheard, Liverpool.

WINCHESTER—Erection of headmaster's house at Peter Symond's School, Winchester. Messrs. Cancellor and Hill, 12, Jury-street, Winchester.

WOKING (SURREY)—Orphanage. Architect, Mr. W. E. Trevenor, Southampton-street, South Farnborough, Hants.

WOLVERHAMPTON—Corporation electricity undertaking. Expenditure of £35,000 proposed.

YSTRAD (WALES) — Erection of warehouse, showrooms, etc., and additions to shops for Mr. G. Dutfield. Architect, Mr. T. E. Richards, Market-square-chambers, Pontypridd,

CONTRACTS FOR ELECTRICAL SUPPLIES.

Belgium.—The Municipality of Beaufays invite offers for an electric lighting system. Tenders by July 22.

Belgium.—The Ougrée Municipality invite offers for the electric lighting of the district. Tenders by July 27.

Ealing.—Tenders are invited for the annual supply of stores to the electricity department. Tenders by July 22.

Salford.—Tenders are invited for 14 cars and four salt wagons for the Corporation Tramways Department. Tenders by Aug. 12.

Madrid.—The Public Works Department invite tenders for the construction of electric tramways in Valencia. Tenders by Aug. 12.

Madrid.—Tenders are invited by the Public Works Department for the construction of an electric tramway at San Sebastian. Tenders by July 30.

Walsall.—The Town Council invite tenders for the haulage required during a period of one year in connection with the electricity undertaking.

Wanganui (New Zealand).—The Municipality invite tenders for the construction of an electric tramway and the supply of cars, etc. Tenders by Aug. 1.

London.—The Metropolitan Water Board invite tenders for plant, including electric generator, boilers, piping, pumps, coal conveyor, moters, etc. Tenders by July 24.

Derby.—Tenders are invited for the supply of small steam coal to the Electricity Department. Particulars on application to the Borough Electrical Engineer, Full-street, Derby.

Portsmouth.—The Tramways Committee invite tenders for best large smokeless steam coal. Mr. V. G. Lironi, engineer, Fratton-grove, Portsmouth. Tenders by Aug. 5.

Dublin.—The Corporation invite tenders for the annual supply of machinery oils for the electricity works. Specifications, price 5s., from the Town Clerk. Tenders by July 23.

Willesden.—The Urban District Council invite tenders for 2½ miles of stoneware conduits for electrical mains. Particulars from the Electrical Engineer, Salusbury-road, Kilburn, London, N.W. Tenders by July 22.

Brussels.—The State Railways Department invite tenders for electric lamp standards, Westinghouse brakes, and sundries. Specification No. 986. The Director, No. 11, rue de Louvain, Brussels. Tenders by July 24.

Leith (Scotland).—The Corporation invite tenders for the supply from Sept. 16 to May 14, 1908, of coal delivered at the electricity station. Particulars from the Borough Electrical Engineer. Tenders by July 22.

Brisbane.—The Postmaster-General invites tenders for the supply and delivery at Brisbane of four sections of a common battery switchboard and 650 subscribers' telephones to specification No. 145. Tenders by Sept. 2.

Winnipeg.—The Point du Bois Hydro-Electric Development invite tenders for an electrical equipment and for constructional work. Specifications, etc., from the Power Engineer's Office, Carnegie Library Buildings, Winnipeg, or at 35-36, Bedford-street, Strand, W.C. Tenders by Sept. 3.

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Blackburn.—The Electricity Committee invite tenders for the supply and delivery of steam coal for nine months ending June 30, 1908. Specifications, etc., on application at the Electricity Works, Jubilee-street. Tenders by Aug. 3.

Wednesbury.—The Corporation invite tenders for the supply of balancer boosters and alterations and extensions to accumulators for the electricity department. Particulars from Mr. W. Fennell, Camp-street, Wednesbury. Tenders by July 23.

Wimbledon.—Tenders are invited by the Borough Electricity Department for the supply of Edwards's air-pump equipment, and voltmeters. Particulars from the Borough Electrical Engineer, Durnsford-road, Wimbledon. Tenders by July 22.

Croydon.—The Electricity Committee invite tenders for the supply of the following: (*a*) flame arc lamps; (*b*) transformers for the same; (*c*) lowering gear. Full particulars to be obtained from the Borough Electrical Engineer, Electricity Works, Factory-lane, Croydon.

Adelaide.—The Deputy Postmaster-General invites tenders for a common battery switchboard and subscribers' telephones. Specification No. 166. Particulars may be obtained from the Commonwealth Offices, 72, Victoria-street, London, S.W. Tenders by Jan. 8, 1908.

Rochester.—The Corporation invite tenders for the construction of permanent way (Contract No. 5) and overhead line (Contract No. 6). Specification, etc., from Mr. E. Rotter, consulting engineer. 47, Victoria-street, Westminster, on payment of £5, which will be returned on the receipt of a bona fide tender. Tenders by July 22.

Newcastle-upon-Tyne.—The Tramways Committee invite tenders for the supply of the various, points, crossings, rails, and other materials in connection with the renewal and extension of a three-road double turn-out junction of tramways at Market-street and Pilgrim-street, Newcastle-upon-Tyne. Tenders by Aug. 3. See advertisement in last issue.

Birmingham Tame and Rea District Drainage Board.—The Board invite tenders for the supply and erection, at their Saltney outfall works, of electrical pumping machinery for the pumping of storm water, comprising three-phase induction motors and electrically-controlled sluice valves, with all the necessary switchgear. Tenders by July 26. See advertisement in last issue.

Queensland.—Tenders are invited by the Postmaster-General for the supply and delivery at the Post and Telegraph Stores, Brisbane, of the following telegraph and telephone material: (1) lead-covered cable; (2) stores and battery material; (3) line material; (4) telegraph and telephone instruments; (5) coin attachments. Tenders to be sent to the General Post Office, Brisbane, by Sept. 9.

West Didsbury.—The Guardians of Chorlton Union invite tenders for the wiring of two hospital pavilions at the Withington Workhouse, West Didsbury, Manchester. Specifications, etc., from Messrs. Peers, Copland, and Cardin, 16, John Dalton-street, Manchester, upon payment of £2. 2s., which will be returned on receipt of a bona fide tender. Tenders to Mr. David S. Bloomfield, clerk to the Guardians, Union Offices, All Saints', Manchester, by July 23.

Wakefield.—Tenders are invited for the following contracts in connection with the second portion of the main institution of the Storthes Hall Asylum, for the West Riding County Council: (1) two engines and dynamos, electric light installation, including wiring, fittings, lamps, etc.; (2) electric bells, telephones, fire-alarms, recording clocks, etc.; (3) heating and ventilation; (4) farm buildings and residence. Full particulars may be obtained on application to the County Architect. Tenders by July 22.

Walton-on-Thames.—The Metropolitan Water Board invite tenders for the provision of four high-class triple-expansion marine type steam-engines, seven centrifugal pumps, three hydraulic turbines, sluice valves, steel mains and cast-iron branch pipes, two 25-kw. electric generators, 10 water-tube boilers, mechanical stokers, two economisers, steam-pipes, feed pumps, coal conveyor, ash hoist, motors, etc., to be erected at the new pumping station at Walton-on-Thames. Tenders to the Clerk, Metropolitan Water Board, Savoy-court, Strand, W.C., by July 24.

Bristol.—Tenders are invited for the construction, delivery, erecting in place, fitting, testing, and maintenance for 12 months after completion, of the following electric jib cranes to be erected at the Royal Edward Dock now in course of construction at Avonmouth, in the port of Bristol, for the Docks Committee of the Council: (Schedule No. 1) 12 30cwt. movable electric jib cranes to be erected on the roofs of sheds No. 1 and No. 2 in course of construction on the east side of the dock; (No. 2) two 10-ton movable electric jib cranes on high pedestals, to be erected on the wharf on the south side of the dock; (No. 3A) three 30cwt. movable electric jib cranes on high pedestals, to be erected on the wharf on the south side of the dock; (No. 3B, as an alternative to Schedule 3A) one 30cwt. movable electric jib crane, two 3-ton movable electric jib cranes. Tenders to the Secretary of the Docks Committee, Dock Offices, 19, Queen-square, Bristol, by July 26.

RESULTS OF TENDERS.

York.—The Electricity Committee of the York Corporation have accepted the tender of the Adams Manufacturing Co. for the supply of Igranic motor-starting rheostats for the period of 12 months, dating from July 1, 1907.

Marylebone.—The Corporation have accepted the tender of Messrs. Parsons and Co., for £200, for the insertion of a steam temperature buffer to ensure that the superheat temperature is not put upon the turbines too rapidly.

Plymouth.—The Guardians have accepted the tender of Dargue, Griffiths, and Co., May Buildings, 51, North John-street, Liverpool, at £334, for the installation of electric lighting at the new workhouse infirmary buildings.

Walsall.—The Town Council have accepted the tender of Jones and Evans, Walsall, for erecting the Bridgman-street transformer station, and the tender of W. H. Bowater, Limited, Birmingham, for supplying the coal required at the Wolverhampton-street generating station for one year.

Bedford.—The Corporation have accepted the schedule of prices submitted by Messrs. Siemens Bros. and Co., for the supply of paper-insulated cable for all purposes in connection with the electricity department required during the year ending June 30 1908. The average cost of the various classes of cable estimated to be required is at the rate of £295. 3s. per mile.

Pontypool.—The Executive Board of the Pontypool and District Hospital have accepted the tender of Messrs. Wyatt and Dixon, Pontypool, for ventilating the laundry and drying chamber, and lighting the hospital by electricity, including fans, wiring, lamps, and fixing, for the sum of £219. A second-hand Crossley engine costing £60 is to be used, and is included in the above quotation.

Condensing Plant.—Among the contracts recently received by the Mirrlees-Watson Co., of Glasgow, is one from Franco Tosi for three sets surface-condensing plant, duty each 20,000lb. steam per hour; one from Fraser and Chalmers, Limited, for two surface condensers, each 3,200 square feet cooling surface; and one from the Lancashire and Yorkshire Railway Co.'s Horwich Works, per W. H. Roy and Co., for one counter-current jet condensing plant, duty 50,000lb. steam per hour.

Dartford.—The District Council have accepted the following tenders for annual stores required for the electricity department: Chamberlain and Hookham, meters, £118. 18s.; S. W. Gibson and Co., paraffin, tallow, mutton cloths, £9. 5s. 3d., block tin, fuse wire, etc., £4. 12s. 6d.; E. E. Beaven, files, tools, and screws, £5. 12s. 4d., jointing material and packing, £7. 3s.; W. T. Henley's Telegraph Works and Western Electric Co., house service cables, jointing materials, and accessories. £185. 10s. 8d.

London County Council.—The following extras have been sanctioned on contracts for the provision of internal fittings at Long Grove Asylum: (1) On Messrs. Lea and Warren's contract (£11,200) for the electric lighting installation—cable and leads for garden buildings and glasshouse, £56. 4s.; two Board of Trade unit meters for main switchboard, £26. 15s.; minor items, £56. 14s. (2) On Messrs. Cox Walker's contract (£1,715) for the installation of telephones, fire-alarms, and tell-tale clocks—overhead leads for farm buildings, £15; sundry small items, £14. 6s.

Stepney.—For the supply and delivery of meters, etc., during the year ending June 30, 1908, for the Borough Electricity Department:

Meters up to a capacity of 10 amperes.			
Reason Manufacturing Co.*	£262	10	0
Chamberlain and Hookham	325	0	0
Ferranti, Limited	325	0	0
Meters above a capacity of 10 amperes.			
Ferranti, Limited	302	15	0
Chamberlain and Hookham*	311	10	0
Supply and delivery of demand indicators.			
Engineering Instruments, Limited	260	1	11
Monte-Callow and Co.	260	1	11
Reason Manufacturing Co.*	337	7	6
Supply and delivery of carbons.			
Sloan Electrical Co.*	767	1	2
Johnson and Phillips	793	5	6
Crompton and Co.	800	15	0
Braulik, G. (5 per cent. less for cash)	839	7	1
Union Electric Co.	894	8	7

* Recommended for acceptance.

London, S.E.—The London County Council have received the following tenders for the manufacture, delivery, and erection of two of the four sets of 5,000-kw. three-phase steam turbo-generators required for the second portion of the Greenwich electricity generating station:

Turbo generators, including provisional sum.			
Willans and Robinson, Rugby*	£42,200	0	0
British Westinghouse Electric and Manufacturing Co., Manchester	42,443	0	0
Ditto (alternative tender)	36,000	0	0
C. A. Parsons and Co., Newcastle-on-Tyne	44,276	0	0
Ditto (alternative tender)	39,866	0	0
Electric Construction Co., Wolverhampton	44,790	0	0
British Thomson-Houston Co., London	47,480	0	0
J. Howden and Co., Glasgow	48,000	0	0
General Electric Co., Birmingham	48,628	0	0
Spare parts.			
Willans and Robinson	1,875	0	0
British Westinghouse Electric and Manufacturing Co.	1,366	0	0
Ditto (alternative tender)	1,205	0	0
C. A. Parsons and Co.	746	0	0
Ditto (alternative tender)	655	0	0
Electric Construction Co.	491	0	0
British Thomson-Houston Co.	392	0	0
J. Howden and Co.	489	0	0
General Electric Co.	462	10	0

* Recommended for acceptance without spare parts.

Bermondsey.—The Electricity Committee have recommended the following tenders to the Borough Council for acceptance: Pryke and Palmer, one length of 4in. feed pipe, £3. 2s. 6d.; engine oils—Silvertown Oil Storage Co., 200 galls. dynamo oil at 1s. per gall., 200 galls. cylinder oil at 2s. 6d., 400 galls. crank-chamber oil (Willans) 2s. 2d; C. C. Wakefield and Co., 200 galls. forced lubrication chamber oil, 1s. 5d.; Sutton and Co., 7,000 yards 4in. single-way conduits 1s. 0¼d. per yard, and 100 bends 1s. 0¼d. each, less 2½ per cent.; Johnson and

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Phillips, 13 six-way disconnecting joint-boxes £91, 14 five-way ditto £91, 18 four-way ditto £90, 12 three-way ditto £54, 29 straight-through ditto £54. 7s. 6d., 8 end-connecting ditto £5. 4s.; Callender's Cable and Construction Co., 7,400 yards ·125 by ·125 by ·06 lead-covered cable £2,980, 400 yards ·2 by ·2 by ·1 £226. 5s.; Johnson and Phillips, 120 yards ·2 by ·2 by ·1 steel armoured, £75. 4s. 5d.

BUSINESS NOTES.

TRACTION.

Hobart Electric Tramway.—The directors of the Hobart Electric Tramway Co. have declared a dividend of 5 per cent.

Fatality.—A child, aged about two years, was run over by an electric tramcar at Whetley Hill, Bradford, and died from injuries received.

The Electrobus.—Three "electrobuses" made their appearance on the streets of London on Monday morning, running between Liverpool-street and Victoria.

Reading.—The employés of the Reading Corporation tramways held their beanfeast last week. On Tuesday the first party, numbering 30, went to Burnham Beeches by road, and the others visited the same place on Thursday. Both days fortunately proved fine there, and the excursionists greatly enjoyed themselves.

Madras.—The traffic receipts of the tramways owned and worked by the Madras Electric Tramways Co. for the fortnight ended July 15 amounted to Rs.17,694, compared with Rs.15,144 for the corresponding period of the preceding year, an increase of 16·8 per cent. The gross receipts from Jan. 1, 1907, amounted to Rs.221,596.

Rawdon.—The District Council have confirmed the arrangements provisionally entered into with the Leeds Tramways Committee relative to the extension of the city tramways from Horsforth to Guiseley. The apportionment of the £400 contribution to Leeds by the three Councils of Rawdon, Yeadon, and Guiseley has also been agreed to.

City and South London Railway.—The directors recommend a dividend for the half-year ended June 30 at the rate of 2½ per cent. per annum, as compared with 2¼ per cent. per annum for the corresponding period of last year, £1,857 remaining to be carried forward, as against £1,870, after £1,500 being placed to renewal fund in both periods.

Leeds.—The Leeds Tramways Committee have considered an application from the tramway employés for a reduction of their hours from 60 to 54 per week. The men ask that the reduction shall not affect their present earnings, and also request other concessions. The committee have decided to instruct Mr. J. B. Hamilton, the general manager, to ascertain the hours worked and the wages paid on systems similar to that of Leeds before taking further steps.

Cardiff.—In accordance with instructions, Mr. Harpur (city engineer) and Mr. Ellis (tramways manager) have presented a report in which they estimated the present cost of maintenance of the tramway section between Cowbridge-road and Clive-road at £400 a year, and the cost of doubling the tramlines and widening the road at £8,000. The cost of maintenance would then be about £200 a year, so that they would save £200 a year to meet a capital expenditure of £8,000. The Tramways Committee, however, consider it inexpedient to go on with the work in view of the large cost.

Metropolitan Railway.—In response to a largely-signed petition from the inhabitants of Willesden Green, the Metropolitan Railway Co. have signified their intention of erecting forthwith an additional station on their Harrow extension line, about midway between Willesden Green and Neasden. The new station will be on the Chapter-road, by the side of Gladstone Park, and will be just over a mile from Neasden and under a mile from Willesden Green, in the midst of a thickly-populated district. It will probably be named Gladstone Park Station.

Ealing.—The Mayor, with Aldermen Green and Tyer, have been appointed representatives of the Ealing Council to attend a conference to be held at the Town Hall, Ealing, on July 26, and have been authorised to pledge the Council to take proceedings against the London United Tramways Co. to cause the abatement of the nuisance from the noise of their cars, and to express a hope that other authorities who have cause to complain of a similar noise would assist in providing evidence, and contribute a fair proportion towards the cost of such proceedings.

Bury.—Mr. William Clough, general manager of the Bury Corporation tramways, in his annual report states that during the year the total number of passengers carried on the Bury sections—that is, excluding Radcliffe and Heywood—was 6,157,759, or a weekly average of 118,418. The working expenses per car mile were 5·536d. The net profit on the year was £5,225, of which £2,500 had been carried to reserve and depreciation fund account and the remainder to the borough rates. The capital expenditure to date was £242,466. 7s. 8d. On the Radcliffe sections the net receipts were £8,374. 16s., which did not meet the working and other expenses.

Newcastle.—The Tramways Committee of the Newcastle Corporation propose that the maximum wages of the motormen, conductors, washers, and cleaners be increased 1s per week. The wages of the motormen and conductors start at the minimum of 26s. per week, and rise 1s. per week every six months, until they reach 30s., the maximum. The new arrangement will, if agreed to, make the maximum 31s. per week for these two classes of men at the end of the third year. The wages of washers and cleaners commenced at 22s. per week and increase every six months until 25s. is reached. The maximum of these men in future, at the end of three years, will be 26s. instead of 25s.

Lowestoft.—The annual report of the general manager of the Lowestoft Corporation tramways shows that the total traffic receipts from Oct. 1, 1906, to June 18, 1907, inclusive, were £5,869. 19s. 4d.; in the corresponding period last year, £5,049. 14s. 6d.—increase, £820. 4s. 10d. The tender of the Law Car and General Insurance Corporation for third-party and workmen's compensation insurance has been accepted. The third-party insurance policy is to indemnify the Corporation against all claims by third parties arising through the working of their tramways or through any defect or failure of their plant. The limit of liability to be £500 on any one accident and £2,500 in any one year. The workmen's compensation insurance policy is to indemnify the Corporation against all claims arising from any accident to employés, whether the Corporation are legally liable or not, and from the date of the accident.

Dundee.—The past year has been a very satisfactory one for the Dundee tramways, and the report of Mr. P. Fisher, the manager, shows that the accounts closed with a surplus. The total revenue was £57,672. 1s. 11d., and the working expenses, including maintenance of lines, amounted to £35,403. 16s. 3d., leaving a balance of £22,268. 5s. 8d., which has been appropriated as follows: interest on capital, including bank interest, £8,536. 5s. 2d.; sinking fund, £5,330; depreciation of plant, £1,416. 1s.; and fund for renewals, £6,900, leaving a balance of £85. 19s. 6d. to be carried forward. The total mileage run by the cars was 1,162,792, an increase over the previous year of 156,881 miles, and the passengers carried numbered 15,554,905, as against 13,086,396. The receipts per car mile were 11·94d., and the average fare per passenger was ·878d. For the current year it is estimated that the total receipts will be £59,360—£58,577 from traffic and £783 from advertising, etc.—while the expenses are expected to amount to £59,280, bringing out a surplus of £80.

Uruguay.—The British consul in Uruguay writes that there are 272 km. of tramlines in Montevideo. A British company, the United Electric Tramways for Montevideo, of London, known locally as the Sociedad Comercial, owns 134 km. The electrification of 85 km. was completed last year under contract by a well-known and experienced firm, and the remainder is being taken in hand. This company has also constructed a large hotel at Pocitos, a seaside suburb of Montevideo, to which their tramlines converge. A German company, the Compaña Alemania Transatlantica, owns 119 km. of lines, which they are engaged in electrifying, but the progress of their work has been retarded by the financial difficulties of contractors and by strikes. This German company is desirous of purchasing all the city electric lighting plant of the municipality of Montevideo, and if they should succeed in doing so, they would be prepared to give the public a cheaper and a more efficient lighting service than the present one. The Norte Co., a local tramway company, owns the remaining 19 km. of lines, but they are as yet doing nothing to abolish the old-fashioned horse traction.

London Traffic Board.—The General Purposes Committee of the London County Council report that they received recently a deputation representing the Browning Hall conference on housing, with regard to the urgent need for the establishment of a Traffic Board for London, as recommended by the Royal Commission on London Traffic appointed in 1903. The committee felt that the establishment of an authority competent to deal with the question of locomotion and transport in London was desirable, though they were not at the moment prepared to express any opinion as to the precise constitution of such an authority. They were supported in this conclusion by the circumstance that the President of the Board of Trade, in a speech on the occasion of the opening of the Hampstead Tube on June 22 last, made it evident that the Government were not opposed to the suggestion of the Royal Commission, but were in fact alive, not merely to the importance, but to the urgency of the problem. The committee recommend that a deputation be appointed by the Council to wait upon the Prime Minister to urge the necessity of the Government's securing the immediate establishment of a London Traffic Board upon the lines indicated in the report of the Royal Commission.

Engineering in the Balkan States.—Mr. A. S. E. Ackermann, who has been travelling in the Balkan States, contributes to the *Times Engineering Supplement* of Wednesday last some impressions of his visit. The following extract from his article is of interest to electrical engineers: "From Innsbrück to the quaint and primitive mountain village of Fulpmes (1,200ft. above Innsbrück) an electric trolley-wire adhesion tramway has been constructed. It is 14 miles long, 1m. gauge, railway-section metals, and is known as the Stubai Railway. The journey takes over an hour. It was the first line in the Tyrol to employ electric traction, the energy being generated by the River Sill, and was opened in 1904. The track is crooked (in one place describing an S) in order to reduce the gradient." He says that "Austria appeared to be well supplied with water power, but this has not as yet been utilised to much extent, and in many cases where it has the apparatus is of the most rudimentary character. One of the exceptions is at the source of the River Ombla, near Ragusa. The power-house contains three horizontal turbines, working with a head of about 10ft. Part of the energy is used on the spot for a mill, and the rest is used for pumping water into the aqueduct which leads to Ragusa."

London County Council.—The traffic receipts on the tramways owned and worked by the London County Council for the week ended July 6 amounted to £32,210, against £27,228 in the corresponding week of the previous year. The total traffic receipts from April 1, the beginning of the financial year, to July 6 were £433,607, against £369,721 in 1906. At Tuesday's meeting of the Council, the report of the Highways Committee recommending that the offer of a firm of whisky dealers to exhibit their advertisements on a certain number of the Council's tramcars was discussed and agreed to. It was stated that the Council are at present deriving about £10,000 or £11,000

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from the advertisements on the tramcars, and there was at least £6,000 worth of empty space at the present time. The acceptance of advertisements from the whisky dealers means an additional revenue of about £500 per annum during the continuance of the contract. The Highways Committee recommend that the Council do concur in the proposal that the question whether the expense incurred by the General Post Office in providing heat coils, fuses, etc., for the protection of telephone and telegraph wires in the neighbourhood of tramways worked on the overhead trolley system of electric traction, should be borne be the Post Office or by the tramways authority concerned, shall be settled by arbitration.

LIGHTING AND GENERAL

Wexford.—A provisional order for an electrical lighting scheme for this town is being applied for in the usual course.

Manchester.—The Local Government Board will hold an inquiry on July 23 into the Council's application for power to borrow £112,850 for their electricity undertaking.

Telegraph Construction and Maintenance Co.—The directors of the Telegraph Construction and Maintenance Co. announce an interim dividend of 12s. per share.

Wolverhampton.—A Local Government Board inquiry will be held on July 23 into the application of the Corporation for sanction to borrow £35,000 for the electricity undertaking.

Grassington.—As the result of a public meeting held in the town hall to consider a scheme for lighting the place by electricity, it was decided to canvass the town to see what number of lights would be required.

Walthamstow.—A Local Government Board inquiry is to be held on July 24 into the application of the Urban District Council for sanction to borrow £26,395 for the provision of an electricity and generating station.

Bermondsey.—Messrs. Lipton's propose erecting illuminating signs at their Bermonsey depôts, and the Borough Council have offered to supply them and all users of electric current for this purpose at a flat rate of 3d. per unit.

Mansfield.—The gross profits on the gas, water, and electricity undertakings of the Corporation amount to £18,607, and after making the necessary deductions for interest, sinking fund, and reserve fund, a sum of £5,300 has been handed over in relief of the rates.

Electrical Engineers (Volunteers).—The adjutancy of the London Division Electrical Engineers (Volunteers) will be shortly vacant, and the War Office is seeking a Royal Engineer officer to fill the appointment, in succession to Captain W. C. Dumble, Royal Engineers.

London.—The new clock tower at St. George's-circus, London, S.E., which was declared by the Lord Mayor of London open on Monday, is illuminated at its four corners by Excello arc lamps, controlled as to the time of lighting and extinguishing by the clock mechanism.

Partnership.—According to the *London Gazette*, the partnership between N. McKenzie and W. T. Wright, carrying on business as electrical and mechanical engineers at 4, Watts-place, Chatham, under the style of Norman McKenzie and Co., has been dissolved by mutual consent.

Johnstone.—Messrs. Wright, Johnston, and M'Kenzie have written the Town Council on behalf of the Strathclyde Electricity Co. that they intend making application for an order to generate, supply, sell, and distribute electricity for all public and private purposes within the burgh of Johnstone.

Liverpool.—A large shed which the Mersey Dock Board are having erected alongside their Sandon Dock is to be equipped with five travelling roof cranes, each to have a safe load capacity of 30cwt. We understand, however, that it has not yet been settled whether these cranes shall be electric or hydraulic.

Blairgowrie.—At the last Town Council meeting a letter was read from Messrs. Foote and Milne, electrical engineers, London, intimating that they intended to apply to the Board of Trade, on or before Dec. 21, for a provisional order to supply electricity within the burgh of Blairgowrie. The letter was allowed to lie on the table.

Manufacturers' List.—We have received from the Newall Engineering Co, Warrington, a copy of their new catalogue. It contains a number of new gauges not previously listed by them. Among these are screw gauges and external micrometers. Particular attention is called to the articles on the Newall system and equipments of limit gauges.

Hemel Hempstead.—At the last meeting of the Town Council a letter was received from the Chesham Electric Light and Power Co. giving notice that they intended to apply to the Board of Trade for a provisional order, to be confirmed by a Bill in the 1908 session of Parliament, authorising the company to supply electricity in the Hemel Hempstead area.

Kensington.—The Borough Council have given permission to the Notting Hill Electric Lighting Co. to extend their main in Portobello-road, and to the Kensington and Knightsbridge Electric Lighting Co. to extend their main along the portion of Princes-gate situate in this borough in order to supply electrical energy to the new buildings of the Victoria and Albert Museum.

Gelligaer.—The Electric Lighting Provisional Order (No. 5) Bill, which has already passed through the House of Commons, came on Tuesday before the Unopposed Committee of the House of Lords. The object of the Bill is to confirm certain provisional orders, one of which is granted to the Rhymney Valley and General Electric Supply Co. in respect of the parish of Gelligaer. The Bill was ordered to be reported for third reading.

Ayr.—At the last Town Council meeting the chamberlain reported that the balance at the credit of the lighting (revenue) account at May 15 last, including the balance of £99. 17s. 11d. brought forward from last account, amounted to £1,026. 16s. 8d. The committee have recommended that £700 of this be transferred to the credit of the burgh general assessment account, and that the balance, £326. 16s. 8d., be set aside as a special reserve account for the lighting department. To this the Council agreed.

Framwellgate Moor.—A scheme has been suggested for supplying electric light to the various cottages at Framwellgate Moor and Pity-Me. The conditions are that each occupier of a cottage should agree that 1s. per fortnight should be stopped from his money at the colliery to pay for the current used and the cost of fitting up three lights in positions to be decided upon. The workmen are being circularised asking if they will take a supply of electric light on these terms, and allow the money to be stopped at the colliery office.

London County Council.—At Tuesday's meeting of the Council, Mr. N. L. Cohen asked the chairman of the Parliamentary Committee if he could inform the Council what had been the cost to London of promoting the Council's Electricity Supply Bill which had been thrown out by a committee of Parliament. Mr. W. Peel replied that he could not give the exact figure, but he thought it would be about £8,500. The sum of £18,000 had been provided in the estimates for the costs of the measure. They had lost the Bill, but they had saved their money.

Anglo-American Telegraph Co.—The directors have resolved to declare an interim dividend for the quarter ended June 30, 1907, of 15s. per cent. on the ordinary stock and £1. 10s. per cent. on the preferred stock, less income tax, payable on Aug. 1 to the stockholders registered on the books on June 30. After paying the foregoing dividends there will be a balance of £24,142 to be carried forward to the next account. The directors point out that the securities held on account of the renewal fund have further depreciated during the past half-year.

County of London Electric Supply Co.—The balance of estimated net revenue for the half-year to June 30, after providing for debenture interest, establishment, and standing charges, shows an increase of £8,004 as compared with the same period last year. The directors have declared an interim dividend on the preference shares at the rate of 6 per cent. per annum, less income tax, for the half-year ended June 30, 1907, and an interim dividend on the ordinary shares of the company for the same period at the rate of 4 per cent. per annum, less income tax, both payable on Aug. 1.

Bedford.—The electrical engineer has been empowered to purchase the following requirements—viz.: assorted tools for replacement, £5. 10s.; chisel steel, 15s.; six box covers and frames for low-tension mains at £2. 5s., £13. 10s.; 440 yards two $^{19}/_{14}$ and one $^{19}/_{16}$ rubber-insulated lead-covered and armoured cable, £242; iron gate for works top yard, £6. 17s. 6d.; two 14ft. 6in. patent eliptical trussed ladders at 19s. 6d., £1. 19s.; one 8ft. 6in. patent eliptical trussed ladder at 11s. 6d., 11s. 6d.—total, £271. 3s. An electric lamp is to be erected at the junction of Park-avenue with Gipsy-lane at an estimated cost of £23.

Reading.—Messrs. the Union Electric Co. have received the following letter from Messrs. Baughan and Co., electrical engineers, Reading, under date of July 13, which is of interest: "We have this day returned to you the six Excello lamps sent for garden party, etc. It might interest you to know that these lamps were used for lighting the grounds, etc., at the University College for the National Poultry Show, promoted by the Palmers and other influential gentlemen. When the lamps were lit at night, the birds had previously gone to sleep, but they immediately woke up and started crowing and cackling."

London County Council Testing Stations.—The metropolitan borough councils held a conference at the Hackney Town Hall this week, at which it was resolved to inform the London County Council of the opinion of the conference that the establishment by the London County Council of testing stations in London was at the present time unnecessary, having regard to the fact that a sufficient test can be made on the premises of any consumers. It was also resolved to appoint a committee, consisting of one representative from each borough council, to take what steps may from time to time be considered necessary.

Stock Exchange.—The Stock Exchange Committee has appointed July 30 special settling day in the Highlands and Lowlands Para Rubber Co.'s 181,454 vendors' shares of £1 each, fully paid, Nos. 8 to 181,461, and 60,000 vendors' shares of £1 each, 7s. 6d. paid, Nos. 181,462 to 241,461, and the Mabira Forest (Uganda) Rubber Co.'s 25,000 vendors' shares of £1 each, fully paid, Nos. 1,003 to 26,002; and have ordered the Kuala Lumpur Rubber Co.'s 4,650 vendors' shares of £1 each, fully paid, Nos. 173,351 to 178,000, and the Madras Electric Tramways (1904) further issue of £11,000 5 per cent. debenture stock to be quoted in the official list.

Radcliffe.—At a meeting of the Electricity and Tramways Committee, held July 2, the committee considered the electrical engineer's report to the Works Sub-Committee as to the provision of additional generating plant at the station, which dealt with the alternative systems suggested by the sub-committee for report. The committee resolved that the Works Sub-Committee be empowered to give instructions for the inclusion in the proposed application to the Local Government Board for sanction to further borrowing powers a generating plant of the type and power they consider advisable, and submit their recommendations on the complete scheme to the committee for approval.

St. Pancras.—The Electricity and Public Lighting Committee of the St. Pancras Borough Council report that the mortgage loans received during the year amount to £27,638, and the sums expended on capital to £8,817, being principally upon extension of mains,

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The total mortgage loans at March 31 last amounted to £506,095, of which £63 604 has been repaid, and the total capital expenditure now is £507,114. The gross income for the year amounted to £74,513. an increase of £2,426, as compared with the previous year, which, after meeting all working expenses and the repayment of loans and interest charges, leaves a net profit of £6.495. The reserve fund showed a net balance in hand at the end of March of £29,383.

Lowestoft —At the meeting of the Corporation Electric Lighting Committee the general manager reported that there are now connected to the mains 770 consumers, representing 38,606 8-c.p. lamps. During the last month there have been connected to the mains 12 new consumers. The chief clerk submitted quotations for workmen's compensation insurance, and it was resolved that the quotation of the Law Car and General Co. at 2s. 3d. and 6s. per cent. (with a Lloyd's indemnity) be accepted. The committee requested the Finance and Rating Committee to make arrangements with the Council's bankers for meeting capital expenditure during the next two months (principally for new cables) up to a sum of £6,000. The report was adopted.

Aberdeen.—The Aberdeen Corporation Electricity Bill, which was passed with certain reservations by a Select Committee of the House of Commons, came up before the committee for the adjustment of clauses. The promoters agreed that until Oct. 1 this year the rights possessed by the Aberdeen County Council to purchase the Cults Electric Lighting Co. should be preserved, but the County Council asked that in the event of their deciding to purchase that company the date of transfer should be extended until Oct. 1, 1908. Counsel for the Corporation opposed this, and ultimately, after some discussion, the committee adhered to the date of Oct. 1 this year. Some minor points were afterwards adjusted, and the Bill was then ordered to be reported to the House.

Islington.—The Lighting Committee report that they have received an application for a supply of electricity for lighting purposes from the National Telephone Co., Kingsland Green, together with a guarantee that the consumption of energy shall for the first two years produce a revenue of not less than 20 per cent. per annum of the cost of providing and laying the necessary low-tension distributing mains. The electrical engineer estimates the cost of laying the mains at £600, and the Council are recommended to sanction the borrowing of money. Application has also been received for a supply of electricity for lighting purposes from the Rev. G. M. Hanks, St. Bartholomew's Church, Shepperton-road, the cost of laying the mains being in this case £100. It is also proposed to extend the mains to give a supply to 2, Hemingford-road at a cost of £172.

Walsall.—The total number of consumers supplied by the Corporation on June 30 last was 510, as compared with 466 at the same date last year. During the past month the total units generated at the station was 133,017, as compared with 120.471 for the same period last year. The total output from the main generators was 128.980 units, as compared with 116,769 for the same period last year. The total units registered on the meters was 94,334, as compared with 85,097 for the same period last year. The machinery was run for 694 hours, as compared with 687 for the same period last year. The wages paid amounted to £137, as against £123 for last year. The Local Government Board have approved of the appropriation of the 35 square yards of land required as a site for the new chimney stack at the Wolverhampton-street generating station, the loan for which stack has now been sanctioned by the Board.

Govan.—At the last meeting of the Council the clerk submitted an application from the Secretary of the General Post Office for permission to lay an underground telegraph line along Mair-street. It was agreed to grant the permission on the usual conditions that the line of the pipe is adjusted to the satisfaction of the burgh surveyor, and that the permanent restoration of the street where opened be executed by the Town Council at the cost of the postal authorities. The clerk also submitted application by the National Telephone Co. for permission to erect two wooden poles on the east side of Langlands-road opposite Margaret and Agnes Drives. The committee agreed to grant the permission on condition that the company undertakes to free and relieve the Town Council from all claims for damages which may be caused on account of the poles being erected, and shall undertake to remove the poles when called on by the Town Council.

Bilbao.—A consular report from Bilbao states that the use of electric light continues to extend. Even the villages in the interior are supplied with cheap lighting and power, being favourably situated in the vicinity of the many waterfalls which abound in the North of Spain. The Bilbao Co-operative Society increased their power during 1906 and now utilise four motors of 1,200 h.p., producing 800 kw. Their machinery was obtained from Swiss and German firms. La Compañia Electra, in order to compete with the above-mentioned co-operative society, have reduced their price to 50 c. (4d.) per unit, and have also extended their cables to the villages and towns on both sides of the River Nervion—a distance of about nine miles—thus competing with small local companies. A Franco-Spanish company has been formed at Irun, on the frontier, for the fitting up of a water-driven electric plant to supply cheap power to the South of France.

Venice Exhibition. — An "Exhibition of Materials" was inaugurated at Venice on July 7, which will continue open for some time. After the opening ceremony the Royal party immediately visited the stand on which were shown the various British-made exhibits of the Edison and Swan United Electric Light Co., 36, Queen-street, Cheapside, London, E.C., where they spent a considerable time in thoroughly examining them. The Queen-Mother personally expressed her pleasure at seeing so great a number of useful and ornamental electrical appliances, and admired the degree of perfection which had been attained by the makers, desiring that her satisfaction should be made known to them. The exhibition is proving a great success, and has been visited by a number of the Italian aristocracy, who, following the Royal example, have also expressed their admiration of the very complete range of articles shown.

Liquidations.—The *London Gazette* announces that the Electric Safety Appliances Co. has been wound up voluntarily, and Mr. H. A. Grimsdick, of 82, Victoria-street, Westminster, S.W., appointed liquidator. The Capilliform Telegraph Instrument Co. has been wound up voluntarily, and Mr. H. Clough, 54, Gresham-street, London, E.C., appointed liquidator. The De Forest Wireless Telegraph Syndicate has been wound up voluntarily, and Mr. W. Lance Davis, 601, Salisbury House, appointed liquidator, to whom creditors are required to send particulars of their claims by Aug. 31. A general meeting of the members of the British Electric Separating Co. will be held at 11 a.m. at Goat-street, Swansea, for the purpose of receiving the liquidator's report. The creditors of the Chatham, Rochester, and District Electric Lighting Co. are required to send particulars of their claims to the liquidator, Mr. C. T. Smith, Violet-hill, Boustall-road, Rochester, by Aug. 16.

Grimsby.—The Corporation Electric Lighting Committee have adopted an unusual course regarding a purchase of cable. Some time ago they advertised for tenders for the supply of cable, with the result that a foreign manufacturing firm quoted the lowest price—some £200 less than their nearest British competitor. The prices were made public. When the tenders were again before the committee, the British firm wrote suggesting that they would amend their price if allowed, and pointing out that every order placed abroad was "a nail in the coffin of the British electrical manufacturing industry." An alderman characterised the letter as improper, and pointed out the dangerous precedent that would be created should an amendment of the tender be allowed. Upon a vote being taken, six voted for the foreign firm and six in favour of the amended tender. The chairman, saying "I'm an Englishman," gave his casting vote in favour of the latter. There was a good deal of further discussion, and it was ultimately decided to advertise again for tenders, limiting competition to British firms supplying British-made cables.

Whitehaven.—At a meeting of the Lighting Committee of the Town Council on July 1 the electrical engineer reported that both plant and mains had run satisfactorily during the preceding month, and that one new consumer had been added to the mains. The electrical engineer also reported that he had had an offer from the Nernst Lamp Co. to supply lamps for street-lighting on very favourable terms, and proposed that one dozen be installed on trial in Lowther-street. It was resolved that the proposal of the electrical engineer be submitted to the Street and Sanitary Committee for their consideration. The Chairman, in moving the adoption of the minutes, said, with regard to the offer for free electricity, it meant that those who came on between now and the end of September would be entitled to one month's free supply, but those who did not come on until the middle of September would only be entitled to a fortnight's free supply. The committee were in hopes that the offer would attract a number of new consumers, and by this means become continuous users for both power and lighting purposes. The motion was agreed to.

Dundee.—A building scheme of considerable magnitude is contemplated by the National Telephone Co. for Dundee. The present exchange is very inconveniently situated at the top of a four-storey block in Panmure-street, and the intention of the company, it is understood, with the sanction of the Government, which in a few years will take over the enterprise, is to build a handsome central structure for themselves. Before soil is cut for the foundations of the proposed exchange an initial expenditure of about £7,000 will probably be necessary. Negotiations are now proceeding for the purchase of a suitable site. Two pieces of ground are in view—that on which stands St. Andrew's United Free Church, and another adjoining. In the former case a sum of £7,000 is understood to have been offered and declined, and matters consequently have not yet reached a definite stage. The managers of the church, who are desirous of moving eastward, some years ago were offered a sum running into five figures for the building by a theatrical syndicate, but at that time they did not see their way to close the bargain. The total cost of the scheme now being considered by the Telephone Co. will probably not be short of £20,000.

Uruguay.—The British consul in his annual report gives some sound advice to British merchants which they would do well to keep in mind if they do not wish to lose their present leading position in the Uruguayan market. He points out that advertisements in local newspapers should be freely resorted to, and says the fatal practice of employing foreign agents and foreign travellers to represent British interests should be abandoned whenever it is possible to replace them by British subjects who will take the trouble to learn the language and to study and respect the idiosyncrasies of the people with whom they wish to transact business. He adds that while foreign firms are prepared to extend the credit to 12 months, if desired, British firms never give credit for more than three months, of which at least one is lost, after receipt of the bills of lading, before the consignments actually reach the warehouses of the agents in Montevideo. His final suggestion is that British merchants should bear in mind that Uruguay is geographically and politically a distinct country from Argentina, and they should, therefore, abandon the practice of appointing agents who reside in Buenos Ayres to represent them, and to push their trade in Montevideo.

Long Eaton.—At a special meeting of the Urban District Council the manager submitted the accounts of the electricity undertaking for the year ended March 31 last, and it appeared the net profit amounted to £865. 13s. 9d., while the accumulated profit to March 31, 1907, was £2,428. 7s. 7d. The scale of charges for the year was revised as follows: for houses, shops, and other premises, except factories, a flat rate of 3½d. per unit, less 5 per cent. discount: for current supplied by slot prepayment meters at the same rate, but without meter rent

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or discount; for factories, 3d. per unit for first 2,000 units per quarter, afterwards 2d. per unit, less 5 per cent. discount; consumption for power or heating, up to 250 units per quarter 2d. per unit, 250 to 500 units 1½d. per unit, to 2,000 units 1½d., from 2,000 to 4,000 1¼d., from 4,000 to 6,000 units 1d., and above 6,000 units ¾d. per unit, less 5 per cent. discount; for stand-by supply to factories 3½d. per unit, and for power ¼d. per unit more than the ordinary power consumers as per scale. The manager reported the electric output for June to be 38,003 units, as against 27,191 in the corresponding period of last year, an increase of 40 per cent. It was decided that a deputation wait upon the authorities with a view to getting better postal arrangements.

Kendal.—At a meeting of the Kendal Chamber of Commerce the proposed new tariff of the National Telephone Co. was discussed, and the following resolutions were adopted: (1) "That this chamber of commerce records its most emphatic dissent from the principle involved in the new tariff proposal of the National Telephone Co., and considers that the proposed scale of charges for all calls over and above the very small free minimum of 500 in a limited area are excessive, and directly opposed to the interests of trade and to the convenience of the public; (2) that the proposal of the National Telephone Co. to impose a charge of 1d. for all calls between the several exchanges within the original free area granted to Kendal, and duly recorded in documents from the company to this chamber, is an unwarrantable deviation from the agreement under which the company's business in this district was established, and very damaging; (3) that this chamber take every possible step, and use all means within its powers, to oppose the proposals of the National Telephone Co., as above, and that copies of these resolutions be sent to the Postmaster-General, the National Telephone Co., the M.P.'s for Westmorland, the Mayor of Kendal, the chairman of the County Council, the chairmen of the Urban District Councils of Windermere, Ambleside, Grange, Grasmere, and Kirkby Lonsdale respectively, and to the Press."

PROVISIONAL PATENTS, 1907.

JULY 8.

15629. Improvements relating to apparatus for the automatic regulation of dynamo-electric machinery. John Pilling and Claude Henry Klyne, Malvern House, King's Lynn.

15634. Improvements in and relating to systems for controlling electrical devices. Wolfgagan E. Ebert, 615, F-street, N.W., Washington, D.C., United States. (Complete specification.)

15636. Improvements in automatically-operated station indicators for electric railways. Michael Daley and Patrick Daley, 20, High Holborn, London. (Complete specification.)

15642. Improvements in collecting the electric current for the working of electric trams or railways. John David Ross, 15, Ampton-street, London.

15646. Improvements in the insulation of submarine cables for telegraphic and telephonic purposes. John Johnston, 3, Florence-street, Hendon, London.

15648. Improved regulating starter for single-phase and polyphase induction motors. Johannes Bruncken, Thanet House, Temple Bar, London. (Complete specification.)

15692. Improvements connected with the manufacture of metallic sodium by electrolysis. Harry Baker, 55, Chancery-lane, London.

15693. Improvements in the manufacture of metallic sodium by electrolysis. Harry Baker and Edward Haworth, 55, Chancery-lane, London.

15715. Improvements in electric arc lamps. Frederick William Edward Schuer, Chancery-lane Station-chambers, London.

JULY 9.

11853/A06. Improvements in means for compensating load variations in electrical installations. James Yate Johnson, 47, Lincoln's-inn-fields, London. (The Felten und Guillcaume-Lahmeyerwerke Akt.-Ges., Germany.) (Date applied for under Rule 5 of the Patents Rules, 1905, May 21, 1906.) (Complete specification.)

15751. Improved high-tension cable. Albert Edgar Tanner and Ernest Alexander Claremont, 4, Bloomsbury-square, London. (Complete specification.)

15755. Ear-guard with holding attachment for telephone receivers. Albert Anker, 224, Friedrichstrasse, Berlin, Germany. (Complete specification.)

15769. Improvements in and relating to electrical railway systems. Lina Beecher, Chancery-lane Station-chambers, London. (Complete specification.)

15789. Improvements in and relating to receiving instruments for electric telegraphy. Robert Henry Edgar, 323, High Holborn, London.

15798. Electric incandescence lamp with U or V shaped supported metal filaments. Hans Kuzel, 322, High Holborn, London. (Date applied for under Patents Act, 1901, May 31, 1907, being date of application in Germany.) (Complete specification.)

15799. Improvements relating to the manufacture of incandescent lamps. Frederick Robert Pope, 322, High Holborn, London.

15810. Improvements in or relating to sectional induction coils. Carl Alonzo Pfanstiehl, 31, Bedford-street, Strand, London. (Complete specification.)

JULY 10.

15820. Improved type of permanent magnet generator. George William Somerville, 68, Owen-street, Accrington.

15824. Improvements in or in connection with incandescent electric lamps. Alfred Schwartz and Charles Cartwright Metcalfe, 3, Brown-street, Market-street, Manchester.

15830. Improved mould for casting electric accumulater grids. William Fennell and William Pagden Perry, 68, Dudley-road, Tipton, Staffordshire.

15834. Improvements in induction motors, and in the method of starting, connecting up, and controlling the speed of combinations of such motors operated from a single-phase supply. Jens Lassen La Cour, 34, Castle-street, Liverpool. (Complete specification.)

15841. Locating and telephonic device for submerged submarines. Herbert Alfred Tandy, 27, Barrow-road, Lawrence-hill, Bristol.

15846. Improvements in methods of electrical distribution. William Fennell and William Pagden Perry, 68, Dudley-road, Tipton Staffordshire.

15847. Improvements in or relating to axle-box suspension devices for electric tramcars and the like. Mountain and Gibson, Limited, and George Laurie-Walker, 55, Market-street, Manchester.

15857. Improvements in and relating to electric arc lamps. John Owen Girdlestone and Carl Frederik Grimur Thorkelin, 16, Davies-street, Berkeley-square, London. (Complete specification.)

15878. Improved electrically-controlled selective switch and a transmitter of current impulses for use therewith. Siemens Bros. and Co., Limited, and George Sylvester Grimston, Birkbeck Bank-chambers, Southampton-buildings, London.

JULY 11.

15922. Electric winch. Thomas Percival Pollitt, 12, Woodlands-terrace, Aske-road, Redcar, Yorks.

15931. Stands for table telephones. Carlis Wilhelm Hansen, 5, Corporation-street, Birmingham.

15966. Improvements in and relating to electric lamps for carriages, motorcars, and the like. Charles Anthony Vandervell, 1, Queen Victoria-street, London.

JULY 12.

16027. Improvements in arc lamps. John Charles Chalmers and William Alexander Robertson, 44, West George-street, Glasgow. (Complete specification.)

16034. Improvements in the construction of a pocket electric lamp worked with secondary battery, applicable for various purposes. William Thomson, Royal Institution Laboratory, Manchester.

16044. Improved lamp cap and holder for electric incandescent lamps having more than one filament. Francis Harrison, 14, Ossian-road, Stroud Green, London.

16051. Improvements in or relating to dynamo-electric machines. Siemens Bros. Dynamo Works, Limited, and William Parker, 139, Queen Victoria-street, London.

16052. Improvements in or relating to dynamo-electric machines. Siemens Bros. Dynamo Works, Limited, and William Parker, 139, Queen Victoria-street, London.

16053. Improvements in arc lamps. Henry Stafford Hatfield and Frank Michael Lewis, 18, Palmeira-square, Hove, Sussex.

16073. Improvements in electrically-operated cloth-cutting machines. Percy Richard Julius Willis, Fife House, Kingston-on-Thames. (Edward Millington Waring, United States.)

16087. Telephone alarm with attuned call. John William Mackenzie, 40, Chancery-lane, London. (C. Lorenz, Germany.) (Complete specification.)

16090. Improvements in and relating to liquid gauges. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

16091. Improvements in and relating to electric switches. The British Thomson-Houston Company, Limited, and Edmund Basil Wedmore, 83, Cannon-street, London.

16092. Improvements in and relating to alternating-current machines of the commutator type. Allgemeine Elektricitäts Ges., 83, Cannon-street, London. (Date applied for under Patents Act, 1901, July 13, 1906, being date of application in Germany.) (Complete specification.)

16098. Improvements in apparatus for electro-plating. Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London. (Complete specification.)

JULY 13.

16145. Improvements in or relating to safety electric apparatus for lighting miners' safety lamps. John Cunningham Bowie and John Henry Phelps, Birkbeck Bank-chambers, Chancery-lane, London.

16166. Improvements relating to the supplying of current to electric motors. John Somerville Highfield, 322, High Holborn, London.

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16137. Improvements in and relating to signal-operating mechanism and signalling systems. Allgemeine Elektricitäts Ges., 83, Cannon-street, London. (Date applied for under Patents Act, 1901, July 14, 1906, being date of application in Germany.) (Complete specification.)

16175. Improvements in means for attaching flexible conductors to commutator brushes, and also applicable for uniting other bodies or articles. The Morgan Crucible Company, Limited, and Cyril Douglas McCourt, 4, South-street, Finsbury, London.

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Aug. 1.)

1906.

15200. Covers of electric cells. Segnitz and Parkes.

15200A. Supporting the plates of secondary batteries. Segnitz and Parkes. (Date applied for under Rule 5, Patents Rules, 1905, June 5, 1906.)

15310. Electric arc lamps. Oliver.

15310A. Electric arc lamps. Oliver. (Date applied for under Rule 5, Patents Rules, 1905, July 5, 1906.)

15615. Appliance for the amplification of signals produced by variation of the local currents in wireless telegraph receivers. Sharman, and De Forest Wireless Telegraph Syndicate.

15711. Windings for alternating-current dynamo-electric machines. Hunt, and Sandycroft Foundry Company.

16747. Receiving apparatus for use in wireless telegraph systems. Hellyar, and Johnson Secret Wireless Telegraph and Telephone Testing Syndicate.

17355. Dynamo-electric machines. Farrell.

18070. Automobile and like electric horns. Judkins. (Hutchison.)

18516. Starting switches for electric motors. Smith.

18621. Dynamo-electric machines with compensating windings. Torda.

18877. Systems of electric motor control. British Thomson-Houston Company. (General Electric Company.)

18905. Construction of switch for automatic electric lifts or elevators. Joseph Richmond and Co., Burnett and Lyon.

19005. Oil-break electric switches. Eckstein, Heap, and Mellis.

19218. Liquid seal glands for fluid-pressure turbines and other purposes. Chilton, Newton, and Brush Electrical Engineering Company.

19690. Electrical terminal fittings for effecting junctions between sections of main cables and main and branch cables in conduit junction boxes without the aid of a soldered joint. Hirst and Gunner.

20131. Telegraphic or secret codes. McNeill.

20201. Electric switches. Electric Ignition Company and Hall.

20639. Removing metallic cylinders from mandrels on which they are electrodeposited. Cowper-Coles.

21668. Terminals and the like for electric conductors, especially applicable for use in electric incandescent lamps. British Thomson-Houston Company. (General Electric Company.)

25143. Multiple-way electric switches. Lundberg, Lundberg, and Lundberg.

25877. Magneto-electric machines more especially intended for effecting sparking for the ignition of the explosive mixture in internal-combustion engines. De Saint-Romain. (Date applied for under International Convention, May 25, 1906.)

26981. Electric furnaces. Reynolds.

26985. Locking frames for operating electrically-controlled railway points and signals. Siemens Bros. and Co. and Ferreira.

28125. Wireless telephony. De Forest. (Date applied for under International Convention, Dec. 22, 1905.)

23519. Submergible electric heaters. Stapledon.

1907.

532. Clip for fixing electric conductors to insulators. Von Sonnenthal.

1162. Electrical influence machines, commonly called static machines. Dean.

3522. Indication of the blowing of fuses in electrical distribution systems. Schultz. (Date applied for under International Convention, Feb. 14, 1906.)

4607. Arrangement for supporting electric motors on shafts. Siegfried. (Date applied for under International Convention, March 3, 1906.

5865. Means for automatically breaking an electric circuit in the event of a leakage to earth or giving an indication of said leakage. Nalder Bros. and Thompson, Limited, Harris, Wallis-Jones, and Cox.

7696. Manufacture of reflectors. Siemens Bros. Dynamo Works, Limited, and Holmes.

10452. Systems of electric traction. Allegemeine Elektricitäts Ges. (Date applied for under International Convention, May 4, 1906.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	–	½-⅝
—— Ord., 1 125,000	1	..	¼-½
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	⅝-¾
British Aluminium Co., Ordinary, 2,001-40,000	5	..	5-5¼
—— 7 per cent. Cum. Pref., 1-40,000	5	..	5¼-5⅜
—— "A" 6 per cent. Cum. Pref., 1-20,000	5	..	5-5¼ xd
—— 4 per cent. Funding Certificates, 1-20,000	5	..	3⅝ 4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	100-103
—— 5½ per cent Loch Leven Deb (Reg.), Red , 1-3,000	100	..	98-101
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6¼ 7
—— 6 per cent. Cum. Pref., 1-100,000	5	..	6¼-6¼
—— 4½ per cent. Mortgage Debentures	100	–	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	–	83-83
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	5	..	1-1¼
—— 4 per cent. Mortgage Debenture Stock	100	..	58-63
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	¼-⅜
—— Non. Cum., 6 per cent. Pref.	2	..	⅜-1¼
—— 4½ per cent. 1st Debenture Stock	100	..	88-91
—— 4½ per cent. 2nd Debenture Stock	100	..	7 -74
Callender's Cable, Debentures	100	–	105½-107½ xd
—— Ordinary	5	–	9½-10½
—— 6 per cent. Pref.	5	..	5⅝-5⅞
Consolidated Electrical Co., Ordinary, 1-110,000	1	..	7/16-9/16
Crompton and Co.	5	..	1⅞-2⅛
—— 5 per cent. Debentures	100	–	86-89
Dick, Kerr, and Co., Ordinary, 1 260,000	1	..	1⅛-1⅜
—— 6 per cent. Cum. Pref., 1-305,000	1	..	1-1¼
—— 4½ per cent. Debenture Stock, Red.	100	..	100-105
Edison and Swan United, "A" Shares, 1-99,261	5	–	1⅛ 1⅜
—— "A" Shares, 01-017,139	5	–	2¼-2⅜
—— 5 per cent. Debentures	100	–	83-92
—— 4 per cent. Deb. Stock, Red.	100	..	83 85
Electric Construction, Nos. 1 to 112,100	2	–	3/16-7/16
—— 7 per cent. Cumulative Pref.	2	–	1½ 1⅝
—— 4 per cent. Perp. 1st Mort Deb.	100	..	77-81 xd
Electrolytic Alkali Co., Ordinary, 1-202,218	1	..	¼-⅜
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	–	—
General Electric Company (1900), 5 per cent. Cum. Pref.	10	–	8-8½
—— 4 per cent. 1st Mort. Deb. Stock	100	..	82-86
W. T. Henley's Telegraph Works, Ordinary	5	–	11½-12½
—— 4½ per cent. Preference	5	–	5-5½
—— 4½ per cent. Debentures	100	..	105½ 107½
India Rubber, Gutta Percha, and Telegraph Works	10	..	14 16
—— 4 per cent. Debentures	100	–	97-99
National Electric Construction Co., 1-170,000	1	..	27/32-31/32
Parker, Thos., Limited, Ordinary	10	–	10-10¼
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5	..	3¾-4¼
Telegraph Construction and Maintenance	15	–	31-33
—— 5 per cent. Bonds	100	–	96 0)
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	..	9¼ 9⅜

Electric Lighting and Supply.—

Name.	Amount paid.		Last price
	£		£
Adelaide Electric Supply Co., 6 p c. Cum. Pref., 1-10,000		..	4¾-5¼
Bournemouth and Poole, Ordinary	10	–	10 11
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	–	9¾ 10¼
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	–	101 10⅜
—— 4½ per cent. Debenture Stock, Red.	100	–	99 102
Bromley (Kent) Electric Light and Power Co.	5	–	4¾ 5¼
—— 4½ per cent. 1st Debenture Stock, Red.	100	–	98 100
Brompton and Kensington, Ordinary	5	–	7⅜ 8⅜
—— 7 per cent. Preference	5	–	7½ 8½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	–	6¾ 7¼
—— Nos. 80,001-100,000	4	–	6¼ 7¼
Cambridge Electric Supply Company, £10 Ord.	8	–	13-13½
Canadian General Electric Co., Common Shares	$100	..	120-125 xd
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	–	99-102
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	–	3¼ 4
—— 4½ per cent. Cum. Pref., 1-80,000	5	–	4 4¼
—— 4 per cent. Debenture Stock, Red.	10	–	95 98
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	–	3⅝ 4¼
—— ditto (1903) 40,001-80,000	5	–	3¼ 4¼
Chelsea Electricity Supply	5	–	3¼-4¼
—— 4½ per cent. Debentures	100	–	102-105
Chicago Edison Co, 1st Mt. 5 p. c. 30-yr. Gld. Bds, Red., 1-1,200	$1000	..	98-101
City of London, Ordinary	10	–	9-10 xd
—— 6 per cent. Cumulative Pref.	10	–	11-12 xd
—— 5 per cent. Debenture Stock	100	–	120½-122½
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	–	96-98
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1,500	50	..	50 53
Cordoba Light and Power Co., 1st Mt. Stk. 5 per cent. Bds., Red., 1-1,000	100	..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5	..	4½-5
—— 5 per cent. Preference, 1-50,000	5	..	4½-5
County of London Electric Supply, Ordinary	10	–	7-8
—— 6 per cent. Cum. Pref.	10	–	10½-11½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	–	106-109
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	–	93-96
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5	–	½-1
—— 6 per cent. Cum. Pref.	5	–	1-2
—— 4½ per cent. First Mort. Deb	100	–	76 81 xd
Electrical Development Co. of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, 10,751-15,750	—	..	79-81 p.c.
Electric Lt & Traction Co of Aust., 6p.c Cm Pf , 1 30,000	5	–	2¼ 2⅜
5 per cent Debenture Stock Red	100	–	85½ 89½
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red	100	–	94½ 96½
Folkestone Electric Supply, Ord. Nos. 1-10,000	5	–	4⅜-5⅜
—— 4½ per cent. First Deb. Stock, Red.	100	–	98-101
Hove Electric Lighting, Ord., 1-13,000	5	–	6¾-7¼
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100	..	103-106
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Deb. Stk. Red.	100	–	94-97
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	–	25/32-29/32
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5	–	8¼-8½
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	–	96 99
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9¾-10¼
London Electric, Ordinary	5	–	1⅝-2⅛
—— 6 per cent. Pref.	5	–	4¼-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	–	93-96

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Name.	Amount paid. £	Last price £
Madras Electric Supply Corporation, 5 per cent. Construction Deb. Stock., Red. (Prov. Certs.), all paid	— ..	94-97
Metropolitan Ordinary, 100,001-300,000	5 —	5⅛ 6¼
—— 4½ per cent. First Mortgage Debenture Stock	100 —	103 107
—— 4½ per cent. Cum. Pref.	5 —	4¼ 5¼
—— 3½ per cent. Mortgage Debenture, Red.	100 —	86-91
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds., 1935, C 1-1,000 ($100), D 1-5,000 ($500). M 1-4,400 ($1,000)	— ..	74½-76 p c.
Mexican Light and Power Co., Capital Stock	$100 ..	45-47
—— 5 per cent 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14,000 ($1,000)	— ..	84 86
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	— ..	95-98
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,000	5 —	7¼ 7¾
—— do., 57,001-75,000	5 ..	7¼-7¾
—— do., 75,001-87,500 (issued at £22 prem., 16s. paid)	4 —	5-5½
—— 5 per cent. Pref., 1-57,000	5 ..	5 6
—— do., 75,001-87,500 (issued at 10s. prem., 4s. paid)	4 ..	4-4¼
Notting Hill Electric Lighting	10 —	1 ½ 12½ xd
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100 —	96 99
Oxford Electric, Ordinary, 1-96 and 40-14,310	5 ..	5¼ 5⅝
—— 4 per cent. Debenture Stock	100 —	95 97 xd
River Plate Electricity Co., Ord., 1-119,487 & 120,501-120,507	1 ..	⅞-1
—— 6 per cent. Non-Cum. Pref., 1-100,000	1 ..	⅞-1
—— 4 per cent. Debenture Stock, Red.	100 ..	95-98
Rosario Electric Co., 6 per cent Cum Pref., 1-20,000	5 ..	5-5½
—— 6 per cent. Cum. 2nd Pref., 1-15,000	4 .	5-5½
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 —	96 98
Shawinigan Water and Power Co., 5 p c. Cons. 1st Mt. Bds.	— ..	99 101 p c. xd
Smithfield Markets Electric Supply, Ord. 1-12,000	5 ..	⅛-¼
—— 4 per cent. Debenture Stock	100 —	73 77
South London, Ordinary	5 —	1¼ 2¼
South Metropolitan Electric Light and Power, Ord.	1 —	⅝ ¾
—— 7 per cent. Cum. Pref.	1 —	1⅛-1⅜
—— 4½ per cent. 1st Mort. Deb.	100 —	100-103
St. James's and Pall Mall, Ordinary, 101-20,080	5 —	8 9
—— 7 per cent. Pref.	5 —	6½ 7½
—— 3½ per cent. Deb.	100 —	86 91
Urban Electric Supply Co., Ordinary, 8-30-007	5 —	1½ 2¼
—— 5 per cent. Cumulative Preference, 50,001-80,000	5 —	2-3
Westminster, Ordinary	5 —	9 10
—— 4½ per cent. Cum. Pref., 110,101-138,251	5 —	5¼-5⅝

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine, 5½ per cent. Cum. Pref., 1-260,007	5 —	6 6¼
—— Ord.	5 —	8¼ 8⅝
—— Permanent 6 per cent. Debenture Stock, 1888	100 —	131-134
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100 —	102-105
Barcelona Tramways, Ord., 1-20,000	10 —	—
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10 —	—
—— 5 per cent. Deb., Red., 1-600	100 —	—
—— 4½ per cent. Red. Deb. Stock	100 —	—
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1 —	11/16 13/16
—— 5 per cent. Cum. Pref. Shares, 1-58,394	1 —	27/32-31/32
Birmingham and Midland Trams., 4½ p c. 1st Db. Stk., Red.	100 ..	94-97 xd
Blackpool and Fleetwood Tramroad	10 ..	13⅜ 13⅝
Bombay Elec. Supply & Trams. Co., 6 per cent. Cum. Pref.	8 ..	7¼-8¼
—— 4½ per cent. Deb Stock, Red.	100 ..	95-97 xd
Brisbane Tramway Invest., Ord., 1-75,000	5 —	2 15/16 3 3/16
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 —	4¾-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 —	96 100
British Columbia Electric Railway Co., Ord. Def.	100 ..	123-128
—— Ord. Pref.	100 ..	108-112
—— 5 per cent. Cum. Perpetual Pref. Stock	100 —	101-104 xd
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	101-103 xd
—— 4½ per cent. Vancouver Power Deb.	100 —	103-105
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10 —	2¾ 3¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10 —	7¼ 7¾
—— 5 per cent. Perpetual Debenture Stock	100 —	100-103
—— 4½ per cent. 2nd Deb. Stock	100 —	78-81
Buenos Ayres and Belgrano Trams.	5 —	4⅛-4⅜
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 —	4¾-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 —	4¾-5¼
—— 5 per cent. Deb. Stock, Red.	100 —	105-115
—— Prov. Cert., all paid	100 —	100-103
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100 —	93 98
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb. Bonds, Red., 1-1,500	100 ..	99-103
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100 ..	100-105
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	93-95
Calcutta Tramways, 1-105,000	5 ..	7¼-7¾
—— 105,001-137,610	5 ..	7¼ 7¾
—— 4½ per cent. 1st Deb. Stock, Red.	100 —	102 106
Cape Electric Tramways, Nos. 1-480,000	1 —	5/16 7/16
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5 —	4¼ 5
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100 —	96 98
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5 ..	5¼-5⅜
—— 4 per cent. Deb. Stock, Red. 1905	100 ..	95 99
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	00 —	95 99
Cork Electric Tramway and Lighting Co., Ordinary	10 —	13¼-13½
—— 6 per cent. Cum. Pref.	10 —	13-14
—— 4 per cent. Debentures	100 —	99-100
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 —	13½-13¾
—— 6 per cent. Pref., Nos. within 1-60,000	10 —	13 14
—— 3½ per cent. Mort. Debs., 1-3,000 Red.	100 —	94-96
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100 ..	98-101
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6,957	$1,000 —	82-87 xd
Imperial Tramways, Ordinary	all —	18-19
—— 6 per cent. Cum. Pref.	all —	14-14½
—— 4½ per cent. Deb. Stock	100 —	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5 —	1 1¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 —	66-71
Kalgoorlie Electric Tramways, 1-250,000	1 ..	3/32-5/32
—— 5 per cent. "A" Deb. Stock	100 ..	89-93
—— 6 per cent. "B" Deb. Stock	100 ..	78-82
Kidderminster and District Lighting and Traction, Pref.	5 —	3-3½
Lancashire United Tramways Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100 —	93-96
—— £296,500 2nd Mort. Deb. Stock	— —	—
—— £83,330 Deferred Deb. Stock (all fully paid)	— —	—
Lisbon Electric Tramways Limited, Ord., Nos. 1-594,188	1 ..	1 1/16-1 5/16
—— 6 per cent. Cum. Pref., Nos. 1-425,553	1 .	1 1/16-1 3/16
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100 ..	95 98
London United Trys. (1901), 5 per cent. Cum. Pref.	10 —	7⅜ 8¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 —	84 88
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Rd.	100 —	96 99

Name.	Amount paid. £	Last price. £
Manila Elec. R R. and Lghtg. Corp., 5 p c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953. Red., 1-4 635	$1,000 ..	93 95
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,625 and 23,436-25,000	5 ..	4⅜-5¼
—— 4½ per cent. 1st Mort Deb. Stock, Red.	100 ..	97-100
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1 —	3/32 5/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1 —	27 32 31 32
—— 4½ per cent. Deb. Stock, Red.	100 —	84 87
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	— ..	84-85 p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000 —	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 601-2,000 (1922)	100 —	103-105
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5 —	⅜-½
Oldham, Ashton, and Hyde Tramway, Ordinary	10 ..	12
—— 5 per cent. Cum. Pref.	10 —	8¾-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100 —	100 104
Potteries Electric Traction, Ordinary, 1-245,000	1 —	5/16-9/16
—— 5 per cent. Cum. Pref., 300,001-545,000	1 —	⅜-½
—— 4½ per cent. Debenture Stock	100 —	95 98
Provincial Tramways Co., Ordinary, 1-24,912	10 ..	4½-5
— 6 per cent Cum. Pref., 1-10,000	10 ..	10½-11¼
Rangoon Elec. Tramway and Supply Co., 6 p c. Cum. Pref., 1-30,000	5 ..	5¼-5⅝
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	96½-98¼
Sao Paulo Tramway Light, and Power Co.	$100 ..	117-121
—— 5 per cent. 1st Mort. Deb., Red 1929. 1-11,000	$500 ..	92-94 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1 ..	29 32-1 1/32
—— 4 per cent. Deb. Stock, Red. 1940	100 ..	80-84
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs, Red., 1-1,600	100 ..	84-88
Yorkshire (West Riding) Elec. Tram Co., Ord., 70,001-110,000	5 ..	1-1½
—— 6 per cent. Cum. Pref., 1-46,261	5 ..	3¼-3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	88-91

Electric Railways.—

Name	Amount paid. £	Last price £
Central London, Ordinary	100 ..	73-75
—— 4 per cent. Pref.	100 —	92-94
—— " " deferred	100 ..	53-56
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 —	102-105 xd
City and South London, Consolidated Ordinary	100 ...	47-49
—— 4 per cent. Debenture Stock	100	102-105
—— 5 per cent. Pref. Stock '91	100 —	117-121
—— " " " '95	100 —	115-118
—— " " " '01	100 —	110-113
Liverpool Overhead, 5 per cent. Pref.	10 —	10-10¼
—— Ordinary, 1-50,000	10 —	3⅜-4¼
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— —	94-96
Underground Electric Railways of London, 5 per cent. Profit-sharing Secured Notes	— ...	64 67

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price. £
Amazon Telegraph Co., 1-25,000	10 ..	3-3½
—— 5 per cent. Debs., Red., within 1-1,069	100 ..	86-89
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000	$1,000 ..	90-92
Anglo-American Telegraph Co., Ordinary	100 ..	62-65
—— 6 per cent Preferred Ordinary	100 ...	109-110
—— Deferred Ordinary	100 ...	20¼ 20½
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort Deb. Stock, Red.	100 ...	100-103
Chili Telephone Co., 1-44,000	5 ...	6¼-7¼
Commercial Cable Co., Ster. 500-year 4 p.c. Deb Stk., Red.	100 ...	92-94
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10 ...	7¼-8¼
—— 10 per cent. Preference, 1-6,000	10 ...	15¾-16¾
Direct Spanish Telegraph Co., Ordinary	5 ...	3⅜-3⅝
—— 10 per cent. Cum Preference	5 ...	8¾-9¼
—— 4½ per cent. Debs., 1-600	50 ...	98-101
Direct United States Cable Co.	20 ...	15½-16
Direct West India Cable Co., 4½ per cent. Debs., Reg. within 1-1,200, Red.	100 ...	98-100
Eastern and South African, 4 per cent. Mort. Debs., within 1 3,000, 19 9	100 ...	98-101
—— 4 per cent. Reg. Mort Debs. (Mauritius Subsidy), 1-8,000, 1913	25 ...	97-100
Eastern Extension, Australasia and China, 1-300,000	10 ...	17¼-15⅝
—— 4 per cent. Mort. Deb. Stock, Perp.	100 ...	104-106
Eastern Telegraph Co., Ordinary Stock	100 ...	135-140 xd
—— 3½ per cent. Preference Stock	100 ...	88-90
—— 4 per cent. Mortgage Debenture stock	100 ...	103-105
Great Northern Telegraph Co. (of Copenhagen)	10 ...	33½-35½
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1,200, Red.	100 ...	98-100
Indo-European Telegraph Co.	25 ...	56-58
Marconi's Wireless Telegraph Co., 1-256,127	1 ...	¼-⅜
—— 256,128-384,190	1 ...	⅛-¼
Monte Video Telephone Co., Ordinary, 1-72,680	1 ..	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492	...	¾-1
National Telephone, Preferred	100 ...	109-111
—— Deferred Stock	100 —	108-110
—— 6 per cent. Cum. First Pref.	10 —	11¼-11½
—— 6 per cent. Cum. Second Pref.	10 —	10-12
—— 5 per cent. Non. Cum. Third Pref.	5 ..	5 7/16-5 11/16
—— 3½ per cent. Deb. Stock, Red.	100 —	94½-96½
—— 4 per cent Deb. Stock, Red.	100 —	100-102
Oriental Telephone and Electric Company	1 ..	1¼-1⅜
6 per cent. Cum Pref.	1 ..	1 3 16 1 5/16
Pacific and European Tel., 4 p c. Guar. Debs., Red., 1-1,000	100 ...	93-96
United River Plate Tele. Co., Ordinary, 1-100,000	5 ...	7-8
—— 5 per cent. Cum. Pref., 1-40,000	5 ...	5-5¼
—— 5 per cent. Debenture Stock, Red.	100 ...	—
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100 ...	98-101
West African Telegraph Co.	10 ...	10-10¼
West Coast of America, 1-39,000 and 53,001-53,003	2½ ...	1¼-1⅜
—— 4 p c. Debs., 1-1,500, Gua. by Western Telegraph	100 ...	97-100
West India and Panama Telegraph Co., Ordinary	10 ...	¼-⅜
—— 6 per cent. Cum 1st Preference	10 ...	7¼-7½
—— 6 per cent. Cum. 2nd Preference	10 ...	6¼-6½
—— 5 per cent. Debs., Red., 1-800	100 ...	100-103
Western Telegraph Co., 1-207,930	10 ...	13¼-14¼
—— 4 per cent. Debenture Stock, Red.	100 ...	100-103

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.							Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1907.	1906.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Mile of track. Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	July 3	1,571	1,474	+ 95	- 160h	25½	25	May 31	64,071	15,530,351	1,379,723	0·93	11·14	2,512	6·45
Ayr Corporation	,, 6	351	412	- 61	—	8	8	,, 15	14,328	3,316,380	353,945	1	9·71	1,830	5·16
Baker Street and Waterloo Ry.	,, 13	2 595	1,440	+1,155	+ 2,494	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 14	1,163	1,053	+ 110	- 167	23·53	3·53	March 31	55,025	11,145,531	1,309,903	1·18	10·08	2,338b	6·03
Birmingham Corporation	,, 13	6 084	—	—	—	56½	—	,, 31	17,133	4,709,798	266,526	·86	14·5	8 866	—
Blackburn Corporation	,, 10	1,084	1,116	- 32	+ 535	24	24	,, 26	48,875	8,661,720	986 953	1·35	11·29	2,036	7·44
Blackpool Corporation	,, 11	1 549	1,532	+ 17	- 1,518	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	,, 13	944	938	+ 6	- 211	16½	16½	Dec. 31	31,846	2,325,677	57,264	3·28	13 19	—	7·27
Bolton Corporation	,, 14	2 286	2,241	+ 45	+ 943	42	40	March 31	95 766	20,205 196	2,161,130	1·13	10 63	2,394	6·14
Bournemouth Corporation	,, 10	1,773	1,718	+ 55	- 115	17·41	16·82	,, 31	55,276	10,058,288	1,121,623	1·32	11·83	3,226	7·19
Bradford Corporation	,, 13	4,644	4,778	- 134	- 471	95	95	,, 31	230,085	47,108,000	5,053,382	1·172	10·927	2,395	—
Brighton Corporation	,, 14	998	1,029	- 31	- 1,359	9½	9½	,, 31	50,339	11,321 160	1,152,828	1·06	10·48	2,914·8	8·014
Bristol Tramway Company	,, 12	5,459	5,801	- 342	—	51½	51½	Dec. 31	259,799	65,312,373	6,127,135	—	—	—	—
Burnley Corporation	,, 13	1,166	1 391	- 225	—	40	40	March 31	57,942	11,082,704	1,197,772	1·31	11 61	5,388	8·17
Burton Corporation	,, 14	295	308	- 13	- 315	8½	8½	,, 31	17 950	3,878,269	454,082	1·07	9·21	2,0 8	6·76
Cardiff Corporation	—	—	—	—	—	32 68	†32·26	,, 31	112,209	24,134,363	2,770,049	1·12	9 72	3,782	9·44
Carlisle Tramways Company	,, 13	191	197	- 6	- 377	8·5	8·5	Dec 31	10,713	2,935 002	359,756	—	7·14	—	5 18
Central London Railway	,, 13	5,653	5,896	- 243	- 538	6	6	,, 31	347,588	4,875,547	1,281,214	1 86	65·10	57,931	35·80
Charing X, Euston, & Hamp. Ry.	,, 13	2,685	—	—	—	8	—	—	—	—	—	—	—	—	—
City and South London Railway	,, 14	3,176	2 459	+ 717	+ 1,507	6¼	6¼	,, 31	—	—	—	—	—	—	—
Colchester Corporation	May 8	195	195	—	—	8	8	March 31	10,588	2 457,653	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	July 11	554	579	- 25	- 436	15½	15½	Dec 31	24,835	5,814 376	882,256	1 01	6 64	—	4 69
Darwen Corporation	,, 12	268	276	- 9	- 30	7 23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	,, 13	319	327	- 8	- 436	4½	4½	,, 31	11 250	2 853 200	284,343	·94	9·49	2,100	—
Dublin and Lucan Electric Ry.	,, 12	144	132	+ 12	- 11h	6½	6½	Dec 31	6,358	402,511	110,738	3·79	13·78	942	7·33
Dublin U.T.	,, 12	7,768	5,887	+2,181	+ 2,907	48½	48½	,, 31	267,489	50,060,949	7 077,372	1·18	9·07	691	5 55
Dundee City Tramways	,, 10	1,131	1,137	- 6	+ 299	22	22	May 15	50,154	13 086 396	1,005 911	·906	11·96	2,180	7·42
East Ham Corporation	,, 13	965	969	- 4	- 450	14	14	March 31	36,652	3,689,658	863,816	·64	10 18	2 9·4	6 79
Glasgow Corporation	,, 13	17,489	16 957	+ 532	- 2,206h	79½	79½	May 31	756 490	195,767,519	17,945 595	—	10 12	—	—
Gloucester Corporation	,, 10	278	304	- 26	—	15	15	March 31	15,465	3,902,077	563,595	·60	6·68	939	5·32
G.N., Piccadilly, and Brompton	,, 13	4,405	—	—	—	9	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	37	37	,, 31	74 019	17,849,642	1,540 707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 13	1,605	1,521	+ 84	+ 783	35	35	,, 31	69,938	12 838,150	1 665,262	1·24	9·71	1,923	—
Hull Corporation	,, 13	2,380	2,371	+ 9	+ 1,888	26	26	,, 31	112,651	27,104,921	2,910,698	1	9 29	—	—
Ilford Corporation	—	—	—	—	—	10½	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 10	143	142	+ 1	+ 141	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	11,586	3,626,656	419,800	·737	6 62	1 480	5·22
Lancashire United Tramways	,, 10	1,317	1,137	+ 180	+ 8,870	38½	28	—	—	—	—	—	—	—	—
Leeds Corporation	,, 13	6,500	6 512	- 12	+ 3,425	89½	89½	March 25	298,233	64,223,666	7,121,038	1 10	10 02	351	—
Leicester Corporation	,, 13	2,213	2 332	- 119	—	42	42	Dec. 31	26,011	12 039,252	1,229,507	1	9·79	—	4 82
Liverpool Corporation	,, 6	11,142	11,438	- 296	+ 3,390	104	104	,, 31	547 625	116,642 663	12 166 419	—	—	—	—
Liverpool Overhead Railway	,, 14	1,606	1,555	+ 51	+ 99h	6·65	6 65	June 30	81,302	11,171,865	1,024 275	—	—	—	—
London County Council	,, 6	32,210	27,223	+4,982	+63,886	93	98	—	—	—	—	—	—	—	—
Lowestoft Corporation	—	—	—	—	—	6	6	Sept. 30	14,511	3,128 857	359,435	1 08	9 68	2 630	6 48
Maidstone Corporation	—	—	—	—	—	2	2	March 31	4,740	850 121	112,227	1 33	10 13	2,370	—
Manchester Corporation	,, 13	15,309	14,554	+ 755	+16,757	149	149	,, 31	631,956	126,900,875	14,123,124	1 19	10 73	4,299	6·99
Metropolitan District Railway	,, 14	8,125	8,102	+ 23	+ 127	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 14	15,747	15,136	+ 611	+ 1,628	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 13	147	155	- 8	- 7	2½	2½	,, 31	6,159	1,992,647	206,358	82	7 14	2,239	—
Newcastle-on-Tyne Corporation	,, 13	4,061	5,230	-1,169	+ 232	50	50	,, 31	197,849	43,06 ,934	4,326,152	1 07	10 98	3,957	7·0
Newport (Mon.) Corporation	June 29	639	628	+ 11	+ 1,297	15½	15½	,, 31	30,356	7,252,535	783 435	—	9 29	—	6·4
Oldham Corporation	—	—	—	—	—	34	34	,, 25	65 553	13,466,245	1,504,740	1 16	10·45	1,885	—
Portsmouth Corporation	May 25	2,330	1 578	+ 752	+ 632	28½	28½	,, 31	95,702	19,625,329	197,499	1·17	11 63	—	—
Reading Corporation	July 4	610	678	- 68	- 336	33½	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	11·29	21·29	,, 31	14,881	2,837,110	386,547	1·24	9·24	1,102	7 92
Rotherham Corporation	—	—	—	—	—	9½	9½	,, 31	23,569	5 251,472	593,054	1 07	9·53	2,612	7·49
Salford Corporation	,, 15	4 859	4,568	+ 271	+ 1,243	70½	70½	,, 31	214,111	39,213 560	4,894,590	1·28	10 23	—	—
Scarborough Tramways Co.	—	—	—	—	—	4½	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 14	5,536	5,214	+ 322	+ 3,631	35½	35½	,, 25	240,565	63 952,283	6,049,899	903	9 543	3,653	6·477
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,365	9 294,771	1,108,369	1·27	11·02	—	7 83
Southend-on-Sea Corporation	,, 10	448	521	- 76	- 345	9	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	,, 31	39,550	6,766,031	1,027 730	—	9 23	—	4·75
Sunderland Corporation	,, 14	1,519	1,597	- 78	- 161	20	20	,, 31	64,858	15 364 463	1 495 785	1·004	10·36	—	6·37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	4,937	1,315,757	102,751	0·87	11 53	1,371	—
Torquay Tramways	July 11	197	—	—	—	5 16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 13	910	899	+ 11	+ 165	11 85	11·85	,, 31	38,768	7,412,881	778,851	1·30	11 94	3,271	7·54
Warrington Corporation	—	—	—	—	—	9	9	,, 31	17,057	4 418 225	403 363	—	9 85	—	6·33
West Ham Corporation	,, 11	2,390	2,398	- 8	+ 930	14·7	14 7	,, 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	June 31	853	851	+ 2	+ 188	20	20	,, 31	41,905	8,847,066	950,338	—	10 583	2,062	6·13

† And 98 miles of interlacing track. a Train mile. b Per mile of single track. h Half-year's figures. Double track

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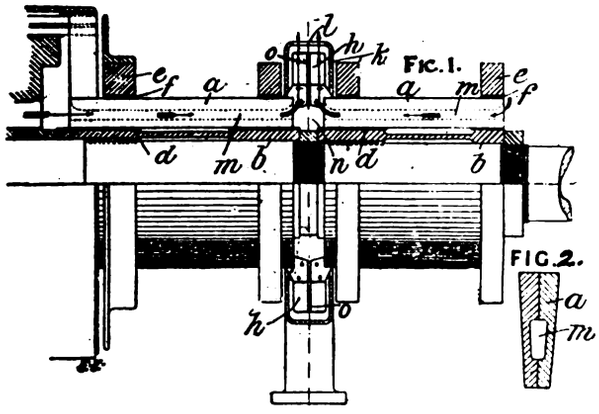
NOTES.

Electrolytic Disinfectant. — There has already appeared in these columns a full description of the plant installed at Poplar for manufacturing disinfectant fluids by electrolytic means, as well as an account of the system adopted. Some months ago we were also able, through the courtesy of Dr. F. W. Alexander, the medical officer of health for the borough of Poplar, who is responsible for the introduction of the enterprise, to give the financial results of the working of the plant for the first 12 months. Now all three are included in Dr. Alexander's report on the health of the borough for the year 1906. The enterprise has proved a complete success, judged either from the financial point of view or from the point of view of public health. The cost of carbolic disinfectants in 1905 amounted to £862, while the cost of the electrolytic disinfectant during the year ended February, 1907, amounted to £597. In comparing the expenditure for the two years, there is shown a saving of £265, and if the sum of £30 paid to the electricity department as rent and supervision be not taken into account, there has been brought about a saving of nearly £300, and this amount does not include any charge for the quantity furnished to the Guardians, as the fluid was supplied to them gratis. The fears that the health of the borough would suffer if an electrolytic disinfectant were introduced have happily proved groundless, for the annual notification rate per 1,000 living in the borough was 6·2, against that of 7·5 for London for the year 1906. The results of the current year's experience will be looked forward to with interest, and if last year's satisfactory record is maintained, all doubts as to the efficacy of the system should be dispelled.

Cooling Commutators.—A device has recently been patented by Messrs. Siemens Bros. and Co. for cooling the



commutators of dynamo-electric machines by air drawn through longitudinal passages in the commutator segments, preferably by means of a fan, the blades of which may be separate from or attached to the segments. The longitudinal passages, *m* (Fig. 1), may have any suitable cross-section, the commutator bars, *a*, being preferably formed in two parts, as shown in Fig. 2. The bars, *a*, are insulated from the sleeves, *b*, on which they are mounted, and from the steel rings, *e*, which hold them in place, by mica rings, *d*, *f*. At the air-gap, *n*, which divides the commutator into two parts, copper vanes, *h*, are sweated to the bars, and the two sets of vanes united by flexible copper strips, *o*. The vanes are surrounded by a casing, *k*, having openings, *l*. The bars, *a*, may be continuous, and perforated to open the passages, *m*, to the air at the place where the vanes are situated.

London County Council Turbo-Generator Contract.—The provision of turbo-generators for the Greenwich generating station appears to have received very close consideration from the Highways Committee. This is not surprising, for not only does the Greenwich station depend to a very great extent upon the successful working of these machines, but there is also the question of obviating as far as practicable vibration from the station, so as to prevent any possible interference with the instruments at Greenwich Observatory. It will be seen from particulars appearing in another column that the principal firms in this country tendered for these machines, but the ultimate issue resolved itself into a contest between Willans and Robinson and the British Westinghouse Companies. Both of these firms are deservedly reputed for the manufacture of turbines, and both were so near in the suitability of the type of machine offered and price quoted, that it became a matter of extreme difficulty for the committee to fix their choice, and before this was accomplished even the minutest details of each offer were carefully considered and compared. It was only because the Willans machine was considered superior in certain respects for the Council's particular purpose that that type of machine was eventually selected, and so important did the committee consider the matter to be that they set out the reasons which led them to prefer the form of construction of the Willans machine. The upper part of the casing of the Willans turbine is hinged, which enables it to be opened easily and quickly for the examination of the interior, without any risk of damage to the blades, and this weighed with the committee. The blades are, as is well known, one of the most important features of turbine construction, and the design submitted by Willans and Robinson, Limited, appears to be satisfactory in every respect. It will be seen from a table appearing in our "Contracts Closed" column last week that there was a difference in the prices quoted of only £614 in favour of the successful tenderers, although the tender as originally accepted (and later amended in price) was some £400 higher than the Westinghouse Company's. Messrs. Willans and Robinson origiually quoted £1,875 for spare parts. This figure was given in error, and should have been £995.

Electric Drive in Paper Mills.—The electric drive is showing its capacity to solve, to a large extent, the many perplexing power problems peculiar to the pulp and paper industries. A large paper mill in the United States was recently added to the already long list of paper mills in which electric driving is employed, and the results of the equipment fully bear out the advantages which that method has been shown to possess. The electrical plant and equipment of the mill in question do not possess any noteworthy features. But in this case the power-houses were built at some distance from the mill, where water power was available. According to the *Western Electrician*, a three-phase 6,600-volt transmission line connects the hydraulic stations with a transformer station at the mills, where the E.M.F. is reduced to 440 volts. All three stations operate in parallel. The equipment of the upper station consists of two Westinghouse revolving-field alternators of 350 kw. capacity, 6,600 volts, 25 cycles, direct coupled to two 500-h.p. turbines operated at 375 r.p.m., made by the Holyoke Machine Company, and governed by a Holyoke waterwheel governor. Excitation is furnished by a 15-kw. 125-volt exciter mounted on the extended shaft of each generator. The water supply is derived through a penstock 11ft. in diameter and 1,500ft. long, which extends from a dam in the river to a large standpipe near the power-house. From the standpipe two smaller penstocks lead to the turbines. The power-house in the pulp mill has an equipment of one 310-kw. and one 270-kw. Westinghouse three-phase 440-volt revolving-field alternator driven by steam-engines

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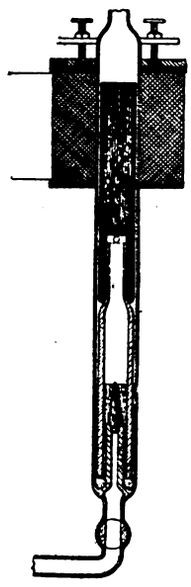
through rope transmission. Excitation is furnished by two 10-kw. 125-volt exciters. Each generator is provided with a switchboard containing standard Westinghouse equipment of instruments. The transformer house contains six 250-kw. oil-cooled transformers, consisting of two banks of three each, connected in delta. The high-tension lines are protected by lightning arresters and choke coils. The switchboard in the transformer house consists of two high-tension panels and three low-tension panels. An additional 60-kw. oil-cooled transformer on the outside transforms current from 440 volts to 1,100 volts for the town-lighting distribution system. Almost every department is operated by electric motors, and from the cutting and conveying of the wood to the cutting of the finished paper induction motors of various sizes are employed. This mill furnishes a typical example of one of the many electrically-driven pulp and paper mills.

Vacuum-Tube Lamps.—A patent granted to Mr. D. McFarlan Moore, and described in the *Electrical World*, gives considerable information concerning the type of valve employed for admitting gas in limited quantities to a Moore vacuum-tube lamp. This automatic feeder valve is shown in vertical section in the accompanying illustration. The essential elements of the valve consist of a porous pencil of arc lamp carbon and a seal of mercury, which covers the tip of the pencil when the valve is "closed," and allows the tip to be exposed when the valve is "open." The vacuum-tube lamp, to which minute quantities of a certain gas are



ed as desired, is connected to the lower extremity of the valve, while the receptacle from which the gas is obtained is joined to the upper extremity. The influx of gas to the vacuum tube is regulated by an electromagnet, whose plunger serves for moving a displacer into or out from the mercury according to whether the valve is to be "closed" or "opened." With the displacer in its lower position the mercury completely covers the tip of the carbon, but when the displacer is raised the mercury surface becomes lowered, and the carbon tip is exposed. The gas percolates through the mass of the carbon, so that there is no sudden influx of gas and no sudden fluctuation of the gaseous tension within the tube lamp.

The Townsend Cell.—At a recent meeting of the New York Section of the American Society of Chemical Industry, Dr. L. H. Baekeland read a paper on the Townsend cell and gave a record of the practical performance of the cell during a continuous operation in a large plant, using 1,000 h.p. This type of cell has been in operation since the beginning of 1906 at the new electrolytic alkali works at Niagara Falls, in sets of 64 cells, each of them carrying from 2,000 to 2,300 amperes, and operated under a heavy current density—about one ampere per square inch of anode surface. The Townsend cell, which was described in full by Dr. Baekeland, is a liquid metal cathode cell; diffusion and recombination of cathions and anions are reduced to a minimum by automatically subtracting every drop of cathode liquor as soon as it appears and surrounding it with a chemically inactive and physically immiscible liquid. Kerosene is the liquid used in practice. The efficiencies of the cells appear to be very good. In special tests, where the cells were operated under very favourable conditions, it was possible to maintain an ampere efficiency quite close to 100 per cent., the voltage not exceeding 3·4 to 3·6 volts; but in practice ideal conditions are seldom realised, and where a large set of cells have to be operated at the same time their efficiency has often to be sacrificed to expediency. But it was stated that ampere efficiencies ranging between 96 and 97 per cent. are not unusual under a load of about one ampere per square inch of anode surface. Dr. Baekeland pointed out that it was absurd to talk about ampere efficiencies or energy efficiencies of an electrolytic cell without mentioning the other factors, and especially without comparing current density. In order to illustrate this, a curve was shown of some cells running under unusually poor efficiencies, but under a load of one ampere per square inch; this showed that it was possible to bring up the ampere efficiency to 93 per cent., the energy efficiency to 55 per cent., and to drop the voltage from five volts to 3·4 volts. It was pointed out that the strength of the caustic liquor produced in the Townsend cell can be regulated at will by increasing or decreasing percolation in conjunction with the strength of the current. By reducing percolation, cathode liquor containing 250 grm. of NaOH per litre or more can be produced. In practice it is found advantageous to produce liquor containing about 150 grm. of NaOH per litre. Such liquor carries also about 213 grm. of salt The latter is separated by evaporation from the caustic lye and is used over again.

Power Supply for London.—Mr. H. B. Renwick, general manager and secretary to the County of London Electric Supply Company, Limited, in a letter to the *Times Engineering Supplement* of July 17, takes to task the writer of a special article in our contemporary on "Cheap Power Proposals for London." Mr. Renwick contradicts the correspondent's statement that average rate for power in London is nearly 2d. per unit, and adds that "the average of the actual rates obtained during the past year by the whole of the supply companies in London was 1·4d., while the average rate obtained by the borough councils for power was below that figure." He attempts to show in reply to the correspondent that the rates charged to consumers in London (where the average user does not exceed 8 h.p.) compares favourably with those charged to small consumers in the North and elsewhere. In fact, the main purport of the letter is to show that there is no great disparity between London and other parts of the country as regards power supply, either in extent of supply or rate of charge, and that the existing companies are doing all they can to meet the present needs. But the conclusion of Mr. Renwick's letter is scarcely consistent. He says: "In conclusion, I would state that both before Parliament and in the Press the extent of the demand for power in London has been grossly exaggerated, and the supply given by the existing undertakers has, on the other hand, been systematically minimised and understated. It can be proved that, as already stated, over 35 per cent. of the power demand in London is being supplied by the existing undertakers, and that the demand is being well met by the companies and the local autho-

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rities, both of whom are in a position to deal efficiently with any demand for manufacturing purposes that may arise. Taking the County of London Electric Supply Company as an example of what has been done to meet the demand for power supply in London, I may mention that that company has secured over 75 per cent. of the power users in its areas, and is daily reducing the outstanding number. Other undertakers can show a similar result." It is only in exceptional cases, of which Mr. Renwick's company forms one, that so large a percentage of power users in any district has been secured by the central station, and the fact that one company alone should satisfy 75 per cent. of the power demanded, while all the undertakers combined do not average more than about 35 per cent., provides one of the most potent arguments in favour of a linking up, under one central authority, of the electricity undertakings in London.

Technical Education.—In the report of Prof. Ayrton on the Central Technical College (embodied in the annual report of the council of the City and Guilds of London Institute) there appears a striking passage which deserves to be engraved upon the mind, for it succinctly states what we consider should be the student's companion thought from the moment he enters college to the time when he embarks upon his professional career. Prof. Ayrton says: "To be successful, men must be thoroughly informed, thoughtful, independent workers, able both to advise and originate; also of good manners, and gifted with some measure of self-confidence and *savoir faire*." These qualities are not to be acquired by any system of "cramming." They are the results of a process of natural development which is helped towards fruition by able and sympathetic tuition. Equipped with these qualities men will be able to take a commanding position in the industrial world, to restore their country's prestige in foreign markets, and to vitalise the somewhat stagnant condition of home manufacturing. It is hardly likely that these ranks will supply an abundance of genuine research students such as would give delight to Prof. Ayrton, for the training imparted to students at technical colleges is in a measure of too practical a character for pure scientific research, while students are, as a rule, more disposed to concern themselves with the application of science to various industries than to exploring the highest reaches of science. After all, a genuine research student is born as such, not made; like the poet, he must not be deficient in imaginative power, or lack that instinct for romance, in the true sense of the word, to deal with hidden forces. His ranks must of necessity be thin compared with the ranks of the "technical" student, and the true test in his case is not one of number but of profundity. Nevertheless, no student should feel discouraged simply because he cannot become a celebrity in scientific research, for there are other circles in which he may be useful. Germany affords a notable example of the efficacy of technical ability apart from any special inventive power. In Belgium, too, technical education is playing an important part in the welfare of the country, for, according to a recently published report for the last year by the American consul, the Belgian system of technical education has been the chief cause of the increasing prosperity of the country, which has attained the fifth place among the world's producing nations. This result is due, so the consul states, to the increased capacity of producers under modern industrial education to compete successfully in the open markets of the world.

Lead-Poisoning.—Last week's debate in the House of Commons on the Home Office vote draws attention to the remarkable increase in the incidence of poisoning in different industries. The question is one which affects the electrical industry in a direct as well as in an indirect way, for in the manufacture of electrical accumulators has been found an additional source of this distressing disease. Thanks to the precautions taken by the owners of such works, and their strict compliance with the regulations, the disease is not so rampant as in other trades. But there is still some room for improvement, and it is certainly to be preferred that manufacturers of electrical accumulators should, by their own effort, endeavour, as far as possible, to remove the cause of lead-poisoning, than that it should be left to the politician to do so, for there are signs and portents in the political heavens which unmistakably show the possibility of political action. To gauge the extent of lead-poisoning in electrical accumulator works, we need only turn to the Factories and Workshops Report for 1906. The medical inspector reports that during 1906 he received notification of 26 cases, as against 27 in 1905 and 33 in 1904. With the exception of the year 1902, when only 16 cases were reported, the figures for last year are the lowest on record. No more than two of the cases in which symptoms of poisoning were last year shown proved severe, the remaining 24 being equally divided between what are officially termed "moderate" and "slight" attacks. The occupations of the persons attacked were—pasting, seven; lead burning, five; casting, two; putting together or packing, nine; and one each in the mixing and in the formation room. The inclination to start this work in unsuitable premises, thereby greatly increasing the danger to which the workmen are exposed, is, in many cases, the cause of lead-poisoning, and this opinion is confirmed by the divisional inspector at Northampton. But manufacturers are equally as zealous for the abatement of the disease as are the authorities, and it is satisfactory to note that irregularities which are pointed out do not long exist. Thus one of the inspectors, writing from Kent, says: "I have found that a very careful observance of the regulations is maintained in the one electric accumulator works in Kent. Although the handling of lead is carried on to a very great extent at these works, there has not been a single case of lead-poisoning during the last two years." If in other works where the disease is liable to occur the same care for its prevention is manifested as in the Kent works, a great step will have been taken towards eradicating the disease—a step greater than can ever be hoped for from political action, which cannot effect its purpose without injuring the manufacturers' interests.

London Traffic Problem.—It really seems as if the first steps toward some solution of this pressing problem will have to come from within, from the companies actually interested, for there is no sign of any action by the Government. On Monday a meeting of railway and omnibus managers was held under the presidency of Sir George Gibb to bring about, if possible, some sort of arrangement which might be productive of reform. Amongst those present were Sir Henry Oakley and Mr. Granville Cunningham, chairman and general manager of the Central London Railway respectively; Sir Clifton Robinson, managing director of the London United Tramways; Mr. T. C. Jenkins, general manager of the City and South London Railway; Mr. A. C. Ellis, general manager of the Metropolitan Railway; Mr. R. P. Brousson, traffic manager of the Great Northern and City Railway; and the managers of the London omnibus companies. No direct decision was arrived at regarding the increase of fares, but the following resolutions were passed, after some discussion: "(1) That a conference be formed, to be called 'the London Passenger Traffic Conference'; (2) that the object of the conference is to create an organisation for mutual conference in regard to fares, routes, and other

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matters of common interest, and generally to take such action as may from time to time be deemed expedient to promote the general interests of the members thereof; (3) that each company represented on the conference shall be entitled to one vote; (4) that the chairman and deputy-chairman of the conference shall be elected by the members at the first meeting held in January in each year, and shall hold office for one year; (5) that any company represented on the conference may at any time record a dissent from any resolution of the conference, and such resolution shall thereupon have no binding effect on the dissenting company." The General Purposes Committee of the London County Council have also given careful consideration to this difficult and complex subject, and they report that the establishment of an authority competent to deal with the question of locomotion and transport in London is desirable, though they are not at the moment prepared to express an opinion as to the precise constitution of such an authority. They recommend: "That it be referred to the General Purposes Committee to arrange for a deputation to wait upon [the Prime Minister to urge the necessity of H.M. Government securing the immediate establishment of a London Traffic Board upon the lines indicated in the report of the Royal Commission on London Traffic." The peculiar part about the situation is that the President of the Board of Trade has made it evident that the Government are not opposed to the suggestion of the Royal Commission, but to a Government composed largely of stage-stamping demagogues, legislation of this practical type is not sufficiently sensational to offer to the public. Nevertheless, the attempt to get the Government to deal with the matter speedily should be pursued with relentless vigour.

Lighting Progress.—Addressing the shareholders at their recent annual meeting, the chairman of one of the electricity supply companies in the country remarked that the introduction of metallic-filament lamps had been responsible for a decrease in the company's revenue from lighting. The same remark has been made by other authorities, and it finds expression once again, this time in the report of the Dudley Corporation electricity undertaking. Dudley's electricity supply account for 1907—which, on a total capital expenditure of £81,410. 13s. 7d., and an income for the past year of £11,705, shows a gross profit of £5,244, or, after paying interest on mortgage loans and repaying loans, a net profit of £68—is accompanied by a statement by Mr. C. E. Savage, the resident engineer. He points out that the increase in income from private consumers is small, and goes on to say: "This, on the face of it, might be put down to the unpopularity of electricity as an illuminant, but is accounted for in a most extremely marked degree by the advent on to the market of cheap, highly economical incandescent lamps and efficient and reliable arc lamps. Both the first and the latter type of lighting will affect, to some extent, all engineers during the next few years, but we trust that in the meantime, with such a low price per unit, to connect sufficient consumers (all new consumers being advised to put in metallic-filament or other highly economical lamps), and thus make up for the decrease in income from the private consumers which must naturally ensue. In order to obtain consumers at a sufficient rate, as engineers we may find it necessary when laying cables down new streets to put in a five-wire system, with local balancers, to adopt the 460-volt supply in the case of Dudley for the present metallic-filament lamps, houses would be wired to take the half-voltage of the two outers—namely, 230 volts—and then, when metallic-filament lamps were capable of being manufactured at a marketable price for 250 volts, the outer and the second outer, in the case of a five-wire system, on both sides would be made the true outer, thus giving consumers supply to the middle wire by 230 volts. This suggestion in large towns might pay, as I find that wiring houses for metallic-filament lamps, 120 or 100 volts is both inconvenient and unpopular, the present metallic-filament lamp two in series in one holder being too large a unit for private house lighting." It is not surprising that engineers are encouraging the use of the higher efficiency lamps. The effect of their use upon income is a comparatively unimportant factor at the present moment, for with their higher efficiencies, and consequent saving to the consumer, they will be the means of securing additional customers for the central station, and restore their earning capacities, besides enabling economies in production to be made. The Cooper-Hewitt mercury-vapour lamp is also making headway, and the factory inspector for the Midland division says the light is exceedingly good, and enables work to be carried on which formerly was not readily performed during hours of darkness. It is also said to be very economical, the waste due to production of heat being much smaller than in incandescent lamps and arc lights.

Electroplate.—Mr. Sherard Cowper-Coles read a paper recently before the Society of Arts on "Sheffield Plate and Electroplate." The greater portion of the paper is devoted to the latter, and his historical sketch of the subject, together with his description of the processes employed in the making-up of electroplating, will be read with a great deal of interest. Electroplating may be said to owe its origin to 1838, when Messrs. G. R. and H. Elkington coated military and other metallic ornaments with silver and gold by immersing them in solutions of those metals. Alexander Parkes at the same time was experimenting for them, with a view of getting thick coherent deposits of gold and silver, the same as had already been obtained with copper by Jacobi, Jordan, and Spencer. Still, little progress was made until John Wright, a surgeon, discovered that, by the use of cyanide of potassium, thick electro-deposits of silver could be obtained. Cyanide in several forms had been used about 16 months before, both for silvering and coppering by simple immersion, but Parkes was the first to deposit silver by the single cell from the double salt of cyanide of potassium and silver. The first article that received the successful coating was a small vase at Wright's residence. The method employed was as follows: An ordinary garden flower-pot was used as a porous cell, and contained the silver solution. This was arranged in a larger vessel filled with dilute sulphuric acid. The vase to be coated was placed in the silver solution, and connected by a wire with a sheet of zinc surrounding the porous cell, and immersed in the dilute acid. Wright having submitted his results to Messrs. Elkington, they were embodied by them in a patent, dated March, 1840, and a royalty of 1s. per ounce of silver deposited was paid. This patent proved to be the basis of successful silver-plating. After having rendered much valuable assistance in the perfecting of details so essential to the commercial success of any process, Parkes ultimately severed his connection with Messrs. Elkington, and died in 1891, having received a large sum from that firm in recognition of his services. Success had now been attained as far as regards the obtaining of a regular thick deposit of silver, but there still remained various smaller difficulties to be overcome, in consequence of which electroplaters had a hard battle to fight, and it was not until some years afterwards that their trade became remunerative. Mr. Coles then goes on to show, in a clear and lucid way, the various processes that have been introduced with this object in view. Of no little importance to the success of

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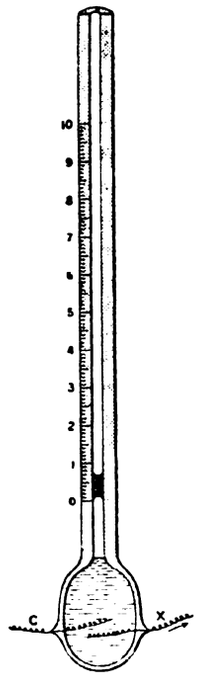
the silver-plating industry was, he says, the introduction of the dynamo. Even when the single cell method, in which articles to be coated were simply made one of the poles of a battery, had been given up, the only reliable source of current was from primary batteries, which required much attention, and entailed a great expense from the large consumption of zinc. It was not until 1863 that the dynamo made its appearance as a substitute for batteries. One of the earliest machines was that of Wilde, separately excited by a small magneto machine. Not very long after the principle of self-excitation was evolved, Wiener Siemens suggested the series dynamo, and Wheatstone the shunt dynamo.

Electro-Therapeutics.—Dr. A. Howard Pirie, well known as an authority on electro-therapeutics, describes in the *Lancet* an instrument which he has made for administering X-rays to patients The instrument, which is illustrated below, consists of a one cubic centimetre pipette about 1ft. long divided into 100 divisions. On one melted end of the



C to coil; X to x ray tube. The drawing is in ½-metre scale.

pipette has been blown a bulb of about the size of a pigeon's egg. Two platinum wires are let through the glass of the bulb and sealed into the glass, so that their free ends project into the interior of the bulb without touching each other. The bulb is then filled with tap water. A drop of water is placed in the lumen of the tube opposite the divisions. This drop adheres to the walls by capillary attraction, which Dr. Pirie calls the indicator drop. The instrument is now ready for use. It is placed in series with the X-ray tube, and the current which flows through the X-ray tube flows through the water in the bulb between the platinum wires. This flow of current decomposes the water in the bulb and bubbles of gas are seen to rise from the platinum wire. These bubbles collect in the lumen of the tube and so force the indicator drop to rise. When a child's scalp is placed at 15cm. from the source of the X-rays while this instrument is in series with the X-ray tube, and the indicator drop has risen 11½ divisions, then the scalp has received a standard dose of X-rays and epilation will follow. The idea itself is not new, but the fact that it can be used for the X-rays is worth noting. The advantage claimed for this method is that, with its use, a patient can be placed at 7½cm. from the source of the X-rays instead of at 15cm., the time required by the standard method. As the intensity of the rays varies inversely as the square of the distance, it follows that at 7½cm. the time required would be a quarter of the time now required.

City and Guilds Institute.—The report of the council of the City and Guilds of London Institute for last year naturally opens with an extended reference to the Imperial College of Science and Technology. Events in connection with this college are now so well known that reference to them may be passed over in favour of a review of the work of the colleges of the institute during the past year. The number of students continue to increase, but the tables showing the admission of students to the two great branches of engineering—civil and mechanical and electrical—are of special interest, as showing how each of the branches alternate in the favour of students. Though the numbers admitted to the two engineering courses have shown a steady increase during the 21 sessions, there have been distinct periods during which first one and then the other course has attracted the great proportion of students. The matter is of interest in so far as it suggests that the choice of students between the two branches may naturally be affected by the state of those industries at the moment. The greater fluctuation is exhibited in the number of students taking the electrical engineering course. The table for the Central Technical College shows that from the opening of the college down to the year 1895 the electrical course attracted the larger number of students, rising steadily from 13 in former year to 96 in the latter. Then for five years the number remained about the same, while the number in the civil and mechanical course continued to increase. This period was followed by four sessions, 1901-5, when the electrical course was again the largest in the college (119-160). The first period of excess is approximately coincident with rapid development of the practical application of electricity to lighting purposes, and the second period to its further practical application to power and traction. In 1905 6 the civil and mechanical students have shown a large increase in number (192, compared with 145 of the previous year), the electrical (135) are fewer than in the previous session, and are again less in number than the civil and mechanical. The foregoing relates only to the courses of instruction, but does not indicate the work of any department of the college. The number of students under instruction in electrical engineering during the winter terms 1905 and 1906 were 319 and 342 respectively; the average length of time in hours per week per student, 9·5 and 9·1; and the student hours of the department—*i.e.*, the number of students multiplied by the time per week they attend—3,029 and 3,106 in 1905 and 1906 respectively. At the Finsbury Technical College, the statistics relating to the electrical engineering day course were liable to the same fluctuations as those for the Central, but the number has always been higher in the electrical than in the mechanical course. Last year the number of students taking the former course was 97 compared with 83 in the latter. In 1905 there were 64 students in the mechanical course and 107 in the electrical. The evening department of the college was attended by 31 students taking the complete course in electrical engineering and 157 attending single classes. The work of the department of technology continues to grow. The conditions of examination in electric wiring have, so the report says, occupied for some time the attention of the committee, particularly having regard to the large number of failures in that subject, and a new and revised syllabus of examination has been introduced into the programme, on the results of which certificates in two different grades will be awarded,

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THE IMPROVEMENT OF THE INCANDESCENT LAMP.

BY R. MILWARD ELLIS.

(*Concluded from page 72.*)

Of all the metals that have so far been employed to form lamp filaments, that which has given by far the most satisfactory results is tungsten. It was this metal that enabled Von Welsbach to transform the fragile low-voltage osmium lamp into the more efficient, longer-lived, and higher-voltage "Osmin" and "Osram" lamps, and it is by its aid that Dr. Zernig has changed what a year ago was a 40-volt 40-c.p. short-lived lamp into the present 220-volt, 40-c.p., 55-watt Zircon-Wolfram lamp. Tungsten was discovered in 1781. It occurs naturally in abundance in Norway and Sweden. Like all these refractory metals that are being used for lamp filaments, it is remarkably heavy, having 1·6 times the density of lead. It was, in fact, this property which gave it its name—tung-sten being Swedish for heavy stone. It fuses at a temperature above 3,000deg. C., is not ductile and cannot be drawn into filaments, chemical means having therefore to be employed. The first attempts that were made to utilise this metal for electric lamps were directed towards coating the carbon filament with tungsten, and several methods of doing this were devised, but no one seems to have accomplised anything useful by their aid.

In 1904 Dr. Alexander Just and Fraz Hanaman patented a process by which pure tungsten filaments could be obtained. The process, which is commendably simple, consists in heating a carbon filament to a high temperature in tungsten and molybdenum compounds—*e.g*, oxychlorides—in the presence of a little free hydrogen. The tungsten deposits on to the carbon filament as basis, while the oxygen which is thus set free combines with carbon to form carbon monoxide. Ultimately, then, the tungsten is deposited as a tube having an internal diameter equal to that of the original carbon filament. A very similar process for osmium and ruthenium had been patented three years previously by Dr. Fritz Blau, in which it was proposed to use volatile tetroxides of the metals. This, however, was found to be not a practical success.

In 1906 Messrs. Just and Hanaman attempted to repatent the Welsbach paste process, applying it to tungsten filaments, instead of, as formerly, to osmium. The attempt was not successful, at least not in Austria, Germany, and other countries which require a detectable amount of novelty in a specification before granting it a monopoly. The filament of the *Just-Wolfram lamp* is, therefore, made by the "deposition" method, the tubular form of the filament being easily visible under a microscope. The external diameter of the tube is about ·59mm., and the internal ·33mm, for a 110-volt 28-c.p. lamp. The initial efficiency of the "Just" lamp is 1·25 watts per candle-power.

Of the different methods of making tungsten filaments, that which has attracted most attention is the Kuzel process. This process consists in obtaining the metal in colloidal form by means of an arc between tungsten electrodes under water. The resulting solution is thickened by evaporation until it can be worked like clay. It is then squirted or pressed into filaments, which are dried and heated as in other paste processes. The advantages of this process are stated as (1) the absence of any binding material, and (2) the absence of a carbon filament basis. It is thought that the presence of either of these in the lamp manufacture may cause the production of a metallic carbide instead of a pure metallic filament. The efficiency of the *Kuzel lamp* is 1·2 watts per candle-power and the life 1,000 hours, during which the candle-power drops 10 to 15 per cent. Until recently the maximum voltage was only 55, but 100-volt 60-c.p. lamps can now be obtained. These figures make it seem probable that the filament cannot be obtained of very small diameter. This seems to be a fault common to all processes in which the filament is obtained by pressing, and one of the great advantages that the "Just" process has is that the cross-section of the filament can be reduced to the minimum that mechanical considerations will permit.

Suspecting in Welsbach's attempts to establish a demand for the osmium lamp as a low-voltage battery lamp a potential monopoly, the Gülcher Accumulator Company instituted investigations into the possibility of using *iridium* as a substitute for osmium. This metal was first suggested as suitable for lampmaking by Edison, nearly 30 years ago Iridium is very hard, very brittle, and very scarce. Filaments were made by a modification of the Welsbach paste process, and it was found that voltages over 24 were impracticable. The lamp was placed on the market at 3s. 6d., and its efficiency was variously stated 1 to 1½ watts per candle-power. In a recent patent specification it is stated that iridium has been found useless as a lamp filament owing to excessive disintegration.

Titanium is stated to have been tried as a lamp filament, and, owing to its extremely high melting point and shiney surface, is said to have an efficiency better than any yet obtained by other metals. Corroborative figures do not, however, seem easily obtainable. The filament is said to be very sensitive to impurities, the presence of which lowers the efficiency enormously. For this reason trouble has been occasioned by vaporised oil from the exhausting pump entering the bulb and combining with the titanium filament.

A short time ago particulars of a nice new lamp filament having more curious properties even than tantalum were published from America. The name of the lamp is the *Helion lamp*. It is composed of a special carbon filament on which silicon, together with other materials, is deposited. It is, consequently, non-metallic, but has the metallic property of fusing together at fractures. A 100 per cent. overload can be carried with safety. It has a temperature coefficient which is initially negative, but afterward changes to positive. Its efficiency is one watt per English candle-power, and remains constant with increase of voltage. Its overload capacity is likely connected with this property. The filament is probably soft, and the light emitted is very white. Only laboratory lamps have yet been constructed, and these would seem to show that the useful life exceeds 1,000 hours. The lamp has been made for 110 volts 32 c.p., and has then a filament no longer than that of the ordinary carbon lamp. Further particulars of this lamp will be awaited with interest.

In view of the great amount of activity which is now raging round the metal lamp, it would be surprising if an attempt were not made to apply some of these many improvements to that old friend of the electrical engineer, the *Nernst lamp*. This lamp, as is well known, is composed of yttria, thoria, ceria, and other "rare earths." It is strange that the first improvement in electric lighting should have been so similar to that which has taken place with gas. In each case carbon was superseded as the light-giving substance by practically the same material—in one case in the form of a rod, in the other in the form of a mantle. It does not seem absolutely impossible that a mantle should be constructed in the fabric of which a fine wire has been interwoven. This wire could then be connected across the electric supply, and the heating accomplished by the current. The Nernst Company, in investigating the possibility of combining the heating coil of their lamp with the glower, have found yet another use for that valuable metal, tungsten. Previous attempts at effecting this combination have been unsuccessful because of the unsatisfactory life that has resulted. With the use of tungstates, however, this is avoided. Tungstates of thorium, zirconium, yttrium, etc., are found satisfactory when employed in vacuum. It is a curious fact that they give better results on alternating current than on continuous. It is essential that an iron wire be still employed in series with the filament to prevent sudden changes in temperature.

There are many points, other than efficiency and life, in which the metallic filament differs from its carbon forerunner. It has, for instance, a valuable property, due to its positive temperature coefficient, of keeping a more constant candle-power on a varying voltage circuit. It has long been known that the candle-power of the carbon filament varies as the sixth power of its voltage, and it has recently been proved that with metallic filaments this power is approximately the fourth The significance of these figures is this: A carbon lamp giving 16 candles on normal voltage would give only 8·5

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if the pressure dropped 10 per cent., while under similar conditions the metallic lamp would give 10·5, an advantage of 22 per cent. With a 10 per cent. increase in the voltage the candle-power of the carbon lamp would increase by 12·3, and that of the metal by only 7·5. There is also a noteworthy disadvantage in the positive temperature coefficient, and that is the large starting current it necessitates. Immediately on switching on a carbon filament, the current flowing has about one-half its final value, but with a metallic filament the starting current is eight or nine times its normal value. The softness of the metallic filament is often a serious disadvantage, as, except in one or, at most, two cases, it precludes the use of the lamp in any but a vertical position. When cold the metallic filament is extremely brittle, and these lamps have to be used with great care. The tantalum filament has an advantage in this respect, in that it does not become brittle until after 200 or 300 hours' use. This is of great utility during transit, as it is then that many of the metal lamps get broken. With metal lamps a break in the filament does not necessarily mean the conclusion of its career as a light-giving article, as in most cases, if the ends of the filament can be enticed to retouch, they will fuse firmly together, and the lamp will run satisfactorily for many more hours.

The great length of filament necessitated by the use of such comparatively good conductors as metals has proved a serious handicap in the construction of these lamps. The effect in this direction of the tubular form of filament resulting from the "Just" process is worth consideration. If we consider two filaments of the same material, one tubular and the other solid, it is clear that to give the same candle-power they must, if working at the same temperature, have the same radiating surface—*i.e*, the product $d \times l$ must be the same. Also, since the materials, the temperatures, and the candle-powers are the same, the efficiencies and, therefore, the watts, and consequently for equal voltages the resistances must be the same. Taking the external diameter of the tube equal to n times the diameter of the solid filament, we must have, by condition (1), length of tube equal to $\frac{1}{n}$ times length of wire, and, by condition (2), length of tube over area of tube section equal to length of wire over area of wire section—*i.e.*, sectional area of tube equal to sectional area of wire times length of tube over length of wire—that is to say, sectional area of tube equal to $\frac{1}{n}$th sectional area of wire. Combining the two results, we have, therefore, weight of tube equal to $\frac{1}{n^2}$ times weight of wire. Consequently, for lamps of equal candle-power, voltage, and efficiency, a tubular filament having an external diameter equal to three times that of a solid filament need have only one-third of its length and one-ninth of its weight, and yet be much better fitted for standing mechanical stresses.

Another point in which the metallic filament differs from carbon, and, incidentally, many other sources of light, is in its intrinsic brilliancy. The intrinsic brilliancy of the metal lamp varies from 450 to 1,200 horizontal candle-power per square inch of projected surface, for carbon lamps from 300 to 600, for incandescent gas mantles from 20 to 40, and for the common candle from 2 to 3. When it is remembered that the eye is attracted to the brightest object in the field of vision, and that the iris adjusts itself to suit the maximum intensity of the light emitted, it will be seen how important is the consideration of this point. The recognition of this is more and more tending to the conviction that a complete alteration in the methods of lighting is desirable, and the practice of lighting wholly by reflection is, with the advent of the electric arc and metallic-filament lamp, becoming increasingly common.

In spite of many claims to that effect, there is not yet upon the market a lamp which will give one English candle-power per watt supplied; but, considering the remarkable progress that electric lighting has experienced during the past few years, it appears certain that such a lamp cannot now be long delayed. As a matter of fact, if all that is said about the "Helion" lamp is true, the problem is even now solved. There can, in any case, be no doubt that the success of the metal lamp is now assured, and the displacement of the older forms of lighting is fast being recognised as an inevitable consequence

The present position is summarised in the following table:

Name of lamp.	Watts per candle-power.	Candle-power per watt.	Approximate: Useful life (hours).	Approximate: Voltage and candle-power.	Approximate: Price.
Ordinary carbon	4·0	·25	1,000	110; 8, 16, 32 220; 5, 8, etc.	10d.
High-efficiency carbon	3·0	·33	500	110; 16	2/3
Graphite	2·5	·40	1,000	110; 16	—
Nernst	1·9	·53	Uncertain	110; 32 220; 60	Various.
Tantalum	1·9	·53	1,000	110; 16, 23 130; 20	2/6
Osmium	1·5	·67	1,000	55; 24	7/6 less 9d.
Osmin	1·1	·91	4,000	110; 60	3/-
	1·2	·83		110; 40 220; 80	
Osram	1·35	·75	1,000	110; 28	3/3
	1·25	·80		110; 50	
	1·40	·72		220; 40	
Zircon carbon	2 5	·40	—	110; 32	—
Zircon carbide	1·2	·83	500	37; 32	—
Zircon-Wolfram	1·4	·72	1,000	110; 28 220; 32	3/- to 4/-
Just-Wolfram	1·25	·80	1,000	110; 28	3/6
Kuzel Wolfram	1·2	·83	1,000	55; 30 110; 60	3/6
Iridium	about 1·5	·67	—	24 volts	3/6
Helion	1·0	1·0	Over 1,000	110; 30	—

INSTRUMENT TRANSFORMERS.

BY CHARLES C. GARRARD, PH.D.

A. POTENTIAL TRANSFORMERS

1. *Introduction: Measurement of High Potentials.*—For the measurement of the moderately high-tension voltages which have been general hitherto in central stations in this country electrostatic voltmeters mostly have been used. Excellent instruments of this type have been made, and no doubt their accuracy has been very great. With the advent of potentials higher than 2,000 it was discovered that the electrostatic voltmeter could not extend satisfactorily its sphere of usefulness to the extent necessary, and to-day the best practice in all high-tension work is to install potential transformers and low-tension voltmeters, scaling these, however, in terms of the primary volts.

The potential transformer also plays an important part in the measurement of high-tension power. In calibrating high-tension wattmeters it is usual to carry out the calibration of the meter in conjunction with its current transformer, and at a voltage equal to the secondary voltage of the potential transformer. This latter is simply adjusted for exact ratio. This procedure is perfectly satisfactory provided a good make of potential transformer be used. The phase displacement introduced by such a transformer is extremely small, and the drop and the consequent change of ratio can be kept likewise within very small limits. Fig. 1 represents the regulation curves of a standard 50-watt, 6,600-volt, 50-period potential transformer constructed by Messrs. Ferranti Limited. It will be seen that for a load of 50 volt-amperes at unity power factor the drop from no to full load does not exceed 1 per cent. The greatest accuracy, of course, is attained if the ratio be adjusted with the transformer feeding the instruments it has eventually got to work with—*i.e.*, when feeding an equivalent load. This is a precaution that it is always as well to take, as, of course, it is a very simple thing to do when standard instruments are concerned. It is, however, by no means essential, and it is sufficient, when extreme accuracy is not required, to adjust the ratio to be exact on open circuit.

2. *Insulation of Instrument Transformers.*—The very first condition of an apparatus which is to form part of a switchboard, is that it should not break down under any circumstances whatever. Mr. Wild (*Electrician*, Jan. 18, 1907, p. 543) makes the rather remarkable suggestion that there

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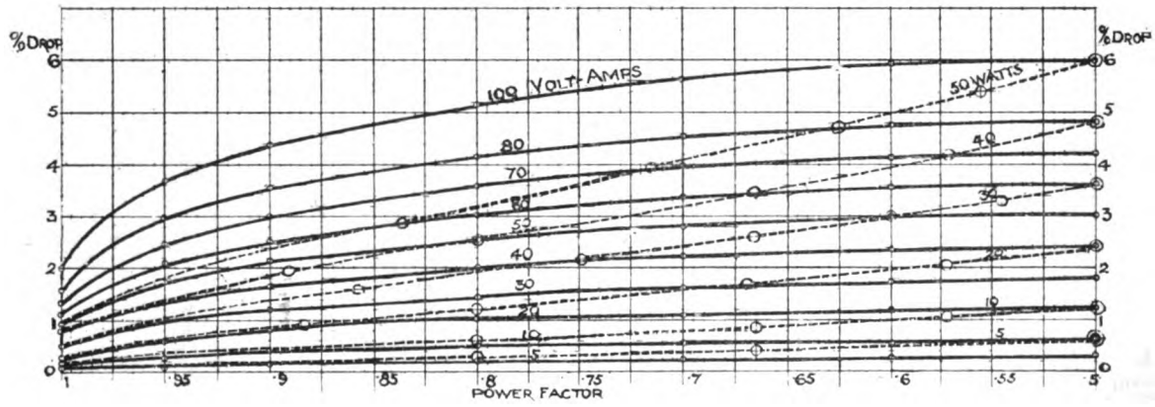
is no room for insulation between the primary and secondary windings of a current transformer, and that the insulation had much better be put into the instrument. But the chief reason for using current transformers at all is to obviate the necessity of insulating the instrument, and to keep high-tension current away from it. Of course, if everything be sacrificed to the attainment of as perfect a transformer ratio as possible, no doubt Mr. Wild is right, but in practice this cannot be done, and one must sacrifice a good deal in perfection of ratio in order to secure absolutely safe insulation. On the other hand, in order to keep down magnetic leakage (and this applies especially to current transformers) the space between the windings should not be needlessly large, and bulky forms of insulation, such as porcelain, should be avoided. Between primary and secondary a mica tube of ample thickness should be used for all voltages of 2,000 and upwards. This mica tube should be used even if the transformer be immersed in oil, but in this case it is necessary to impregnate the tube thoroughly with a varnish which is unacted upon by oil. All transformers for use in 5,000 volts and upwards should be oil insulated. The high-tension windings of all potential transformers should be sub-divided into a large number of sections, so that not more than about 1,000 volts are across a single section. Each section should be taped separately with several thicknesses of impregnated linen tape. The separate sections for each leg of the transformer should be assembled and taped together with many thicknesses of tape. Sufficient taping should be put on to withstand the test pressure alone when applied between the winding and tinfoil wrapped upon the outside of the taping. The mica tube itself should be thick enough also to withstand the test pressure. A very important point is that every particle of air and moisture should be withdrawn from the winding by a vacuum drying process, and the whole transformer should be impregnated thoroughly with a high-quality varnish. The following test pressures (alternating current) should be applied between primary and secondary and core before the transformer is shipped from the factory. The pressure should be applied for half an hour.

Working pressure.	Test pressure.
1,000 volts	3,000 volts.
2,500 ,, ...	7,500 ,,
5,000 ,, ...	15,000 ,,
7,500 ,, ...	22,500 ,,
10,000 ,, ...	25,000 ,,
11,000 ,, ...	27,000 ,,
15,000 ,, ...	30,000 ,,
18,000 ,, ...	33,000 ,,
20,000 ,, ...	35,000 ,,

In addition to this test, the insulation resistance should be measured by means of an ohmmeter and a 1,000-volt generator. The high-tension winding should never show less than infinity (50 megohms), and the low-tension winding never less than 30 megohms. The low-tension winding should be flashed also to core with a testing transformer at 1,500 volts.



Curves showing Regulation of Potential Transformer, 50 Watt $^{2500}/_{100}$ Volt 50 ~ Single Phase.

3. *Terminals of Current and Potential Transformers.*—The function of instrument transformers is to reduce the working current and potential to values suitable for the metering apparatus. It is clear now that each transformer introduces a lag (or lead) of approximately 180deg., and that unless some convention is adhered to in marking the terminals serious errors in the connecting up can be made, necessitating wearisome trial and error experiments before the proper connections for accurate metering can be obtained. This is of very special importance in polyphase work, where not only errors, such as meters running backwards, may be obtained, but also secondary voltages and currents which differ in phase and magnitude enormously from the proper transformed values. Reference should be made here to the paper by M. C. Rypinski, entitled "Polyphase Metering Conventions," which appeared in the *Electric Journal* for February, 1907. In this paper the various arrangements of terminals, etc., of Westinghouse standard measuring apparatus are dealt with.

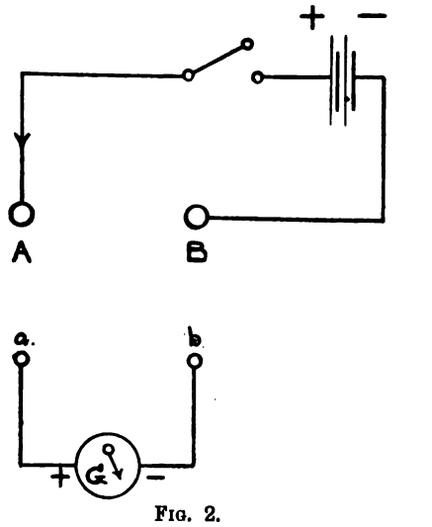


Fig. 2.

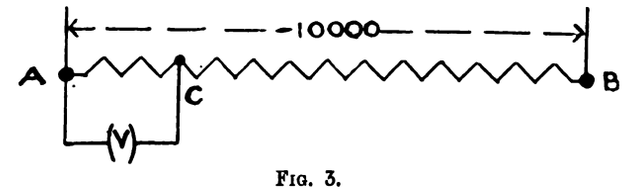


Fig. 3.

As regards transformers, the matter can be made very simple. The criterion should be that the interposition of the transformer between the instrument and the line should be exactly equivalent to connecting the instrument in the line, except that the current and voltage are reduced to convenient dimensions. The high-tension terminals of the instrument transformers should be marked A, B, etc., and the corresponding low-tension terminals marked *a*, *b*, etc. When the positive current flows into A—*i.e.*, from the line—it should, at the same instant, flow out of *a*. In a sense the current flows through the transformer from A to *a*. This scheme of marking terminals can be applied to all current and potential transformers, both single and three phase, and is quite sufficient to obviate all trouble in the connections as far as the transformers are concerned.

4. *Simple Method of Testing Polarity of Instrument Transformers.*—The connections are made as in Fig. 2. A B are the high-tension terminals of the transformer, and *a b* are

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the low-tension terminals. The battery consists of a few Leclanché or secondary cells. The indicator, G, is an ordinary linesman detector. On closing the switch the needle should kick to the left, indicating that the terminal connected to *a* is on the positive. On opening the switch the kick should be in the opposite direction. The test is an extremely simple one.

5. *Test-Room Measurement of High-Tension Voltages.*—It is important that high-tension supply works should possess a means of verifying easily the accuracy of high-tension voltmeters or checking the ratio of potential transformers. Many supply stations sell high-tension current, and the accuracy of the high-tension wattmeters is directly proportional to the accuracy of ratio of the potential transformers used therewith. To rely upon a standard high-tension voltmeter is unsatisfactory, as it is liable to get out of order, and it is not possible to check it easily. The most commercially convenient fundamental standard is the standard cell (Weston or Clark), and by means of any standard make of potentiometer it is possible to compare the calibration of a low-tension electrostatic voltmeter with the standard cell. If, now, a means can be devised whereby the high-tension voltage measurement can be compared, *viâ* the potentiometer, to the standard cell, a very satisfactory arrangement is arrived at. This can be done by means of a suitable resistance (Fig. 3), A B. At C, situated so that the resistance A C is, say, the one hundred and fiftieth of that between A and B, a tapping is taken out. The precise ratio of the resistances A C and A B can be determined by measuring

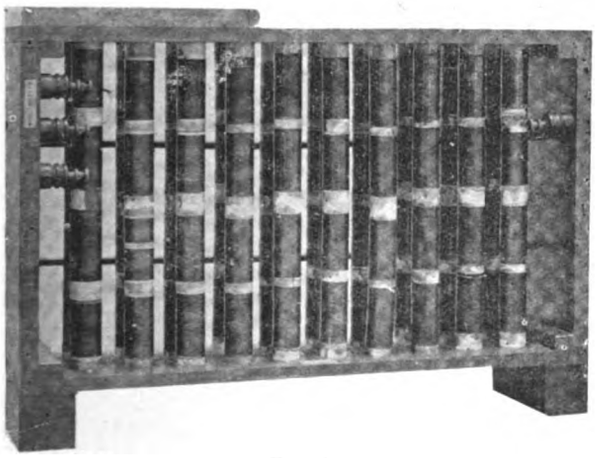

FIG. 4.

them on the potentiometer with continuous current. Across A B the full voltage, say 10,000 or 15,000, is placed, and the proportionate part is read across A C by means of a low-tension electrostatic voltmeter, which instrument can be calibrated on the potentiometer at 100 volts direct current. For safety of working, the point A should be earthed.

The great advantage of this arrangement is that it can be checked easily at any time and referred down to the fundamental standard cell, and is perfectly independent of any instrument remaining constant in calibration. As will be seen later, the resistances are easy to make, and, if proper precautions are taken, the measurement is perfectly accurate. A number of such resistances have been constructed and used by the present writer for a number of years in ordinary commercial work. As experience has shown that a large number of supply stations do not possess any such apparatus, it is thought that a short description of the same will be of general interest.

6. *Description of Non-Inductive Resistance made by the Cambridge Scientific Instrument Company* (Fig. 4).—This consists of a series of china tubes, plain on the outside but fluted inside. It is intended for use up to 15,000 volts, and there are 20 tubes, each 18in. long and 1¼in. outside diameter, mounted in a wooden frame, the over-all dimensions being 2ft. 6in. by 1ft. 6in. by 10in. Each tube is wound in four sections, each section having 450 turns, and is wound non-inductively. This is arranged by doubling the wire upon itself, and winding the doubled wire upon the tube in the ordinary method of making non-inductive resistance bobbins. A diagram of the winding of each tube is shown in Fig. 5. The wire is put upon the tube in a single layer, and wound as closely as possible. The sections are separated by about ½in. of the tube left unwound. As

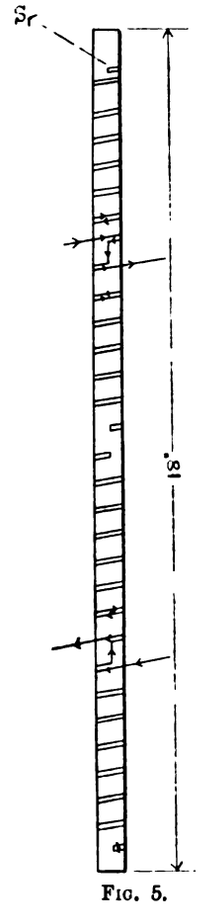

FIG. 5.

there are 80 sections in all, it will be seen that at full voltage there are 187 volts per section. At the end of each section this voltage of 187 volts exists between the two wires, which are only separated by the double insula-

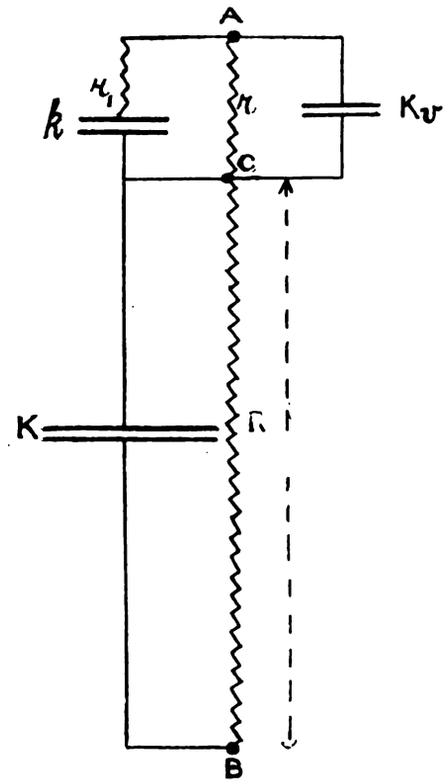

FIG. 6.

tion on the wire—*i.e.*, by four thicknesses of silk covering. This is a source of weakness, and in order to prevent breakdown it is necessary to dry and carefully varnish all the tubes. The wire used is ·0028in. thick (45 S.W.G.).

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The total resistance is 600,000 ohms, so that at 15,000 volts there is a watt dissipation of 375 watts.

A photo of the resistance is given in Fig. 4. It is wound non-inductively, but as each section consists of a double wire it is evident that the winding will possess a certain amount of distributed capacity, and it is necessary to determine whether this will affect the assumption that the ratio of the impedances of A C and A B, when a high-tension alternating current is passing through, is equal to the ratio of the ohmic resistances as measured with low-tension direct current. The effect of the distributed capacity is to provide parallel paths to the main resistance as shown diagrammatically in Fig. 6. In this figure the low-tension voltmeter is indicated as a capacity, K_v, but we will not consider this for the time being. It is evident that if the impedances of the parallel paths were anything approaching the resistances r and R in value, the above assumption might not hold good.

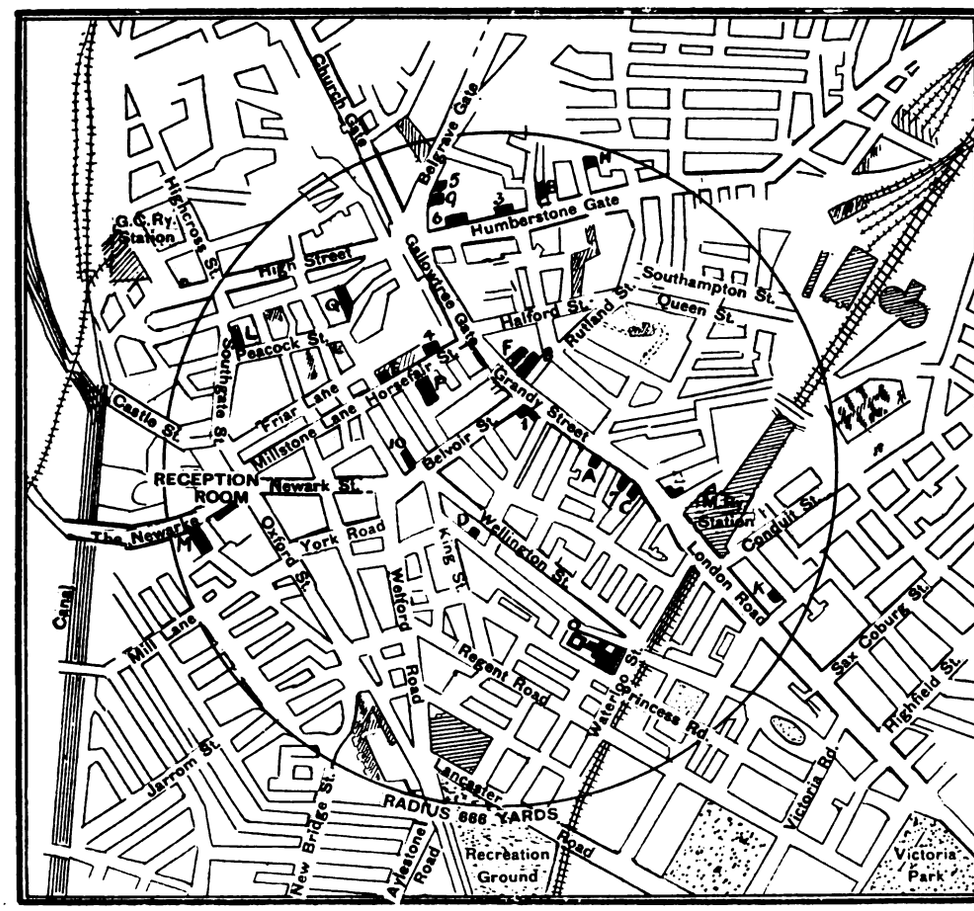
7. *Measurement of Electrostatic Capacity of Ratio Resistance.* The closed end of one section (S of Fig. 5) was cut. This gave two wires lying close together, which are, of course, normally in series, and it was possible by means of a ballistic galvanometer to measure the electrostatic capacity between the two halves of the one section. This gave a value of ·00842 microfarad per section. Now the fall of potential along the resistance is determined practically by the ohmic resistance of the same, as the reactance of the parallel capacity path is very large in comparison. It will be sufficient, therefore, to consider each section as shunted with a capacity having half that found above, as the average voltage applied to the condenser is half that subsisting between the ends of the section. We, therefore, have per section a resistance of 7,500 ohms shunted with a capacity of ·00421 microfarad, which combination has an impedance differing by less than one part in 10,000 from 7,500. It is, therefore, clear that the assumption that the volts will divide up in proportion to the ohmic resistance is a correct one. It should be noted also that this would still hold good if the capacity were much greater, as owing to uniformity of construction the impedance of any part of the multiplier is proportional to the resistance of that part. Provided, therefore, the shunting of one section of the multiplier by the electrostatic voltmeter does not introduce any error, it will follow that the method is an accurate one for high-voltage measurements. (N.B.—The above-found small capacity is large enough to prevent the use of such a resistance as the series coil of a high-tension wattmeter shunt if accuracy on low power factors be desired. The capacity possessed by the resistance would introduce a phase displacement of between ·5deg. and 1deg. in the wattmeter shunt current, which would be a serious matter for power measurements at low power factors.)

(To be continued.)

THE BRITISH ASSOCIATION.

Leicester Meeting.

The preparations for this meeting are now practically completed, and do credit to the local committee, which has been presided over by Mr. A. Colson, the energetic engineer of the gas and electricity department of Leicester.



The map reproduced herewith shows the positions of the various halls and rooms to be utilised by the association while in Leicester. The letters and numbers on this map need the following references: (M) administrative offices; (N) the reception room, drill hall (this will be opened on Monday next for the enrolment of new members); (O) museum and loggia; (P) municipal buildings; (Q) opera house. The various sections will meet in the following rooms: (A) mathematics—Temperance Hall, Granby-street; (B) chemistry—Wyggeston Girls' School, Drill Hall; (C) geology—Association Hall, Granby-street; (D) zoology—Sunday School Memorial Hall, New-walk; (E) geography—Assembly Rooms, Hotel-street; (F) economic science—Victoria Hall, Granby-street; (G) engineering—Wyggeston Girls' School, Humberstone-gate; (H) anthropology—Trades' Hall, St. James's-street; (I) physiology—Co-operative Hall, High-street; (K) botany—Friends' Meeting House, Prebend-street; (L) education—Wyggeston Boys' School, Highcross-street. The hotels of Leicester are indicated on the map by the following numbers: (1) Grand; (2) Wyvern; (3) Bell; (4) Royal; (5) George;

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(6) Stag and Pheasant; (7) Victoria; (8) Wellington; (9) White Hart; (10) Granville.

We have already given the programmes of several of the sections, and that for the engineering is as follows: Thursday, Aug. 1—presidential address by Prof. S. P. Thompson, F.R.S.; Mr. Dugald Clerk, "The Present Condition of Gas and Petrol Engines." Friday, Aug. 2—joint meeting with the members of the Chemical Section (B) to discuss "Gaseous Explosions, with Special Reference to Temperature." Monday, Aug. 5—Sir W. H. Preece, K.C.B., F.R.S., "Pupin's Compensated Cable for Telephone Transmission"; Mr. J. T. Morris, note on "An Oscillograph Study of Duddell Arcs of Low Frequency"; Mr. L. Gaster, "Developments of Electric Incandescent Lamps"; Mr. H. I. Brackenbury, "Modern Machinery and its Future Developments"; Mr. J. F. Brooks, "A Machine for Weighing the Forces on a Cutting Tool"; Mr. R. S. Ball, "Note on the Governing of Hydraulic Turbines. Tuesday, Aug. 6—Mr. J. S. E. de Vesian, "Ferro-Concrete and Examples of Construction"; Mr. W. Noble Twelvetrees, "Some New Uses for Reinforced Concrete"; Mr. H. T. Barnes, "The Ice Problem in Engineering Work in Canada"; Prof. E. G. Coker, "The Equipment of the Engineering Laboratory of the Finsbury Technical Institute"; Mr. J. F. Millet, "Submarine Signalling." On the afternoon of Friday, Aug. 2, members of the section are invited by Mr. C. Bennion to a demonstration of boot and shoe making machinery at the

MR. A. COLSON, M.I C.E., CHAIRMAN OF THE B.A. LOCAL COMMITTEE.

works of the Union Company. On Saturday, Aug. 3, an expedition is arranged for members of the section over the Leicester and Swannington Railway, one of the earliest railways laid down in England. In Section A (president, Prof. A. E. H. Love, F.R.S.) the papers are chiefly of mathematical interest. Prof. H. E. Armstrong, F.R.S., will read a paper on "Ionisation," and Sir Oliver Lodge, F.R.S., will deal with ether density.

The attractive visits arranged to works include the following, and Mr. A. C. Harris has prepared short descriptions of what can be seen at each place: Messrs. Cooper, Corah, and Sons, hosiery manufacturers, St. Margaret's Works, Leicester, open Wednesday, Thursday, and Friday, July 31 and Aug. 1 and 2, 3 to 5 p.m. At these works besides every variety of hosiery machinery there are various other departments concerned with working, dyeing, drying, pressing, soapmaking, printing; these will probably interest the engineer less than the cardboard boxmaking and blouse factory. In the latter a band knife cuts out three or four hundred parts of fabric at once, which are then made up by means of sewing machines. The ironing is done by electrically-heated irons. The Co-operative Wholesale Society, Limited, boot and shoe manufacturers, Wheatsheaf Works, Leicester, open July 31, Aug. 1 and 2, 8 to 4 p.m. The works employs 1,700, is beautifully lighted and ventilated, and has, in addition, a sociological interest. It is electrically driven, and makes its own current. Messrs. Fielding and Johnson, worsted spinners, West Bond-street and Abbey Mills, Ross's-walk, open Thursday afternoon, Aug. 1. The Leicester Corporation gas, chemical, and electricity works, Aylestone-road, open any afternoon during the visit at three o'clock. At these works will be found a well-equipped meteorological station, and a reference to the record register will provide useful information for those interested in meteorology; all the instruments have been certified at Kew. The Leicester Corporation electrical generating station for the supply of power to the Corporation trams, Painter-street, Belgrave, and the tramcar depôt and repair shops, Abbey Park-road, open July 31, Aug. 1, 5, and 6. Messrs. John Richardson and Co., Limited, manufacturing pharmaceutical chemists and surgical instrument makers, 10, Friar-lane, Leicester, open any day except Saturday, 10.30 to 12 30, 2.30 to 5.30. Messrs Stead and Simpson, boot and shoe manufacturers, 12, Belgrave-gate, open on the afternoon of July 31 and Aug. 1.

HOT-WIRE WATTMETERS AND OSCILLOGRAPHS.*

BY J. T. IRWIN, ASSOCIATE MEMBER.

(*Concluded from page 86.*)

HOT-WIRE WATTMETER TESTS.

The instrument on which these experiments were carried out was arranged in tubular form, so as to be able to go inside the tubular air-tight casing, and was constructed on the same principle as the hot-wire oscillograph, except that the small plane mirror is replaced by a concave mirror $\frac{3}{8}$in. in diameter. An ideal hot-wire wattmeter should have the following properties: (1) high sensibility (not so desirable if a pressure transformer is used); (2) deflection proportional to the difference in the rate of heating of the two strips and independent of the actual heating of the strips. If condition (2) is fulfilled then it should be possible: (*a*) to pass a current of any value that would not damage the instrument through the two wires in series without producing any deflection; (*b*) to apply any voltage within limits across the two strips in parallel without producing any deflection; (*c*) to have a deflection proportional to the square of the current through one strip only. The following particulars of the instrument may be of interest:

Total effective length of wire for each strip.....	10cm.
Diameter of wires	0·005cm.
Distance apart	0·15cm.
Material, platinum silver	—
Resistance of strips	10·39 ohms.
	10·30 ohms.

The natural period of the instrument was $\frac{1}{60}$th of a second at first, and on account of it being so high it was liable to get in phase with the variation of heating in the instrument on alternating current. The mirror was weighted with lead to stop this movement. Sensibility, 290mm. deflection at a scale distance of 1m. for a current of 0·2 of an ampere through one strip—that is, an expenditure of power of 0·4 of a watt. The author would suggest as a sensibility factor for hot-wire wattmeters the term

$$\frac{\text{deflection}}{\text{scale distance} \times \text{difference in watts dissipated.}}$$

The factor in the present case comes to 0·72, but could easily be increased to a higher value by employing finer wires in the instrument, by using longer wires not tied back so far, or by putting the wires nearer together. Table I. shows the approximation to which condition 2 (*a*) and (*b*) mentioned above is satisfied—namely, the result of passing the same current through the strips in series, and of putting the strips in parallel and passing a current through them. There would have been no deflection if the instrument had been perfect.

It is seen from Table I. that to improve the readings one of the strips would have to be shunted so as to make the mean deflection more nearly zero, as at present the deflection is always in one direction. A small resistance should also be placed in series with the same strip to reduce its mean deflection to nearly zero. The deflection follows no definite

* Paper read before the Institution of Electrical Engineers.

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law, and is probably due chiefly to convection currents cooling one wire more than the other and, perhaps, slightly due to a change in the emissivity of the wires at different temperatures. That convection currents are to a certain extent operative can be shown by tilting the instrument into various positions from the vertical, which increases or decreases the deflection in each case. This can easily be overcome by shielding the wires from each other so that the convection current from one wire does not influence

TABLE I.

Current.	Deflection strips in series— Ascending.	Descending.	Deflection strips in parallel— Ascending.	Descending.
	mm.	mm.	mm.	mm.
0	0	0	0	0
0·1	6	10	7	—
0·15	8	5	7	—
0·2	10	3	7	—
0·25	2	2	5	—
0·3	—	—	2	—
0·35	—	—	0	-5
0·4	—	—	-8	-10

the other. By adjusting the strips but without any shielding it was possible to reduce maximum deflection to less than 5mm. for any safe current. The effect could also be eliminated by taking the mean of the deflection in each direction.

The curve given in Fig. 6 is from this wattmeter, and shows the deflection plotted against the current in centi-amperes sent through the two strips in series, when the

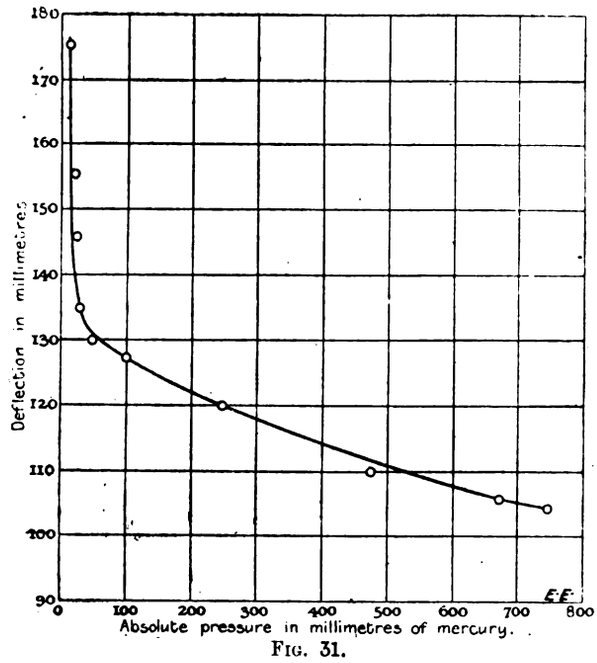

FIG. 31.

current through the strips in parallel is constant at 0·1 of an ampere. It will be seen that the deflection is almost exactly proportional to the series current. This corresponds to the case of a wattmeter on a non-inductive load where the difference in the rate of heating is proportional to the current multiplied by the voltage. A test was undertaken to find out how altering the tension on the strips altered the sensibility. Decreasing the tension on the strips from 8oz., the normal tension, to 4oz., the sensibility was increased by 15 per cent. It was also found that the deflection when a current was sent through one wire only was proportional to (current).[2] This small change of sensibility, due to change of tension, is of considerable importance, since it shows that slight alterations of the spring, which may arise from change of temperature, will only produce a very small effect on the sensibility of the instrument. The tension of 8oz. was kept on, for although less sensitive the deflection was more constant for a given difference in heating. With a view to obtaining increased sensibility, the wattmeter was enclosed in its case and the case exhausted. The curve in Fig. 31 shows how the deflection is increased for a constant difference in the watts dissipated in the strips. It will be seen that for a small diminution in the pressure the sensibility is very little increased, but when the pressure falls below 50mm. of mercury, the increase in sensibility is very rapid. The total increase in sensibility from atmospheric pressure to 12mm. of mercury is 70 per cent. The shape of this curve is very important, as it shows that unless one is able to keep a constant reduced pressure in the instrument the sensibility will vary very much, and this makes this arrangement commercially impracticable. The most important test for a wattmeter is whether inherently it will read correctly the difference in the watts expended in the two wires, independent of the absolute watts expended in each wire. This was partially shown in Table I., where the difference in heating was zero.

Fig. 32 shows a typical curve for this hot-wire instrument on a non-inductive load. The wattmeter readings are plotted against the product of amperes and volts. As a matter of fact it was as much a calibration of the *ammeter* as of the wattmeter, as the ammeter used was only a

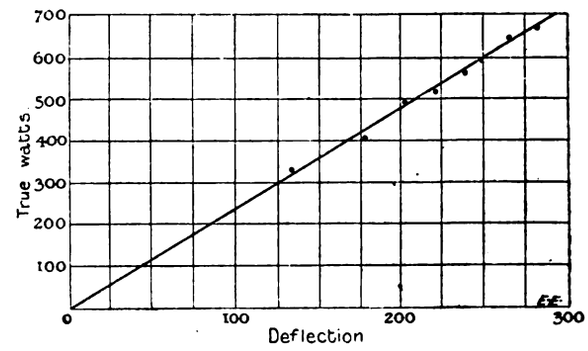

FIG. 32.

commercial hot-wire one. Fig. 33 shows a typical curve for the wattmeter on an inductive load of power factor about 0·15. It will be seen that the deflection is practically proportional to the watts + a constant, and any error is likely to be introduced by the transformer, since inherently the wattmeter will be right to 1 part in 80 on a non-inductive load, if the deflection is taken in one direction only, and to a much higher degree if the mean of the deflections in both directions is taken. On a power factor of 0·1 the maximum inherent error is about 15 per cent., and the error if the mean deflection is taken is probably about 5 per cent. These are the inherent errors due to the deflection of the instrument not being strictly proportional to the difference in heating, and they can be reduced very largely by better design and more careful shielding of the wires from convection currents of air.

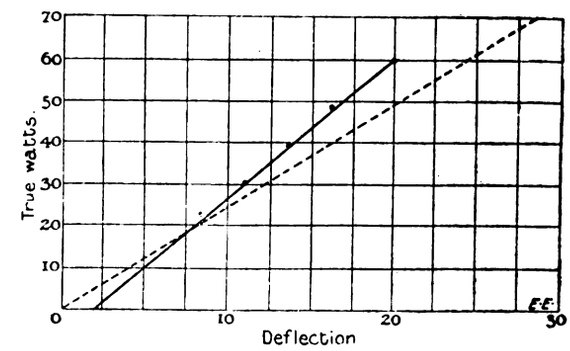

FIG. 33.

The experimental results given above are only a few of a great many experiments carried out at the Central Technical College, and the author has to thank Prof. Ayrton and Mr. Mather for the facilities afforded and for help in connection with the research. Messrs. Carr and Tubini carried out the investigation on the hot-wire oscillograph, and Messrs. Kinnes and Parry that on the hot-wire wattmeter. The success so far attained is due in a large measure to the resource and care displayed by these students in carrying out experiments. The author is also indebted to Messrs. McEwen, Denton, Robson, Haworth, and Mackinney, his colleagues, for help and advice, and to Mr. Alexander Russell for assistance in connection with the calculations on the free period of instrument. The instruments were made by Mr. F. W. Andrews, instrument maker to the college, whose practical skill overcame a number of difficulties met with in the construction.

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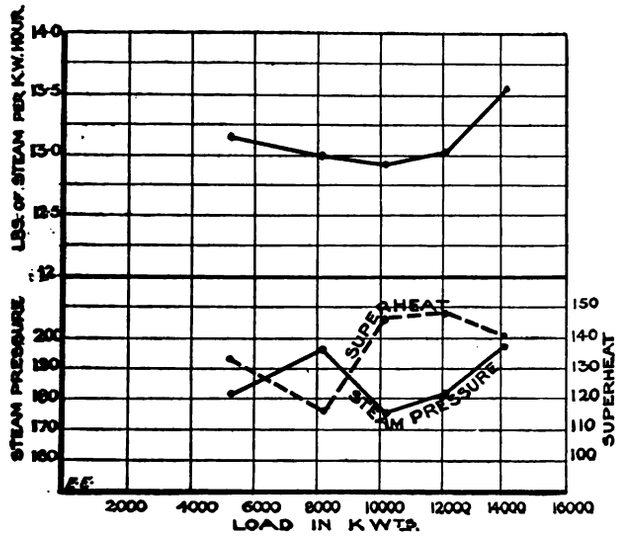
TEST OF 9,000-KW. CURTIS TURBINE.

The Commonwealth Electric Company, of Chicago, U.S.A., has installed during the past year in their Fisk-street station four 9,000-kw. Curtis turbines. In order to obtain reliable information in reference to the economy of these sets, independent engineers were employed to make a series of tests on one of them. These tests were carried out with the greatest care, and the results were repeatedly verified before being accepted as final. The table and curves given below contain the results of these tests, and shows an economy which is believed to be better than that obtained in any previous tests within the same ranges of temperature and pressure, the flatness of the steam-consumption curve over such a large range of load being very remarkable.

Load in kilowatts.	Gauge pressure, lbs.	Vacuum, inches.	Superheat, deg. F.	Steam consumption, lbs. per kw.-hour.
5,374	182	29·43	133	13·15
8,070	197	29·55	116	13·0
10,186	176	29·47	147	12·9
12,108	182	29·34	148	13·05
13,900	198	29·31	140	13·6

Results practically similar to those obtained at Chicago have also been obtained on a 5,000-kw. unit of similar design installed in the station of the Boston Edison Company, and tested on Jan. 29, 1907, the figures being as follows: load, 5,195 kw.; gauge pressure, 174lb.; vacuum, 29·3in.; superheat, 142deg. F.; water rate, 13·52lb. per kilowatt-hour. This difference from the Chicago figures is fully accounted for in the losses of the generator alone.



When reduced to similar conditions, these figures differ by only 0·3lb. from those obtained at Chicago. The Boston tests were verified by three separate runs with different sets of instruments, some of which were specially calibrated for the purpose. These figures appear to demonstrate that the large clearances which are characteristic of the Curtis turbine have no detrimental effect upon its economy. They also show the great overload capacity of these turbines.

THE STARTING, REGULATING, AND STOPPING OF CONTINUOUS-CURRENT MOTORS.*

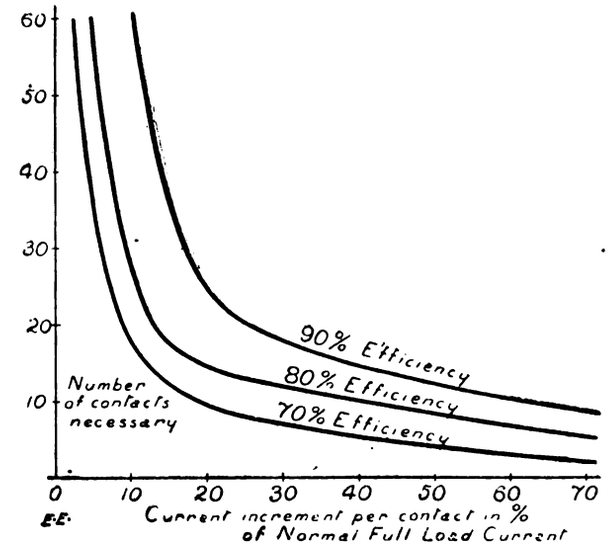
BY JOHN T. MOULD.

"Dynamo and Motor Speed Regulation and Control," which is set down in the syllabus for consideration to-night, is a subject covering a very wide field—too wide, I think, to be adequately dealt with in one short paper. Therefore, I have taken the liberty of narrowing it, and I propose to confine myself to the consideration of "The Starting, Regulating, and Stopping of Continuous-Current Motors." This leaves dynamos and alternating-current machinery out of account, but these can form the subject of a separate paper at some future date, which will ensure for them treatment more worthy of their importance than they could possibly receive to-night.

* Paper read before the Association of Engineers-in-Charge on April 10, 1907.

Starting.—The necessity for the use of some external device to start a direct-current motor arises from the well-known fact that if the motor while at rest were to be connected directly across the lines, and the full current that its internal resistance would permit were to be allowed to flow through it, there would be three very serious dangers: (1) as the conductors in the armature are only designed to carry approximately normal full-load current, there would be a great probability, amounting almost to a certainty, of these conductors being burned out; (2) even if the armature escaped destruction a great amount of current would be wasted, and the voltage of supply would be seriously interfered with owing to the existence for a short time of a practical short-circuit; and (3) the rate of acceleration of the motor would be so violent as to be destructive to the mechanical parts of the motor and probably to the driven machinery.

Practically the only exceptions to this rule are small series-wound motors, in which the initial current is considerably limited by a very high internal resistance, as well as by self-induction, and the tendency to very violent acceleration is diminished by the very intense field produced by the excessive current in the field windings. To reduce the voltage and limit the current, therefore, until the contra E.M.F. has been developed, it is necessary when starting to insert an external resistance in series with the armature, and gradually cut this out as the contra E.M.F. increases. The simplest form of starting resistance is the liquid type. Resistances of this character used to be very extensively used, but have now almost entirely disappeared in the United States and most Continental countries, although in this country many are still employed in connection with large motors, and motors used in crane work and mining work, the principal reason for



No. I.—Curves connecting number of Contacts and Current Increment per Contact for Various Efficiencies (approximate only).

their persistence being their low initial cost. Another good feature of liquid resistances is the perfect curve of the commutation (by which I mean the absence of steps involving arbitrary changes), and also there is, of course, very little liability to sparking.

But liquid resistances possess many disadvantages, among which are prominent: (1) liability of the vessel to be upset and the liquid spilled; (2) loss of the liquid by evaporation and decomposition, with consequent variability of the ohmic value of the resistance, entailing the necessity of constant attention in order to preserve uniformity; (3) a tendency to boil over when subjected to a heavy load, or if enclosed to generate steam, and sometimes to burst; (4) when used until the liquid is hot a noxious vapour may be emitted, which has been known in some cases to overpower the motor attendant; (5) owing to the necessity of frequent inspection and renewal of the electrolyte, the cost of maintenance is high—in fact, if the maintenance and renewal charges are taken into account, the advantage of low initial cost largely disappears.

To provide a more permanent form of starting switch, electricians soon began to use solid resistances divided into sections, each section being connected between steps of a multiple-way switch in such a manner that by moving the switch from step to step the resistance could be gradually cut out. At first very few steps were provided, the maximum number seldom exceeding five or six, even for large motors, but this entailed such large differences of voltage between adjacent steps, and such unequal current increments, that in the early starting switches arcing from step to step was very serious and destructive (Curve No. 1). When voltages of 200, 400, and 500 began to prevail, it was found necessary to increase the number of steps

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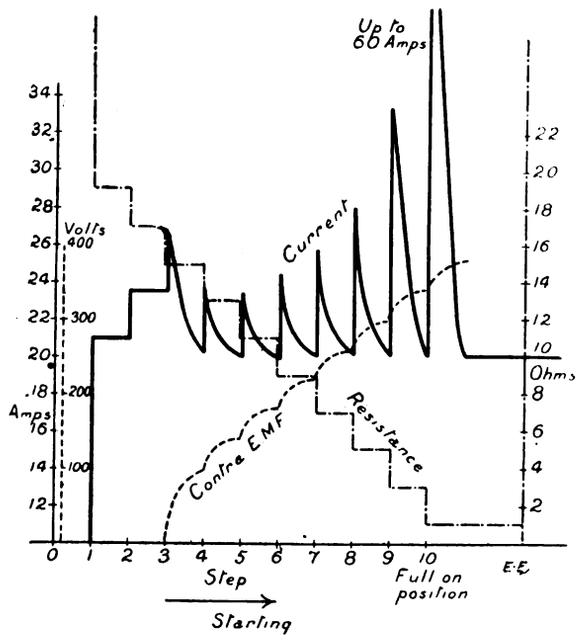
in multiple-way switches of the sliding-contact type. But the number of steps is not the only point demanding consideration in order to avoid destructive sparking. The proper distribution of the resistance between the various steps is of equal, if not greater, importance. In early rheostats the custom was to distribute the resistance equally between all the steps, but this was very unsatisfactory, because it resulted in small voltage differences between some steps with great voltage differences between others, with very unequal increments of current and consequent violent sparking and very uneven acceleration. As an example of this consider a 10-h.p., 400-volt starting switch with, say, 10 steps, and resistance equally divided among all the steps. Assume that the normal full-load current is 20 amperes, the starting current 25 amperes, and the resistance of the armature and brushes one ohm. The resistance of the starter we will assume as being 18 ohms, which, added to the internal resistance of the armature, would limit the current on first step to about 21·05 amperes, or rather more than normal full-load current. Equally divided into nine sections, the ohmic value of each section of resistance would be two ohms. On the first step the motor would not start, therefore the switch would be moved to the second step, thereby reducing the resistance to 17 ohms and increasing the current to about 23·53 amperes. The starting current not yet having been reached, the switch would be moved another step forward, reducing the resistance to 15 ohms and increasing the current to about 26·66 amperes. The motor would now start, and would accelerate until the current had been decreased (by the growth of the contra E.M.F.) to 20 amperes. With this current pass-



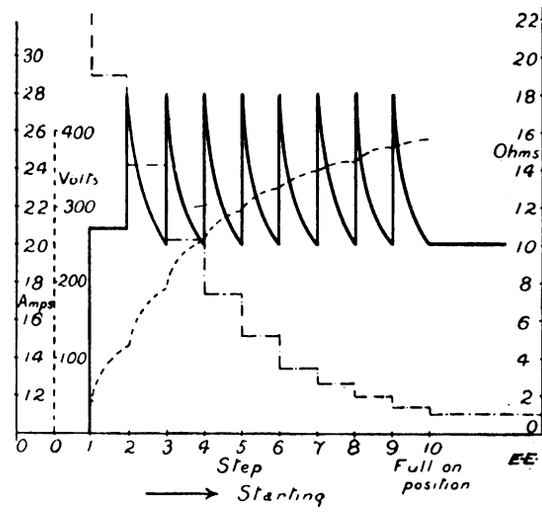
No. 2.—Curves Illustrating the Effect of Equally Distributing the Starting Resistance.

ing 280 volts would be dissipated by the 14 ohms of rheostat resistance, making the pressure at the armature terminals 120 volts. The contra E.M.F. would be 100 volts, leaving a balance of 20 volts to force the 20 amperes of current through the one ohm of internal resistance. Now move the switch to the fourth step, reducing the resistance to 13 ohms, and causing the current to increase to about 23·08 amperes. The motor again accelerates until the current falls to 20 amperes, when 240 volts are dissipated by the 12 ohms of rheostat resistance, the pressure at the armature terminals is 160 volts, and the contra E.M.F. is 140 volts. Moving the switch to the fifth step reduces the resistance to 11 ohms, when the current rises to 23·64 amperes. When the current has again fallen to 20 amperes the contra E.M.F. will be 180 volts. On the sixth step the contra E.M.F. is 220 volts and the pressure at the armature terminals 240 volts, the eight ohms of rheostat resistance having dissipated 160 volts. On the seventh step, with a total resistance of seven ohms, the momentary current will be 25·71 amperes, and when that has again been reduced to 20 amperes the contra E.M.F. is 260 volts, and the pressure at the armature terminals 280 volts, the rheostat resistance having dissipated 120 volts. On the eighth step the total resistance is five ohms, and the momentary current 28 amperes, and when this has been reduced to 20 amperes, the contra E.M.F. is 300 volts and the pressure at the armature terminals 320 volts, the four ohms of rheostat resistance having dissipated 80 volts. On the ninth step, with a total resistance of three ohms, the momentary current will be 33·33 amperes, falling again to 20 amperes. Then the contra E.M.F. will be 340 volts, and the pressure at the armature terminals 360 volts, the rheostat resistance having dissipated 40 volts. On the tenth and last step, the total resistance being the one ohm of internal resistance, the momentary current will be 60 amperes, causing a violent acceleration till the current has again fallen to 20 amperes, when the contra E.M.F. will be 380 volts, and the pressure at the armature terminals 400 volts.

Curve No. 2 shows the movement I have just described. In the arrangement just considered, a considerable spark may be expected always when passing on to the tenth step, which often repeated will have destructive effects. If, instead of equal divisions, the resistance had been divided up into a series of steps such that the total resistance in circuit on successive steps formed a geometrical ratio, the current increments could have been equalised. The following arrangement may be taken as an example:

Step.	Resistance.		Total resis.	Current in amperes.		Volts of C.E.M.F.	
	Rheostat.	Armature.		Initial.	Final.	Initial.	Final.
1	18·00	1·00	19·00	21·05	21·05	—	—
2	13·34	1·00	14·34	27·9	20·00	—	113·2
3	9·28	1·00	10·28	27·9	20·00	113·2	194·4
4	6·37	1·00	7·37	27·9	20·00	194·4	252·6
5	4·28	1·00	5·28	27·9	20·00	252·6	294·4
6	2·78	1·00	3·78	27·9	20·00	294·4	324·4
7	1·71	1·00	2·71	27·9	20·00	324·4	345·8
8	·94	1·000	1·94	27·9	20·00	345·8	361·2
9	·39	1·00	1·39	27·9	20·00	361·2	372·2
10	Nil	1·00	1·00	27·8	20·00	372·2	380·0

Curve No. 3 shows these results graphically. In both the cases just considered it has been assumed that the contact lever would be held on each step until current fell to normal, which is the correct way in starting a motor. The arrangement last



No. 3.—Curves Illustrating a Distribution of Starting Resistancey Designed to secure equal Increments of Current per Step.

described is only put forward as representing a desideratum to be aimed at. In actual practice it would be modified by many considerations, and especially by manufacturing and commercial conditions, which entail the use of standardised resistance units and the reduction of the number of standards to reasonable limits. The following, however, is the resistance table of a standard "Igranic" motor starter:

STANDARD 10-H.P. 400-VOLT MOTOR-STARTING RESISTANCE.

Step.	Ohms of resistance, rheostat
1	18·67
2	12·52
3	8·42
4	5·39
5	3·37
6	2·36
7	1·35
8	·68
9	·34
10	Nil

This shows a fairly close approximation to the theoretical table given above. Sparkless commutation also depends to a very large extent on the size of the contact making and breaking surfaces. The greater the line of contact the smaller will be the tendency to spark. For this reason, circular or button contacts are quite unsuitable for large currents when used in connection with a sliding contact maker. The best form of contact in such cases is a segmental one in which, when contact is first made, it is made along the whole length of the contact brush and the contact step (see Fig. 1). As the result of large experience, the company with which I am connected years ago

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discarded the use of circular contacts for starters rated higher than 50 amperes, and even for quite small motors they have to be frequently started. For very large motors, say from 50 h.p. upwards, it is desirable to reject sliding contacts altogether, and use a form of switch in which contact is made by pressing one surface against another. This makes it possible for contact to be made over the whole ultimate area at the first movement, instead of (as with a sliding contact) making contact at first on an inadequate surface. A switch built on this method is shown in Fig. 2. This entails a more expensive construction, because a number of contact levers are required, but this

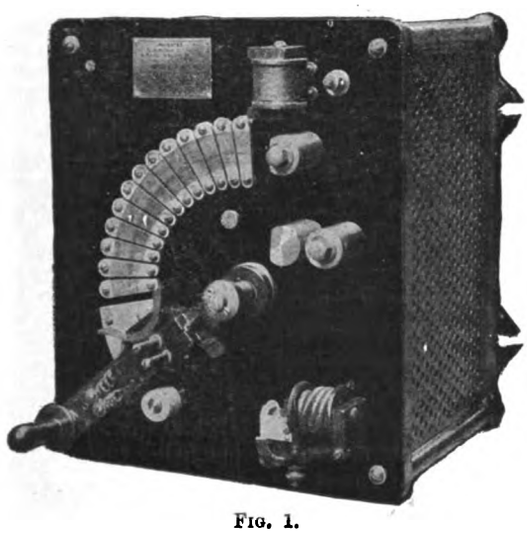


FIG. 1.

additional expense is somewhat modified by the fact that this form of contact permits of greater current increments without disadvantage, and, therefore, fewer stops are required. An essential of sparkless commutation is that the contact surfaces should be large enough to carry quite easily the currents for which they are designed. It has to be remembered that perfect contact cannot always be secured in a movable contact maker, and this has to be allowed for in deciding the current density on the switch contacts (Curve No. 4). For this reason a density of 100 to 130 amperes per square inch cannot wisely be exceeded in rubbing surfaces which have to come into contact by a sliding movement. Where contact is made (as in Fig. 2)

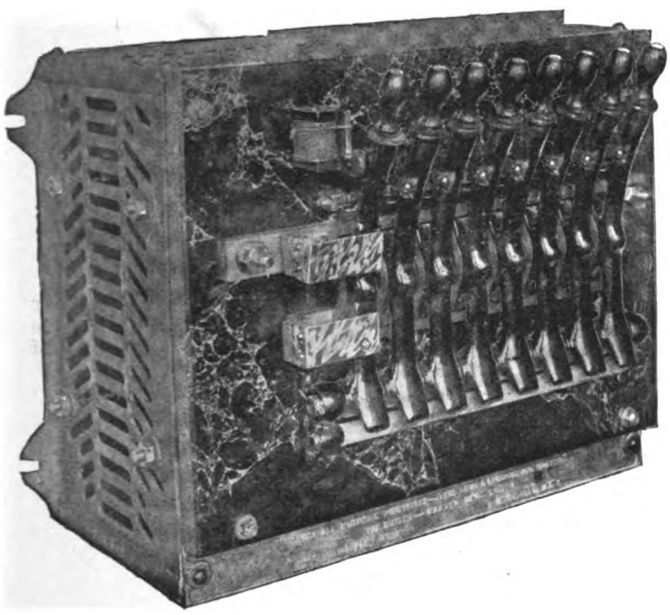
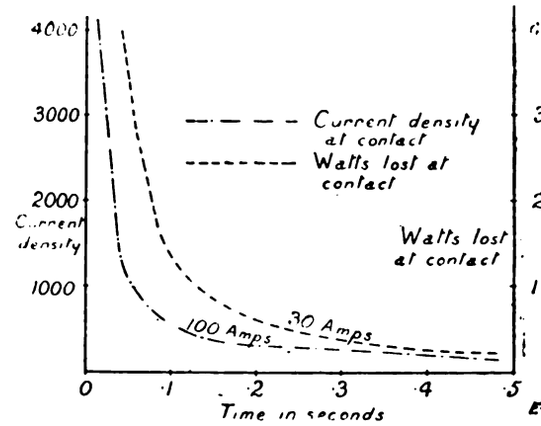


FIG. 2.

by pressing the edges of the leaves of a laminated brush against a hard-rolled metal surface of high conductivity, the density may be increased to 500 amperes per square inch. This is not only because contact over the whole area is secured at the first touch, but also because the laminated brush forms a yielding surface, and it is well known that a contact made by merely pressing together two unyielding surfaces cannot be so efficient as one consisting of a yielding surface pressed against an unyielding one (Curve No. 5).

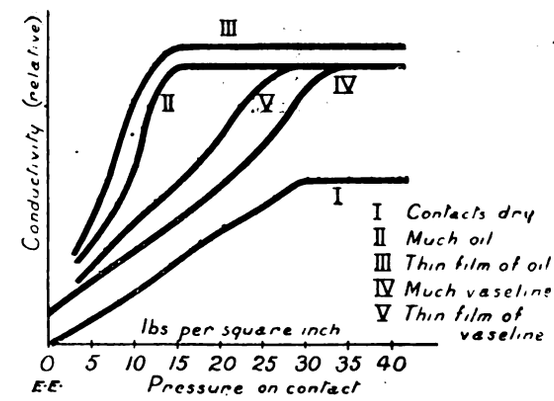
In all the foregoing remarks the assumption has been that the only sparking to be guarded against is what may be expected to occur in starting a motor, and I would like to say here that, as far as possible, starting switches should only be used for starting, and not for opening circuit. The custom of using the starting switch to stop a motor is responsible for much damage to such apparatus, and many a complaint arises of starters proving unsatisfactory, when really the only fault is that they are improperly used. But when a starting switch is equipped with an automatic overload release, it must be made capable of automatically opening the motor circuit, and for this purpose it is advisable that carbon breaking surfaces should be provided on all starters rated for more than, say, 50 amperes. Automatic circuit breaking, however, is not by any means the most severe that a starter has sometimes to undertake. Some machines — notably printing machines — require to be



No. 4.—Curves Connecting the Watts lost and the Current Density of a Brass Contact being moved on to a 1 in. square Contact at 2 ins. per second.

"inched"—*i.e.*, moved round or forward for an inch or two, or, perhaps, only a fraction of an inch — and immediately stopped, and this may be frequently repeated. Opening the circuit under these conditions is likely to produce a very severe arc because the motor has not been allowed to accelerate, and, consequently, the full voltage of the circuit has to be broken instead of only the difference between the line voltage and the contra E.M.F. A starter that has to be used for inching should be, therefore, not only equipped with easily renewable contacts and with carbon breaking surfaces, but also these surfaces should be protected by a magnetic blowout; and when the circuit-breaking lever is to be moved by hand (and may consequently be moved slowly), it is good practice to make the ohmic value of the starting resistance sufficient to considerably reduce the current *before opening circuit*.

A question that often arises, and on which many different opinions are expressed, is the amount of current that should



No. 5.—Curves Showing Relation between Conductivity and Pressure for Smooth Copper Contacts.

be permitted to pass on the first contact. So far as the protection of the motor is concerned, there seems to be no reason why the initial current should be limited to less than is necessary to cause the motor to start, and for this reason it may be considered good practice to build standard starting switches with only sufficient ohmic resistance to limit the initial current to normal full-load amperes. But some starting switches are called upon not only to start the motor, but also to prevent the starting of the motor from causing serious and sudden fluctuations in the load on the supply system, which are always detrimental to close and effective voltage regulation. This is the case particularly in small private installations which are used for lighting as well as for power work, and also in small public networks. In such case the ohmic value of the rheostat resistance must be increased in accordance with the demands of the station engineer. Some station engineers have framed rules

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requiring that the current on first step and subsequent increments shall not exceed 10 amperes, while in a few cases even smaller initial currents have been specified. Most engineers have now learned that the cultivation of the power consumer is a *sine qua non*. With this end in view, their best interests (as also the consumer's) are served by only imposing such restrictions as are essential for safety and making it easy for their customers to adopt standard apparatus, and thereby secure the advantages of cheapness, quick delivery, and ease of repair and of renewal. Generally, therefore, the authorities have found it necessary to be very lenient in the enforcement of such regulations, on account of the expense in which they involve their customers. For it must be remembered that when a large motor is in question, compliance with the 10-ampere rule necessitates a very special starter with a ridiculously large number of contacts, or otherwise very large increments of current (and very improper acceleration) on the later steps. On account of the difficulties and the expense that such restrictions involve, it is good practice to impose them only in cases of absolute necessity, and genarally to pass full-load current on first step.

The rating of starting resistances should depend upon the conditions under which the motor is required to start. Obviously, if a motor is to start light or under a load which permits of rapid acceleration, the rating need not be so liberal as when very considerable inertia is to be overcome or energy is to be stored up, as when starting a machine fitted with a heavy flywheel. Yet some engineers demand an exceedingly liberal rating even for quite ordinary work. The author has often met with cases in which a two minutes' rating at a low temperature rise has been specified for starters which had to start motors that could be accelerated to normal speed in 10 seconds without the starting current exceeding normal full-load current by more than, say, 40 per cent., and in a few cases it has been specified that the resistance must be capable of carrying full-load current continuously on any step without a dangerous increase of temperature. This represents excessive carefulness. Of course, it is eminently safe, but it is also unnecessarily expensive, and would make the standardisation of starters at a commercial price quite impossible. The first question to be decided is the maximum temperature to be allowed, and this, I think, should depend on what maximum temperature may be frequently attained without damaging the resistance material, and also what can be permitted without danger to the surrounding objects. Experiments with wire resistances of various alloys have shown that no change is caused in the character of the wire by frequently heating it to a temperature of 300deg. F., and this is a temperature not likely to damage surrounding objects, provided the resistance is enclosed properly in an incombustible and properly-ventilated case. As to time limit, the majority of motors under ordinary loads can be started and brought to normal speed within 10 seconds without the starting current exceeding 130 per cent. to 140 per cent. of full-load current. Therefore, sufficient margin of safety would appear to be provided by rating the resistance to carry 150 per cent. of full-load current without the temperature exceeding 240deg. F., allowing 20 seconds to start the motor. This rating, of course, is only suggested as being suitable for ordinary standard commercial starters. It would not be suitable for motors starting against heavy inertia loads or that have to start very frequently. For printing machines, for instance, which have to be "inched," a more liberal rating is necessary, but much actual practice has shown that the same current and temperature limit may be maintained if the time limit is increased to 60 seconds.

In starting machines which constitute a flywheel load, it is often necessary to be still more liberal—in fact, to start a loaded hydro-extractor with a current not greater than 150 per cent. of normal, as much as three minutes is often necessary.

The necessity of preventing the motor being damaged by an excessive current, as the result of a temporary interruption of the current supply, has led to the common use of automatic releases. Hardly a starting switch is installed now that does not include a "no-volts" release. This is as it should be, for this device protects the supply system against temporary short-circuits; prevents the motor from being burnt out or seriously damaged after an interruption of supply; and it prevents the starting resistance being burned out through the contact lever being carelessly left in an intermediate position between "off" and "full on," thereby obviating the necessity for providing an expensive resistance rated for continuous service when really only a "starting" rating is necessary. Also if the "no-volt" release coil is placed in series with the shunt field, as it always should be, if possible (and it is generally possible), it prevents the motor being damaged as the result of a rupture of the field circuit. Automatic overload release, although very useful in many cases, is not so universally essential as "no-volts" release. It is, of course, a useful feature in cases where the load ought to be steady, and especially if there be very little margin in the rating of the motor. But for cases in which the starting load is very much in excess of the running load, as in lifts, or where high peaks regularly or frequently recur, as in reciprocating bed printing machines, the ordinary overload device is useless, and may even prove a nuisance, because it has no time-lag feature, but opens circuit immediately the current for which it has been adjusted is exceeded, no matter whether the motor is capable of withstanding such a temporary overload or not. Consequently, in such cases either the adjustment has to be such as to permit of the peak-load current passing continuously in which case the protection afforded is practically nil (and the rating of the motor must be necessarily low as a precaution), or else the machine will be stopped when it ought not to be, with resultant loss of time and annoyance. For those reasons every engineer should carefully consider, before ordering his starting switches to be equipped with overload release, whether such a device is really necessary. Experience has shown that for the majority of printing presses, especially small ones, the protection afforded by properly selected fuses is quite sufficient, and fuses are not likely to give trouble, because, of course, they possess the necessary time-lag feature.

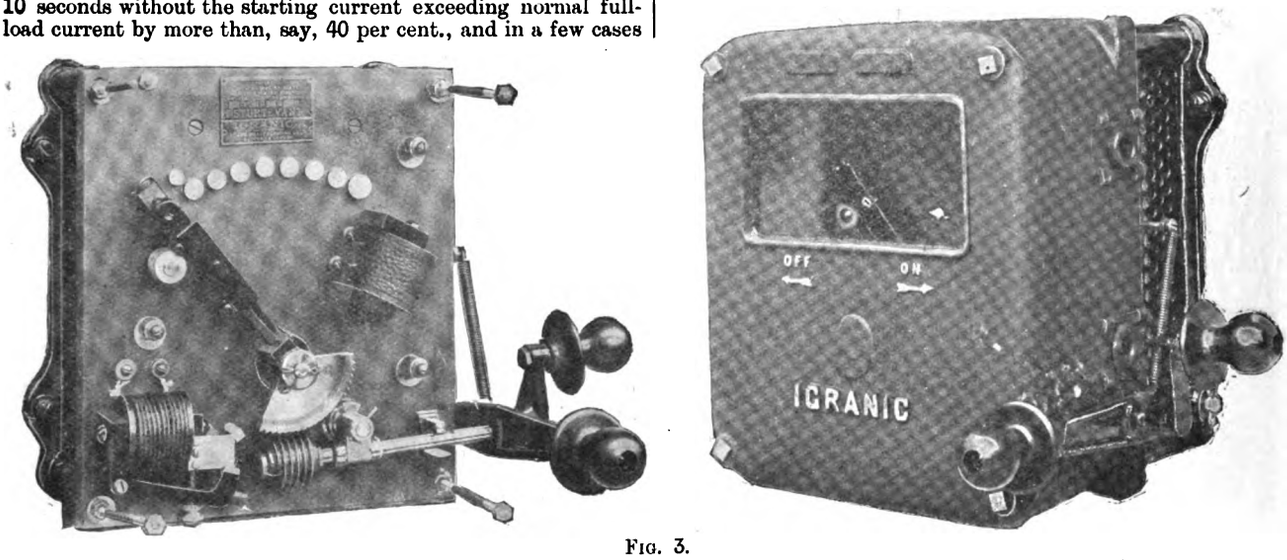

FIG. 3.

But with many irregular loads and high starting currents it is desirable to employ an automatic overload device. Particularly this refers to irregular or greatly varying loads in places where the fuses are accessible to, or have to be replaced by, persons without any technical knowledge, or in the case of elevators in which the normal load to be lifted demands a starting current which, while not dangerous as a starting current, would be injurious if continued as a running current and where it is, nevertheless, possible for anybody to convert it into a running current by putting too heavy a load into the car. For such cases the overload release employed should be designed so that it will discriminate between slight and serious excesses, and also between temporary and continuous overloads. This is very easily done either electrically or mechanically. The electrical method (which is covered by a patent owned by the Adams Manufacturing Company) is to place a resistance in parallel with the overload release coil, so that the main current is divided between two paths—one through the coil, and the other through the parallel resistance. The resistance of the magnet coil is so proportioned in relation to that of the parallel path that the portion of the maximum working current which is shunted through the magnet coil will not excite it sufficiently to cause it to operate to open circuit, but the material used for the parallel resistance must be one

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in which a rise of temperature causes a corresponding increase of resistance. Consequently, when as the result of an overload its temperature increases, its ohmic relation to the magnet coil is changed, so that a larger proportion of current is shunted through the latter, causing it to operate and open circuit. In the case of slight overloads this change will not occur until some period has elapsed, but if the overload is considerable it will take place quickly, while anything approaching a short-circuit will cause the circuit to be opened immediately. The flexibility of the method just described can be considerably increased by providing, in addition to the parallel resistance, a resistance in series with the overload magnet coil, composed of such a material as carbon, the ohmic value of which decreases as the temperature increases. By this means two processes are utilised at once—viz., a tendency towards a decrease of current in the parallel resistance simultaneously with a tendency towards an increase of current in the magnet coil. This electrical time limit has proved exceedingly reliable in practice, and has the great advantage of permanence after it has once been adjusted.

The mechanical time lag, which has recently been patented by Mr. J. G. Statter, consists of a plunger which carries a smoothed-faced disc, which in its normal position rests against a second smooth surface and acts as a sucker. The overload circuit breaker in order to open must pull these two surfaces apart. The time taken to do this will depend upon the force exerted in pulling, and will, consequently, bear a fixed relation to the value of the current in the overload magnet coil. In order to avoid the necessity of making an absolutely accurate fit between the disc and the other surface, Mr. Statter places the disc in a vessel containing some glycerine or other viscous substance, and to exclude dust generally closes the vessel. This seems a fairly good method, but apparently it would

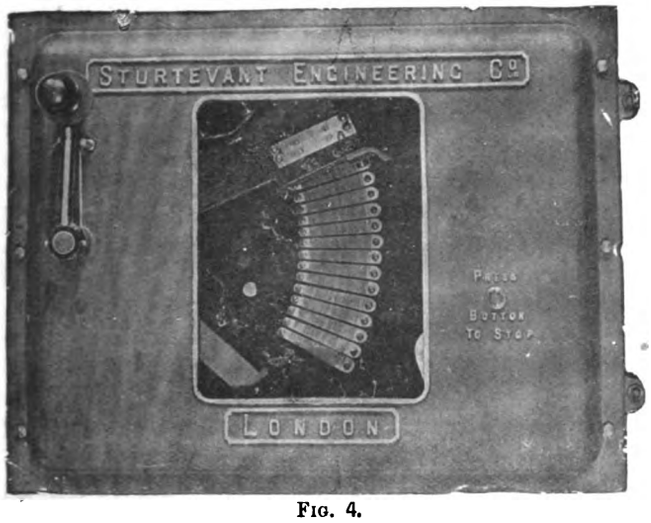

FIG. 4.

require more or less attention in order to keep it in a condition in which its operation will be uniformly reliable. There are two well-known types of overload device, either of which may be, if desired, equipped with the time-limit features just described. In one the overload magnet, when brought into action by an overload, makes contact to short-circuit or open the circuit of a magnet which has previously been holding the circuit-maintaining switch in a closed position in opposition to a spring or gravity. In the other the overload magnet is used either to trip a mechanical detent and allow a spring or gravity to open the switch, or else it is used to actually force open a switch which is normally held closed by a spring or gravity. Which of these two is preferable depends largely upon the circumstances of individual cases, but it is advisable to avoid mechanical detents wherever possible on account of their liability to become inoperative as the result of rust or dirt, especially if they are seldom called upon to operate. I propose, however, to show illustrations of both types mentioned.

In addition to automatic no-volt and overload releases, various other safety devices are sometimes added to starting switches, a very common one being intended to prevent the starting resistance being cut out too quickly. For this purpose, dash-pots and ratchet and worm gears are ordinarily used. The dash-pot is simple and cheap, but obviously requires some attention, wherefore the ratchet or worm gear may be considered the most permanently reliable. The illustration (Fig. 3) shows a worm gear which requires both hands to operate it, and which falls out of gear when the hands are removed, and so does not interfere with the action of the automatic releases. But automatic features may be added until the switch is absolutely fool-proof, by which I mean that it cannot be operated so as to cause damage even if used by ignorant, careless, or malicious people. Such an one is illustrated below (Fig. 4), and is the subject of a patent by Mr. A. H. Adams and the writer. This depends entirely upon electrical devices for its safety features, and it has proved quite reliable and satisfactory in use, as has also one of a mechanical character which was invented and patented by Mr. Frank Broadbent, and which is also here illustrated (Fig. 5). These elaborate pieces of apparatus, however, must necessarily be expensive, and some people consider it better to educate the

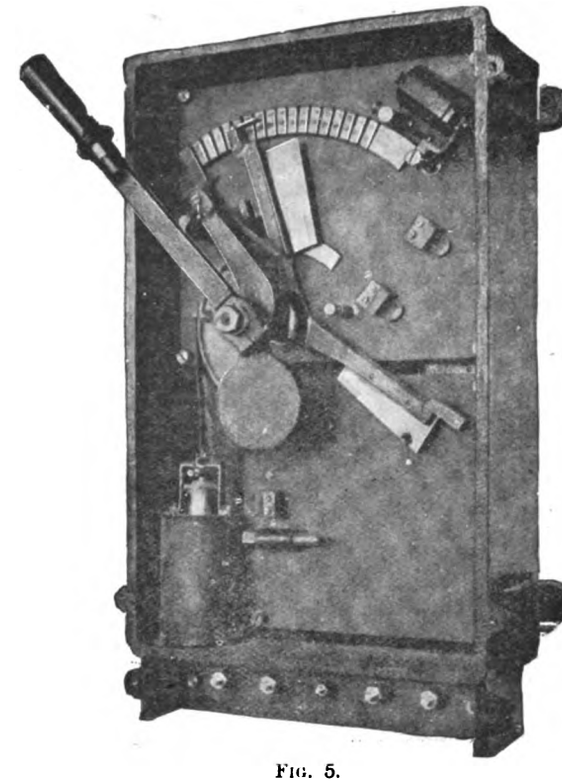

FIG. 5.

operator to a proper use of plain starting switches rather than attempt, by automatic safety devices, to remove responsibility from his shoulders. My own opinion is that there must be very many cases in which the wages bill could be very considerably reduced by the use of fool-proof starters, and when the saving that can be thus effected exceeds, even slightly, the interest on the additional initial expenditure, it would seem that the use of

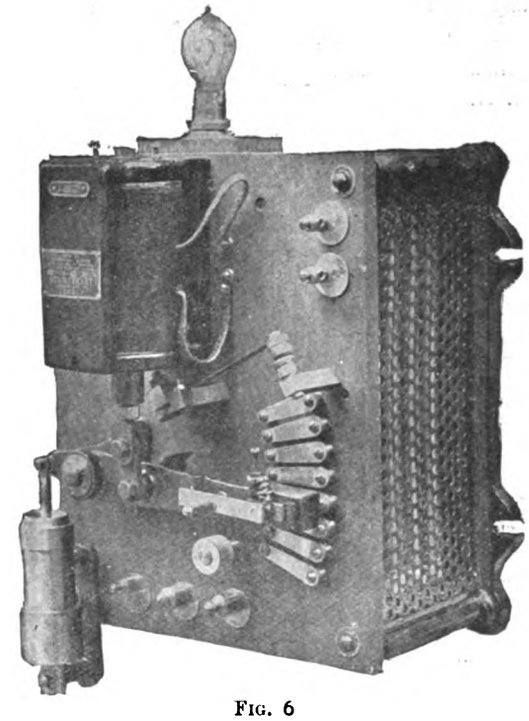

FIG. 6

such safety starters is justified, for the liability to accident and damage is certainly much decreased. Automatic or self-starting switches, such as illustrated by Fig. 6, are now very largely used for automatic control of pumps, air-compressors, hydraulic accumulators, lifts, etc., and as they are practically fool-proof and permit of unlimited "inching," they are being increasingly used for starting printing machines.

(To be continued.)

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WIRELESS TELEGRAPHY.

That international convention is causing a lot of unhappiness. Mr. Henniker Heaton suggests that the convention be not ratified, and the Postmaster-General, in reply, says that, with the exception of those representing the Marconi system and Mr. Henniker Heaton before the Select Committee, "every witness expressly favoured ratification." Well, could you have expected anything different? The Marconi Company, so far as an outsider can see, is the only unit that has anything to lose; all the rest have something to gain, and that gain must be at the expense of the Marconi Company. There have been various periods in English history when spoliation of something or somebody was the order of the day, and it is difficult to believe that the spoliators were not in favour of spoliation. The history of wireless telegraphy is simple, and within a period of time that many of us can well remember. It is customary to start with the late Clerk Maxwell's theories, then to go to those magnificent experiments of Hertz whereby theory was shown to be practically correct. These, however, were researches in pure science, and the applied science had to be developed by Marconi. He it was who came along with the first practical system to be commercially tried in the interests of the world. We cannot tell—it does not much matter—whether the other workers in the field of practice were urged on to work by the success of Marconi, or worked without a knowledge of what he was doing and perfectly independently. The fact remains that he and his financial backers were again first in the field with installations. Naturally, the business men finding the money to exploit an essentially new departure tried to make agreements so binding as under all conceivable circumstances to protect their interests. These agreements in the course of developments seemed to weigh somewhat heavily against the success of followers and imitators in the field. The latter found that to a large extent their efforts to obtain installations and to sell apparatus had been forestalled by the energy and enterprise of the Marconi Company. Politics came in, and an attempt has been made—successfully if this convention is signed, as it is certain to be—to interfere with the ordinary course of business. We admit the power of politics, but from the time of Assyria onwards, through the history of every great nation, politics have done more harm than good. Yet politics go on, scarcely or never troubling about what is right, but under the control of what is deemed to be expedient by the powers acting at the moment. This convention, if we read it aright, is just the outcome of political expediency. It is a farcical way of attaining objects that ought to have been secured in another manner. A circular we have received tells us: "Its principal objects are to regulate wireless telegraphy so as to make it more useful for defence and general communication, and to provide against the growth of a monopoly in the hands of one company." The former object may go; it is put to save the face. The latter is material. Here are civilised nations acclaiming an inventor taking his money for patents, to protect those inventions as a monopoly through a course of years. As soon as those patents have by energy and enterprise secured a good hold, and bring or are about to bring in large remuneration, so soon the Governments stultify themselves and say, 'tis for the good of the general community. The Governments primarily concerned knew as well in the earliest days of wireless telegraphy as they do now what its advantages would be if its application was successful. They could have as well then as now have devised rules and regulations if the expediency for these was so great. They knew then as well as now that standing aloof forced private enterprise to develop, and

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that private enterprise in this case must busy itself in all lands where ships come and go. The one great opening for wireless was from ship to shore and *vice versâ*. They knew from what scientific men told them that competition could not proceed as in the case of grocers' shops, that the circumambient æther was a vehicle which, harnessed too much by wave radiation within fairly definite areas, would allow of mutual interference and spoil good signalling. Yet private enterprise was allowed to proceed, to establish installations, to prove value, and generally to solve that particular problem of communication at a distance which the invention purported to solve. Then came this convention. Generous treatment is provided for the pioneers if the convention is found to have trespassed upon their due reward, but we think that, carefully considered, it savours more of political expediency than of any real desire to benefit the work. It will benefit certain powerful interests—hence the convention.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TELEPHONE TARIFFS.

SIR,—In your issue of the 19th inst. a letter from Mr. H. L. Webb attacks me at considerable length for my advocacy of reasonable telephone tariffs, and after making various statements about municipal telephone systems which are at variance with fact, and, therefore, incapable of proof, proceeds to extenuate and justify the recently-imposed tariffs of the Post Office and National Telephone Company, which, if submitted to, will have the effect of doubling—or possibly even trebling—the cost of telephonic communication to all but the smallest users, thereby creating a fresh tax on industry and still further handicapping our commercial community in their uphill struggle with foreign competitors, whose Governments are wise enough to foster intercommunication instead of hampering it, as is obviously the fixed intention of our present Free-Tradeocracy. If Mr. Webb had had the candour to subscribe himself an employé of the National Telephone Company—as he really is—your readers would have been in a better position to estimate the value of his arguments; as it is, he must be regarded as the mouthpiece of monopoly posing as an independent observer. That in this capacity he will succeed in selling the commercial public a gross of green spectacles with silver rims and shagreen cases complete is inconceivable, unless that public prove as innocent and credulous as little Moses Primrose.

Mr. Webb's misstatements about the municipal telephone systems are stock ones, and have been exposed full many times and oft; they will be repeated, nevertheless, unless the matter is set at rest by a proper inquiry—by Select Committee or otherwise. Such an inquiry the Post Office and the National Telephone Company cannot by any means view with equanimity, and will use every effort to prevent. But it is to be hoped that the chambers of commerce will insist upon means being taken to ascertain the truth. Such an inquiry would establish:

1. That unlimited service can be given at a profit at exclusive rates of from £5 to £6. 6s. per annum, cheap measured rates being at the same time provided for small users.

2. That subscribers to municipal exchanges are, as a rule, satisfied with the service they get. No subscribers of the Post Office or the National Telephone Company have ever been known to express themselves similarly, their rôles being invariably those of grumbler and complainer. It has been reserved to the Corporations of Brighton, Swansea, and Guernsey to produce a telephone service acceptable to all, both as regards cost and efficiency.

3. That the instruments used by the municipalities are more convenient and efficient than those of the Post Office.

4. That the sale of several of the municipal systems has had nothing to do with insufficiency of tariffs imposed. Briefly the reason is the hostile attitude of the Post Office and Local Government Board, in face of which several corporations have found it impossible to proceed. With your permission I will enter into the details of this in another letter, as I cannot cumber your space with an explanation at the present moment.

I am no supporter of municipal trading in the concrete, and advocated municipal telephones simply because they offered the only possible means of evading the oppressive monopoly of the telephone ring. In this view I was supported by the late Mr. Hanbury, an earnest Conservative, and by the Government of the day, but was opposed then, since, and always by the Post Office officials, who have never yet been known to be right on any matter relating to telephones. If the municipalities are now allowed to render an account of their stewardship, which they can do without shame or regret, the success of the policy I advocated would certainly be established. The spread of municipal telephones I do not regard as possible, simply because the municipalities cannot trust Post Office promises or good faith; but I do contend that what is possible in the way of efficiency and economy on the part of a municipality ought to be capable of repetition by a Government department

I have some right to speak on the subject. Had it not been for my earnest advocacy of free telephones between the years 1890 and 1898, the present Post Office London exchange would never have existed. The Select Committee of 1898 declared competition in London to be necessary, and the Post Office undertook it in order to keep out the Corporation of London and the London County Council, who were then willing to accept licences, and who would have inaugurated a real competition instead of the delusion and sham which the Post Office have imposed on the Metropolis. Matters are now so ruled that people in some parts of London cannot obtain a telephone service at any price; the instruments used are old-fashioned, inconvenient, and inefficient, while the bulk of telephone manufacturing work is forced out of the country. The Post Office took up the London telephone service for the express purpose of stopping reform, and in this object they have certainly succeeded.—Yours, etc.,

A. R. BENNETT.

NEW DEVELOPMENTS IN ARC LAMPS AND HIGH-EFFICIENCY ELECTRODES.*

BY GEORGE M. LITTLE.

Arcs for lighting may be formed between electrodes of many different kinds. This paper deals with the development of the so-called magnetite electrodes and of a lamp suitable for burning them. A few points of comparison between these metallic-oxide electrodes and carbon electrodes will be considered, and some of the many interesting advantages possessed by the metallic-oxide electrodes and lamp will be touched on. Among these are the long life, high efficiency, and good distribution and colour of light. The magnetite electrodes were so named because magnetite is usually one of the constituents of the negative or cathode, but it would be more satisfactory to call them *metallic-oxide* electrodes, as, in addition to the magnetite, there are always at least two other oxides present—namely, oxide of titanium and oxide of chromium. These electrodes are made in a very different manner from the carbon electrodes. As is well known, the latter are squirted or modelled from a plastic mixture, and are baked, the carbon furnishing sufficient mechanical strength and electrical conductivity. A metallic-oxide electrode cannot be made this way, for it is a familiar fact that a fine powder is a poor conductor, no matter of what it is composed, and as these electrodes are made for the most part from finely-powdered oxides, it is evident that a conducting binder or a conducting case would have to be used. In practice the mixture of oxides is tamped into a thin iron tube, and the end sealed in an arc. The oxides have distinct and separate reasons for their presence. The

* Paper read before the National Electric Light Association, New York.

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titanium oxide has the property of rendering the arc luminous, and it may be here noted that the metallic-oxide arc is a flame arc, the light not coming from a crater as with carbons. The oxide of iron gives conductivity to the fused mixture when cold, the other oxides being conductors only when hot. The oxide of chromium prevents a too rapid consumption, so that by its use an electrode may be given a very long life. The positive or anode used with these metallic-oxide negatives is generally a metal, and is consumed much more slowly than the negative. This is contrary to what would be expected, judging by the action of carbon electrodes.

There are a number of advantages possessed by the metallic arc over the carbon arc. In the first place, the efficiency is much better—that is, a metallic arc lamp operating on a four-ampere current with approximately 65 to 70 volts at the arc will give a light equal or superior to that of a 6·6-ampere, 75-volt, direct-current, enclosed-carbon arc lamp. The distribution of light is far better. This is owing to the fact that in the enclosed-carbon arc practically all the light comes from the crater on the flat under-surface of the upper electrode, most of it being thrown down and not serving to illuminate the street between lamps. The light from the carbon arc itself is weak and of a blue colour. This is very pronounced at times, especially if the flat under-surface of the upper electrode is somewhat inclined, thus hiding the crater. In the case of the metallic-oxide electrodes, the arc is itself the source of light, practically none coming from the crater, except by reflection. The metallic arc is much like a candle flame, having its luminous and non-luminous zones. The light is brightest near that end of the arc which is next to the negative electrode, and comes from a hollow

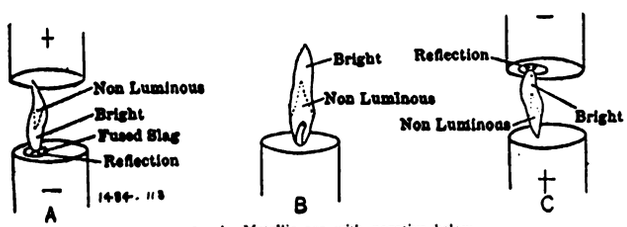

FIG. 1 A—Metallic arc with negative below
B—Candle flame.
C—Metallic arc with negative above.

cone-shaped mantle of volatilised oxide of titanium rendered incandescent by the heat of the arc, just as in the candle flame the light comes from a hollow cone-shaped mantle of carbon particles made white hot by the heat of the flame.

The voltage required to maintain a metallic arc is less than that of an enclosed-carbon arc. It is a familiar fact that an enclosed-carbon lamp will not burn properly with the arc voltage down to 65, while a metallic arc will burn well at less than 55. Metallic arcs are adjusted to burn at from 65 to 75 volts in different cases, while the carbon arcs are all set at 80. This is a very evident advantage in favour of the metallic arc, as more lamps may be put on a circuit without raising the voltage on the line. The life of carbon electrodes, as a rule, is not over 150 hours, while the metallic-oxide electrodes can go considerably longer The uniform white colour of the metallic arc is in marked contrast to the changeable blue and white of the enclosed-carbon arc. As the metallic-oxide electrodes are not burned "enclosed," there is no inner globe required on the lamp. While it looked easy to secure all of these advantages, many difficulties appeared, but they have now practically all been overcome. In the first experiments the electrodes were trimmed with the anode or positive above, and the negative or metallic-oxide electrode below, just as carbon lamps are trimmed, but a number of troubles presented themselves:

1. The bright portion of the arc was near the surface of the lower electrode, which cast a large shadow.

2. The light reflected from the brilliant surface of the fused slag on the lower electrode was thrown upward, and could only be partly saved by using a reflector.

3. An under-feed mechanism was seen to be necessary, as, contrary to the action of carbon electrodes, the negative metallic-oxide electrode is the more rapidly consumed.

4. Only a comparatively short metallic-oxide electrode could be used, as a long one would necessitate the use of an unwieldy long glass globe. This would limit the life, and could only be met by adopting a negative electrode of large diameter, which it is evident would be undesirable.

5. A particularly undesirable feature was the gathering of a large amount of reddish soot that would collect in spongy masses around the electrodes, obscuring the light.

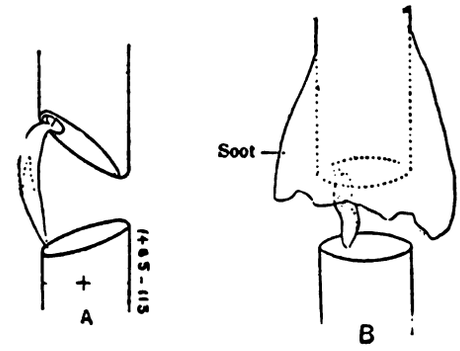

FIG 2

A—SHOWING HOW THE ENDS OF CARBONS WASTED AWAY TO A BEVEL BEFORE USING THE DOWN-DRAFT OF AIR.

B—SHOWING ACCUMULATION OF SPONGE-LIKE MASSES OF SOOT BEFORE USING THE DOWN-DRAFT OF AIR.

This had to be removed by some mechanical means, such as scraping or shaking it off, and some receptacle other than the glass globe had to be provided to catch it.

6. The negative or metallic electrode was seen to burn to a blunt taper point, causing the arc to be very unsteady, as it tended to leave the end and run up the side in the manner of the carbon arc when flaming.

As noted above, the bright portion of the metallic arc is located near the surface of the negative electrode, and it was seen to be very desirable to burn the electrodes with the negative above, thus getting the bright portion of the arc in such a position that the shadow thrown down would

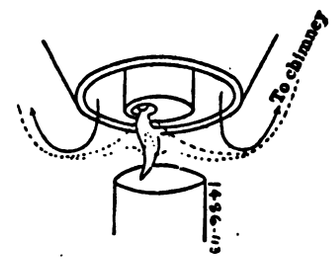

FIG 3.—THE DOWN-DRAFT OF AIR FORCES THE SOOT TO TAKE THE PATH SHOWN BY THE DOTTED LINE, EFFECTUALLY KEEPING IT FROM TOUCHING OR DEPOSITING ON ANYTHING.

be less, and that the light reflected from the brilliant surface of the fused pool of slag on the negative electrode would be thrown down and utilised instead of being thrown upward and wasted. The other advantages noted above possessed by the carbon lamp would be retained if this inverted position of the electrodes could be made practical.

The first attempt to burn the metallic-oxide electrode above and the metallic electrode below showed that there were serious obstacles to be overcome before it could become a practical method. In the first place, the electrode would not keep a square end, but would waste away on one side, and the arc would run up this bevel, or slope, giving a very unsteady light. In the second place, the volatilised oxides of iron, chromium, titanium, and so forth, would condense on the sides of the electrodes and hang down as a fringe or curtain, hiding the light.

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The first means taken to overcome these troubles was the introduction of a rotating draught of air around the arc. This had the effect of forcing the arc to hold to a central position, stopped the crooked burning, and steadied the light, but did not take care of the fumes. Attempts to blow the fumes away sidewise gave only partial success. Finally, a current of air was directed down around the arc, and this gave excellent results. The electrode burned perfectly square, and the clean layer of air prevented any gathering of fumes. This was a very marked advance, as this did away with any need for a mechanical scraper or shaker, the soot practically all passing out of the chimney, and not requiring to be caught in any receptacle, the globe remaining clean.

When burning metallic-oxide electrodes with the metallic-oxide stick below, copper was used as an anode with fair

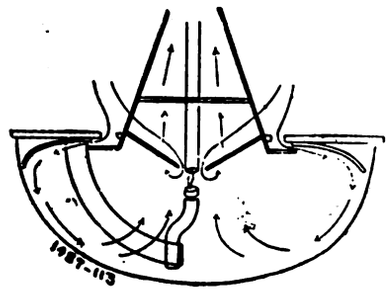

FIG. 4.—PATH TAKEN BY AIR CURRENTS IN LAMP.

results. On reversing the position of the electrodes, it was found that the new conditions made it possible to improve on the action of a pure copper anode, and a number of changes were accordingly made. If the first place, if the arc plays for a time on pure copper, it will oxidise the surface. This oxide will fuse to a slag that becomes an insulator when cold, and on starting a cold lamp it is necessary to strike the electrodes together hard enough to break through the slag. To strike such a hard blow is undesirable, as if it is done while the lamp is burning—for example, when feeding—it is liable to spatter the fused slag out on to the glass globe. A simple remedy for this consisted in using an anode containing metals or alloys whose oxides, when fused together, would make a slag that is a good conductor when cold. The steadiness of the

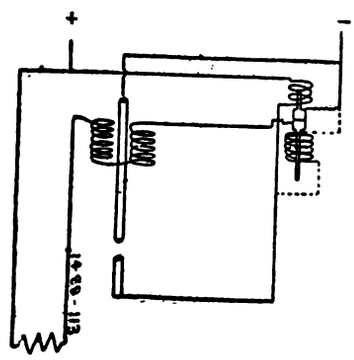

FIG. 5.—DIAGRAM OF CONNECTIONS.

light largely depends on the composition of the slag, its uniformity, and temperature. The anode surface is at all times covered with this slag, which slowly dissolves the metal and is itself slowly volatilised. If the arc plays on bare metal it consumes it rapidly, and it was found desirable to secure this slag cover from being knocked off. This was accomplished by providing a rough surface for it to cling to, and by running the entire anode tip very hot.

A characteristic property of the metallic arc has been a very noticeable dying-down or dimming of the light, which would occur at irregular intervals, especially after the electrodes had burned for 20 hours or more. These dim spells would last from a few seconds to two or three minutes, when the normal brilliancy would return. This is explained as follows: In the metallic arc, the brilliancy is largely due to the presence of volatilised oxide of titanium, and anything that interferes with the uniform evolution of vaporus of titanium will cause the light to dim—for example, the presence of a high percentage of highly infusible oxide of chromium. This oxide of chromium is volatilised at a slower rate than the oxides of titanium and iron, and after the electrode has been burning some 20 hours the slag on the end of the cathode has become very rich in oxide of chromium, which forms a film on the surface of the fused pool of oxides. When the film is not present there is a plentiful evolution of oxides of iron and titanium, and there is a bright arc. The oxide of chromium can be seen to gather on and finally entirely cover the surface of the pool. This stops the evaporation of titanium and iron, and the light turns to a bluish colour and dies down until the chromium film is burned away again. This trouble was met by modifying the mixture in such a way that the oxide of chromium could not separate from the oxides of iron and titanium, thus doing away with the film on the surface and entirely doing away with the dim spells.

In carbon lamps there was very little done to keep the impurities volatilised from the carbons from depositing on the globe. This trouble had to be met by the carbon manufacturers, who were prodded up to produce carbons containing less than 0·2 per cent. of impurities, but this means was not to be considered in the case of the metallic-arc lamp. The metallic-arc electrodes, being chiefly composed of oxides of iron, titanium, and chromium, do not burn away to an invisible gas, as does a carbon stick, but are volatilised bodily, and the vapours instantly condense on leaving the arc to a fluffy reddish soot that settles on everything it touches, so that a chimney is a very necessary feature in the lamp. This soot, if it comes in contact with the reflector or globe, will smudge them badly in 10 minutes. As was noted before, a current of air flowing down round the electrode served admirably to keep it clean, so it was applied to the reflector and globe with gratifying results. A thin layer of air is introduced at the top of the reflector, and forms a shield through which the soot laden air cannot penetrate, so that the reflector and globe will keep clean for a long time.

As the air currents play such an important part in this lamp, it became necessary to do a large amount of experimental work on the design of an air intake and of a chimney top. The chimney could not be made long enough to cause a very powerful draught, so the wind was very apt to blow down it; but by persistent effort the openings have been so designed that the wind may blow from any direction (up, down, or sidewise), and the only effect is to increase the natural draught in the lamp. Incidentally, the increasing of this draught actually centres the arc and holds it remarkably quiet.

It was found advisable to run the lamp at four amperes and 65 to 68 volts at the arc with a cut-out set at 85. This low cut-out was made possible by the inverted position of the electrodes and by the peculiar arrangement of the air draught, which prevented any tendency of the arc to flame or to run up the side of the electrode. Without these features a cut-out of 100 to 110 volts would be necessary. As the power factor at which the lamps operate depends largely on the amount of variation of voltage in the arc, this 85-volt cut-out is seen to be very desirable. In actual service the lamps, including a mercury arc rectifier, run very well at from 65 to 70 per cent. power factor.

In several places above we have described special conditions that must be obtained for getting the best results with these electrodes, and these conditions, of course, must be supplied by the lamp in which they are burned. An example of a lamp well adapted for this service is here shown. A study of its design and construction will show that it is simple and rugged, as no float feed is used, it being necessary only to strike an arc and hold the electrode in a permanent position until, due to change in voltage, the cut-out causes the restriking of the arc. The lamp consists essentially of a base and top, connected by a chimney, a set of magnets for striking the arc, a shunt cut-out for causing the lamp to feed due to rise in voltage, and a series cut-out for disconnecting the striking magnets after the arc has been formed.

The special conditions described with regard to draughts are obtained as seen here by the down-draught tube, which

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directs the current of air down around the electrode, another current of air over the reflector and circling around the globe, forming a means of protection to them, and a special construction of top and case for giving proper draught conditions when under all conditions of wind.

McCULLOCH'S PATENT IMPROVED PISTONS AND PISTON RINGS.

The many disadvantages connected with all kinds of packed pistons and piston valves, and the great difficulty of adjusting the same to keep the fluid or liquid getting at the back of piston rings, and so putting on enormous pressure and friction against the walls of the cylinder, is

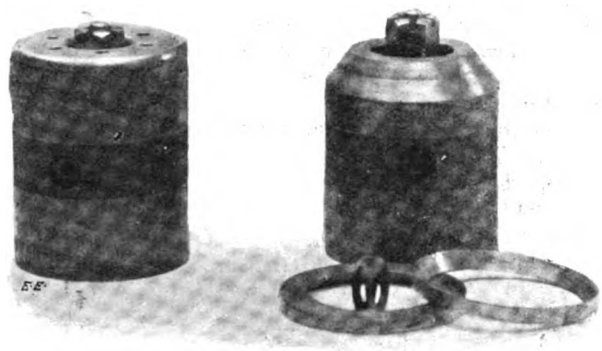

FIG. 1.

recognised by most engineers, so much so that some adopt piston valves without any packing rings, at a sacrifice of loss of power through leakage and having to scrap the valves when worn. To get over the latter several devices have been brought out—such as "limited rings"—but although they may get over the excessive friction the leakage remains, as they are not self-adjusting. Mr. McCulloch's improved piston rings are designed to overcome these defects in the following way. As seen in the illustrations, the back of the improved rings are conical-fitting, fluid-tight on corresponding conical faces formed

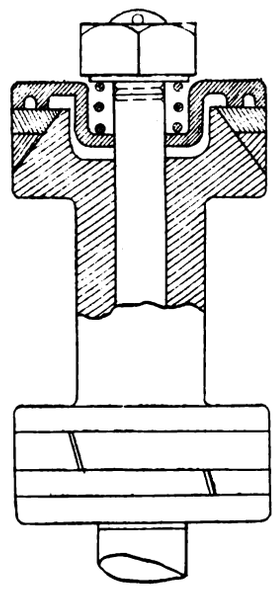

FIG. 2.

on the piston, which prevents any possible pressure getting at the back of the rings. The slight wear of the rings against the walls of the cylinder is automatically taken up by a spring; moreover, the spring keeps the rings butting together, and the rings being fluid-tight against the walls of the cylinder and on the cone of the piston, no pressure can possibly leak through the open split joint of the rings.

Fig. 1 represents a motorcar piston, and it will be seen that, besides the advantages already described, the rings can be easily and readily fixed without distortion to the rings, which rings in trunk pistons are subjected to through having to be sprung over the flanges of the grooves; and, moreover, the improved rings can be turned exactly to the bore of the cylinder and afterwards split, and as they wear the split getting wider does not in any way affect them as it does other rings, this considerably increases the life of the rings. It has been found in actual work the improved rings increase the power of the motorcar, through the minimum of friction being obtained against the walls of the cylinder and a better compression maintained through all leakage being perfectly sealed. Fig. 2 represents a piston valve with the improved rings, from which it will be clearly seen that the rings are entirely free from

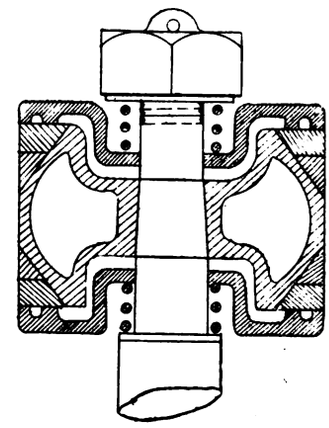

FIG. 3.

collapsing at the highest of pressure thrown on same when working over ports. Fig. 3 represents a steam or water piston. It will be noted that no tongue-piece or junk ring is necessary, and for water pistons the wearing of the sides of the usual ring grooves is entirely avoided, thereby enabling water pistons to be most advantageously used for pumps and the like.

MANCHESTER CORPORATION ACCOUNTS.

Electricity Department.

The report of the Electricity Committee for the year ended March 31, 1907, has now been presented to the City Council. The capital outlay on the undertaking, which includes Manchester, Levenshulme, Heaton Norris, Gorton, and Denton, shows a total at March 31, 1907, of £2,338,373, and the gross profit on the year's working amounts to £161,744, from which, after deducting various items such as for the payment of interest on mortgage debt, loan and allotment to sinking fund, there is net surplus of £26,267. The following statement summarises the revenue account table:

Dr. *Expenditure.*	£	s.	d.
Generation and electricity — Dickinson-street station	21,126	0	10
Bloom-street station	17,844	17	2
Stuart-street station	39,739	19	11
Distribution of electricity	28,258	9	4
Rents, rates, and taxes	27,100	11	5
Management expenses	9,393	2	4
Law and parliamentary charges	14	17	7
Special charges	1,157	5	2
Written off as bad debts	165	9	10
	£144,800	13	7
Renewals suspense account	40,000	0	0
Balance to net revenue account	161,744	8	11
	£346,545	2	6

Cr. *Income.*	£	s.	d.
Sales of current—Private lighting supplies	171,199	0	0
Power and heating	40,870	19	6
Traction supplies	130,001	16	5
Street lighting supplies	814	16	10
Rental of meters	390	17	9
Rental of motors	2,635	6	3
Cottage rental	129	17	6
Warehouse rental	502	8	3
	£346,545	2	6

Of the gross surplus, £40,000 has been contributed to renewals suspense account. This account amounted to £74,590 at the beginning of the year, but certain abnormal expenditure, totalling £13,978, on discarded plant and mains having been debited during the

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year, the account only shows a net increase of £26,022, leaving a total balance at March 31, 1907, of £100,612. There has been allotted to the sinking fund £64,045, for the payment of interest on mortgage debt £65,958, while £5,474 has been repaid as an instalment of loan to Public Works Commissioners. Out of the net surplus of £26,267, the sum of £2,352 has been appropriated for extension of works, for which borrowing powers cannot be obtained, and the balance, £23,915, has been carried to the reserve fund. This fund at the beginning of the financial year stood at £34,836. During the year there has been charged to it the sum of £6,402 for expenditure in respect of vibration at Dickinson-street station, and in respect of the Fountain-street and Victoria-street explosions. From the account there has also been transferred the cost, £47,122, of the warehouse property in Dickinson-street and Bloom-street, the transfer being due to the fact that the purchases were an application of the reserve fund, and not an investment permitted by the Manchester Provisional Order. On the other hand, there has been credited £1,096 for interest and £23,915, being the net surplus on the year's working. The balance forward to next year is therefore £6,323. During the year the Local Government Board granted additional borrowing powers to the extent of £165,136, and an application for further powers is now under consideration. The amounts sanctioned total £2,545,941. The total output of electricity from the three generating stations during the past 12 months amounted to 63,056,914 units as compared with 55,025,966 units of the previous year, an increase of 14·59 per cent. The quantity measured and accounted for during the same time was 51,361,612 units, showing a difference of 11,695,302 units, or 18·55 per cent., being the quantity used in distribution or otherwise not accounted for. The corresponding percentage in the previous year was 19·50. The total mileage of conductors laid at March 31, 1907, equalled 322 miles 83 yards, being 20 miles 1,439 yards more than at March 31, 1906.

Tramways.

During the 12 months ended March 31, 1907, 10 miles 261 yards of route (single track) were added to the 151 miles 647 yards (single track) open at the date of the last annual report. At the beginning of the year through running arrangements with the Oldham Corporation tramways were commenced, thereby establishing a through route between Manchester and Oldham of nearly nine miles. A similar arrangement was later entered into with the Ashton-under-Lyne Corporation. Thus the length of single track, including the lines over which the Corporation exercised running powers at March 31, 1907, aggregated 169 miles 811 yards. The revenue account is as follows:

Dr.	*Expenditure.*	Average per car mile year ended March 31. 1907	1906.
Traffic expenses	£196,785 8 11 ...	3·04d. ...	3·091d.
General expenses	63,374 1 5 ...	·98d. ...	1·0d.
General repairs and maintenance	63,269 9 10 ...	·98d. ...	·91d.
Power expenses (cost of current 1·259d. per B.T. unit.)	131,263 13 6 ...	2·03d. ...	2·096d.
Total	£454,692 13 7 ...	7·03d. ...	7·10d.
Balance to net revenue account	264,980 11 3 ...	4·09d. ...	3·77d.
	£719,673 4 10 ...	11·12d. ...	10·87d.
Cr.	*Income.*		
Traffic revenue	712,975 11 3 ...	11·02d. ...	10·84d.
Other revenue	6,697 13 7 ...	·10d. ...	·03d.
	£719,673 4 10 ...	11·12d. ...	10 87d.

To the gross profit must be added the sum of £1,910. 12s. 7d. bank interest, leaving a sum of £266,891. 3s. 10d. Out of this the following charges have been met: Interest on mortgage debt, etc., £50,140. 12s. 8d.: redemption of debt, £39,594. 8s. 7d.; rents, etc, of tramways, £24,038. 14s. 5d.; leaseholds—proportion of outlay, £1,309. 6s. 4d.; income tax, £4,769. 2s. 3d.—total, £119,852. 4s. 3d. The remainder of the balance has been appropriated as follows: Reserve, renewals, and depreciation account, £87,827. 3s. 5d.; contribution in aid of the rates, £55,000; street improvements round infirmary, interest, etc., £4,211. 16s. 2d.—total, £147,038. 19s. 7d. The total borrowing powers for the year under review amounted to £1,875,014. 17s. 2d., out of which £1,558,668. 13s. 1d. were exercised. The gross capital expenditure totals £1,725 844. 19s. The population served by the tramways last year numbered 800,000, 15,523,459 car miles were run, and 143,264,501 passengers were carried. The total number of units consumed were 25,072,791, an average of 1·61 per car mile compared with 1·53 last year. Against this we note that the percentage of working expenses to receipts went down from 65·3 to 63·18 and the average traffic revenue per car mile increased from 10·84d. to 11·02d. The number of passengers per car mile averaged 9·23, and the average journeys per head of the population were, during the year just closed, 179 against 178 of the previous year.

PERSONAL.

Mr. W. E. Hart, deputy town clerk, Sheffield, has been appointed solicitor to the National Telephone Co.

Mr. Henry Walter Jenvey, electrical engineer at Melbourne, Australia, has been granted six months' leave of absence on full pay.

The Liverpool Corporation tramway employés held their fourth annual sports last week in excellent weather, and in the presence of a large attendance.

Mr. Mackenzie has been appointed power-house foreman, *vice* T. Budgett, at the West Ham Corporation electricity works at a salary of £3. 10s. per week.

Messrs. Foster and Co., Wimbledon, makers of Foster's patent arc lamps, have appointed Mr. David Alexander, 43, Mains-street, Waterloo-street, Glasgow, to be their sole agent in Scotland.

Mr. C. H. Rosoman, of the British Thomson-Houston Co., Rugby, has joined the firm of Messrs. W. F. Jones and Co., manufacturers of switchgear, Dacre House, Victoria-street, Westminster, S.W.

The Gilbert Arc Lamp Co. have appointed Mr. H. G. Barrett, of 209, Hope-street, Glasgow, to be their agent in Scotland for enclosed and open type arc lamps, flame lamps, raising gear, transformers, etc.

Mr. H. W. Ashton, switchboard attendant at the Harrogate Corporation electricity works, was on Monday night presented by his colleagues with a handsome marble clock on the occasion of his marriage.

We regret to record the death of M. Gaston Emanuel Sautter, civil engineer, member of the Chamber of Commerce of Paris, and chevalier of the Legion of Honour, who died last month in his fifty-third year.

Messrs. Taylor and Co., mica merchants and manufacturers, of 40, Hatton-garden, London, E.C., have taken into partnership Mr. John Frederick Podger, who has been connected with the mica industry throughout his business career.

Mr. C. A. J. Hunter has been transferred to the position of senior assistant on the electric lighting and tramways accounts of the West Ham Corporation at a salary of £150 per annum, with two annual increments of £10 and one of £5 to a maximum of £175.

The annual outing of the British Electrical Friendly Society was held last week. The party proceeded from Stoke to Liverpool. The Potteries Electric Traction Co. gave to all the employés and their wives a sum of money to assist in making the outing enjoyable.

Messrs. W. F. Dennis and Co., Albert-buildings, 49, Queen Victoria-street, London, E.C., have been appointed the sole agents for the United Kingdom for Heinrich Remy, G. m. b. H., Tiegelstahlwerk, Hagen-in-Westphalia, Germany, makers of steel for magnets of all kinds.

The mechanical staff of the Cardiff city tramways had their annual picnic last Saturday, Abergavenny being the destination. The party were accompanied by three officials—Messrs. New, Hosgood, and Preston. The outing was voted a complete success, the only regret being the absence of the manager, Mr. A. Ellis, owing to other engagements.

Messrs. F. and C. Osler, manufacturers of crystal glass and china and electric fittings, of London and Birmingham, celebrated the centenary of the foundation of the firm last Saturday. An interesting fact connected with the celebration of electricity led to a still greater development. In celebration of the centenary Mr. Henry Osler gave a garden party at his residence, Burcot Grange, Bromsgrove, near Birmingham, to which the entire staff in London and Birmingham was invited.

The first annual outing of the West Ham Corporation's electricity department took place last Saturday, the weather being all that could be desired. At 8.20 a start was made for Stanstead Abbots, in Hertfordshire, in four four-horsed brakes, containing no less than 104 occupants, all of whom were employed in the various grades of the department, from Mr. A. H. Seabrook (engineer and manager) downwards, with the exception of Mr. Alderman Littler (chairman of the Electric Lighting and Tramways Committee), and Messrs. W. Davies, J. Halsey, J. Storey, and W. J. Woodward, well known and respected members of the West Ham Electrical Contractors' Association. After a brief stay at Woodford, where the company was photographed, the journey was resumed and destination reached about 2 p.m., where dinner was served. Short speeches were made by Mr. Alderman Littler, Mr. A. H. Seabrook, and Mr. W. J. Woodward, all of which were received with great applause and evident appreciation. After the usual happy day was spent an enjoyable drive home finished off the first annual outing of the West Ham electricity department, which, it is unnecessary to say, will not be the last of its kind. Before separating close on to midnight outside the offices in Romford-road, three rousing cheers were given for Alderman Littler, whose reply was short and hearty. The thanks of everyone present are due to Mr. W. H. Collings, the indefatigable secretary, and Mr. J. Smith, the honorary and painstaking treasurer, who both acquitted themselves worthily of the onerous duties imposed upon them.

LEGAL INTELLIGENCE.

LYNCH v. MACARTNEY, McELROY, AND CO.

Before the Master of the Rolls, Sir Gorell Barnes, and Lord Justice Kennedy, in the Court of Appeal on Monday, the Court delivered judgment in the case of Lynch *v.* Macartney, McElroy, and Co., on an application by the defendants for judgment or a new trial on an appeal from the verdict and judgment of Mr. Justice Bigham and a common jury.

The action was brought by the plaintiff against the defendants, who are electrical engineers, to recover damages for an alleged libellous advertisement published in a Maltese newspaper. The trial resulted in a verdict for the plaintiff for £250 damages, and the action arose out of the advertisement published to the effect that plaintiff was not at a certain date in defendants' employment.

Lord Justice Kennedy, who read the judgment of the Court, said the Lords Justices had come to the conclusion that the learned judge.

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(Mr. Justice Bigham) was right in leaving the question of libel or no libel to the jury, but they were clearly of opinion that the damages awarded by the jury were grossly excessive. In the circumstances the case must go down for a new trial.

Mr. McCall, K.C., subsequently stated that, in order to avoid the expense of a new trial, he had on behalf of the plaintiff agreed to accept £50 in settlement and the costs of the trial, there being no costs in the appeal.

The Master of the Rolls said he thought the arrangement was a wise one.

DUDLEY TRAMWAYS.

In the House of Lords on Tuesday the case of the Dudley Corporation *v.* Dudley, Stourbridge, and District Electric Traction Co. was heard before the Lord Chancellor and Lords Robertson, Atkinson, and Collins. The case was an appeal by the mayor, aldermen, and burgesses of the borough of Dudley from a decision of the Court of Appeal, reversing a judgment of Mr. Justice Swinfen Eady, and declaring that upon a special case stated that the higher of two alternative sums mentioned in the case was the price payable by the appellants to the respondents for a certain light railway, described in the pleadings as Railway No. 5.

By a majority the appeal was allowed, with costs.

TRAMWAYS AND CARRIAGE DUTY.

In the King's Bench Division of the High Court Mr. Justice Bray had before him the revenue case of the Attorney-General *v.* the Yorkshire (Woollen District) Electric Tramways Co., which came before the Court in the form of a special case, and raised the point as to whether 12 of the respondents' cars on their undertaking at Dewsbury were liable to pay carriage duty. It was contended on behalf of the Crown that the cars were propelled on the road, and that the undertaking was a tramway constructed upon the road, and not a light railway at all, and, therefore, the cars were not exempt from duty. It was argued on behalf of the respondents that the undertaking was in every sense a light railway to which all Acts applicable to light railways applied, and, therefore, these cars were exempt from passenger duty.

Mr. Danckwerts, K.C., for the respondents, submitted that the information was misconceived, and therefore the respondents were entitled to judgment.

His Lordship said the question he had to decide was whether these light railways were railways within the meaning of the section of the Act, and consequently exempted the cars in question from carriage duty. To his mind, it was obvious that the intention of the Act of Parliament was that light railways should be treated as railways as distinct from tramways. The Act and the authorities made it clear that it was a light railway. He had nothing to do except to decide that this was a railway within the meaning of the section, and these carriages not being propelled elsewhere than on a railway were not subject to duty.

The information was, therefore, dismissed with costs.

THE SWINDON TRAMWAY DISASTER.

In the King's Bench Division on Friday last the case of Townsend *v.* the Mayor and Corporation of Swindon, which was tried at the recent Bristol Assize, came before Mr. Justice Walton.

Mr. Foote, K.C., who appeared for the defendants, said the action was to recover damages for personal injuries sustained in the Swindon tramway accident about a year ago. The jury awarded the plaintiff £8,000 damages, and the defendants now desired a stay of execution pending an appeal, on the ground that the damages were excessive. To base the damages on the assumption that the plaintiff was in receipt of £700 a year was fundamentally wrong.

Mr. Clavell Salter, K.C., for the plaintiff, opposed the application.

Mr. Justice Walton granted a stay on the defendants paying the £1,500 in court to the plaintiff at once, and an additional £1,500 within four weeks.

ST. MARYLEBONE ELECTRIC LIGHT.

At the Marylebone County Court on Tuesday, before his Honour Sir Wm. Selfe, Messrs. Myring and Co., Messrs Pemberton and Clark, Mr. R. J. Knox, and Mr. Sobocuiski were sued by the St. Marylebone Borough Council for various amounts said to be due for electricity supplied.

Plaintiffs' solicitor explained that an arrangement was made under the Local Government Act some time back for certain portions of the parish of Hampstead to be transferred to the parish of St. Marylebone and *vice versâ* for local government purposes, and following that an agreement was made under Section 5 of the London Electric Lighting Areas Act of 1904, by which the same portions were also transferred for electric lighting purposes. The agreement had since been confirmed by the Board of Trade. The section of the Act gave St. Marylebone the same powers and duties held by them in other parts of the parish. The St. Marylebone electric light rate was 8d. a unit for anything up to 200 hours a quarter and 1d. a unit after, but the Hampstead charge was 4d. a unit, and although the defendants had offered about half the amount charged, they refused to pay the whole amount.

The defendants contended that it was a great injustice for them to be transferred without their consent to a district where they had to pay what amounted in most of their cases to double the amount they had previously had to pay.

His Honour strongly sympathised with the defendants, who did not seem to have had any voice in the matter at all. He gave judgment for the plaintiffs, but stay of execution and leave to appeal was granted in view of the importance of the cases.

OPENINGS FOR CONTRACTORS.

Aberdeen—Weaving mill at Ann-street for Richards, Limited. Architects, Messrs. Wilsons and Walker.

Aldershot—Soldiers' home. Architect, Mr. R. Curwen, 149, Bishopsgate-street Without, London, E.C.

Barnsley—Corporation electricity undertaking (£2,000).

Bromsgrove—Dairy and farm buildings at the Barnsley Hall Asylum. Architect, Mr. A. B. Rowe, Worcester-chambers, Worcester.

Dublin—Public library at Great Brunswick-street. City Architect, Municipal Buildings, Cork-hill, Dublin.

Edinburgh—Electrical engineering works at baths. City architect, Mr. R. Morham, City Chambers, Edinburgh.

Exmouth—Destructor sheds, including plant and electrical installation. Engineer and surveyor to the Council, Mr. S. Hutton, Exmouth.

Hollingworth—School for 600 children. Architect, Mr. C. T. Adshead, Leinster-chambers, St. Ann's-square, Manchester.

Ipswich—Secondary school. Mr. E. T. Johns, Tower-chambers Tower-street, Ipswich.

Kendal—Library. Borough Surveyor's Office, Kendal.

Leeds—Demolition and rebuilding of old dispensary, New Briggate. City engineer, Mr. W. T. Lancashire, Municipal Buildings, Leeds.

Lincoln—Warehouses, loading wharves, and offices for Great Central Railway Co. at Lincoln. Engineer-in-chief, Mr. C. A. Rowlandson, Great Central Railway Co.

Lightcliffe (Yorks)—Houses and shops. Architect and surveyor, Mr. E. C. Brooke, 6, Huddersfield-road, Brighouse.

Llanelly—Houses and shop, etc. Architect, Mr. W. Griffiths, Llanelly.

London—Buildings at Colney Hatch Asylum, New Southgate, N. Clerk of Asylums Committee, London County Council, 6, Waterloo-place, London, S.W.

London—Boiler-house and workshops at Fever Hospital, Tottenham. Engineer-in-chief, Mr. W. T. Hatch, Metropolitan Asylums Board, Embankment, London, E.C.

London—Extensions to National Gallery. H.M. Commissioners of Works, Storey's-gate, S.W.

London, S.E.—Buildings for the Metropolitan Asylums Board at Peckham Rye (£17,571).

London, W.—New station buildings, etc., at Hammersmith for the Joint Committee of the Great Western and Metropolitan Railways. Engineer, Paddington Station, London.

Nottingham—Public baths. City architect, Mr. F. B. Lewis, Guildhall, Nottingham.

Ruabon—Chapel, school, etc. Mr. E. Hawkins, Church-street, Rhos, Ruabon.

St. Leonards-on-Sea—Children's wing at Buchanan Hospital Architect, Mr. Henry Ward, 8, Bank-buildings, Hastings.

Salford—Timber shed at Hope-street for the Lancashire and Yorkshire Railway. Engineer's Office, Hunt's Bank, Manchester.

Sheffield—New soldiers' home, Langsett-road. Architect, Mr. G. M. Wilson, 37, Surrey-street.

Stretford—Corporation electricity undertaking (£53,460).

Whitehaven—Two villas at Herbert-hill. Architect, Mr. J. T. Moffatt, Whitehaven.

Wirksworth—Grammar school. Mr. G. H. Widdows, County Education Offices, St. Mary's-gate, Derby.

Wrexham—School for 1,000 scholars. Town Clerk's Office, Guildhall, Wrexham.

Ystrad Mynach—Nine cottages. Architect, Mr. W. Dowdeswell, Treharris.

FORTHCOMING EVENTS.

Friday, July 26.

Civil and Mechanical Engineers' Society.—At 3 p.m., visit to motorcar works of the Simms Manufacturing Company, Limited, Willesden-lane, Kilburn, N.W.

Platinum Substitute, Limited.—At 4.30 p.m., opening of factory at East-road, Hoxton.

Tuesday, July 30.

Institution of Mechanical Engineers.—At 10 a.m., Aberdeen meeting.

Wednesday, July 31.

Institution of Mechanical Engineers.—At 10 a.m., Aberdeen meeting.

British Association.—July 31 to Aug. 7, seventy-seventh annual meeting at Leicester.

Iron and Steel Institute.—Sept. 23, 24, and 25, Vienna meeting.

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COMPANIES' MEETINGS AND REPORTS.

ELECTRIC CONSTRUCTION.

The fourteenth annual general meeting of the Electric Construction Co. was held on the 18th inst., Mr. W. L. B. McLaren presiding.

The CHAIRMAN, in moving the adoption of the report and accounts, said that the directors greatly regretted that the year's operations showed a loss of £1,442. It should, however, be noted that this loss was only arrived at after writing off £5,000 for general depreciation and about £2,000 for new tools and patterns in excess of the amount usually expended on such matters. Referring to the balance-sheet, the shareholders would see that the sum of £7,614 had been expended on additions to plant which were strictly in the nature of new capital expenditure. This was almost exclusively on fixed machinery of the latest type, and as its installation had been followed by reduced cost of working, the directors considered this expenditure was thoroughly justified. Shares in other companies had been increased by £18,893, representing a further allotment of preference shares in the Madras tramways in part payment of the equipment of four miles of extensions supplied by this Company. Although the stock in trade and work in progress showed a diminution of £14,665, it must not be inferred that the Company had less work on hand; it simply meant that last year they had more work near completion than they had this year, for, as stated in the report, the orders on the books were greater than they were at this time last year. The gross profit on manufacturing and contracting was £4,000 less than last year. The result of the Company's operations was quite inconsistent with the hard work and anxiety which had devolved upon the Board and the management. It was but a small consolation to know that the absence of profit was not exceptional nor confined to this Company, for he could not find that any purely manufacturing and competitive business similar to theirs could show any better result. For the purpose of satisfying himself that undue competition was responsible for the present state of affairs he had compared the average selling prices of the year 1903-4—the last year the Company paid a dividend upon its ordinary shares—with those of the past year, and found that, while the output of machinery had been approximately the same, the turnover, in consequence of the slump in prices, had been diminished by no less than £28,000. The Company's staple article of consumption—namely, copper—had increased in price since 1904 by 80 per cent., or £50 per ton. The shareholders would, therefore, recognise that if the methods of the Company had not been progressive, and if the production had not been cheapened and strict economy exercised, the results would have been still more serious. He thought he was justified in saying that at present the outlook was more encouraging. They had more work in hand than at this time last year, and at distinctly better prices. As, however, they were well aware that keen competition in the electrical industry would continue, the directors had under their consideration the necessity of adopting further branches of engineering, and arrangements to this end had been made in one important direction. Referring to the Madras tramways, he said that while the Board were satisfied that the tramways would ultimately yield a satisfactory return, its development had been slower than was anticipated. They had sold a portion of the Company's holding in that concern, and this would give them a large amount of additional working capital.

Sir HENRY MANCE seconded the motion.

The CHAIRMAN, in reply to questions, stated that the directors were perfectly ready to consider with other companies a fair scheme of co-operation. Attempts had been made in that direction, the Board having tried to obtain a standard price as specific rates in competition. Two firms positively refused to come in, and the directors felt that without the co-operation of, at any rate, all the leading firms it was impracticable to go on.

The resolution was carried.

NATIONAL TELEPHONE.

The fortieth ordinary general meeting of the National Telephone Co. was held on Tuesday, Mr. George Franklin (the president) presiding.

The CHAIRMAN, in moving the adoption of the report (*Electrical Engineer*, July 19), referred at the outset to the great loss the Company had sustained by the death of their general manager, Mr. Gaine. He said that the income accrued in respect of the business of the half-year was £1,314,790, as compared with £1,195,151, or an increase of £119,639. The Post Office royalties showed an increase of £11,963, the figures being £125,311 as compared with £113,348. The net income amounted to £1,189,478, as compared with £1,081,803, or an increase, after deducting royalties, of £107,675. The working expenses, amounting to £753,207, showed an increase of £61,469, so that the net result of the half-year was £436,271, being an increase of £46,205. The half-year's income represented the earnings of 428,703 stations, being an increase of 20,967 in number. The increased income in respect of each station constituted a record. The income had increased by £119,000, and it had cost them an increase of £73,000 to earn it, so they were left with a balance of £46,000. Adding the diminished balance carried forward of £5,000, they had £51,000 more for distribution among the shareholders. Eleven thousand pounds had already been absorbed by debenture and other interest, £30,000 more went in dividends, and they had added £10,000 to the reserve fund. Referring to the question of cheaper tariffs, he said that in the year 1900 the average income per station was £7. 11s. 8d., and since then it had been gradually falling until it reached last year £6. 3s. 7d. per station. For the first time since 1900 the average income for the first five months of this year had risen to £6. 4s. 5d. per station, so that he thought they might predict that the decline in revenue per station, owing to the adoption of those cheaper and popular tariffs, had at last been overcome by the increased users. If that was so, then there was no reason why the Company should not look forward to being as prosperous during the remaining tenure of their licence as they had in the past. The increased prosperity of the Company had enabled the directors for the first time to make the dividend on the deferred stock 6 per cent. The Company now had a staff of 17,500 persons, and 16,600 shareholders, which indicated the area and extent of their business obligations.

Mr. S. H. SANDS seconded the motion, which was carried unanimously.

ANGLO-ARGENTINE TRAMWAYS.

An extraordinary general meeting of this Company will be held to-day (July 26), at which resolutions will be proposed to carry into effect the provisional agreement entered into with the Compagnie Générale de Tramways de Buenos Ayres. Under the proposed arrangements the existing £1,300,035 5½ per cent. cumulative preference shares will be altered to 6 per cent. cumulative preference shares as from July 1, 1907, and the present £1,600,000 ordinary shares of the Company will be converted into 10 per cent. second non-cumulative preference shares. Of the proposed creation of £5,000,000 new ordinary capital, £1,600,000 is to be the purchase consideration to be paid for the Buenos Ayres and Belgrano electric tramways undertaking, and the shareholders will be asked to give the Board authority to devote the whole or any part of the balance (£3,400,000) of this issue to the purchase of shares in other tramway undertakings in Buenos Ayres and the neighbourhood at the directors' discretion. The profits derivable from the Buenos Ayres and Belgrano Electric Tramways Co. and the dividends payable upon any shares in other companies which may hereinafter be acquired in the same manner will add materially to the security of both classes of the existing shareholders. The scheme generally contemplates the acquisition by the Anglo-Argentine Tramways Co. of a controlling interest in other tramways systems in Buenos Ayres and its neighbourhood upon terms which substantially improve the position of this Company's present shareholders, not only as regards the above-mentioned increase in their dividends, but also in the security for the due payment thereof.

CHILI TELEPHONE.

The ordinary general meeting of the Chili Telephone Co. was held on the 18th, Mr. Geo. Keith presiding.

In moving the adoption of the report (*Electrical Engineer*, July 12), the CHAIRMAN said that the period under review had been a difficult one for the Company's business. The terrible earthquake which took place last August caused great loss of life and property in Chile, and the whole of their subscribers in Valparaiso and district were disconnected. Santiago also suffered severely, but fortunately their plant in that city escaped with comparatively slight injury. Within a fortnight of the disaster telephone communication was again established with Santiago, to the great satisfaction of the Government, and a commencement was made to join up those subscribers who had been able to provide themselves with temporary premises. Before the end of the Company's financial year—March 31 last—a large portion of the subscribers who had been cut off by the earthquake were reconnected, and the undertaking resumed its normal condition of working. Business generally throughout the country had been active and prosperous. Owing to the exceptional cost of reconstruction work, the net profit in Chile for the year (£30,414) showed a decrease of £7,021. It was proposed to make a final distribution of £11,000, making the dividend for the year 8 per cent., free of income tax, being the same as for the previous 12 months. In the circumstances, he thought that the shareholders might be congratulated on the outcome of the year's business. Its recovery from the earthquake had been, to say the least, most remarkable. So far during the current year the business had made satisfactory progress.

Mr. FRANK W. JONES seconded the motion, which was unanimously agreed to.

CALCUTTA ELECTRIC SUPPLY.

An extraordinary general meeting of the Calcutta Electric Supply Corporation was held on Friday last at Salisbury House, E.C., to increase the capital of the Company to £1,000,000 by the issue of 100,000 additional shares of £5 each.

Colonel A. J. FILGATE, who presided, said further capital had had to be expended to a considerable amount in the development of the undertaking at Calcutta. They started the Company with a subscribed capital of £100,000, and that amount was increased to £200,000 in 1900. The capital was further increased to £500,000 in 1902. Their capital expenditure during the last five years had amounted to £334,618, while the total capital expenditure at Dec. 31 last amounted to £544,353, the subscribed capital being £500.000. The generating plant installed at their several stations represented a total of 5,817 kw. capacity, and the total length of their feeders and mains was 171 miles. They had recently had to order further generating plant, and the demand for additional mains extensions continued. The number of their customers also continued to increase. From Jan. 1 last to June 21 they had added more than 300 customers, the additional lamps attached to the system being an equivalent to 25,780 of 8 c.p., the total number of lamps at that date in connection with the mains being 289,174. As would be seen from their annual reports, the revenue had steadily kept pace with their increasing expenditure. It was difficult at present to say what the results were likely to be for the current year, seeing that the price charged for current had been reduced, and consequently there was for a time a natural reduction in the increase of income. The directors had no doubt that the reduction of price of current would bear fruit in the early future by still further increasing the demands on their system. The capital available for expenditure was exhausted, the total outlay

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exceeding the subscribed share capital by over £50,000, and, under those circumstances, they had to ask the shareholders to consent to increase the nominal capital of the Company. They did not intend to issue more than £100,000 for some time to come, but they thought it better to take powers for future increases up to a total of £500,000 of new capital, to be issued in such amounts and at such times as might be found necessary to meet the requirements of the Company. He might add that their present intention was to issue £100,000 of preference shares in the autumn. He concluded by moving a resolution to increase the capital.

Mr. E. BOULNOIS seconded the motion, which was agreed to.

SHANGHAI ELECTRIC CONSTRUCTION.

The first annual general meeting of the Shanghai Electric Construction Co. was held on the 19th inst., Sir Alfred Dent presiding.

The CHAIRMAN, in moving the adoption of the report, stated that the expenditure on construction account up to May 31 last had been £230,140. As regarded the additional expenditure not provided for by the original issue of shares, the directors had found it advisable, as the work progressed, to make certain extensions and additions to the original plan, all of which were done under the sanction, if not under the advice, of the municipal authorities. An arrangement had been come to with the company which obtained the tramway concession in the French settlement, under which they would have mutual running powers over their respective lines. The essence of the agreement was that the number of car miles run by each company should be identical. As to the progress which had been made by the French company, he was informed that they expected to be ready early in 1908. Their cars were under construction in this country, and were exact repetitions of this Company's. With regard to the tramways on the Chinese Bund and in the Chinese quarter round the native city, all negotiations appeared to be at a standstill, but there seemed every probability when the Chinese authorities saw the tramways running successfully in the English and French settlements, that they would desire to have them extended to the streets under their own jurisdiction. As to the date at which the Company would be able to commence running the tramways, they were practically in the hands of the Municipal Council. As far as the Company were concerned it was probable that the whole of the undertaking would be ready by Oct. 10 next. The prospects for their service were more promising than ever.

Mr. EMILE FRANCQUI seconded the motion, which was carried unanimously.

DIRECT UNITED STATES CABLE.

The half-year's revenue, after deducting outpayments, amounted to £57,055, as compared with £56,264 for the corresponding period of 1906, showing a difference of £790 in favour of the half-year under review. The working and other expenses for the same period, including income tax, amounted to £24,699, leaving a balance of £32,356 as the net profit, making, with £17,031 brought forward from the previous half year, a total of £49,388. For the corresponding period of 1906 the working expenses and other payments amounted to £23,294. Three quarterly interim dividends of 4s. each per share, amounting to £36,426, have been paid during the year, and a final dividend of 4s. per share is now proposed, together with a bonus of 2s. 6d. per share, making, with the three interim dividends, 4⅝ per cent. for the year, being a total distribution of £56,156. After transferring £15,000 to the reserve fund account, the balance of £2,515 on the revenue account is proposed to be carried forward. The reserve fund has been debited with £4,184 for the cost of cable maintenance, and £40,000 on account of market depreciation of securities, and, after being credited with interest on the investments, profit on sale of securities, and amount transferred from revenue, the balance now amounts to £491,968.

THOMAS PARKER, LIMITED.

The directors' report and statement of accounts for the year ending April 30, 1907, shows that the amount standing to the credit of the profit and loss account is £18,033. 6s. 2d., which it is proposed to deal with as follows: To add to the general reserve fund £5,000, to put to a depreciation reserve fund £5,000, to write off the suspense development account £3,500, and to carry the balance of £4,533. 6s. 2d. to next year's accounts. The patent "C" type dynamos and motors which were put on the market last year have proved very successful and have become the Company's standard type, replacing all previous designs. The orders for electrical work have increased by nearly 50 per cent. over the previous 12 months, but, owing to the continued competition and over-production, prices for electrical machinery have shown little tendency to rise, whereas the prices of raw material, especially copper, have been maintained at a high figure. The developments indicated in the half-yearly report have made exceedingly satisfactory progress during the six months. The Rees Roturbo Development Syndicate was formed, and is now a very valuable property. The result of the agreement between Thomas Parker, Limited, and the Rees Roturbo Development Syndicate secured the full manufacturing rights in Great Britain for Thomas Parker, Limited, in all classes of pumps, turbines and machinery under the "Roturbo" patents. The result of the sale of the patents to the Rees Roturbo Development Syndicate, Limited, is a profit balance of £17,737. 11s. 7d. after writing off the whole of the formation expenses and the preliminary expenses of developing the business in the works. When particulars were sent to the shareholders of the formation of the Roturbo Co. there were only three patents applied for. Since then these have been granted by the Patent Office and published, and beyond these a number of development patents on the "Roturbo" principle have been filed, extending the control of the "Roturbo" in various directions, where there will undoubtedly be a large demand for plant of this description. The increase of orders since publication of details has been rapid, and the shops are accumulating patterns and standardising sizes as quickly as possible. The list of patents applied for, for which Thomas Parker, Limited, have the sole British manufacturing rights as above are as follows:

Title of patent.	Date of application.	Final patent filed.	Position.
Original Roturbo pump patent	Feb. 27, 1906	Aug., 1906	Granted.
Application for fire purposes...	June 21, 1906	Dec., 1906	,,
Application of principle to turbines	June 21, 1906	Dec., 1906	,,
Application of principle to condensers	Oct. 11, 1906	Mar., 1907	—
Detail patent in connection with original	Nov. 23, 1906	May, 1907	—
Ditto	Ditto	Ditto	—
Application of principle to air extractor and compressor ...	Dec. 4, 1906	June, 1907	—
Application of principle for clutches	Dec. 13, 1906	June, 1907	—
Application of principle for boiler feed and circulation	Feb. 7, 1907	—	—
Detail patent in connection with original	Mar. 27, 1907	—	—

The list will show that the property and value of "Roturbo" patents have been increased and safeguarded by the further applications for patents which have not had time to pass through the Patent Office up to date. It will be noticed that the last application was only dated the end of March this year. The directors not only consider that the prospects of the Company are very satisfactory, but owing to the development of sales and margin of profit in the Roturbo business are more than satisfied that the Company can look forward to occupying a place in the front rank of successful manufacturing concerns in the country. As will be seen from the above, the base of the business has been greatly enlarged, and the Company is no longer dependent on one branch of engineering. In order to realise fully the advantages secured by the patents, it is desirable to increase the capacity of the works so as to standardise rapidly and manufacture all the "Roturbo" machinery without interfering with the electrical output. With this object in view the directors intend to call an extraordinary meeting of shareholders to authorise the issue of fresh capital with the object of paying off the bank overdraft, redeeming the debentures and providing further working capital. The directors deem it advisable to deal with this matter at an extraordinary general meeting, when they will produce complete proposals. The directors deeply regret to report the death last April of Mr. R. Armistead, who has for many years been a director of the Company. Mr. G. Balfour was elected to fill the vacancy. Pursuant to the articles of association, he now retires and offers himself for re-election. The director who retires by rotation is Mr. J. E. Underhill, who is eligible and offers himself for re-election. The directors propose to increase their number from four to five, and with the object of strengthening the technical side of the Board will propose at the general meeting that Mr. W. Armistead, who is eligible and willing to serve, shall be elected to a seat on the Board. The auditor, Mr. W. A. Nelson, also retires, is eligible, and offers himself for re-election

ELECTRIC SUPPLY CORPORATION.

The report of the Electric Supply Corporation for the year ended Dec. 31 last, to be submitted at the meeting on the 31st inst., states that the gross revenue shows a steady and satisfactory improvement, and, including the dividend from the Chelmsford company, amounted to £7,285. After providing for debenture interest and other items, there remains a net profit of £151. The supply of electricity was commenced in Dumbarton, Hitchin, and Falmouth, and 6,853 lamps have been connected to the mains in those towns. The dividend received from the Chelmsford company amounted to £1,873, notwithstanding a reduction in the price for current and an additional cost which was incurred in providing increased illumination in the public lighting of the streets. The six towns, Jedburgh, Melrose, Dalkeith, Dollar, Exmouth, and St. Andrews, produced a gross revenue of £3,730, compared with £2,060 in the preceding year. The Totnes undertaking is now working at a profit. The guarantors having paid the sum necessary, a final dividend for 1906 has been paid, and they will now provide the amount sufficient for the payment of an interim dividend at the rate of 5 per cent. per annum for six months ended June 30 last.

METROPOLITAN RAILWAY.

The report of the Metropolitan Railway Co. for the half-year ended 30th ult. states that the total receipts (deducting this Company's proportion of the revenue of the City lines and extensions) have been £345,519, and the expenses £193,361, leaving a profit of £152,158. Compared with the corresponding half-year of 1906 (when the receipts included for three months the earnings of the line north of Harrow which is now joint), the receipts show a decrease of £43,494, and the expenses a decrease of £19,670. The net revenue account, after providing for the interest upon the debenture stocks and other fixed charges and the dividend upon the preference stocks, shows a balance of £17,624 available for dividend upon the ordinary stock. The directors accordingly recommend a dividend on the ordinary stock at the rate of 10s. per cent. per annum, and to carry forward £3,294. The first three months of the half-year compare with a period prior to the coming into force of the agreement with the Great Central Co. and the partial diversion of their traffic from the Metropolitan to the new Great Central and Great Western Joint Line. The falling off in revenue

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is due partly to this cause and partly to the competition from the tube railways and motor omnibuses. The dividend on the surplus land stock for the past half-year will be at the rate of £2. 15s. per cent. per annum. By arrangement with the District Railway Co. and the tube railways, the fares by the Hammersmith and City line from Hammersmith and from other stations in the West of London to the City were advanced on July 1, and the effect on the receipts since that date has been satisfactory. It was felt that the fares had, in many instances, fallen to an unremunerative level, and that concerted action on the part of the carrying companies concerned was necessary in order to restore the fares to a more reasonable basis. Throughout the half-year the working of the electrical plant and machinery has given every satisfaction, and the current is being produced at a very low cost per unit. The increased services of trains on the Circle and on the St. John's Wood line have been greatly appreciated by the public, and in the latter case have assisted the Company materially to meet the motor-omnibus competition. The Bill promoted by the Company in the present session of Parliament to provide for the establishment of a pension fund for their wages staff has passed both Houses of Parliament, and has received the Royal assent.

CROMPTON AND CO.

The report of Crompton and Co. for the year ended March 31 last states that the works at Chelmsford have been fully occupied, and it has been found necessary to make still further extensions to the shops in order to deal with the increasing business in a prompt and economical manner. The improved results at the works referred to in last year's report have been more than maintained, and, notwithstanding the increased cost of raw material, the selling and contracting departments have succeeded in earning satisfactory profits. The net profit amounts to £38,291, as compared with £20,060 in the preceding year, and from this figure has been deducted £6,572, representing the loss on stock which, owing to the introduction of improved designs, it has been thought advisable to sell or scrap. After providing for debenture interest, directors' fees, and other items there remains, with the sum brought forward, an available balance of £30,165. The directors propose a dividend at the rate of 5 per cent. per annum for the year, to provide £1,500 for doubtful debts and contingencies, to place £10,712 to the reserve fund, bringing that account up to £20,000, and to carry forward £5,840. Although the accounts of the Electric Supply Corporation for the last financial year are not yet published, the directors have reason to believe that the undertakings of the corporation are making steady progress. A sum of £8,950 has been invested during the year in shares of the guaranteeing company, being the estimated amount required for the year's dividend on the shares of the Electric Supply Corporation. The amounts so invested are repayable out of future profits of the Electric Supply Corporation. The directors are of opinion that the amount proposed to be placed to reserve out of the year's profits is sufficient to provide for any possible depreciation of the investments. In view of the activity of the Company's business, and particularly of the importance of some of the contracts in hand, the directors deem it advisable to ask the shareholders to increase their borrowing powers from the present limit of £150,000 (in which is included the debenture issue of £100,000) to £200,000, and for this purpose a resolution will be submitted to the meeting. The orders and contracts already secured are of such volume that satisfactory results for the current year may be anticipated.

EDMUNDSON'S ELECTRICITY.

The report of Edmundsons' Electricity Corporation for the year ended March 31 last states that the net profit after payment of debenture interest amounts to £16,595, which, with £15,211 brought forward, makes a total of £31,807. After deducting the dividend on preference shares paid to Oct. 30, 1906, amounting to £14,000, there remains £17,807, which the directors recommend should be carried forward. The directors regret that, owing to the slow development in the demand for electric light during the past year, the results have been so disappointing. They believe, however, that with the economies which may be expected from an extended use of the new high-efficiency lamps and an increased demand for power purposes, an improvement will ultimately follow. The policy of the Board has been to restrict the expenditure of capital as much as possible. The result of this is shown in the schedule of investments and advances attached to the report, which have only increased by £37,599, as compared with an increase of £160,312 last year. The profit on trading account has necessarily diminished with the much smaller amount of work done, and after providing for all standing charges the net profit is only £4,059, as compared with £27,709 last year. In accordance with a suggestion made at the last general meeting, in addition to the usual list of shareholdings in various other undertakings a schedule is now published showing the earnings of each. Owing to increased debenture and other prior charges of the subsidiary companies, the Edmundson's Co.'s income from these investments was only £31,136, against £32,182 last year. An improvement in this respect during the current year may be looked for. The directors regret to report that, owing to illness, Mr. H. Wolfenden has recently resigned his position of chairman and joint managing director and his seat on the Board. Upon the request of a number of the larger shareholders, Mr. P. D. Tuckett has been elected to fill the vacant seat on the Board, and the shareholders at the meeting will be asked to confirm this appointment.

CITY AND SOUTH LONDON RAILWAY.

The report of the directors states that the receipts from all sources for the past half-year have amounted to £82,456 and the costs of working has been £36,592, leaving a profit of £45,863. Inclusive of the balance brought forward from Dec. 31 last, the net revenue account shows an aggregate total of £52,516. After making provision for the debenture stock interest and the transfer to the renewal fund of £1,500, a balance remains available for dividend of £39,107. Out of this sum the directors recommend that the full dividend of 5 per cent. per annum be paid on the preference stocks 1891, 1896, 1901, and 1903, and that a dividend at the rate of 2½ per cent. per annum be paid upon the consolidated ordinary stock for the half-year, leaving a balance of £1,857 to be carried forward to the next account. Since the opening of the railway the number of passengers carried has been 180,177,381, and the receipts have amounted to £1,439,724. Throughout the half-year the traffic on the old line and the old connections has shown a satisfactory increase, and the extension to Euston has brought in a considerable amount of new traffic. These receipts, added to what has come in from through bookings with allied systems, enable the directors to recommend a dividend at the rate of 2½ per cent. per annum for the half-year, being an increase on the dividend for the corresponding period last year at the rate of ¼ per cent. per annum. The directors have not issued any of the capital authorised at the special meeting held on April 16 last. With a view, however, to adjusting the capital account and to meet the small additional capital required for other purposes, their intention is to take the first favourable opportunity of doing so in the way most advantageous to the Company's interest.

BUENOS AYRES ELECTRIC TRAMWAYS.

The report of the Buenos Ayres Electric Tramways Co. for the year ended Dec. 31, 1906, states that the gross receipts amounted to £75,156, as compared with £64,514 in 1905. The working expenses, inclusive of London administration charges, were £60,080, as against £51,228 in 1905, showing a net profit of £15,076 for the year, as compared with £13,286 in 1905. After paying debenture interest and transferring £1,731 to the sinking funds for redemption of debenture stock, there remains, with £697 brought from last year's account, £2,639 to be carried forward.

NEW COMPANIES REGISTERED.

Guernsey Electric Light and Power Co.—Registered in Guernsey July 20. Capital, £100,000 in £1 shares. Objects: to acquire the business and property of Edmundson's Electricity Corporation in Guernsey, and to carry on the supply of electric light and power in that island.

Wireless Telephony (Entertainments) Co., Limited.—Registered July 15. Capital, £1,500 in £1 shares. Objects: to adopt an agreement with F. E. Brown and H. F. Rogers, and to carry on the business indicated by the title. No initial public issue. Registered office: 4, International Exchange, Edmund-street, Birmingham.

British Electrical Federation.—Registered July 19. Limited by guarantee. 100 members. Liability for each individual member 5s., and for each company which is a member 5s. for every £1,000 of its authorised share capital. Objects: as title. Managed by council. Chairman for time being of British Electric Traction Co. to be president of this company.

Pyrenees Electrical Society.—Registered July 27. Capital, £60,000 in £1 shares. Objects: to promote, construct, equip, maintain, work, and control roads, tramways, railways, motorways, telegraphs, telephones, cables, ships, lighters, piers, harbours, reservoirs, embankments, mills, smelting, hydraulic, gas, electric lighting, and power supply works, etc. No initial public issue. Offices: Parliament-mansions, Victoria-street, Westminster.

Anchor Tube Co.—Registered July 16. Capital, £50,000 in £1 shares. Objects: to acquire, as from April 1, 1907, the business of tube manufacturers carried on in Gas-street, Birmingham, and elsewhere, as the Anchor Tube Co.; to adopt an agreement with T. Turley, J. H. Turley, and C. H. Turley; and to carry on the business of manufacturers of and dealers in iron, steel, brass, copper, and other tubes, pipes, fittings, and boilers, metallurgists, engineers, etc. No initial public issue. Office: 31, Gas-street, Birmingham.

Liens Registered.

Scottish House-to-House Electricity Co., Limited, London, E.C.—Charged registered July 13 for £500; secured on the assets, subject to prior issues.

Granada Motor Co., Limited, Southsea.—Lien registered July 16, for £1,050 5 per cent. debentures, part of £1,100 authorised. No trustees. Charged on the business, assets, and goodwill.

Anglo-Argentine Tramways Co., Limited, London, E.C.—Trust deed registered July 8, supplemental to a trust deed dated Aug. 13, 1888, for securing £266,600 6 per cent. debenture stock. Charged on a certain concession granted by the Municipality of Buenos Ayres, relating to electric tramways, and on the company's central station in that city, together with all the other assets, property, and rights.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Salford.—Tenders are invited for 14 cars and four salt wagons for the Corporation Tramways Department. Tenders by Aug. 12.

Madrid.—The Public Works Department invite tenders for the construction of electric tramways in Valencia. Tenders by Aug. 12.

Madrid.—Tenders are invited for the construction of electric tram way at Saragossa for the Public Works Department. Tenders by Aug. 7.

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Barnes.—The Urban District Council invite tenders for mechanical stokers and cables for the Electricity Department. Specifications £1. 1s. each. Tenders by Aug. 12.

Hull.—The Corporation invite tenders for pipe work, ejector type condenser and pump. Particulars from Mr. H. Bell, city electrical engineer, Hull. Tenders by Aug. 2.

Sofia.—Tenders are invited for the supply of an accumulator battery for the Postal Department. Tenders to the District Finance Commissioners, Sofia. Tenders by Aug. 8.

Portsmouth.—The Tramways Committee invite tenders for best large smokeless steam coal. Mr. V. G. Lironi, engineer, Fratton-grove, Portsmouth. Tenders by Aug. 5.

Madrid.—Tenders are invited for the construction of two electric tramway lines in Madrid, and one from Baeza to Linares. Particulars from the Public Works Department, Madrid. Tenders by Aug. 5.

Brisbane.—The Postmaster-General invites tenders for the supply and delivery at Brisbane of four sections of a common battery switchboard and 650 subscribers' telephones to specification No. 145. Tenders by Sept. 2.

London, S.W.—The Crown Agents for the Colonies, acting on behalf of the Central South African Railways, invite tenders for the supply of 27,000lb. hard-drawn copper wire. Tenders to the Crown Agents for the Colonies, Whitehall-gardens, S.W., by Aug. 20.

Blackburn.—The Electricity Committee invite tenders for the supply and delivery of steam coal for nine months ending June 30, 1908. Specifications, etc., on application at the Electricity Works, Jubilee-street. Tenders by Aug. 3.

Croydon.—The Electricity Committee invite tenders for the supply of the following: (*a*) flame arc lamps; (*b*) transformers for the same; (*c*) lowering gear. Full particulars to be obtained from the Borough Electrical Engineer, Electricity Works, Factory-lane, Croydon.

Adelaide.—The Deputy Postmaster-General invites tenders for a common battery switchboard and subscribers' telephones. Specification No. 166. Particulars may be obtained from the Commonwealth Offices, 72, Victoria-street, London, S.W. Tenders by Jan. 8, 1908.

Winnipeg.—The Point du Bois Hydro-Electric Development invite tenders for an electrical equipment and for constructional work. Specifications, etc., from the Power Engineer's Office, Carnegie Library Buildings, Winnipeg, or at 35-36, Bedford-street, Strand, W.C. Tenders by Sept. 3.

Newcastle-upon-Tyne.—The Tramways Committee invite tenders for the supply of the various, points, crossings, rails, and other materials in connection with the renewal and extension of a three-road double turn-out junction of tramways at Market-street and Pilgrim-street, Newcastle-upon-Tyne. Tenders by Aug. 3.

Queensland.—Tenders are invited by the Postmaster-General for the supply and delivery at the Post and Telegraph Stores, Brisbane, of the following telegraph and telephone material: (1) lead-covered cable; (2) stores and battery material; (3) line material; (4) telegraph and telephone instruments; (5) coin attachments. Tenders to be sent to the General Post Office, Brisbane, by Sept. 9.

Limerick.—Tenders are invited for the building of an extension to the gas-house at the electricity works, Limerick, the work consisting of masonry with iron roof, concreting, excavations, etc., for the Electric Light Committee. Specifications, etc., from Mr. James Gallinagh, borough electrical engineer, on payment of 10s., which will be returned on receipt of a bona fide tender. Plans may be seen at the Engineer's Office, Frederick-street, Limerick. Tenders to Mr. W. M. Nolan, town clerk, by July 30.

Gothenburg.—The Commercial Intelligence Branch of the Board of Trade are notified by his Majesty's Consul at Gothenburg that tenders are invited for supply of the electrical equipment for the Government power station at Trollhattan, comprising three electric generators for direct current, each of 350 kw.; one accumulator battery of 4,800 ampere-hours capacity; four three-phase generators, each of a maximum of 11,000 kilovolt-amperes; 12 transmitters, each of a maximum of 3,670 kilovolt-amperes; connections; regulators; and control tables. Sealed tenders, marked "Anbud a elektrisk utrustning for Statens kraftverk," should be sent to the Managing Director of the Royal Trollhattan Canal and Waterworks, Trollhattan, Sweden, by noon on Oct. 1 next. Tenders are binding until Jan. 1, 1908. Delivery is to be completed by Sept. 1, 1909. Further information may be obtained from the Managing Director, from whom a copy of the programme can be had against a deposit of 50 kronor, which will be returned on receipt of a tender in accordance with the programme.

RESULTS OF TENDERS.

Ealing.—The Borough Council have accepted the tender of Johnson and Phillips for the supply of cables.

Hankow.—The Electric Light Department have placed an order with Johnson and Phillips for the supply of arc lamps.

Fleetwood.—The Electric Light and Power Syndicate have placed an order with Johnson and Phillips for supply of cables.

Handsworth.—The Urban District Council have accepted the tender of Johnson and Phillips for the supply and laying of tramway feeders and pilot cable, troughs, etc.

Portland.—The Admiralty have placed an order with Johnson and Phillips for the supply and erection of cables, conduits, troughs, boxes, glow lamp pillars, etc., for H.M. coaling depôt.

Cambuslang.—The Lanark County Council have placed an order with Johnson and Phillips for the supply and erection of motor-generator, booster, switchboard, and machine, also battery cables.

Hammersmith.—The Electricity and Lighting Committee recommend the acceptance of the tender of the Phœnix Dynamo Co., at £132, for the supply of a new motor-generator for use at the King's Theatre.

Pembroke.—The Urban District Council have accepted the tender of the Union Electric Co. for supply of flame and arc lamps at £133. 7s. 9d. and that of the Switchgear Co. at £347. 6s. 6d. for switchboard, etc.

London.—The County Council have accepted the tender of Johnson and Phillips for the supply and erection of complete high and low tension switchgear equipment for eight tramway sub-stations, together with all cable for connecting machines.

New South Wales.—The tender of R. B. Hungerford, of 163, Pitt-street, Sydney, has been accepted, at £720, for the supply and delivery of an additional junction section of the present magneto metallic-circuit branching system multiple telephone switchboard, Central Exchange, Sydney.

Dublin.—The Lighting Committee recommend the acceptance of the tender of Ferranti Limited for the supply and erection of sub-station switchboards at £2,068. 2s., also tender at £340. 5s. for the extra feeder panels, at Fleet-street; the tender of the Electrical Transformer Co. for the erection of 100-kw. transformers for sub-station in Sackville-street and Pigeon House, and transformers in connection with the extension of the electric lighting to the Viceregal Lodge, at £2,320. 9s. 7d.

London.—The London County Council have received the following tenders for the provision of overhead travelling cranes at the central car repair depôt: Higginbottom and Mannock, Manchester*, £1,116 to £1,205; Ransomes and Rapier, London, £1,200 and £1,370 (according to type of motor); J. Spencer and Co., Hollinwood, £1,240; Applebys, London, £1,276; T. Broadbent and Sons, Huddersfield, £1,305 (amount including £50 provision money).
* Recommended for acceptance at £1,205, which is for the supply of cranes fitted with motors of the type supplied by the Electric Construction Co.

London.—The London County Council have received the following tenders for the supply, delivery, and erection of the overhead electrical equipment required for the tramways from Beresford-square, Woolwich, to Wickham-lane, Plumstead:

Dick, Kerr, and Co., London*	£2,323	4	2
Brush Electrical Engineering Co., London	2,389	0	6
R. W. Blackwell and Co., London	2,413	19	3
British Insulated and Helsby Cables, Prescot	2,652	16	9
Fry Bros., London	2,811	18	6
S. G. Smith, London	2,962	0	11
Special trackwork (points and crossings).			
Hadfield Steel Foundry Co., Sheffield*	967	5	0
E. Allen and Co., Sheffield	1,064	5	0
F. H. Lloyd and Co., Wednesbury	1,295	0	0

* Recommended for acceptance.

Eastbourne.—The following tenders have been submitted for the extension of plant at the Corporation electricity works:

Water-tube boiler and pipework.			
Babcock and Wilcox*	£2,030	0	0
B. R. Rowland and Co.	1,996	0	0
J. Musgrave and Sons (Woodesen's)	2,412	0	0
Clarke, Chapman, and Co. (Woodesen's)	2,152	0	0
Stirling Boiler Co.	2,054	0	0
Davies Patent Boiler, Limited	2,290	0	0
Extension to high-tension switchboard.			
Ferranti Limited	148	4	0
Cowans, Limited	122	10	0
Ditto (not erected)*	106	10	0
Spray cooling plant.			
J. H. Harrison, Middlesbrough*	257	0	0
Korting Bros.	250	0	0

* Recommended for acceptance.

London.—The following tenders have been received by the London County Council for supply, delivery, and erection of 78 feeder pillars required for the electrification of portions of the tramways:

British Insulated and Helsby Cables, Prescot*	£1,896	3	0
T. L. Scott and Co., London	2,154	17	6
J. E. Spagnoletti and Co., London	2,178	15	0
Dick, Kerr, and Co., London	2,244	19	5
W. T. Henley's Telegraph Works Co., London	2,304	2	1
R. W. Blackwell and Co., London	2,304	10	9
Callender's Cable and Construction Co.	2,355	13	0
Universal Electrical Manufacturing Co., London	2,420	0	6
Tramway Supplies, Limited, Leeds	2,424	8	0
Estler Bros., London	2,444	13	0
Cox-Walkers, Darlington	2,470	9	0
Brush Electrical Engineering Co., London	2,521	4	0
Johnson and Phillips, Charlton	2,535	1	3
Western Electric Co., North Woolwich	2,569	6	6
Wenham and Waters, Croydon	2,677	17	6
Kelvin and J. White, Glasgow	3,290	13	0
General Electric Co., Salford	3,827	15	0

* Recommended for acceptance.

Victoria.—The following tenders have been accepted for the supply of material for the Post Office: British Insulated and Helsby Cables, Melbourne, 31¾ miles of paper-insulated lead-covered telephone cable and 49,000 paper sleeves, £15,537; Dalgety and Co., Melbourne, 20,000 galvanised-iron stems for No. 6 insulators, £291. 13s. 4d.; Williams and Co., Brunswick, 500 angle-iron extenders and 1,500 wrought-iron brackets for extenders, £300; Millars' Karri and Jarrah Co. (1902), Limited, South Melbourne, 500 butts for 25ft. Sullivan poles and 500 butts for 30ft. Sullivan poles, £241. 13s 4d.; J. Moore and Sons' Proprietary, Limited, South Melbourne, 500 shafts for 25ft.

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Sullivan poles, £450; J. G. Black, Melbourne, 20 tons No. 14 gauge galvanised-iron wire, £290.

BUSINESS NOTES.

TRACTION.

Northenden.—The Council have consented to the widening of certain roads necessary for the construction of tramways.

Dublin United Tramways.—In their report for the half-year ended June 30 the directors recommend a dividend at the rate of 6 per cent. per annum, leaving £6,615 to be carried forward.

Geneva.—The receipts for the month of June, 1907, of the tramways owned by the Geneva Tramways Co., Limited, amounted to £10,424, being an increase of £543 compared with June, 1906.

Imperial Tramways Co.—At a meeting of the directors of the Imperial Tramways Co. an interim dividend was declared at the rate of 8 per cent. per annum for the half-year ended June 30. The dividend warrants will be posted to the shareholders on Friday, Aug. 2.

Bombay Electric Supply and Tramways.—The accounts for the year 1906 show gross receipts of £102,192 and net revenue of £41,900, while, after providing for debenture and loan interest, together with the dividend on the preference shares, there remains a balance of £1,363 to be carried forward.

Hampstead.—The London Underground Electric Railways Committee has received permission from the Hampstead Borough Council to fix small direction notices to the Hampstead Tube to two or three lamp-posts in the vicinity of Hampstead, Belsize Park, and Chalk Farm Stations upon payment of £1 per annum for each notice.

Oxford.—The Council have accepted the guarantee executed by Martin's Bank, bankers, of 68, Lombard-street, London, dated July 4, 1907, by which a maximum sum of £50,000 is guaranteed to the Corporation under their agreement with the National Electric Construction Co., dated Dec. 14, 1906, and the supplemental agreement thereto.

Liverpool Overhead Railway.—The accounts of the Liverpool Overhead Railway Co. for the past half-year show an available balance of £8,128. 5s. 1d. The directors have resolved to recommend payment of a dividend at the rate of 5 per cent. per annum on the preference shares, which will absorb £3,675. 17s., and carry forward a balance of £4,452. 8s. 1d.

Western Wagon and Property Co.—At a meeting of the directors of the Western Wagon and Property Co. held on Monday afternoon at the offices of the company an interim dividend at the usual rate of 10 per cent. per annum was declared for the half-year ended June 30. The dividend warrants will be posted to the shareholders on 31st inst.

Canals Commission.—Mr. J. M. Grant, the deputy-lieutenant of the county of Inverness, gave evidence before the Canals Commission respecting the Caledonian Canal. He suggested various improvements in the way of reconstruction and dredging, and the installation of electric power to work the locks and light the canal, or, alternatively, the use of hydraulic power.

Dundee.—The Tramways Committee have, on the recommendation of the manager, decided to ask the Board of Trade to intervene in the present dispute between the tramway employés and the management, the latter alleging that the Board of Trade regulations have been violated by the employés, and asking for an inspector to be sent to make a searching inquiry into the troubles.

Salford.—The new tramway offices and depôt in Seaford street, which have been built for the Salford Corporation at a cost of £12,960, were formally opened last week. The premises comprise receiving offices, committee room, offices for the car depôt superintendent and his clerks, residence for the car depôt superintendent, quarters for the overhead equipment staff, tower wagon house and stables, messrooms, lavatories, and recreation rooms for the men.

Glasgow.—The Corporation tramway cars ran 388,481 miles last week, as compared with 396,583 in the corresponding period of last July, carried 4,301,320 passengers as against 4,182,868, and the receipts were £17,489, in comparison with £16,957. Since the beginning of the financial year on June 1 the number of passengers carried has been 27,340,848, as compared with 27,700,201 in the corresponding period of last year, while the drawings were £109,604, as against £111,810.

Central London Railway Co.—The directors of the Central London Railway Co. recommend the following dividends: at the rate of 3 per cent. per annum on the undivided ordinary stock and 4 per cent. per annum on the preferred ordinary stock for the half-year ended June 30 last, providing also for a dividend at the rate of 2 per cent. per annum on the deferred stock, this latter dividend only being payable when the result of the year's working has been ascertained. After making the above provisions, £25,890 is carried forward.

Fulham.—A deputation from the executive of the Franco-British Exhibition recently waited upon the Borough Council asking them to expedite the construction of the proposed London County Council electric tramways from Putney to Harlesden. The town clerk pointed out that the London County Council had statutory power to construct the trams on the conduit system, but had asked Fulham to consent to the overhead system. The latter had agreed conditionally, and it now only remained for the London County Council to push the work forward.

Argentina.—According to the monthly *Bulletin* for May of the French Chamber of Commerce at Buenos Ayres, the Municipal Council of that city have definitely decided upon a project for the construction and leasing of two underground electric tramways. The lease for the working of these lines will be granted for a period not exceeding 25 years. The estimated cost of the works is 2,700,000dol. (paper) per kilometre, including the electric power plant. The contract will be open to tender for a period of six months after specifications have been prepared.

Belfast.—Notice has just been issued to the motormen and conductors of the Corporation that their engagements may expire to-day (Friday), as the electric power supply may fail to-day owing to the want of coal through the labour war in the city. The coal supply will last out till Friday, by which time it is hoped that an amicable settlement will be arrived at. The notice affects about 500 men. Mr. Nance, the manager, whilst responsible for the above notice, is of the opinion that there will be no cessation in the tramway service. There is a large supply of gas coal on hand, so that the lighting of the city is not imperilled.

West Ham.—The annual report of the West Ham tramways department gives the net profits for the year as £21,712. 5s. 2d., against £18,680. 10s. 7d. Of this sum £7,722. 8s. 10d. is carried to the reserve and renewals fund, £9,668 (equal to a rate of 2d. in the £) is a grant in aid of rates, and the balance of £4,321. 16s. 4d. is carried forward. The capital expenditure of the undertaking, which was inaugurated three years ago, was £501,885. Altogether £24,668 has been voted to the relief of the rates. The West Ham trams have inter-running agreements with Leyton and East Ham, but in the Romford-road, Forest Gate, a length of 1,160 yards is still occupied by horse cars, and prevents through running between West Ham, East Ham, and Ilford. If this span were electrified it would be possible to run through cars from Bow Bridge to Chadwell Heath or to Barkingside, distances of about seven miles. The staff of the department numbers 481, and the wages paid last year amounted to £41,937, including £1,078. 19s. 5d. holiday pay to the outside staff.

Gloucester.—The City Council on Tuesday discussed the position of the tramways undertaking. A resolution was moved to the effect that it was desirable to continue the tramways as a municipal undertaking. An amendment was, however, moved and carried (also as a substantive motion) that a sub-committee, consisting of the Mayor and Councillor Harland Bowden, be appointed to make inquiries and report as to whether or not the light railways could be let on lease on terms favourable to the ratepayers and the city generally. Later, another resolution was moved to the following effect: "That a special committee be appointed to consider the working of the light railways and making suggestions for the improvement of the service, the reduction of expenses, and the increase of receipts, and that such committee report in the first instance to the Light Railway Committee, and report as to the return to ½d. fares; and that such committee consist of the Mayor (chairman), the Deputy-Mayor, the City High Sheriff, Councillors Braine, Poole, Harland Bowden, Evans, Bibby, C. G. Clark, and Ford." This was carried.

York.—The York City Council met in committee last week to consider a report of the Tramways Committee on the question of the provision of an up-to-date system of electric tramways for the city. The committee reported that they had certain routes under consideration, and their estimate of the cost was based upon those routes being adopted. They recommended that a double track should be laid on all the routes (which would comprise a total length of track of 5 miles 5 furlongs) with the exception of about 250 yards, which must of necessity be laid with a single track. The cost of the overhead system was estimated to be £110,917, and of a surface-contact system £119,959. After sitting 2¼ hours in committee, the Council resolved itself into a special meeting, and the adoption of the Tramways Committee's report was moved and seconded. An amendment was moved and seconded that the report be referred back to the committee, with instructions to ascertain from the Light Railway Commission whether a clause can be inserted in an order for the construction of electric tramways in the city to the effect that the Corporation should not work tramways themselves without taking a poll of the citizens, and that they should be authorised to take such poll. The amendment was ultimately adopted.

London County Council.—The Council at their meeting on Tuesday authorised the Highways Committee to obtain tenders from 16 selected firms, together with sealed estimates from the works department, to be considered concurrently, for the erection of the central car-repairing depôt, the Tooting tramways sub-station, and the first portion of the Bow tramways car-shed. The Council discussed the report of the Highways Committee upon the conversion of the Aldgate-to-Bow horse tramways to electric by means of surface-contact traction at a cost of £72,000. (This scheme was outlined in full in our issue of last week.) The debate was opened by Mr. Leverton Harris, M.P., who was of the opinion that the experiment was a very interesting one. It had two objects—the discovering of a system which would be useful to the Council in cases where the conduit system was unsuitable, and the means of meeting the present objections of the local authorities. In attacking the recommendation, the opposition mainly contented themselves with the complaint that the information given the Council was inadequate. Mr. Gordon moved that the report be sent back for reconsideration. He asserted that no system of surface traction had been invented which precluded the possibility of live studs, and that they had been found in Lincoln. The report was adopted, the amendment being defeated by 30 votes. The figures were: against the amendment, 66; for, 36.

Railway Electrification.—Lord Claude Hamilton presided on Tuesday at the meeting of the East London Railway Co., and in referring to the disappointing nature of the results said the main factor in the decrease of revenue had been the falling off in the passenger receipts, due to the electrification of the District, and more

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latterly the Metropolitan Railway, and the non-electrification of their own line. He had obtained a rough estimate of the cost of electrifying their line from Mr. Firth, the electrical engineer of the Great Eastern Railway. He had mentioned two systems to that gentleman—namely, the direct-current third and fourth rail system and the alternating-current overhead conductor system—but on consideration he had come to the conclusion that as the latter system was in its infancy as regarded railways in this country, and they had had no practical experience of its working and cost, and that as the Metropolitan and the District were equipped with the former system, it would be more to their purpose to confine the estimate to the direct-current third and fourth rail system. Mr. Firth surveyed their line and prepared the necessary estimates, and his conclusions were as follows: To equip the whole 12 miles of single track would cost £32,000, but that would not include point rodding, signal wiring, and other details comprised under the head of "track alterations," but probably they would not amount to much. If the supply of power could be obtained from outside sources both north and south of the Thames the track work for that purpose would cost £20,000, which, added to the former figure, made £52,000, and if, owing to the difficulty of obtaining a supply from the southern section, a sub-station had to be erected south of the Thames, there would be a further cost of £18,000, or £70,000 in all. He imagined, however, that a direct supply could be obtained, but even in that case the cost would be £52,000.

Aberdeen.—The report of the Aberdeen Corporation tramways for the year ended May 31 shows that the total revenue for the year was £72,605. 11s. 6d., as compared with £70,507. 19s. 6d. in 1906, an increase this year of £2,097. 12s. The increase in revenue is chiefly attributable to the university quater-centenary celebrations and the visit of the King and Queen, in September last year. During the week of these celebrations the tramway receipts increased £1,400. The working expenses for the year ended May 31, 1907, amounted to £40,434. 16s., and for last year to £40,684. 9s. 8d., a decrease this year of £249. 13s. 8d. The working expenses for 1907 show a decrease, while the miles have increased by 9,453. Economies have been introduced with regard to current consumption, maintenance of track work, lighting of depôts, and general traffic expenses. Car repairs and salting of track show an increase owing to heavy snow-storms. New plant for the steam heating of works, and platforms for several depôts, which have cost £131. 9s., have been charged against revenue. Interest, sinking fund, etc., this year amounted to £18,747. 15s. 10d., as against £18,160. 19s. 10d. last year, an increase of £586. 16s. The balance for the year ended May 31 this year is £13,422. 19s. 8d., and for last year £11,662. 10s., an increase this year of £1,760. 9s. 8d. It may be noted that while the balance over last year stands at £1,760. 9s. 8d., there was incurred at the same time an extra outlay of some £586. 16s. on new plant, etc., which has been set against revenue. The balance for the year is the largest which has yet been available for the renewal account, which now stands at £16,888. 1s. On Sept. 27, 1906, being the visit of the King and Queen, record traffic receipts for one day were obtained—namely, £565. The previous highest receipts for one day were £434 on the September holiday, 1904. Since Sept. 1, 1906, a charge of 1d. has been made for personal luggage over 28lb. in weight, and all packages other than personal luggage for any distance on any one car. The receipts from this new source have been £165. 5s. 5d. The following statistics are given with reference to the consumption of energy. Units used for traction purposes: 1906, 2,019,515; mileage, 1,520,229; ditto, 1907, 1,906,218; mileage, 1,529,682. A decrease in units of 113,297; an increase in miles of 9,453. The cost of electrical energy is £9,361 for 1907, against £9,241 in 1906, an increase of £120, although the units are 113,297 less. This is explained by the rebate from the electricity department being £142 in 1907, against £1,137 in 1906. "During this year much time and care has," says Mr. Pilcher, the manager, "been devoted to the instruction and supervision of motormen. All the men have been properly instructed how to operate the controller in an efficient manner; they have been instructed in the electrical system of control, and shown how a car can be driven to avoid waste of electrical energy. I am pleased to be able to report that the efforts of the management in this direction have not been in vain. Notwithstanding the extra top-covered cars in use, as well as the severe snowstorms, the gradual yearly increase in current consumption has not only been stopped, but has been reduced from 1·328 per car mile to 1·246 per car mile, a decrease of 6 per cent., or a saving of £621. 18s. 10d. on the year's working. The whole staff, and more particularly the motormen, deserve every credit for the willing assistance they have given me on this important subject."

LIGHTING AND GENERAL

Southwark.—The Borough Council have decided to fix 80 Excello lamps throughout the borough at an estimated cost of £800.

St. Pancras.—The London County Council have sanctioned the borrowing of £5,940 by the Borough Council for electric lighting.

Newcastle-upon-Tyne Electric Supply Co.—The directors of the Newcastle-upon-Tyne Electric Supply Co. have declared an interim dividend of 2½ per cent.

Battersea.—The Borough Council have agreed to provide feeders, resistances, booster switches, switch pillars, etc., in connection with a lighting extension to cost £2,830.

Electric Supply Football League.—A committee meeting will be held at the offices of the St. James's Supply Co., Carnaby-street, W., on Tuesday, July 30, at 6.45 p.m.

Barnsley.—A Local Government Board inquiry will be held on July 31 into the application of the Council for sanction to borrow £2,000 for electric lighting extensions.

Stretford.—A Local Government Board inquiry will be held on July 30 into the application of the Council for sanction to the borrowing of £53,460 for an electricity supply.

Mumbles.—The Oystermouth District Council have received notice that the Oystermouth Electric Supply Co. intend applying for a provisional order to supply Mumbles with electric light.

St. James's and Pall Mall Electric Light Co.—The directors of this company have declared an interim dividend for the half-year ended June 30 last at the rate of 10 per cent. per annum on the ordinary shares.

Notice of Intended Dividend.—According to the *London Gazette*, the last day for receiving proofs in the estate of A. Blackburn and J. Walker, electrical and mechanical engineers, Upper-lane Mills, Cleckheaton, Yorkshire, is Aug. 3.

Montreal Light, Heat, and Power Co.—The Bank of Montreal are authorised to announce that a dividend has been declared by the Montreal Light, Heat, and Power Co. for the three months ended the 31st inst. at the rate of 6 per cent. per annum.

Dungannon (co. Tyrone).—The Dungannon electric lighting scheme, which has been hanging off and on for a considerable time, has gone a step forward, an English firm having placed an offer with the Urban Council. The present gas contract is about to expire.

Bristol Tramways and Carriage Co.—The directors of the Bristol Tramways and Carriage Co. have declared an interim dividend at the rate of 8½ per cent. per annum for the half-year ended June 30. The dividend warrants will be posted to the shareholders on Aug. 2.

Middlesbrough. — At the last meeting of the Corporation Electricity Committee the engineer's report showed that the accounts for the June quarter amounted to £3,153, compared with £2,886 on the corresponding period of last year, an increase of £267, or nearly 10 per cent.

Calcutta.—The number of units delivered to consumers during the five weeks ended May 31, 1907, were 704,888, compared with 687,460 units in the corresponding five weeks of 1906. And for the four weeks ended June 28 the units delivered were 577,338 in 1907 and 538,356 units in 1906.

Hammersmith.—The Kensington and Notting Hill Electric Lighting Companies have offered to supply the Borough Council with a bulk supply for the Exhibition of Science, Arts, and Industries at the rate of ·8d. per unit, with a minimum of 1,000,000 units during the period the exhibition is open.

Coventry.—The accounts of the Corporation electricity department for the past year show a net profit of £5,114. 14s. 1d. It is proposed to use a thousand pounds of the surplus in relief of rates, and to place the balance to a reserve fund. The department derives a considerable revenue from the letting out of electric motors on hire.

Trieste.—The report of the consul shows that dynamos and refrigerators placed in vessels during the past year were generally of Austrian production, but British goods still hold the first place, without at present feeling much competition, in such specialities as winches, windlasses, steering engines, and small engines for auxiliary machinery.

Huddersfield.—At the last meeting of the Electricity Committee the engineer reported that there were 2,533 consumers, an increase of 18 on last month; 184,139 lamps connected increase 1,361; and that the units metered for the half-year ending June 30 were 1,139,429, an increase on the same half of the previous year of 89,854 units, equal to 8 56 per cent.

Dissolution of Partnership.—The *London Gazette* announces that the partnership between G. L. Campbell, S. T. Isherwood, and J. A. G. Williams, carrying on business as electrical engineers at Raleigh street, Bootle, has been formally dissolved as regards S. T. Isherwood. The firm will be continued under the present title of "Campbell and Isherwood."

Ravensthorpe.—As the time for lighting the compulsory area at Ravensthorpe with electric light under the electric lighting order will shortly expire, the clerk to the District Council recently wrote to the Board of Trade asking for an extension of time. The Board of Trade has replied promising to defer the consideration of the revocation of the order for 12 months from the present date.

Ventilation of the New Bailey.—Some severe strictures were passed by the judge sitting in the Central Criminal Court on Monday on the ventilation of the court. It appears that the failure was due to a breakdown in the machinery, the engines being placed out of action through a cracked boiler pipe. We understand that an electric motor is to be installed to act as stand-by in case of failure of the engines.

Edinburgh.—By five votes to three the Electric Lighting Committee of Edinburgh Town Council have decided to recommend that the balance of £9,000 (after taking £1,000 from the electric lighting surplus, and devoting it to bringing the reserve fund up to the maximum) be applied to the reduction of capital expenditure. The amendment was to the effect that the balance of £9,000 be devoted to the relief of the rates.

Advertising.—Mr. H. Clifford Palmer has recently resigned his position as advertising manager to the General Electric Co. in order to take an active part in the management of the Clifford Palmer Co., specialists in advertising and printers and compilers of high-class trade catalogues and advertising literature. This concern is specialising particularly for engineering firms and electricity supply undertakings. Their London office is 6 and 7, Creed-lane, Ludgate-hill, E.C.

Bluntisham-cum-Earith.—A committee of the Parish Council has been appointed to interview the several authorities concerned in the laying of the proposed telephone lines to Earith, with the view to prevent, if possible, the erection of posts between the rectory corner and the approach to Earith. There are several alternate

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routes, and probably the Telephone Co. will adopt their suggestions, as by using them money would be saved, seeing they would shorten the distance.

Platinum Substitutes.—There will be a demonstration this afternoon at 4.30 p.m. of the Bastian-Calvert process of enamelling copper strips with glass for use in the manufacture of electric lamps. Platinum Substitutes, Limited, are opening a factory at Hoxton, and the Lord Mayor of London has promised to perform the opening ceremony. The sole employment at this factory will be of cripple labour, and we hope that the employment of cripples on strictly commercial lines will be successful.

St. Marylebone.—The Electric Supply Committee recommended the Council at their last meeting that the existing tariff of charges for electric current should be continued for a further period of 12 months, but that the maximum charge for meter rent should be £1 per meter per quarter. After some discussion, in the course of which it was stated that the committee should look after and endeavour to increase the small consumers, it was decided that the recommendation should be altered to six months instead of twelve.

Australian Customs Tariff.—The following decisions relating to the customs tariff are published in the *Commonwealth Gazette*: Electrical machinery and appliances—ebonite accumulator forks free, ebonite rods cut into lengths for fitting into accumulators free, otherwise 15 per cent.; glass rods cut into lengths for fitting into accumulators free, otherwise 20 per cent.; armature slot troughs, 12½ per cent.; dry-cell batteries for electric pocket lamps when imported separately, free as dry cells. This cancels previous decisions.

St. Annes.—The latest statistics issued show that the electricity undertaking of the St. Annes Council is proving a profitable municipal enterprise. This year's gross profit of £4,534 is a percentage of 12 on the capital employed at the beginning of the year, and is 1·3 per cent. more than the profit last year. The cost of producing electricity has been reduced from 1·39d. to 1·37d. per Board of Trade unit, while the average price has increased from 2·765d. per unit to 2·773d. Out of the profits a sum equal to 2½d. in the £ was devoted to the relief of the rates.

Partnership.—As will be seen from our "Personal" column, the well-known and old-established firm of Taylor and Co., mica merchants and manufacturers, have taken into partnership Mr. John Frederick Podger, a gentleman who has been connected with the mica industry throughout his business career, and they anticipate that his association with the firm will be of advantage both to themselves and their clients. The firm have lately removed from 19 to 40, Hatton-garden, which latter are very large and well-equipped premises, which have been especially built for them.

Electric Lighting Orders.—The Bill to transfer to the company the electric lighting undertakings and works of Exmouth Urban District Council authorised by the order of 1900; of Sidmouth Urban District Council, authorised by the order of 1903; of the works of Messrs. Crompton and Co., authorised by the Dawlish Urban District Electric Lighting Order, 1903; the Teignmouth Electric Lighting Orders, 1899 and 1904; and the Totnes Electric Lighting Order, 1900, was on the 18th inst. before the Select Committee of the House of Commons on Unopposed Bills, and it was passed.

American Cablemakers' Amalgamation.—The Electric Cable Co., of New York, has just bought the entire business of the Eastern Wire and Cable Co., of Roxbury, Mass. The latter company is one of the oldest and largest manufacturers of rubber-covered wires and cables in New England. Its entire equipment will be removed to Bridgeport, Conn., where it will be installed in the plant of the Electric Cable Co., which has in course of construction a large addition to its plant. The officers of the Electric Cable Co. are: president, Edwin W. Moore; vice-president, F. H. Cowles; treasurer, J. Nelson Shreve.

Small Country House Lighting.—In issuing their revised edition of "Light in the Country," Messrs. R. J. Nicholson and Co., of Macdonalds-lane, Manchester, and 46, King William-street, E.C., claim that a definite demand exists for an electrical equipment at a price approximating that of a self-contained gas lighting plant. This they assert is possible with their "Ideal" electrical outfit, and to prove their contention they have published a net price-list for entire plants—engine, dynamo, storage battery, and switchboard—for houses of various sizes. They will send a copy of this list to any authenticated member of the electrical fraternity.

City and Guilds Institute.—The council of the City and Guilds of London Institute have awarded the diploma of associate (A.C.G.I.) to the following matriculated three years' students of electrical engineering of the Central Technical College: J. W. Wheeler (Siemens medal and premium), C. H. Harvey, A. Collins, P. E. Hosegood, A. Kinnes, C. H. Toms, C. G. Barker, R. P. Abel, H. R. Rivers-Moore, H. E. Parry, L. N. Vine, J. O. Fraser, J. M. McG. Whellens, L. G. Dalais, C. A. Schurr, L. B. Sparks, G. E. W. Broade, E. H. Child, W. R. Harding, B. A. Tubini, C. H. Lauth, J. B. G. Northcott, C. Latham, L. T. Young, H. L. Bazalgette, and J. Mc. L. Donald.

Stock Exchange.—The Stock Exchange Committee has appointed special settling days as under: July 30, Pena Copper Mines, Limited, further issue of 114,600 shares of £1 each fully paid, Nos. 400,001 to 514,600; Aug. 8, Electric Traction Co. of Hong-Kong, 325,000 shares of £1 each fully paid, Nos. 1 to 325,000, and Whim Well Copper Mines, Limited, 20,007 shares of £1 each fully paid, Nos. 1 to 7 and 100,008 to 120,007; and ordered Birmingham and Midland Tramways, Limited, further issue of £152,237 4½ per cent. first debenture stock to be quoted in the official list. Application has been made to the committee to allow National Telephone Co.'s further issue of £616,425 deferred stock to be quoted in the official list.

South London Electric Supply Corporation.—The General Purposes Committee of the Lambeth Borough Council have presented a report with reference to the dispute with the South London Electric Supply Corporation. For some years the matter has been in an unsettled state, and resulted from the refusal of the company to continue to burn the refuse from the dust-bins. Interviews have recently taken place, and the Corporation agreed to settle the dispute on the following terms: the company to give the Council free light to the value of £1,000 a year and to pay £300 towards the Council's out-of-pocket costs of the action. The committee recommended that the actions against the corporation should be settled on the lines indicated. It was agreed that the committee's recommendation should be adopted.

Rawtenstall.—The Town Council have decided to apply to the Local Government Board for power to borrow £29,000 for providing an electricity generating station at Hareholme, and the mains and equipment for a general electricity supply for the borough, including a supply for tramway purposes. Messrs. Lacey, Sillar, and Leigh, electrical engineers, have been asked to prepare the necessary plans and estimates of the cost. It has also been decided to offer a certain price to the Rossendale Valley Tramways Co. for their undertaking, which is to be electrified by the Rawtenstall Corporation. The Corporation has declined to fall in with a proposal from the Bacup Corporation that the three boroughs of Bacup, Rawtenstall, and Haslingden should combine in purchasing electricity in bulk from a private company.

Lewisham.—The Works and Highways Committee have reported the receipt of a notice from the South Metropolitan Electric Light and Power Co. of their intention to lay a main along a portion of London-road, Forest Hill. The committee have approved the proposal subject to the reinstatement being carried out by the Council, at the cost of the company, in accordance with the scale of charges adopted for such works, and to the trenches where they are in tar paving being broken up, either to the forecourt line or to the kerb, whichever is the nearer, and to no part of the footways being kept open more than one week, the Council reserving to themselves the right to fill in the ground and charge the company with the cost of the trenches if allowed to remain open for a longer period, and also subject to the cables being laid at a depth of at least 2½ft. where crossing a carriageway.

Bethnal Green.—The Electricity Committee received a letter from the Shoreditch Borough Council with reference to the London County Council (Electric Supply) Bill, stating that they had asked the London County Council to convene a conference of metropolitan borough councils possessing electricity undertakings to consider the question of electricity supply for London, and that, as the interests of those councils not possessing electricity undertakings are so different from the interests of those who do, it was thought advisable for them to be consulted in two groups. The committee, however, are of opinion that it would be far better for all the metropolitan borough councils to be invited to attend one conference, whether carrying on electricity undertakings or not, and are recommending that the Council join in a request to convene a conference, provided that all the metropolitan borough councils be invited to attend it.

Liverpool and District Electrical Association.—The first meeting of the above association was held at the Common Hall, Hackins Hey, Liverpool, on the 16th inst. Through the unavoidable absence of Mr. J. E. Lloyd Barnes, the chair was occupied by Mr. J. J. Richardson, of Liscard. The scheme and position up to date was explained by Mr. S. Frith, the promoter and hon. secretary, supplemented by remarks by the chairman, and afterwards considerable discussion took place. It was decided that the present committee, formed by Mr. Frith, should continue to carry on the business for a term of three months, when the question would come up for further consideration. To-morrow, July 27, the association will pay a visit to Formby power station by kind permission of Mr. H. E. O'Brien, (Lancashire and Yorkshire Railway). The next meeting will be held in the Common Hall, Hackins Hey, Dale-street, Liverpool, at 8 p.m. on July 30.

Midhurst.—A special meeting of the Midhurst Ratepayers' Association has been held for the purpose of hearing a statement by Mr. Walker, a representative from the G.P.O., on the subject of introducing telephone facilities at Midhurst. Mr. C. Lane presided, and the attendance included the majority of the tradesmen of the town. Mr. Walker stated that the Post Office propose to link up Midhurst, Petworth, and Pulborough in one area, and subscribers in this area could have a three years' agreement at £5 a year, for which they would have 500 "local" calls in the linked area. He explained at some length the advantages of the telephone, and replied to numerous questions. At the close of the meeting several tradesmen signed provisional agreements with the Post Office to become subscribers. It is understood that if 30 subscribers can be obtained, arrangements will be made immediately to extend the system to Midhurst from the nearest trunk line.

Manufacturers' Lists.—The Consett Iron Co. has issued a booklet which contains full particulars and information respecting its manufactures. It is of interest that this booklet is also printed in Esperanto, and a copy will be sent to anyone interested who will make application to the company.—We have received from Mr. T. Schoner, 3, Alexander-street, Park-lane, Leeds, a sample and particulars of Schoner's staple driver, which is a simple device for fastening electric wires, etc., with staples. The driver is constructed to hold several sizes of staples, and is made entirely of steel. It is sold at the price of 1s.—Messrs. S. Wolf and Co., 138, Southwark-street, Blackfriars Bridge, London, S.E., have issued a new catalogue of electric drilling and grinding machines and portable electric tools. Mention should be made of the fact that this firm can supply continuous, single, two, and three phase current machines up to 500 volts. A special feature in the way of labour-saving tools is a portable hand grinding and polishing machine for such work as vice, finishing castings, motor chassis work, and for polishing and grinding *in situ*.

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Tewkesbury.—At a meeting of the Town Council the General Purposes Committee reported the receipt of a letter from Messrs. Foote and Milne giving notice of their intention to apply for a provisional order to supply the borough with electric light. The town clerk reported the receipt of a letter from the Board of Trade inquiring what steps had been taken, or were to be taken in the immediate future, to carry out their obligations under the electric lighting order. He was instructed to reply that, after proper inquiries had been made, it appeared very doubtful whether the works could at the present time be erected and conducted at a profit, and subsequently further inquiries were made. These various inquiries had occupied the time since the order was granted, and it was now felt that if an extension of the period for carrying out the works was made, it was very probable that in a short time arrangements would be entered into for the transfer of the order to a company.

York.—The returns of the city of York electricity department for the month of June contain the following statistics as to electricity produced and income: Units generated, 75,307; used on works and battery, 5,808; unaccounted for (lost in distribution, etc.), 12,411; used on public lighting, 8,576; ditto private lighting and power, 45,012; ditto private arc lamps, 3,500—total sold, 57,088. Income—public lighting, £132. 10s. 5d.; private lighting and power, £411. 9s. 5d.; motor and radiator rents, £44. 6s. 8d.; private arc lamps, £25. 4s.—total, £613. 10s. 6d. Total income per unit sold, 2·53d.; horse-power of motors connected during month, 13½; total horse-power of motors connected to date, 895; 8-c.p. lamps connected during month, 216; total 8-c.p. lamps connected to date, 56,068; equivalent 8-c.p.'s connected—total, 78,443. The percentage of units unaccounted for (lost in distribution, etc.), is 21·74. The total works cost during the month amount to £261. 0s. 10d., consisting of £68. 14s. 5d. for steam for destructor, £35. 16s. 1d. for coal, £6. 1s. 10d. engine-room stores, £66. 16s. 9d. wages at generating station, £83. 11s. 9d. for repairs, maintenance, wages for distribution, etc. In addition, £45. 10s. 9d. appears for rent, rates, and taxes, £30. 6s. 10d. for renewals and attendance of public arcs, and £46. 18s. for insurance, legal, and management expenses, including salaries of engineering department and clerical staff. The total cost for the month was £383. 16s. 5d., as compared with £389. 10s. 3d. in the corresponding month of last year.

Wolverhampton.—Mr. A. G. Drury, on behalf of the Local Government Board, held an inquiry with regard to an application by the Town Council to obtain sanction to borrow £35,000 for the purposes of their electricity undertaking. The proceedings were of a formal character, there being only about half a dozen members of the Council and officials present. The case for the Corporation was explained by the town clerk (Mr. Horatio Brevitt), who said the money was required to extend the generating station, erect new boilers, put in new plant, and extend the mains. Recently, he explained, the Town Council had entered into an important contract to supply Messrs. Bayliss, Jones, and Bayliss with electricity to be used at their works at Monmore Green. This would involve an expenditure of £16,000 with regard to the generating plant. In addition, the Corporation would have to cope with the general demand for electricity and the growth of the undertaking throughout the borough generally. It was proposed to provide four more boilers—the boiler-house would have to be enlarged—and four more generating sets. The electricity would be transmitted to Messrs. Bayliss, Jones, and Bayliss, where it would be transformed. The town clerk asked that the repayment of the loan should be on the longest possible terms. Several witnesses were called, and it was understood, after the inspector had visited the generating station, that his report would be of a satisfactory character.

Lowestoft.—The Lowestoft Town Council having applied for permission to raise £18,150 for electric light extensions, Mr. R. H. Bicknell, M.I.C.E., one of the Local Government Board inspectors, attended at the town hall for the purpose of holding the usual inquiry. Mr. Cann, deputy town clerk, gave statistics. The population of the borough in 1901 was 29,850; it was now estimated at 33,946. The annual assessable value for poor-rate purposes was £140,520, and for the general district rate £129,946. The area of the borough is 2,306 acres, and this was served by the electric light undertaking. The general district rate last half-year was 2s. 8d. in the £, and it was 2s. 7d. this. The poor rate was 2s. 1d. in the £, making 4s. 8d. for the half-year—9s. 4d. in the £ for the year. The Electricity Act received the Royal assent in July, 1898, and the works were started in 1899. Supply operations were commenced in 1901. The Local Government Board had consolidated the loans, and the actual amount outstanding last March was £64,345. The original sanction was for £75,472. The total amount now applied for was made up as follows: services, £1,500; meters, £1,500; public lighting, £1,200; distribution, £3,500; new feeder to Kirkley, £1,600; new feeder to Nelson-street, £1,200; new distributor for Kirkley, £1,700; new feeder to bridge, £1,500; oil filter, £250; motors on sale or hire, £3,000; free wiring, £1,000—a total of £17,950. There was also an additional amount of £200, which made up the £18,150. The inspector asked for the details of the £1,200 for street-lighting, and was told that part was for the lamps and part for the posts. He replied that he should like to know the proportions, so that the amount could be equated, otherwise the whole of the loan would be for lamps, and the term would be very much shorter. The engineer thereupon remarked that the details should be sent up to the Board. The inspector then proceeded to view the electricity depôt.

Merthyr.—At the last meeting of the Council the following letter was read from the Dowlais Gas Co.: "I am instructed to acknowledge receipt of your letter of July 2, and express the great surprise of my directors to receive three months' notice to terminate the lighting of the public lamps in the New-road, North-street, Union-street, and Victoria-street, Dowlais. You are well aware that the agreement with us is for the lighting of all the streets in Dowlais at 75s. per lamp per annum. The price was fixed after a most careful study of the average cost of the close town streets, and the more scattered outside area, and it is self-evident that it is perfectly impossible to light the scattered and distant outside districts at the same cost as if the better lighted and near town streets were included. My company, therefore, feel that they have been most unfairly dealt with by the Council accepting an offer without any competing tender whatsoever for the lighting of the easiest and cheapest lit portion of the town. They are the more surprised, as not only was no request at all made to them to submit any alternative tender, but an offer made by them (on information gleaned only from the Press) was not even considered by the Council. In these days it is beyond all question proved and generally accepted that gas lighting is far more efficient and economical than electric light for illuminating purposes. My directors, therefore, feel there must be some misunderstanding of the actual facts by the majority of the Council, and they trust it is not too late to ask for a reconsideration of the whole question, and that they may be given an equal opportunity of quoting for any improved lighting that may be decided upon either for the whole or any portion of the town.—I am, etc., David Jones." The Chairman said the tender of the traction company had been accepted and confirmed. In reply to questions, the Town Clerk said the company were never asked to tender for lighting a particular portion of the town, but they were asked to reduce the cost of lighting as a whole. Councillor F. T. James moved, and Alderman D. W. Jones seconded, that the letter be referred to the Public Works Committee, but the Chairman ruled that the question had been settled.

Manchester.—Dr. A. W. Brightmore, an inspector of the Local Government Board, held an inquiry into an application by the Electricity Committee of the Corporation for sanction to borrow £112,850 for the purposes of the electricity undertaking. Mr. T. Hudson, deputy town clerk, appeared for the committee, and explained that the application came before the inspector under a resolution adopted by the City Council on June 12 last. The loan was needed partly to provide new machinery at the Dickinson-street and Bloom-street stations, and also at the Stuart-street station, for purposes of economy. For these works £5,752 was required. With regard to Dickinson-street and Bloom-street, it was expected that upon the provision it was proposed to make there would be a saving of about £1,000 a year in the coal bill, which was a consideration, and was the object of the committee in putting down this particular plant. For mains a sum was required of £60,498; for transforming plant at sub-stations on consumers' premises, £32,000; and for additional plant at the Corporation distributing stations, £14,600—making up the total to £112,850. This expenditure was necessary because the business of the department was continually growing, and additional provision must be made. The amount which the committee asked sanction to borrow would be exhausted in the next three years. It was proposed that the committee should have a blank cheque for the expenditure of the money within that period. A new suspense account would be opened, and he undertook, when the expenditure was completed, to render a full statement as to the amounts expended, similar to that which was given in relation to the £72,000 the committee had previously been authorised to borrow. This was not, Mr. Hudson pointed out, an application for a loan which would involve any charge whatever upon the rates. The electricity department of the Corporation had never during its existence been a charge upon the rates of the city, and, as far as could be seen from present experience, it never would be. On the contrary, the committee had seen their way in their last estimate to insert a figure which they had every reason to think would be realised—namely, a sum of £10,000 as a grant in aid of the rates. The terms of repayment proposed were: for the loans for generating stations and mains, 25 years; and for new plant at sub-stations or consumers' premises, and additional plant at Corporation distributing stations, 20 years. Mr. S. L. Pearce, chief electrical engineer, gave details of the work proposed to be done. At the close of the inquiry the inspector visited the works.

Grimsby.—An inquiry was held on the 20th inst. into the proposal of the Town Council to borrow £3,825 for the purposes of the electricity undertaking. The deputy town clerk, Dr. Grange, stated the case for the Corporation. He said the population of the town was 69,000, the rateable value £276,988, the assessable value £231,663, and the amount of the town's indebtedness on March 31 last £219,809, including £84,357 for electric lighting undertaking. He gave particulars of the current rates, and went on to inform the inspector that it had become necessary to increase the electrical plant for the coming winter, hence they wished to obtain the loan of £3,825, and they asked that the Local Government Board should extend the repayment of the loan over as long a period as possible. The inspector asked if there was any opposition to the proposal. There was no response, and Mr. W. A. Vignoles made his statement, in the course of which he gave a *résumé* of the scheme since its inception. He submitted a copy of his last annual report, covering the year 1906-7, from which the steady increase in the amount of business done was shown, and the net surplus, after providing interest and repayment of capital, amounted to £1,261. The plant had been extended from time to time, and on May 26, 1907, the Local Government Board sanctioned a loan of £8,819 for additional plant, buildings, etc. This plant had been installed, and had been working since November of last year but instead of it being sufficient, as anticipated, to deal with the increase in the load during the three years, the increase of private consumers had been so great that further extension was necessary. The Corporation were under contract to supply the railway company with electric energy for use on the docks for a period of three years, but if the company ceased to take a supply at the end of their contract, the new plant would still be usefully employed, as the load would be greater than the normal capacity of the existing plant. After carefully considering the matter, the capacity of the boilers and con-

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densing plant was found to be sufficient to supply a new 500-kw. set, if two of the 92-kw. sets were removed, thus increasing the total capacity of the plant by 316 kw. This scheme was therefore decided upon, the cost being estimated at £3,490, without including anything for cutting away old foundations, etc., all of which would be done out of revenue. In addition to this amount, £335 was required for the supply, delivery, and erection of one motor-generator, one switchboard, one automatic regulator, and three small switchboards, making the total to be borrowed £3,825. Councillor Moss confirmed the statement which had been very clearly laid before the inspector by Mr. Vignoles, and said that the matter had been carefully considered by his committee, and he hoped the inspector would grant the application, so as not to cripple them in their finances. This concluded the inquiry.

PROVISIONAL PATENTS, 1907.

JULY 15.

16188. Improvements in fixing the terminals and contact pieces of electrical fittings. Henry Bevis and Frederick Morris Chapman, Peel Works, Adelphi, Salford, Manchester.

16191. New or improved automatic electromagnetic switch or cut-out for disconnecting charged conductors in overhead systems of electric traction or the like. Willie Barraclough, 32, John William-street, Huddersfield.

16227. Means for controlling the supply of electricity at a distance. William Corin, 111, Hatton-garden, London.

16235. Improvements in and relating to electric light and bell fittings. Hugh Vaughan Pears, 70, Chancery-lane, London.

16251. Improvements in insulating conduits for electric wires. Anthony Paul Hinsky, 40, Chancery-lane, London. (Complete specification.)

16252. Electric switch operating device. Paul Rojcsik, 40, Chancery-lane, London. (Complete specification.)

JULY 16.

16286. Improvements in or relating to signals on electric and other vehicles for the prevention of accidents to passengers or pedestrians. Cornelius John Sutton and Joseph Rudd, Nelson-square, Bolton.

16301. New form of electric lamp for lighthouse apparatus. Charles Alexander Stevenson, 28, Douglas-crescent, Edinburgh. (Complete specification.)

16324. Improvements in printing telegraphs. Siemens Bros. and Co., Limited, and George Sylvester Grimston, Birkbeck Bank-chambers, Chancery-lane, London.

16345. Improved starting device for the motors of automobile vehicles. Bernard Mauvillier, 7, Southampton-buildings, London.

16346. Improvements in electrical systems of distribution. William Arthur Turbayne, 7, Southampton-buildings, London. (Date applied for under Patents Act, 1901, July 25, 1906, being date of application in United States.) (Complete specification.)

16360. Improvements in and relating to electric batteries. Horace De Martis and Harry Otto Thomas, 18, Southampton-buildings, London.

16364. Improvements in automatic multiple fuse blocks. William Cornelius Mayo and John Houlehan, Norfolk House, Norfolk-street, London. (Complete specification.)

16366. Improvements in starters for electric motors. William Cornelius Mayo and John Houlehan, Norfolk House, Norfolk-street, London. (Date applied for under Patents Act, 1901, Feb. 11, 1907, being date of application in United States.) (Complete specification.)

16369. Improvements in electric switches. Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London.

16372. Improved method of and means for applying insulating material to electric cables, parts of electric generators or motors and the like. Hugh McPhail, 7, Southampton-buildings, London.

JULY 17.

1197A. Improvements in and relating to the treatment of refractory materials by electricity. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.) (Date applied for under Rule 5 of the Patents Rules, 1905, Jan. 16, 1907.)

16383. Improvements in electric light carriers or fittings. Henry Milnethorpe Appleyard and Edgar Quiggin, 15, Water-street, Liverpool.

16386. Improvement in starting switches for electrical motors. Frederick Joseph Arundel Matthews, 73, Victoria-crescent, Eccles, Lancashire.

16393. New or improved appliance for electrical or mechanical massage. John Charles Macdonald Moore, 123, Fleet-street, London.

16409. Improvements in telephonic transmitters and translators. William John Rickets, 34, Church-lane, Charlton, Kent.

16431. Improvements in connection with incandescence electric lamps. Charles Henry Stearn and Charles Fred Topham, 46, Lincoln's-inn-fields, London.

16434. Improvements in or relating to electric contact breakers, particularly for use with internal-combustion engines. John Milburn, 18, Hertford-street, Coventry.

JULY 18.

16450. Improvements in electric motor control. Francis Albany Petch, Frederick Duncan, and Otis Carter Formby King, 30, Broadway, Westminster, London.

16461. Improvements in or connected with devices for making and breaking electric contacts. Frederick Henry Varley, 57, Chancery-lane, London.

16467. Improvements in telemeters. Carl Zeiss, Jena, Germany. (Date applied for under Patents Act, 1901, June 12, 1907, being date of application in Germany.) (Complete specification.)

16485. Improvements relating to appliances for regulating or controlling and measuring electric currents. Raffaello Lenner, 37, Essex-street, Strand, London.

16469. Manufacture of a plastic mass from tungsten compounds. Siemens und Halske Akt.-Ges., Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Patents Act, 1901, July 21, 1906, being date of application in Germany.) (Complete specification.)

16500. Improvements relating to electric self-winding clocks. William Edward Lake, 7, Southampton-buildings, London. (Charles Edward Sanford, United States.) (Complete specification.)

16503. Improved method of attaching tungsten filaments in electric glow lamps. Deutsche Gasglühlicht Akt.-Ges. (Auergesellschaft), 55, Chancery-lane, London. (Date applied for under Patents Act, 1901, May 6, 1907, being date of application in Germany.) (Complete specification.)

16508. Improvements relating to mouthpieces for telephones, speaking tubes, and the like. George William Bécheraz, 8, Quality-court, Chancery-lane, London.

16529. Improvements in and relating to alternating-current electric motor of the commutator type. Allgemeine Elektricitäts Ges., 83, Cannon-street, London. (Date applied for under Patents Act, 1901, July 19, 1906, being date of application in Germany.) (Complete specification.)

16530. Improvements in and relating to the preparation of refractory materials. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

16531. Improvements in and relating to supports for the filaments of electric incandescent lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

JULY 19.

16536. Improved form of telephone or other message recorder. Edward Ernest Moore and Walter Powles, 249, Kensal-road, London.

16553. Improvements relating to electrical testing apparatus. Charles Thomas Gambrell and Thomas Edward Gambrell, 23, North-side, Clapham Common, London.

16559. Improvements in electrically-driven tyre inflaters. Cecil Robert Whipple, 37, Moorfields, Liverpool.

16574. Improvements in electrical switches. Andreas Peter Lundberg, Gustaf Charles Lundberg, and Perival André Lundberg, Queen Anne's-chambers, Westminster, London. (Complete specification.)

16577. Improvements in fittings for supporting electric conductors. Theodor Buchholz, Thanet House, Temple Bar, London. (Complete specification.)

16582. Improvement in controlling switches for electric trains. Siemens-Schuckertwerke G. m. b. H., Birkbeck Bank-chambers, Southampton-buildings, London. Date applied for under Patents Act, 1901, July 28, 1906, being date of application in Germany.) (Complete specification.)

16585. Improvements in electric clock systems. Alfred René Upward, 11, Caithness-road, Brook Green, London.

16586. Improvements in or connected with washers and terminals or the like for electrical work. Gilbert Harrison Bartlett, Birkbeck Bank-chambers, Southampton-buildings, London.

16590. Improved electrically-propelled vehicle. Hugo Paul Schreiber, 35, Grosvenor-mews, Bond-street, London.

16615. Improvements in and relating to protective devices for electric distribution systems. British Thomson-Houston Company, Limited, Edmund Basil Wedmore, and William Pancras Hamlyn, 83, Cannon-street, London.

16616. Improvements in and relating to filaments for electric lamps. British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

16617. Improvements in and relating to filaments for electric lamps. British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

16618. Improvements in and relating to transformers and controlling apparatus therefor. Allgemeine Elektricitäts Ges., 83, Cannon-street, London. (Date applied for under Patents Act, 1901, July 19, 1906, being date of application in Germany.) (Complete specification.)

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JULY 20.

16642. Electrical device for the automatic control of time signals or electric light circuits. Frank Clare Webber, 85, Park-street, Bristol.

16644. Improvements in electrical devices for exhibiting advertisements. Cecil Charles Hewett, Robert Tweedy Smith, and William Frederick Foster, 34, High Holborn, London.

16675. Improved magnetic ore separator. Gustaf Waldemar Lundberg and Anders Gustaf Holmberg, 116, High Holborn, London. (Complete specification.)

16696. Improvements in or relating to electrically-heated apparatus suitable for cooking and other purposes. Arthur Francis Berry, 46, Lincoln's-inn-fields, London.

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Aug. 8.)

1906.

15839. Electric driving gear for machine tools and like machines. Wichler and Rennert.

16066. Rests for telephone receivers. Coan.

16263. Automatic switching apparatus for use in installations for electrically lighting railway trains. Wright.

16590. Railway train electric lighting apparatus. Martin.

17459. Electrical machines having flywheels. (Felten und Guillcaume - Lahmeyerwerke Akt.-Ges. (Date applied for under International Convention, Nov. 21, 1905.)

17742. Solenoid-controlled electric switches. Curtis and Adams.

18186. Systems of electric motor control. British Thomson-Houston Company. (General Electric Company.)

18220. Utilisation of wind power for generating electricity for lighting or other purposes. Broughall.

18738. Manufacture of filaments of metallic tungsten or molybdenum for electric incandescent lamps. Lederer.

19411. Electrodeposition of alloys. Cowper-Coles.

19627. Self-regulating dynamo-electric machines. Mather and Platt, Limited. (Rosenberg.)

19704. Brushes for dynamo-electric machines. Morgan Crucible Company and Spiers.

20752. Mounting of dynamo-electric machines. Loring.

20803. Electric motor control devices. British Thomson-Houston Company. (General Electric Company.)

21253. Control of electric motors, more especially applicable in the operation of bulkhead doors and the like. British Thomson - Houston Company. (General Electric Company.)

21299. Means for preventing the spread of fire in connection with electric wiring. Robinson and Walker.

21583. Electrolytic manufacture of metallic wire, strip, or the like. Cowper-Coles.

22317. Control of electric motors. British Thomson-Houston Company. (General Electric Company.)

22904. Dynamo-electric machines. British Thomson - Houston Company. (General Electric Company.)

23054. Electric drive for paper-making and like machines. James Bertram and Son and Happer.

23246. Two-phase alternating-current distribution. Russell and Berry.

23444. Brushes for dynamo-electric machines. British Thomson-Houston Company. (General Electric Company.)

23602. Electricity meters. Hookham.

23781. Electrical resistance thermometer. Johnson. (Firm of Heraeus.)

24209. Maximum demand indicators for electrical measuring instruments. Garrard, and Ferranti, Limited.

24239. Method of and means for electrically driving printing and other machines. Mitchell.

26829. Magnetic compasses and the like. St. Aubin.

1907.

538. Slot switches for electric tramways and the like. Korns.

615. Electric safety-lamps for use in mines. Mallet.

1663. Electricity meters. May.

1665. Telephones. Kountz. (Date applied for under International Convention, Jan. 22, 1906.)

2491. Elastic suspension for wheels of bicycles and motor cycles. Sprung. (Date applied for under International Convention, Feb. 1, 1906.)

2613. Electrical maximum demand or rebate indicators. Hatfield, and Reason Manufacturing Company.

2983. Automatic electrical targets for rifle practice. Rose and Crowle.

3245. Arc lamps. Carbone. (Date applied for under International Convention, March 17, 1906.)

4927. Electric furnaces. Chaplet. and Soc. la Neo Metallurgie. (Date applied for under International Convention, Sept. 25, 1906.

5937. Electric heating apparatus for dentists' instruments and the like. Lord.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	–	½-⅝
—— Ord., 1 125,000	1	..	½-¼
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	⅝-¾
British Aluminium Co, Ordinary, 2,001-40,000	5	..	4½-5½
—— 7 per cent. Cum. Pref., 1-40,000	5	..	5-5¼
—— "A" 6 per cent. Cum. Pref., 1-20,000	5	..	5-5¼ xd
—— 4 per cent. Funding Certificates, 1-20,000	5	..	3¾ 4¼
—— 5 per cent. 1st Mort Deb. Stock, Red.	100	..	100-103
—— 5½ per cent Loch Leven Deb (Reg.), Red , 1-3,000	100	..	98-101
British Insulated and Helsby Cables, Ord., 1-100,000	5	–	6¾ 7¼
—— 6 per cent. Cum. Pref., 1-100,000	5	–	6¾-6¾
—— 4½ per cent. Mortgage Debentures	100	–	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	–	89-93
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	5	..	1-1½
—— 4 per cent. Mortgage Debenture Stock	100	..	58-63
Brush Electrical Engineering, Ordinary, Nos. 1-106,731	2	..	¾ ⅞
—— Non. Cum., 6 per cent. Pref.	2	..	⅞ 1¼
—— 4½ per cent. 1st Debenture Stock	100	..	88-91
—— 4½ per cent. 2nd Debenture Stock	100	..	7 -74
Callender's Cable, Debentures	100	..	105½-107½
—— Ordinary	5	..	9½-10½
—— 5 per cent. Pref.	5	..	5⅜-5⅝
Consolidated Electrical Co., Ordinary, 1-110,000	1	..	7/16-9/16
Crompton and Co.	3	..	1⅞-2⅛
—— 5 per cent. Debentures	100	–	96-99
Dick, Kerr, and Co., Ordinary, 1 250,000	1	..	1⅜-1⅝
—— 6 per cent. Cum. Pref., 1-305,000	1	..	1-1¼
—— 4½ per cent. Debenture Stock, Red.	100	..	100-103
Edison and Swan United, "A" Shares, 1-99,261	3	–	1⅛ 1⅜
—— "A" Shares, 01-017,139	5	–	2¼-2⅜
—— 5 per cent. Debentures	100	–	8 92
—— 4 per cent. Deb. Stock, Red.	100	–	83 85
Electric Construction, Nos. 1 to 112,100	2	–	3/16-7/16
—— 7 per cent. Cumulative Pref.	2	–	1⅛ 1⅜
—— 4 per cent. Perp. 1st Mort Deb.	100	–	77 81 xd
Electrolytic Alkali Co., Ordinary, 1-202,218	1	..	¼-⅜
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	—
General Electric Company (1900), 5 per cent. Cum. Pref.	10	–	8-8½
—— 4 per cent. 1st Mort. Deb. Stock	100	–	92 96
W. T. Henley's Telegraph Works, Ordinary	5	–	11½-12½
—— 4½ per cent. Preference	5	–	5-5½
—— 4½ per cent. Debentures	100	–	105½ 107½
India Rubber, Gutta Percha, and Telegraph Works	10	–	15 6
—— 4 per cent. Debentures	100	–	97-99
National Electric Construction Co., 1-170,000	1	..	27/32-31/32
Parker, Thos., Limited, Ordinary	10	–	10-10¼
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5	..	3¼ 4
Telegraph Construction and Maintenance	10	–	31-33
—— 5 per cent. Bonds	100	–	99 02
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	..	9¼ 9½

Electric Lighting and Supply.—

Name.	Amount paid.		Last price
	£		£
Adelaide Electric Supply Co., 6 p c. Cum. Pref., 1-10,000		..	4⅜-5¼
Bournemouth and Poole, Ordinary	10	–	10 11
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	–	9¾ 10¼
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	–	10¼ 0¼
—— 4½ per cent. Debenture Stock, Red.	100	–	99 102
Bromley (Kent) Electric Light and Power Co.	5	–	4¾ 5¼
—— 4½ per cent. 1st Debenture Stock, Red.	100	–	98 100
Brompton and Kensington, Ordinary	5	–	7¾ 8¼
—— 7 per cent. Preference	5	–	7¼ 7½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	–	6¾ 7¼
—— Nos. 80,001-100,000	4	–	6¼ 7¼
Cambridge Electric Supply Company, £10 Ord.	8	–	12-13
Canadian General Electric Co., Common Shares	$100	..	122-126
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	–	99 102
Charing Cross, West End, and City Electric Supply, Ord., 1-8 ,000	5	–	3¼ 4
—— 4½ per cent. Cum. Pref., 1-80,000	5	–	4 4¼
—— 4 per cent. Debenture Stock, Red.	100	–	95 98
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	–	3¼ 4
—— ditto (1905) 40,001-80,000	5	–	3¼ 4¼
Chelsea Electricity Supply	5	–	3¼ 4¼
—— 4½ per cent. Debentures	100	–	101 104
Chicago Edison Co , 1st Mt. 5 p. c. 30-yr. Gld. Bds , Red., 1-1 200	$1000	..	98-101
City of London, Ordinary	10	–	9- 0
—— 6 per cent. Cumulative Pref.	10	–	10¾-11⅛ xd
—— 5 per cent. Debenture Stock	100	–	121-124
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	–	96 99
City of Wellington Electric Light and Power Co , 5 per cent. Registered 1st Debs., Red., 1-1,650	50	–	50 53
Cordoba Light and Power Co., 1st Mt Stl. 5 per cent. Bds., Red., 1-1,000	100	..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001- 0,000	5	..	4¼-5
—— 5 per cent. Preference, 1 50,000	5	..	4½-5
County of London Electric Supply, Ordinary	10	–	7 8
—— 6 per cent. Cum. Pref.	10	–	10½-11½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	–	106-109
—— 4½ per cent 2nd Debentures Prov. Certs.	100	–	94 97
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5	–	¾ 1
—— 6 per cent. Cum. Pref.	5	–	1-2
—— 4½ per cent First Mort. Deb	100	–	76 81 xd
Electrical Development Co of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, 0,751-15,750	—	..	79-81 p.c.
Electric Lt & Traction Co of Aust., 6 p c Cm Pf , 1 30,000	5	–	2¼ 2⅜
5 per cent Debenture Stock Red	100	–	85½ 89½
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red	100	–	91½ 96½
Folkestone Electric Supply, Ord. Nos. 1-10,000	5	–	4⅛ 5⅜
—— 4½ per cent. First Deb. Stock, Red.	100	–	98 101
Hove Electric Lighting, Ord., 1-13,000	5	–	6¾ 7¼
Indian Electric Supply and Traction Co , 6 per cent. Construction Deb. Stock, Red.	100	..	103-106
Isle of Wight Elec Lt. and Pwr., 4½ p.c. Db. Stk. Red.	100	–	94-97
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	–	—
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5	–	8¼-9⅛
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	–	96 99
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9¾-10¼
London Electric, Ordinary	5	–	1⅝ 2⅛
—— 6 per cent. Pref.	5	–	4¾ 5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	–	95-96

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Name.	Amount paid.	Last price
	£	£
Madras Electric Supply Corporation, 5 per cent. Construction Deb. Stock., Red. (Prov. Certs.), all paid	—	94-97
Metropolitan Ordinary, 100,001-300,000	5	5½ 6¾
—— 4½ per cent. First Mortgage Debenture Stock	100	103-107
—— 4½ per cent. Cum. Pref.	5	4¾ 5¼
—— 3½ per cent. Mortgage Debenture, Red.	100	87 92
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds., 1935, C 1-1,000 ($100), D 1-5,000 ($500), M 1-4,400 ($1,000)	—	74¼-76 p.c.
Mexican Light and Power Co., Capital Stock	$100	45-47
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14,000 ($1,000)	—	84½-86½
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	95-98
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,000	5	7¼ 7¾
—— do., 57,001-75,000	5	7¼-7¾
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid)	4	5-5¼
—— 5 per cent. Pref., 1-57,000	5	5 6
—— do., 75,001-87,500 (issued at 10s. prem., 4s. paid)	4	4-4½
Notting Hill Electric Lighting	10	1 ¼ 12½ xd
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	96 99
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	5¾ 6¼
—— 4 per cent. Debenture Stock	100	95 97 xd
River Plate Electricity Co., Ord., 1-119,687 & 120,501-120,507	1	⅞-1
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	⅞ 1
—— 4 per cent. Debenture Stock, Red.	100	95-98
Rosario Electric Co., 6 per cent Cum Pref., 1-20,000	5	5-5½
—— 6 per cent. Cum. 2nd Pref., 1-15,000	4	5-5½
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	96 98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	—	99 101 p.c.
Smithfield Markets Electric Supply, Ord. 1-12,000	5	¾-1½
—— 4 per cent. Debenture Stock	100	73 77
South London, Ordinary	5	1¾ 2¼
South Metropolitan Electric Light and Power, Ord.	1	⅝ ¾
—— 7 per cent. Cum. Pref.	1	1⅛-1⅜
—— 4½ per cent. 1st Mort. Deb.	100	100-103
St. James's and Pall Mall, Ordinary, 101-20,080	5	8 9
—— 7 per cent. Pref.	5	6¾ 7¼
—— 3½ per cent. Deb.	100	86 91
Urban Electric Supply Co., Ordinary, 8-30-007	5	1¼ 2¼
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	2-3
Westminster, Ordinary	5	9 10
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	5-5½

Electric Tramways.—

Name.	Amount paid.	Last price.
	£	£
Anglo-Argentine, 5¼ per cent. Cum. Pref., 1-260,007	5	6-6¼
—— Ord.	5	8¼ 8¾
—— Permanent 6 per cent. Debenture Stock, 1888	100	101-104
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	102-105
Barcelona Tramways, Ord., 1-20,000	10	—
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	—
—— 5 per cent. Deb., Red., 1-600	100	—
—— 4½ per cent. Red. Deb. Stock	100	—
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1	¾ ⅞
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	29/32-1 1/32
Birmingham and Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100	94-99
Blackpool and Fleetwood Tramroad	10	13⅜-13⅝
Bombay Elec. Supply & Trams. Co., 6 per cent. Cum. Pref.	8	7¼-8¼
—— 4½ per cent. Deb. Stock, Red.	100	95-97
Brisbane Tramway Invest., Ord., 1-75,000	5	2 15/16-3 3/16
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4¾-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	96 100
British Columbia Electric Railway Co., Ord. Def.	100	123-128
—— Ord. Pref.	100	108-112
—— 5 per cent. Cum. Perpetual Pref. Stock	100	101-104 xd
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	100 103
—— 4½ per cent. Vancouver Power Deb.	100	101-103 xd
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	2½ 3
—— 6 per cent. Cm. Pf., 30,001-60,000	10	7½ 8
—— 5 per cent. Perpetual Debenture Stock	100	100-103
—— 4½ per cent. 2nd Deb. Stock	100	78-81
Buenos Ayres and Belgrano Trams.	5	4⅛-4⅜
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	4¾-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4¾ 5¼
—— 5 per cent. Deb. Stock, Red.	100	105-115
—— Prov. Cert., all paid	100	100-103
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100	92 97
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb. Bonds, Red., 1-1,500	100	99-103
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	101-106
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	93-96
Calcutta Tramways, 1-105,000	5	7⅛ 7⅝
—— 105,001-137,610	5	5⅛ 5⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	102 106
Cape Electric Tramways, Nos. 1-480,000	1	5/16 7/16
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	4¾ 5
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100	98 101
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	5 3/16-5 7/16
—— 4 per cent. Deb. Stock, Red. 1985	100	97-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	90	94 98
Cork Electric Tramway and Lighting Co., Ordinary	10	13½-13⅝
—— 6 per cent. Cum. Pref.	10	13-14
—— 4 per cent. Debentures	100	99-100
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	13½-14¼
—— 6 per cent. Pref., Nos. within 1-60,000	10	13-14
—— 3½ per cent. Mort. Debs., 1-3,000 Red.	100	93-97
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100	98-101
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6,957	$1,000	83-88 xd
Imperial Tramways, Ordinary	all	18-19
—— 6 per cent. Cum. Pref.	all	14-14¼
—— 4½ per cent. Deb. Stock	100	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5	1 1¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	66-71
Kalgoorlie Electric Tramways, 1-250,000	1	3/32-5/32
—— 5 per cent. "A" Deb. Stock	100	89-93
—— 6 per cent. "B" Deb. Stock	100	78-82
Kilderminster and District Lighting and Traction, Pref.	5	3-3½
Lancashire United Tramways Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	93-96
—— £296,500 2nd Mort. Deb Stock	—	—
—— £83,330 Deferred Deb. Stock (all fully paid)	—	—
Lisbon Electric Tramways Limited, Ord., Nos. 1-594,188	1	1 1/16-1 5/16
—— 6 per cent. Cum. Pref., Nos. 1-425,553	1	1 1/16-1 3/16
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100	95 98
London United Trys. (1901), 5 per cent. Cum. Pref.	10	7⅜-8¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	84 88
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Rd.	100	96-99

Name.	Amount paid.	Last price.
	£	£
Manila Elec. R R. and Lghtg. Corp., 5 p c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4 635	$1,000	93-95
Manx Elec Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 23,436-25,000	5	4⅝-5⅛
—— 4½ per cent. 1st Mort Deb. Stock, Red.	100	97-100
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	3/32 5/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	27 32-31 32
—— 4½ per cent. Deb. Stock, Red.	100	94 97
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	—	83½-85½ p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 601-2,000 (1922)	100	103-105
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	⅜ 1⅜
Oldham, Ashton, and Hyde Tramway, Ordinary	10	12
—— 5 per cent. Cum. Pref.	10	8¾-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Sk.	100	100-104
Potteries Electric Traction, Ordinary, 1-245,000	1	5/16-9/16
—— 5 per cent. Cum. Pref., 300,001-545,000	1	9/16-13/16
—— 4½ per cent. Debenture Stock	100	95 98
Provincial Tramways Co., Ordinary, 1-24,912	10	4½-5
— 6 per cent Cum. Pref., 1-10,000	10	10½-11¼
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-30,000	5	5¼-5⅜
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	98½-98¾
Sao Paulo Tramway Light, and Power Co.	$100	118-122
—— 5 per cent. 1st Mort. Deb., Red 1929, 1-11,000	$500	92½-91¼ p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1	29 32-1 1/32
—— 4 per cent. Deb. Stock, Red. 1948	100	80-84
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs, Red., 1-1,600	100	84-88
Yorkshire (West Riding) Elec. Tram Co., Ord., 70,001-110,000	5	1-1½
—— 6 per cent. Cum. Pref., 1-46,261	5	3¼-3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	88-91

Electric Railways.—

Name	Amount paid.	Last price
	£	£
Central London, Ordinary	100	73-75
—— 4 per cent. Pref.	100	92-94
—— " " deferred	100	53-56
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)]	100	102-105 xd
City and South London, Consolidated Ordinary	100	47-49
—— 4 per cent. Debenture Stock	100	102-105
—— 5 per cent. Pref. Stock '91	100	117-121
—— " " " '95	100	115-118
—— " " " '01	100	110-113
Liverpool Overhead, 5 per cent. Pref.	10	10-10¼
—— Ordinary, 1 50,000	10	3⅜-4¼
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	64 67

Telegraphs and Telephones.—

Name.	Amount paid.	Last price.
	£	£
Amazon Telegraph Co., 1-25,000	10	3-3½
—— 5 per cent. Debs., Red., within 1-1,069	100	85-88
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000	$1,000	90-92
Anglo-American Telegraph Co., Ordinary	100	62-65
—— 6 per cent Preferred Ordinary	100	109-110
—— Deferred Ordinary	100	20¾ 21¼
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort Deb. Stock, Red.	100	101-104
Chili Telephone Co., 1-44,000	5	6¾-7¼
Commercial Cable Co., Ster. 500-year 4 p.c. Deb Stk., Red.	100	92-94
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	7¼-8¼
—— 10 per cent. Preference, 1-6,000	10	15⅜-16⅜
Direct Spanish Telegraph Co., Ordinary	5	3⅜-3⅝
—— 10 per cent. Cum Preference	5	8⅜-9¼
—— 4½ per cent. Debs., 1-600	50	98-101
Direct United States Cable Co.	20	15½-16
Direct West India Cable Co., 4½ per cent. Debs., Reg. within 1-1,200, Red.	100	98½-100½
Eastern and South African, 4 per cent. Mort. Debs., within 1 3,000, 19 9	100	99-102
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8,000, 1913	25	98½-100¼
Eastern Extension, Australasia and China, 1-300,000	10	13⅛-13⅜ xd
—— 4 per cent Mort Deb. Stock, Perp.	100	104-106
Eastern Telegraph Co., Ordinary Stock	100	134-139 xd
—— 3½ per cent. Preference Stock	100	88-90 xd
—— 4 per cent. Mortgage Debenture Stock	100	103-105
Great Northern Telegraph Co. (of Copenhagen)	10	34-36
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1,200, Red.	100	98½-100½
Indo-European Telegraph Co.	25	56-58
Marconi's Wireless Telegraph Co., 1-256,127	1	¼-⅜
—— 256,128 384,190	1	¼-⅜
Monte Video Telephone Co., Ordinary, 1-72,680	1	15 16 1 1/16
—— 5 per cent. Preference, 1-86,492		1-1
National Telephone, Preferred	100	109-111
—— Deferred Stock	100	108-110
—— 6 per cent. Cum. First Pref.	10	11½-12½
—— 6 per cent. Cum. Second Pref.	10	10-12
—— 5 per cent. Non. Cum. Third Pref.	5	5 7/16-5 11/16
—— 3½ per cent. Deb. Stock, Red.	100	96-97
—— 4 per cent Deb. Stock, Red.	100	100-102
Oriental Telephone and Electric Company	1	1¼-1⅜
6 per cent. Cum Pref.	1	1 3/16-1 5/16
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100	93-96
United River Plate Tele. Co., Ordinary, 1-100,000	5	7-8
—— 5 per cent. Cum. Pref., 1-40,000	5	5-5¼
—— 5 per cent. Debenture Stock, Red.	100	—
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	98-101
West African Telegraph Co.	10	10-10¼
West Coast of America, 1-30,000 and 53 001-53 003	2½	14-14¾
—— 4 p.c. Debs., 1-1,500, Gua. by Western Telegraph	100	97-100
West India and Panama Telegraph Co., Ordinary	10	⅛-⅜
—— 6 per cent. Cum 1st Preference	10	7¼-7½
—— 6 per cent. Cum. 2nd Preference	10	6¼-7¼
—— 5 per cent. Debs., Red., 1-800	100	100 103
Western Telegraph Co., 1-207,930	10	13⅜-14¼
—— 4 per cent. Debenture Stock, Red.	100	100-103

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.							Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1907.	1906.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pass'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	July 17	2,013	1,662	+ 371	+ 81*h*	25½	25	May 31	64 071	15,530,351	1,379 723	0 93	11·14	2,512	6·45
Ayr Corporation	,, 20	981	943	+ 38	—	8	8	,, 15	14,428	3,316,380	353,945	1	9·71	1,830	5 16
Baker Street and Waterloo Ry.	,, 20	2 320	1,352	+ 96	+ 3,462	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 21	1 143	1, 69	- 26	- ·82	23 53	3·53	March 31	55,025	11,145,531	1,309 903	1·18	10·08	2,338*b*	6·03
Birmingham Corporation	,, 20	5 398	—	—	—	56½	—	,, 31	17,133	4,709,788	266 526	·86	14·5	8 865	—
Blackburn Corporation	,, 17	1,175	1 073	+ 101	+ 662	24	24	,, 25	48,875	8,661,720	986 953	1·35	11·29	2,036	7·44
Blackpool Corporation	,, 18	1 792	1,991	- 199	- 1,656	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	,, 20	1,270	1,311	- 41	- 254	16½	16½	Dec. 31	31,846	2,325,677	573,264	3·28	13 19	—	7·27
Bolton Corporation	,, 21	2 582	2,206	+ 376	+ 1,319	42	40	March 31	95 766	20,205 196	2,161,130	1·13	10 63	2 394	6·14
Bournemouth Corporation	,, 17	1,993	1,736	+ 197	+ 42	17·41	16 82	,, 31	55,276	10,058,288	1,121,623	1·32	11 83	3 226	7·19
Bradford Corporation	,, 20	5,721	4,617	+ 704	+ 233	95	95	,, 31	230,085	47,108,000	5,053,392	1·172	10 927	2,395	—
Brighton Corporation	,, 21	1,081	1,079	+ 2	- 1,357	9	9½	,, 31	50,339	11 321 160	1,152,828	1·06	10·48	2,914·8	8·0.4
Bristol Tramway Company	,, 19	5 573	5,400	+ 173	—	51½	51½	Dec. 31	259.799	65 312,373	6 127,135	—	—	—	—
Burnley Corporation	,, 20	1,282	1 079	+ 203	—	40	40	March 31	57,9·2	11,092,704	1,197,772	1·31	11 61	5,388	8·17
Burton Corporation	,, 21	415	337	+ 78	- 236	8½	8½	,, 31	17 950	3,878,269	454,082	1 07	9·21	2,0 8	6·76
Cardiff Corporation	—	—	—	—	—	32 62	†32·26	,, 31	112,209	24,134,363	2,770,049	1·12	9 72	3,782	9 44
Carlisle Tramways Company	,, 20	237	218	+ 19	- 359	8 5	8·5	Dec 31	10 713	2,935 002	359,756	—	7 14	—	5 18
Central London Railway	,, 20	5,128	5 747	- 609	- 1,147	6	6	,, 31	347,588	4,875,547	1,281,214	1 86	65·10	57,931	35 80
Charing X, Euston, & Hamp. Ry.	,, 20	2 585	—	—	—	8	—	—	—	—	—	—	—	—	—
City and South London Railway.	,, 21	3,188	2 499	+ 689	+ 2,196	6¼	6¼	,, 31	—	—	—	—	—	—	—
Colchester Corporation	May 8	195	195	—	—	8	8	March 3	10,588	2 457,553	220,788	·97	7 47	1,401	6·12
Cork E. T. and L. Company	July 18	577	573	+ 4	- 431	15¼	15¼	Dec 31	24,895	5 814 376	882,256	1 01	6 64	—	4 69
Darwen Corporation	,, 19	264	215	+ 19	- 10	7 23	7·23	March 3	—	—	—	—	—	—	—
Dover Corporation	,, 20	256	296	- 40	- 476	4½	4½	,, 31	11 250	2 853 200	284,343	·94	9·49	2,500	—
Dublin and Lucan Electric Ry.	,, 19	172	159	+ 13	— *h*	6¾	6¾	Dec 31	6 358	402,511	113,738	3·79	13·78	942	7·33
Dublin U.T.	,, 19	8 122	5,801	+2,321	+ 5,269	48½	48½	,, 31	267,489	50,050,949	7 077,372	1·8	9·07	691	5 55
Dundee City Tramways	,, 17	1,214	1,107	+ 107	+ 407	22	22	May 15	50 154	13 086 396	1,005 911	·906	11·96	2,180	7·42
East Ham Corporation	,, 20	988	932	+ 56	+ 330	14	14	March 31	36,652	3,689,658	863,816	·64	10 18	2 9·4	6 79
Glasgow Corporation	,, 20	15,638	12,765	+2 873	+ 668*h*	79½	79½	May 31	756 430	195,767,519	17,945 595	—	10 12	—	—
Gloucester Corporation	,, 10	278	304	- 26	—	15	15	March 31	15,465	3,902,077	563,595	·80	6·58	939	5·32
G.N., Piccadilly, and Brompton	,, 20	4 115	—	—	—	9	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	37	37	,, 31	74 019	17,849,642	1,540 707	—	11 53	2,085	8·56
Huddersfield Corporation	,, 20	1 714	1,587	+ 127	+ 9·0	35	35	,, 31	63,938	12 838,150	1 665,262	1·24	9 71	1,923	—
Hull Corporation	,, 20	2,412	2,326	+ 86	+ 1,374	26	26	,, 31	112,651	27,102,921	2,910,698	1	9 29	—	—
Ilford Corporation	—	—	—	—	—	10½	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 17	158	141	+ 17	+ 158	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	11,586	3,626,656	419,800	·737	6 62	1 480	5·22
Lancashire United Tramways	,, 17	1,426	1,145	+ 281	+ 9,150	38½	28	—	—	—	—	—	—	—	—
Leeds Corporation	,, 13	6,500	6 512	— 12	+ 3,425	89½	89½	March 25	298,233	64 223,666	7,121,038	1 10	10·02	351	—
Leicester Corporation	,, 20	2,350	2 309	+ 41	—	42	42	Dec. 31	26,011	12 039,252	1,229,507	1	9·79	—	4 82
Liverpool Corporation	,, 13	11,354	11,374	— 20	+ 3,370	104	104	,, 31	547 625	116,642 663	12 166 419	—	—	—	—
Liverpool Overhead Railway	,, 21	1,975	1,601	+ 374	+ 473*h*	6·65	6 65	June 30	81,302	11,171,865	1,024 275	—	—	—	—
London County Council	,, 6	32,210	27,223	+4,982	+ 63,886	98	98	—	—	—	—	—	—	—	—
Lowestoft Corporation	—	—	—	—	—	6	6	Sept. 30	14 511	3,128,857	359,435	1 08	9 68	2 630	6 48
Maidstone Corporation	—	—	—	—	—	2	2	March 31	4,740	850 121	112,227	1 35	10 13	2,370	—
Manchester Corporation	,, 20	16,155	13 816	2 3·0	+ 18 853	149	149	,, 31	631,956	125,900,875	14,123,124	1 19	10·73	4,299	6 99
Metropolitan District Railway	,, 21	7,635	7,770	- 137	- 10	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 21	15,520	15 112	+ 408	+ 2,036	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 20	169	153	+ 15	—	2¾	2¾	,, 31	6.159	1,992,647	206,358	82	7 14	2 239	—
Newcastle-on-Tyne Corporation	,, 20	4,126	3,871	+ 255	+ 533	50	50	,, 31	197 849	43,061,934	4,326,152	1 07	10 98	3 957	7·0
Newport (Mon.) Corporation	June 29	639	628	+ 11	+ 1,197	15¼	15¼	,, 31	30,356	7 252,535	783 435	—	9 29	—	6·4
Oldham Corporation	—	—	—	—	—	34	34	,, 25	65 553	15,466,245	1,504,740	1 16	10·45	1,883	—
Portsmouth Corporation	May 25	2,330	1 578	+ 752	+ 632	28½	28½	,, 31	95,702	19,625,329	197,499	1·17	11 63	—	—
Reading Corporation	July 18	674	661	+ 13	- 372	33½	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	11·29	21·29	,, 31	14,881	2,837,110	386,547	1·24	9·24	1,102	7 92
Rotherham Corporation	—	—	—	—	—	9½	9½	,, 31	23 563	5 231,472	593,054	1 07	9·53	2,612	7·49
Salford Corporation	,, 22	5 074	4,711	+ 323	+ 1,566	70¾	70¾	,, 31	214.111	39,213 560	4,894,590	1·28	10 29	—	—
Scarborough Tramways Co.	—	—	—	—	—	4½	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 21	5 829	5,398	+ 431	+ 4,062	35½	35½	,, 25	240,515	63 952,283	6,049,899	903	9·543	3,653	6 477
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,365	9 294,771	1,108,369	1·27	11·02	—	7 83
Southend-on-Sea Corporation	,, 17	577	516	- 9	- 354	9	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	,, 31	39,550	6,766,031	1,027 730	—	9 23	—	4·75
Sunderland Corporation	,, 21	1,601	1,557	+ 44	- 120	20	20	,, 31	64,858	15,364 463	1 495 785	1·004	10·36	—	6·37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	4,937	1,315,757	102,751	0·87	11·53	1,371	—
Torquay Tramways	July 18	232	—	—	—	5 16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 20	1,019	910	+ 109	+ 276	11 85	11·85	,, 31	38,762	7,412,881	778,851	1·30	11 94	3,271	7 54
Warrington Corporation	—	—	—	—	—	9	9	,, 31	17,0 7	4,418 225	403 363	—	9 83	—	6·33
West Ham Corporation	,, 18	2,480	2,352	+ 128	+ 1.059	14·7	14 7	,, 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	,, 18	983	904	+ 78	+ 243	20	20	,, 31	41,905	8 847,066	950,338	—	10 583	2,062	6·13

† And 98 miles of interlacing track. *a* Train mile. *b* Per mile of single track. *h* Half-year's figures. *k* Double track

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NOTES.

Islington Electricity Undertaking.—It will be remembered that in December last the Islington Borough Council appointed a special committee to inquire into and report upon the position, financial and otherwise, of the electric lighting undertaking, including the scheme for the extension of street arc lighting passed by the late Council on March 2, 1906. The scheme propounded and accepted by the late Council was to light 15 miles of streets (then lit by gas) by electricity, displacing 714 incandescent gas lamps, and to lay cable along the streets for public and private lighting. The committee which is inquiring into all matters concerning the undertaking have now presented an interim report dealing only with the scheme for the extension of street arc lighting. They are recommending the Council to abandon the scheme altogether, and an extraordinary meeting of the Council was held on Tuesday to consider this recommendation.

Electrical Installations in Spain.—*L'Industrie Electrique* gives some interesting statistics relating to electrical installations in Spain. From official compilations to the end of 1904, it gathers that there were 1,151 such installations having a total power of about 100,000 kw. The distribution of energy among different classes of users is seen in the following table:

	Public			Private	
	No.	Power in kw.		No.	Power in kw.
Motive power	3	1,847	...	8	543
Motors and lighting	114	38,144	...	34	3,329
Lighting	670	45,577	...	—	—
Traction	8	6,347	...	—	—
Hotel installations	—	—	...	11	251
Industrial installations	—	—	...	302	3,744
Furnaces (electric)	—	—	...	1	—
Totals	795	91,915	...	356	7,957

Steam is used for generating current on 75 of these installations, hydraulic power is used in 148 cases, gas-engines in 25 cases, and on 42 installations steam and gas are used.

The Scottish National Exhibition.—The arrangements for the Scottish National Exhibition of 1908, to be held at Edinburgh, have made good progress. The plans, subject to any alteration which may be deemed advisable, have been accepted, and work on the grounds and buildings will commence by the end of this or the beginning of next month. In the accepted designs the industrial hall, of 100,000 square feet, and the machinery hall, of 20,000 square feet, are included in one magnificent building, and everything, both in connection with the structures and the grounds, has been planned with a view both to charm the eye and facilitate the commercial requirements. The classification of the various sections includes fine arts, education, and history; arts and crafts; mining, engineering, and metallurgy; transportation and motive power; shipbuilding and waterways construction; chemistry and scientific appliances; lighting, heating, and ventilation; artisans' work, etc. The charge for floor space in the industrial hall and machinery section will be 3s. a square foot for spaces over 100 square feet. The committee will make an extra charge for small areas or special positions. All information can be obtained from the manager, Mr. W. H. Knight, 45, York-place, Edinburgh.

Electrical Accidents in Switzerland.—Official statistics relating to accidents due to electricity in Switzerland during the year 1906 are published in a French contemporary. Thirty-four accidents occurred during the year, and 35 persons (compared with 30 in 1905) were injured, nine of them fatally (compared with two in 1905). The greater number of the persons injured (17) were employed in works in which electricity was used, 10 were employed in electricity works, and accidents occurred to eight persons other than employés. Over 50 per cent. of the accidents were due to reckless behaviour on the part of the workpeople, and 18 per cent. were due to negligence. Twenty-nine per cent. of the accidents occurred on low-tension systems (up to 250 volts), compared with 21 in 1905; 15 per cent. occurred on systems the voltage of which did not exceed 1,000; and 56 per cent. occurred on high-tension systems (exceeding 1,000 volts), compared with 68 per cent. in 1905. One of the fatal accidents occurred on a low-tension installation where 220-volt continuous current was employed. It is noteworthy that while the percentage of accidents on high-tension systems has decreased, on low tensions it has increased 8 per cent., thus showing that the dangers of low tension are not duly respected by workpeople, and there is either insufficient protection of such installations or else foolish neglect.

An Electrical Novelty.—The following is a brilliant example of English as it is written in some foreign contemporaries. It has been culled from a paper known as the *Sun*, published in Bremen, and designed for the purpose of describing the most important inventions that appear. A recent issue of that paper has come into our hands, and our curiosity was aroused by the title of a lengthy article: "Apparatus performing horse-Shoes." The opening sentences read: "To one of the best inventions, being made during the last years, belongs undoudtedly this machine, invented by Mr. Heddo Vosberg, Leer i. O.—The apparatus serves for automatic massproduction of horseshoes in one work done, and it is enabled to perform with help of two apprentices, by using working-power 4 HP, about 6000 horse-shoes of all possible set forms, ready fashioned" (in what time?). "The maschine is useable for all sorts of forms and is working perplexing precisely, that you need not be an enthusiast if being exaltet, seeing this gain of modern technics." But we could proceed no further, the detailed description (?) of this wonderful apparatus being altogether unintelligible. We are assured, however, on no less authority than that of the *Sun*—and we have no means of testing whether its judgment is as sound and intelligible as its mode of expression—that the machine will have a good future, and that: "Especially in England and the United States of A. will be a lot of interested people to this real novelty." Whether by "real novelty" the writer means the machine or his own literary effort, we can hardly say with certainty. But there can be little room for doubt which the English reader will regard as being the most novel

Electricity in Medicine.—In the electrical section of the congress of the British Medical Association at Exeter this week an address was given by Prof Stephane Leduc. The following papers were read: Dr. Delpratt Harris, "Some Statistics of X-Ray Therapeutics in Rodent Ulcer and Carcinoma"; Prof. Wertheim Salomonson, "The Einthoven Galvanometer"; Dr. Lewis Jones, "Oscillograph Tracings of Medical Coil Currents"; Dr. J. Goodwin Tomkinson, "A Method of Treating Lupus Vulgaris"; Dr. W. F. Somerville, "The Effects of High-Frequency Currents on the Urinary System"; Dr. Hugh Walsham, "The Orthodiagraph"; lantern demonstration; discussion on "X-Rays and Sensitive Plates," opened by Mr. Mackenzie Davidson; Dr. Ellis Pearson, "The Use of the X-Rays from the Point of View of the General Practitioner"; E. W. H. Shenton, M.R.C.S., L.R.C.P., "The Examination of the Hip Joint"; Dr. J. R. Riddell, "The Measurement of the Brim of the Female Pelvis by

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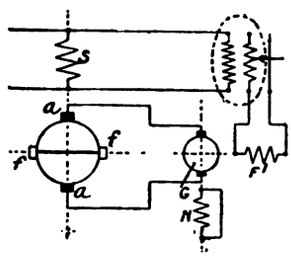
means of the X-Rays"; Dr. Howard Pirie, "A New Meter for Measuring the Currents through an X-Ray Tube and Measurement of the Reverse Current passing through an X-Ray Tube"; Prof. Wertheim Salomonson, "The Electro-Diagnosis of Oculomotor Paralysis"; Dr. Taylor, "A Case of Paget's Disease treated by X-Rays" (microscopic specimens); lantern demonstration; discussion on "The Dosage of X-Rays," opened by Dr. Sequeira; Dr. Howard Humphries, "The Rationale of Static Currents"; Dr. R. Morton, "Alternating Currents of Slow Periodicity"; Dr. A. Reid, "Ureteral Calculi"; Dr. Ironside Bruce, "Systematic Radiography"; Dr. Stanley Green, "X-Rays and Chest Disease"; Dr. D. Arthur, "A New Static Machine." The annual exhibition in connection with the congress was held at the Victoria Hall. Altogether there were 90 stands, arranged in the large hall and upon the two platforms at either end, allotted to the leading drug firms and surgical appliance manufacturers. Naturally the whole of the goods shown by these firms represented the most modern productions in their particular branches. There was a strong electrical section. The leading chemical manufacturers were represented, while food and drug firms of world-wide reputation sent down the most skilled of their employés to arrange exhibits showing the process of the manufacture or their specialities.

Alternating-Current Motors.—A recent patent granted to Mr. V. A. Fynn describes means of improving the power factor of alternating-current motors and transformers, and of improving the regulation of generators. These improvements are effected by the introduction of an auxiliary E.M.F., derived from a practically non-inductive generating winding, into one or more circuits. The auxiliary generator consists of an armature, G, wound with open or closed circuit winding, rotating in an alternating field produced by a winding, F^1. Armature reaction is compensated for by a winding, N, either in series with the armature or closed on itself, the ampere-turns of which may be a little greater than those of the armature, G. The application of the invention to a single-phase shunt induction motor is shown; the terminals of the auxiliary generator are connected to brushes, *a*,



coaxial with the transformer field due to the stator winding, S, of the motor. In a modification the armature of the auxiliary generator is mounted on the motor shaft, one winding extending over the two rotors and being short-circuited by the brushes, *a*, while another winding, extending only over the main rotor, is short-circuited by the brushes, *f f*. The auxiliary E.M.F. is opposed in phase to the E.M.F. of self-induction set up in the rotor circuit, and hence the rotor current can be brought into phase with the working E.M.F. in that circuit, or can be made to lead. This invention is applicable to single and polyphase induction and conduction motors and transformers, and to the regulation of generators, and also to the exciting circuits of such generators as are excited by rectified currents.

Transmission Line Protection.—The protection of transmission lines which are designed to deliver power at great distances from the point where it is generated forms a somewhat acute problem in countries where thunder-storms prevail. But with the installation of high-tension systems the protection of lines exposed anywhere to lightning discharges becomes important. An effective method of avoiding a direct stroke is to direct the discharge to earth, and in the *Electrical World* of New York Mr. D. S. Carpenter suggests that the most practical manner of accomplishing this result is to install a ground wire directly above the line. The argument has been advanced against the overhead ground wire that it can afford but little protection, due to the fact that it is practically at the same distance from the cloud that the line conductors are, and lightning is thus just as likely to strike the line conductor as the ground wire. But Mr. Carpenter controverts this argument. He says that tests made with high-potential discharges show that the discharge is preceded by brush discharges and pilot sparks, which increase in length until the air-gap between the extremities of these arcs gives way under the strain and the spark is established from electrode to electrode. It is evident, he adds, that in cases where the tension may exist for some time before the discharge takes place the potential may be just sufficient to establish the arc through this distance, the potential breaking down successive portions of the air-gap intervening between it and the ground, and thus the last portion of the path over which it passes as it reaches earth will be determined by the relative length and impedance of the possible paths it may traverse. Thus, he is of opinion that an overhead ground wire with lightning arresters installed at intervals along the line affords the best possible protection to the line. Another method of protecting transmission lines is by means of choke coils. The principle of the choke coil, that it serves to reflect waves and surges in whole or part, and thus prevents the station apparatus from being subjected to potentials of such magnitude as to endanger their insulation, is admitted to be theoretically correct, and all engineers advise the installation of choke coils with arresters. It is impossible to prevent oscillations being set up in a system due to lightning discharges in the immediate vicinity of the line, but with properly-designed protective apparatus these oscillations should be prevented from developing high power surges.

Canada's Century.—There has just been published in book form, under the title of "Canada's Century," the series of articles which recently appeared in the *Financier and Bullionist* from the pen of Mr. R. J. Barrett. The work is the result of an extended tour in the Dominion undertaken by Mr. Barrett last year, and it has, therefore, the additional merit of being prepared from knowledge gained on the spot. The development of Canada is a subject of great and growing interest particularly to electrical engineers. For the country is extremely rich in water resources that only await the introduction of additional capital and enterprise for the generation of electrical energy, while the field in which this energy can be applied is greatly extending. One of the most important directions in which electricity may be applied is in railway working. Ample evidence is available to show the remarkably rapid progress which electric railway construction has made in Canada There are at present 814 miles of electric railway in Canada, and Mr. Barrett holds out the hope that this figure will be considerably increased in the course of time. As showing the great headway that electric railway construction is making in Canada, he mentions that Ontario alone has 441 miles and Quebec 198 miles operated solely by electricity. The capital of the electric railway concerns in Canada totalled up last year to an aggregate of £12,771,594, and their earnings for the year collectively amounted to £858,387, while they carried in the same year

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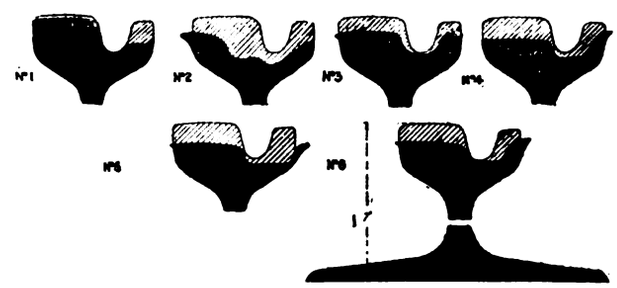
237,655,074 passengers, an increase of 34,187,757 over the result of the previous year's working, and all this with fatalities which decreased in number from 30 to 16. The Canadian Pacific Railway Company are leading the way in electric railway development, and it is understood that the company are merely awaiting the results of experiments now being carried out on the New York Central before undertaking the electrification of the Toronto to Sudbury section. If successful, the conversion of the Montreal-Toronto-Detroit line to electrical traction will doubtless be undertaken. Power can, of course, be obtained from local companies, but for such an area, and with an abundance of water power, the Thury system should offer advantages. A long chapter is devoted to the harnessing of Niagara, and Mr. Barrett emphasises the importance of Niagara and other falls as cheap and efficient means of generating electricity, and he does not overestimate the economic industrial advantage which these falls give the Dominion. The book is published by the Financier and Bullionist, Limited, 54, Wool-exchange, London, E.C., at the price of 6s. net, and it deserves to be widely read for the reliable and useful data which it contains.

Electricity on the s.s. "Lusitania."—The completion of the Cunard liner "Lusitania" is a feat of which the builders and engineers may well be proud. For this vessel is, with the exception of her sister ship, by far the largest and most powerful vessel afloat. The character of the propelling machinery on so huge a steamer is a matter of supreme importance, and it was not until an expert inquiry, extending over several months, had been held, that the Cunard Company decided upon the Parsons type of marine turbine. Four of these turbines, each driving its own propeller shaft and screw, are installed. But in reality the number of turbines should be stated as six, since the two central propeller shafts are each worked on by two turbines, one for going ahead and the other for going astern. Normally, the steam from the boilers at 195lb. pressure to the square inch passes to the high-pressure turbines on the two outer shafts, and thence to the low-pressure turbines on the inner shafts; but when it is desired to run the vessel backwards, the reversing turbines on the inner shafts take steam direct from the boilers, and the outer shafts are idle. The rotating portions of the low-pressure turbines attain a diameter of nearly 16ft., and at full speed have a peripheral velocity in the neighbourhood of 150ft. a second, yet the clearance between the tips of their blades and the casings in which they run is only from $\frac{1}{30}$in. to $\frac{1}{25}$in.—a fact which shows the precision of the workmanship required in their construction. Of course, electricity plays a conspicuous part on board. Indeed, as showing the possible applications in providing for the safety, comfort, and convenience on board, the installation on the s.s. "Lusitania" may be said to be a perfect model. Telephonic communication is provided between the officers and all parts of the ship, and there is a regular telephone exchange for the passengers. Two electric lifts convey passengers between the five principal decks. Electric lighting for public and private uses is installed on a most lavish scale. In the kitchens electricity is a most valuable servant; it polishes the silver, washes the dishes, turns the joints before the kitchen fires, blackens the boots, boils the eggs, cuts the bread, and peels the potatoes. By turning a switch on the bridge the officer of the watch can see instantly which watertight doors in the bulkheads are open and which are closed. There are 120 electric motors on board. The electric cables distributing current for all these purposes are over 200 miles in length. The various applications of electricity form a conspicuous feature of a vessel which is notable for many remarkable features, and the "Lusitania" installations should amply testify to the advantage of employing electricity for many purposes on board ship.

Tramway Rail Wear and Maintenance.—It would be interesting to obtain from engineers statistics as to the cost of repairs and renewals of the tramway rails under their charge in a like manner to that presented by Mr. C. F. Wike, the city engineer of Sheffield, at a recent meeting of the Association of Municipal and County Engineers. The rails at Sheffield are of British standard specification section No 5, 60ft. in length, and weigh 110lb. per yard. The older rails, as to the wear of which details are given in the diagram, weighed 108lb. per yard. Electric traction has been in use in Sheffield for nearly eight years, so there is a fair amount of experience available as to the cost of repairs. The following table shows the costs of track repairs and renewals since the lines were opened:

Year ending March 25.	Car mileage.	Cost per mile of single track. Repairs. £ s. d.	Renewals. £ s. d.	Cost per car mile. Repairs. Pence.	Renewals. Pence.
1900 (7 months)	527,292	0 3 2	—	0·002	—
1901	1,886,415	28 8 2	13 3 6	0·148	0·068
1902	3,525,999	60 12 7	39 5 11	0·207	0·134
1903	4,777,146	57 7 7	—	0·177	—
1904	5,768,231	129 2 5	47 6 7	0·356	0·131
1905	6,049,899	139 13 6	38 4 5	0·375	0·102
1906	6,236,561	111 19 5	98 10 5	0·299	0·263
1907	6,804,655	101 9 0	173 4 0	0·249	0·425

Mr. Wike also presented the accompanying sections of worn rails taken from busy routes. These, he says, were



of low carbon, but they have worn very evenly, and given good running till the last without showing signs of corrugation. The following particulars respecting each rail were given in the paper: No. 1.—Rail taken up on disused track after little service, but worn by vehicular traffic; life of rail, 78 months; carbon, 0·35 to 0·45 per cent. No. 2.—Gradient, 1 in 11; radius of curve, 130ft.; life of rail, 92 months; car journeys, 766,584; carbon in rail, 0·35 to 0·45 per cent. No. 3.—Gradient, 1 in 542; radius of curve, straight track; life of rail, 93 months; car journeys, 2,938,658; carbon in rail, 0·35 to 0·45 per cent. No. 4.—Gradient, 1 in 15; radius of curve, 150ft.; life of rail, 84 months; car journeys, 2,505,208; carbon in rail, 0·35 to 0·45 per cent. No. 5.—Gradient, 1 in 25; radius of curve, 230ft.; life of rail, 84 months; car journeys, 2,505,208; carbon in rail, 0·35 to 0·45 per cent. No. 6.—Gradient, 1 in 23; radius of curve, straight track; life of rail, 84 months; car journeys, 2,134,561; carbon in rail, 0·35 to 0·45 per cent. Touching on the question of corrugation, Mr. Wike says the trouble has not been so pronounced in Sheffield as in other towns. Occasionally, he adds, the corrugations disappear of themselves. When treatment is required, the most hopeful method seems to be by attaching grinding blocks to a car.

Electro-Plate.—We have already referred to Mr. Sherard Cowper-Coles's paper before the Society of Arts on Sheffield plate and electro-plate, and have outlined the salient feature of the method of electro-plating described in the paper. To Mr. Coles is due the introduction of more than one process in metal work which produces a high

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artistic effect by improved scientific methods, and if Mr. Coles should be instrumental in establishing the manufacturing process of electro-plating on a more scientific basis, and in supplanting some of the present crude electrical applications, he will have performed a service for which electrical engineers will be grateful. Electro-plating in many large establishments is still carried on by rule of thumb with much waste of material, and there is yet a large field of investigation open to the electro-chemist. Mr Coles refers in his paper to the electro-deposition of silver alloys. Outlining the chief work which has been done in getting a suitable alloy, he alludes to alloys of cadmium and silver produced by electrolysis, which has been most successful on a commercial scale, and which, while having the appearance of pure silver, come near to possessing the additional advantage of hardness and resistance to tarnishing influences. The process consists of casting anodes of the same composition as the alloy to be deposited. An alloy of 30 per cent. of cadmium and 70 per cent. silver when rolled develops a remarkable crystalline formation. If it is desired to deposit an alloy of this composition, cast anodes must be used not rolled. The electrolyte is composed of the double cyanides of potassium and silver and cadmium. The relative proportions of the two metals in the solution cannot be based upon their electro-chemical equivalents, as a number of other important factors control the composition of the alloy deposited. The results of many hundreds of experiments show that the minor differences between the two metals play a very important part; there is an E.M.F. between the two metals independent of the E.M.F. of the cell; further, the current that will deposit 40·248 grm. of silver will only deposit 2·076 cadmium, whilst there are considerable differences between the resistance of their respective salts in solution. Various methods have been tried with the object of determining whether silver can be rendered less tarnishable, but while some methods have given promising results in the laboratory, they have been found unreliable when put to practical test. These and many more problems yet remain to be solved in connection with the electro-plating industry, and it is by the promotion of the study of electro-chemistry and its application to this branch of industry that the outstanding problems may near solution.

Publications Received.—"Balancing of Engines (Steam, Gas, and Petrol)," by Mr. Alexander Sharp. (Longmans, Green, and Co., 39, Paternoster-row, London, E.C.) Price, 6s. net. The subject of engine balancing has come into prominence with the development of the steam-turbine and the motorcar engine, but the literature on the subject is very small. The subject matter of the present book is mainly concerned with the balance of the inertia forces of the engine, an important factor in smooth running. A chapter is, however, devoted to the subject of uniform torque on the crankshaft. Mr. Sharp describes his book as an elementary text-book for the use of students, draughtsmen, designers, and buyers of engines. With the exception of a few analytical investigations, the method of treatment is graphical. To the work has been appended a series of exercises, with answers, some being taken from the papers set at the qualifying examinations of the Institution of Civil Engineers.—"Report No. 30" issued by the Engineering Standards Committee (price, 2s. 6d.), deals with the British standard specification for steel castings for marine purposes.—The *Atti* of the Associazione Elettrotecnica Italiana (vol. xi., No. 3) contains an article by Guiseppe Belluzzo on the gas turbine, and another on the photometry of electric lamps by Mario Buffa.—We have received from the publishers, 30, Fleet-street, London, E.C., an advance copy of the Great Eastern Railway Company's new illustrated "Tourist Guide to the Continent," published at the price of 6d. Among its features are particulars of new tours, *viâ* Holland, in North Germany, including the Harz Mountains and Thuringian Mountains; in South Germany, of the less known side valleys of the Rhine; in Belgium, *viâ* Antwerp, of fresh tours in the Ardennes and among the old Flemish cities. A practical feature of the guide is a series of Continental maps.—The June issue of the *Journal* of the Western Society of Engineers (Chicago) contains the following among other articles: "The Rotary Converter Sub-Station," by R F Schuchardt; "Development and Operation of a Large Electric Transmission and Conversion System," by Ernest F. Smith.—Among the contents of the June issue of the *Proceedings* of the American Institute of Electrical Engineers are the following: "The Heating of Copper Wires by Electric Currents," by A. E Kennelly and E R. Shepard; "Interaction of Synchronous Machinery," by Morgan Brooks; "Power-Factor, Alternating-Current Inductive Capacity, Chemical, and other Tests of Rubber-Covered Wires of Different Manufacturers," by Henry W. Fisher; "Protective Apparatus Engineering," by E. E. F. Creighton; "Practical Testing of Commercial Lightning Arresters," by Percy H. Thomas; "A Proposed Lightning-Arrester Test," by N. J. Neall; "Notes on Transformer Testing," by H W. Tobey; "A New Type of Insulator for High-Tension Transmission Lines," by E. M. Hewlett; "Some New Methods in High-Tension Line Construction," by H W. Buck; "Switchboard Practice for Voltages of 60,000 and Upward," by Stephen Q Hayes.

Welfare Work.—The importance of amicable and sympathetic relations between employers and employés is now recognised as a factor in industrial prosperity, and this is the order of the day except where outside forces are permitted to hinder its consummation. In the present circumstances it is important to view these relations from a purely economic standpoint, for no undertaking which has to be carried on by a combination of capital and labour will exist if sentimental considerations are to prevail in the conduct thereof. But employers of labour are to some extent morally bound to interest themselves in the well-being of those who are dependent upon them, and those employers who continue to treat their workmen with a supreme disregard, and who do not deign to give them even the same careful attention that is bestowed upon the tools and apparatus in the factory, are placed at an economic disadvantage. For it must be obvious that in any works where firm but kindly control is lacking, and where a rigid discipline is imposed, without any of the lighter human touches, the workmen on their part will in no way exert themselves to promote the aims of their employers. In such a works the absence of intercourse between employers and employés, and the absence of respect on the one side and feeling on the other, generally fosters a spirit of restlessness and discontent among workmen and prepare fertile ground for the hireling agitator to sow his seed of discord in. One of the best reasons for the employers interesting themselves in the welfare of their workpeople is furnished by referring to an analogous case. Much consideration is given to the question of operating machinery in a factory, and no expense is spared to bring this to a high state of perfection in order to secure the most economic results. How much more important is it, therefore, that those who are called upon to handle this machinery should be in a fit condition—physically and mentally—and that their minds should be bent on getting the most favourable results? There are examples in this country of this happy consummation

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being brought about by the employers manifesting some interest in the welfare of their workers. Welfare work seems to have taken deeper root in America than in this country. It is, however, of interest to note how our efforts in this direction appear when looked at through American spectacles. The commission appointed by the National Civic Federation of the United States to inquire into municipal ownership have reported on welfare work here and in their own country. They say: "So far as welfare work is concerned, British employés have not been taught to expect the same attention as the American. While the welfare works of Great Britain's municipal undertakings are a shade better than the private, they seem to have not been worth any special notice from our investigators. When a good word is said for Liverpool's coffee, cake, and billiard rooms at any one of the car depôts, and the tidiness of two or three retiring places at other plants, the subject is quite exhausted. In this country the company plants visited have usually far better methods both for assuaging hardship and encouraging men in self-respect and worthy ambition than the municipal." The commissioners did not apparently see the new tramways depôt opened at West Ham last year nor take account of the excellent facilities which exist there for the workers; in their report they do not make any mention of the excellent hygienic arrangements in factories and workshops in this country, of the benefit and athletic clubs which employers encourage and support, of the opportunities that are placed in the way of clever and diligent apprentices, and of the close connection between manufacturers and the technical colleges. They are concerned rather in emphasising our faults than in revealing the good points in our system. But after all is said and done, the close personal relationship between the principals of the large American companies and their employés, the system of instruction introduced in certain works, the gradation of employés, the system of promotion on merit, the care for the aged, etc., are good features, the possession of which we do not yet boast.

Municipal Ownership in America.—Municipalisation has not made such headway in the United States as it has done in Great Britain. That is not to say, however, that the problem has not received serious attention in the States, for a searching investigation, extending over two years, has just been concluded by an important commission. This commission was appointed by the National Civic Federation to inquire into municipal working in Great Britain and in the United States, and four reports (including reports on labour conditions and electric lighting and power plants) have now been issued. From the lengthy extracts that appear in American contemporaries it is evident that a great diversity of opinion exists among the commissioners, while those who are opposed to municipal ownership are unsparing in their attack upon the British municipal undertakings—especially tramways—which they visited. Two of the commissioners—Messrs. Walton Clark and Charles L. Edgar (president of the Edison Electric and Illuminating Company of Boston)—criticise severely the municipal plants examined, while two other writers—Prof. Frank Parsons, of Boston, president of the National Public Ownership League, and Edward W. Bemis, superintendent of the Cleveland (Ohio) waterworks—find much to favour in municipal plants which were investigated. It is of interest to point out here that the two commissioners opposed to municipal ownership are actively interested in companies carrying on undertakings which municipalities seek to possess, while those who report in its favour are probably not uninfluenced by their associations. Messrs. Clark and Edgar concur in the statement that the inquiry of the committee, both from the standpoint of British and American experience, more especially the latter, has shown that "where municipal ownership has been removed from the realm of philosophic discussion and put to the test of actual experience it has failed ingloriously." The belief is expressed by these gentlemen that the "few enthusiasts" who still advocate municipal ownership "will soon be convinced by the logic of events, and turning their energies to other things will through them realise their ambitions of usefulness to their fellows." Prof. Parsons and Mr. Bemis, on the other hand, take a most hopeful view as to municipalisation, declaring that the failures of municipal ownership are insignificant compared to the failures of private ownership, either in number or importance. "It is not public ownership, but private ownership," Prof. Parsons says, "that is responsible for our periodic crises and the ruin of our industries." As to the fitness of American cities to manage business affairs, many of them, he says, have clearly proved their fitness, and the rest can be made fit. "It is not impossible," he adds, "that the elimination of the public service corporations through public ownership is one of the things that would do more to help along the process of making our cities fit." Mr. Bemis believes that the greatest reason for the strength of the municipal ownership movement lies in the relations of the public service corporations with the state and local governments, which relations he declares are destructive of political purity, democracy, and free institutions. In this same connection Mr. Edgar and Mr. Clark take the view that the evil of building up political machines with city employés as a basis exists now to a degree in American municipalities, and that the disastrous effects would be much greater if the many gas, electrical, and street railway employés were added to the present number of city office-holders. Very few will be found to agree with the fear expressed by the latter that municipal trading will not attract the best men. In coming to this conclusion, Messrs. Edgar and Clark appear to have been largely, if not solely, influenced by the administration of Chicago. They might have given a little closer attention to British experience in this part of their investigations, and they would have been convinced that such a fear was groundless. There is no doubt that the conditions in this country and in America differ in no small degree, but there is not such a great disparity as to render our experience a valueless guide. Municipal ownership may not, under present conditions, be ideal; but in respect to this country, at least, it attracts the very best men, and the personnel of the various municipal undertakings of which we are qualified to speak is entirely beyond the faintest suspicion. Four of the best known American municipal electric plants, those of Chicago, Detroit, South Norwalk, Conn., and Allegheny, Pa., were examined by the commission and the experts. Of these South Norwalk is the only one that does commercial lighting. As to the cost of operation of these plants, the Chicago plant is cited to show that, including items of depreciation, interest, taxes, proportion of salary, insurance, and water, there is a loss to the city, based on simple interest on the amount paid, of 6·70dol. per lamp per year, or a total of 284,202dol. annually, compared with what the cost would be if service were taken from a private company. Computed with compound interest on the amount paid, the loss is 11·07dol. per lamp, or 469,217dol. per year. These figures are based on statements submitted by the commission's expert accountants, and do not agree with the estimates of the city electric department, which show a saving to the city. The type of the plant in use at the stations is also severely criticised, much of it being declared either obsolete, inefficient, or expensive to operate.

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THE BRITISH ASSOCIATION.

Leicester Meeting.

This meeting practically commenced on Wednesday last, although the enrolling of new members commenced on Monday. The programmes of the various sections have been varied somewhat since they were first published by us. The following gives the latest information as to the accepted papers and of the dates they will be read:

Revised Programme for Section A (Mathematical and Physical Science).

FRIDAY, AUG. 2, 10.15 A.M.

1. Discussion on "The Constitution of the Atom," to be opened by Prof. E. Rutherford, F.R.S. The following members will take part: Sir O. Lodge, Sir W. Ramsay, Messrs. F. Soddy and G. A. Schott.
2. Sir William Ramsay, K.C.B., F.R.S.: "On Variability in the Products resulting from Changes in Radium Emanation."
3. F. Soddy and T. D. Mackenzie (Carnegie research scholar): "Pseudo High Vacua."
4. Miss I. Homfray: "The Absorption of Gases by Charcoal."
5. Prof. H. E. Armstrong, F.R.S.: "On the Nature of Ionisation"
6. Report of Committee on Electrical Standards.
7. Dr. L. N. G. Filon: "Note on the Shear Theory of Rupture."
8. Prof. F. T. Trouton, F.R.S.: "An Electrical Experiment illustrating the Two Modes of Condensation of Water Vapour upon Surfaces."

MONDAY, AUG. 5, AT 10.15 A.M

1. Dr. L. Holborn: "Optical Pyrometry." Prof. C. Féry and Dr. Harker will take part in the discussion.

The section will then divide into two departments—viz., (*a*) department of mathematics, in which a number of papers will be read, and (*b*) department of general physics, in which the following papers will be read:

1. Sir O. Lodge, F.R.S.: "The Density of Ether."
2. A. O. Rankine: "On a Theoretical Method of attempting to detect Relative Motion between the Ether and the Earth."
3. Prof. W. M. Hicks, F.R.S.: "The Use of Calcite in Spectroscopy."
4. H. Stansfield: "Note on the Echelon Spectroscope and the Resolution of the Green Mercury Line."
5. Prof E. Rutherford, F.R.S.: "On the Production and Origin of Radium."
6. Prof E. Rutherford, F.R.S, and Dr. J. E. Petavel, F.R.S.: "The Effect of High Temperature on the Activity of the Products of Radium."
7. Dr. C. V. Drysdale: "The Ultimate Efficiency of Illuminants"

TUESDAY, AUG. 6, 10.15 A.M.

1. W. Palin Elderton: "Examples of Modern Methods of treating Observations." The following members will take part in the discussion: Dr. W. N. Shaw, G. U. Yule, and A. R. Hinks.

Revised Programme for Section G (Engineering).

FRIDAY, AUG. 2, AT 10 A.M.

1. B. Hopkinson: "On the Gases exhausted from a Petrol Motor."
2. Joint meeting with Section B (Chemistry) in the meeting room of Section G. Discussion on "Gaseous Explosions, with special reference to Temperature."

In the afternoon the British United Shoe Machinery Company, Limited, invite members of the section to an exhibition of machinery in operation arranged for this visit, and to tea. A descriptive pamphlet has been prepared, and can be obtained from Mr. A. C. Harris, local secretary of Section G, and at the reception room.

SATURDAY, AUG. 3.

A day's expedition for members of the section over the Leicester and Swannington Railway, conducted by Mr. Clement Stretton. Programme of the arrangements and tickets can be obtained from Mr. A. C. Harris, local secretary of Section G. The number is limited to 40.

MONDAY, AUG. 5, AT 10 A.M.

1. Sir W. H. Preece, K.C.B., F.R.S.: "Pupin's Compensated Cable for Telephone Transmission."
2. Sir Oliver Lodge, F.R.S.: "Tuning in Wireless Telegraphy."
3. J. T. Morris: "Note on an Oscillograph Study of Duddell Arcs of Low Frequency."
4. L. Gaster: "Developments in Electric Incandescent Lamps."
5. C. V. Drysdale: "Resistance Coils and their Comparison."

TUESDAY, AUG. 6, AT 10 A.M.

1. J. S. E. de Vesian: "Ferro-Concrete and Examples of Construction."
2. W. Noble Twelvetrees: "Some New Uses for Reinforced Concrete."
3. W. Worby Beaumont: "The Origin and Production of Corrugations in Tramway Rails."
4. J. F. Brooks: "A Machine for Weighing the Forces on a Cutting Tool."
5. H. S. Brackenbury: "Modern Machinery and its Future Developments."

In the afternoon members of the section are invited by the committee of the Corporation to inspect the gas and electric lighting station, Aylestone-road.

WEDNESDAY, AUG. 7, AT 10 A.M.

1. R. S. Ball: "Note on the Governing of Hydraulic Turbines."
2. H. T. Barnes: "The Ice Problem in Engineering Work in Canada."
3. J. Smyth: "The Application of Water Power and how to secure the greatest efficiency in working the same."
4. E. G. Coker: "The Equipment of the Engineering Laboratory of the Finsbury Technical Institute."

The report of the council for the year 1906-1907 was considered at the general committee meeting on Wednesday. At this Mr. Francis Darwin, F.R.S., was nominated by the council to fill the office of president of the association for the year 1908-1909.

In view of the number of visitors in Leicester this and next week, we give herewith short descriptions of the electric lighting and tramways undertakings of the Corporation.

Leicester Electricity Works.

The supply of electricity to Leicester was commenced in December, 1894, and the works were arranged under the design and supervision of Mr. A. Colson, the gas engineer. A full description of these works was published in the *Electrical Engineer* on April 26, 1895. The original equipment was of Hick-Hargreaves engines and Mordey alternators. These alternators were afterwards replaced by others of the inductor type made by Ganz and Co. When looking through the works last week, we found the four original engines with these alternators still at work. They are each capable of giving 350 kw. Since then the station has been increased in size, and three engines of 1,000 kw. added. These engines, as before, are of the Hick-Hargreaves make, and Fig. 1 shows the valve gear adopted. Fig. 2 gives a view of one of these new alternators, but the illustration does not flatter the design of the building. These larger alternators were made by the Brush Electrical Engineering Company, and are also of the inductor type. When the station was first opened there was considerable difficulty in the running of the machines in parallel. This was largely due to the governors of the engines, which were much too sensitive. These have been slightly altered, and now the station is run as one unit. The exciters for these alternators are placed along one side of the engine-room, as shown in Fig. 3. Several of these consist of Allen engines driving dynamos which were also manufactured by Messrs. W. H. Allen and Co., Limited, of Bedford. The switchgear (Fig. 4) occupies one end of the engine-room, and from the gallery all the plant can be seen and controlled. The switchboard is of the

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Brush manufacture, and was designed while there was still trouble with the parallel running of the alternators. In consequence of this, it was designed to enable the various feeders to be grouped together for circuit running. On each of the feeder panels there are two high-tension switches so linked together that when one is closed the other is open. By this means the loaded feeders can be transferred from one alternator to another.

The single-phase high-tension current at 2,000 volts is carried by means of concentric cables to 52 sub-stations in various parts of the town. These are usually constructed under the streets. The cables are mostly of the B.I.W. type, while transformers of the Brush, Westinghouse, and B.T.H. types are used. The low-tension mains are fused, and the supply is given at 100 volts in the centre of the town and at 200 volts in the outlying areas.

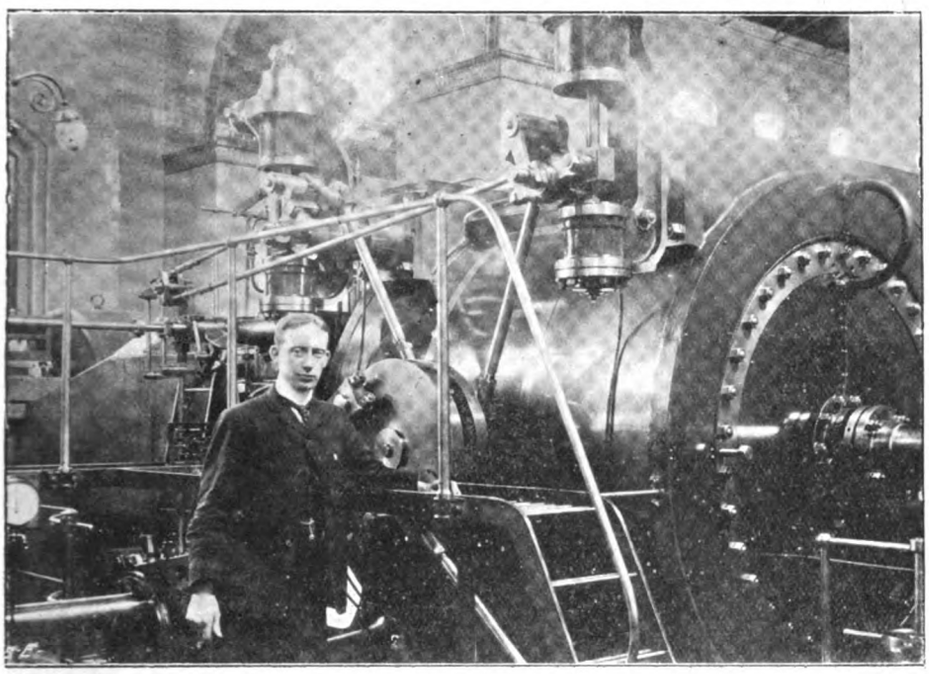

FIG. 1.—The Valve Gear of the Hick-Hargreaves Engine.

The system of charging is exceedingly simple—one inflexible rate of 4d. per unit for light and 2d. per unit for power. The curves (Fig. 5) reproduced herewith show the working of this department during the last five years. The equivalent number of lamps now connected to the mains is 184,041 of 8 c.p., and there are 250 motors, supplied with the aggregate horse-power of 881. The total number of consumers is 2,880. These figures are creditable to Mr. Colson, who is still responsible for the electricity supply, and to Mr. J E. M. Stewart, who is superintendent of the electrical section of the combined gas and electricity department.

Leicester Corporation Tramways.

The tramways at Leicester belonged to a company at first, and were then run as horse tramways. After they had been purchased by the Corporation they were completely reconstructed by Mr. E. G. Mawbey, M.I.C.E., the borough engineer and surveyor. This work included the building of a power-house, and was completed early in 1904, the opening ceremony being held on May 18 of that year. We gave at the time a description of the work, and it will suffice here to mention a few details of the equipment. There are in the power station four engines by Yates and Thom (one of 1,560 i.h.p. and three of 780 i.h.p.) of the vertical cross compound type; generators by Dick, Kerr, and Co., compound wound, 550 volts—total capacity, 2,500 kw.; one Thury reversible booster, three negative and two positive boosters; a battery of Tudor accumu-

MR. A F. LUCAS, MANAGER OF THE LEICESTER CORPORATION TRAMWAYS.

MR E G. MAWBEY, M.INST C E., BOROUGH ENGINEER AND SURVEYOR, LEICESTER.

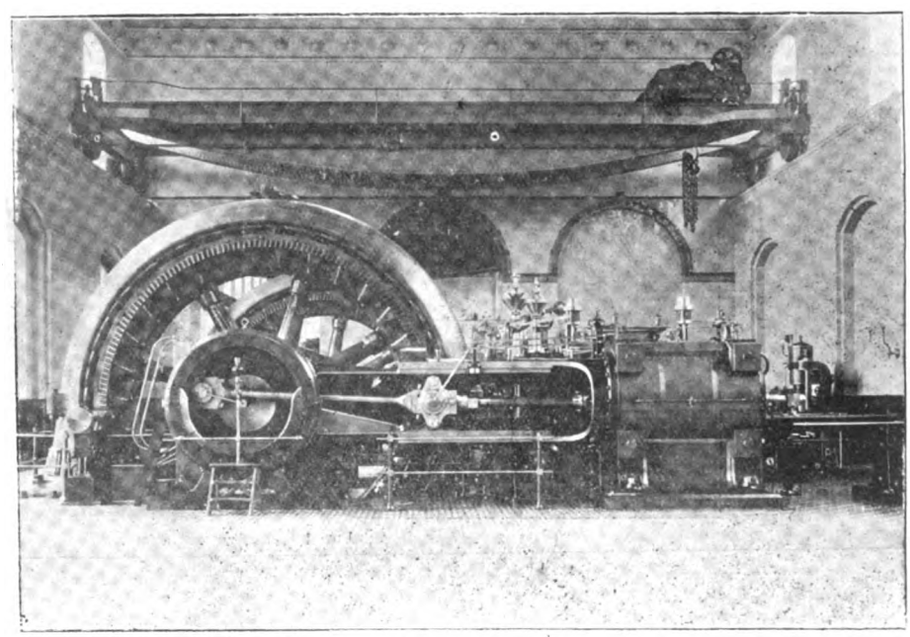

FIG. 2.—The 1,000-kw. Hick-Hargreaves Engines and Brush Alternators at Leicester.

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lators of 240 cells, with. a discharge rate of 600 amperes for one hour; six Lancashire boilers, with Bennis stokers and Green economisers. There are two novelties at these

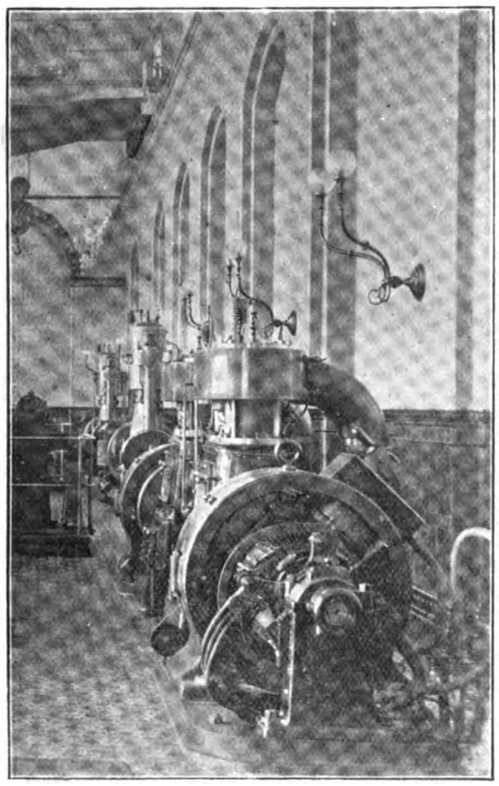

FIG. 3.—The Exciters.

works worth special attention from engineers—one an instrument for recording the quantity of CO_2 in the chimney stack, and the other an electrolytic oil-separating

ANALYSIS OF POWER GENERATION COSTS—1905 AND 1906.

	1905. £	s.	d.	Pence per unit.		1906. £	s.	d.	Pence per unit.
Coal and other fuel	3,259	10	6	·157	.....	4,172	15	1	·1743
Oil and waste	453	7	7	·021	.....	573	6	1	·0240
Wages and salaries	2,548	14	9	·122	.....	2,885	7	7	·1205
Water	198	8	2	·009	.....	324	14	11	·0135

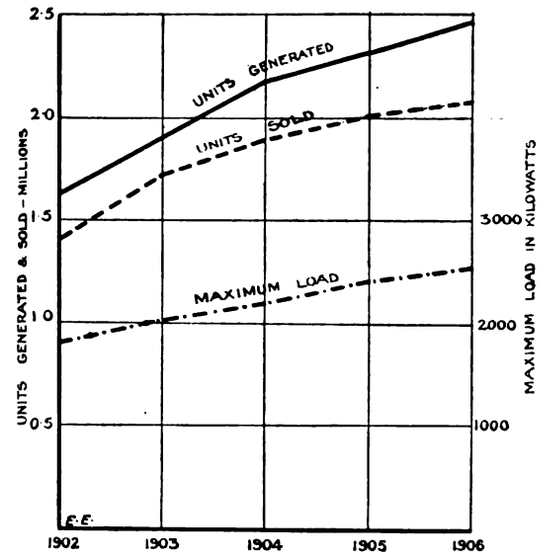

FIG. 5.—Progress Curves of the Leicester Electricity Supply Undertaking.

Stores	228	9	10	·011	.....	210	7	6	·0088
Repairs to steam plant	213	8	6	·010	.....	211	16	5	·0008
Repairs to electrical plant	70	1	6	·003	.....	73	13	2	·0031
Repairs to buildings	82	0	11	·003	.....	119	7	5	·0050
Works costs ..	£7,054	1	9	·340	.....	£8,571	8	2	·3580

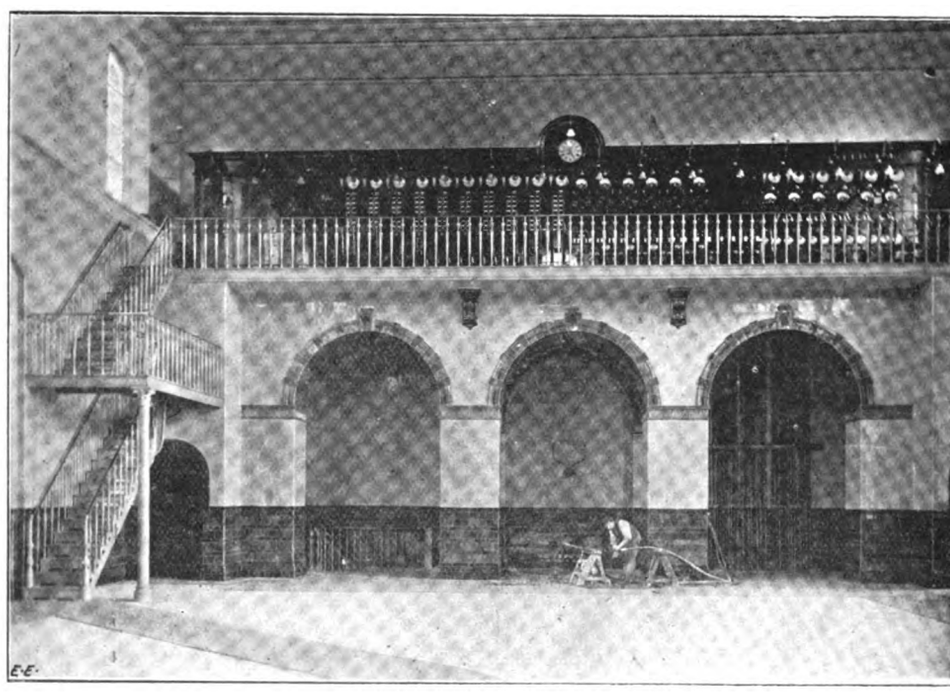

FIG. 4.—The Switch Gallery.

apparatus for rendering the oil emulsified in the condensed water and removable by filtration. Under the charge of Mr. T. Robert Smith, A.M.I.E.E., the tramways engineer, this station has been most successful in producing cheap power. The total number of units generated for the 12 months ended Dec. 31, 1906, amounts in all to 5,745,620, and we give herewith a tabulated form for the 12 months' working and for the previous year.

In the annual report the following statistical information is given, which shows the present satisfactory state of the undertaking: total borrowing powers, £734,867. 16s.;

Proportion of rents, rates, and taxes	552	15	11	·026	.....	569	4	0	·0238
Proportion of insurance premiums	80	10	8	·003	.....	72	16	7	·0030
Proportion of interest and sinking fund on capital, at 5 per cent.	4,695	8	3	·226	at 5½ %	5,247	19	4	·2192
Grand total costs .	£12,382	16	7	·597	.....	£14,461	8	1	·6040

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borrowing powers exercised, £677,129. 16s. 8d.; unexhausted borrowing powers, £58,032. 14s. 11d. (£1,705. 4s. 5d. value of stock taken over from old company provided for part of the loans for purchase); gross capital expenditure, £677,829. 5s. 3d.; mileage of track — single 2 miles 6 furlongs 88 yards, double 17 miles 176 yards; population served by tramways (estimated), 232,111; traffic revenue, £114,752. 7s.; total revenue, £116,527. 12s.; working expenses, £68,940. 9s. 6d.; interest on capital, £22,761. 5s. 9d.; sinking fund, £11,871. 11s. 6d.; net balance, £13,110. 2s. 4d.; disposal of net balance (reserve fund), £13,110. 2s. 4d.; car miles, 3,331,998; passengers carried, 27,467,984; total number of units used for traction, 5,349,665; total number of units used for lighting power station, depôts, and offices, 395.955; number of units used per car mile, 1·60; percentage of working expenses to receipts, 59; average traffic revenue per car mile, 8·265; average traffic revenue per mile of single track, £3,101. 8s. 3d.; average total revenue per car mile, 8·393; average working expenses per car mile excluding power cost, 4·377; average working expenses per car mile including power cost, 4·965; average distance per penny fare, 2·15 miles; average fare per passenger, 1·002d.; average number of passengers per car mile, 8·243; average journeys per head of population per annum, 118; number of cars in stock, 140; total amount of sinking fund, £46,671. 11s. 8d.; amount of reserve or renewals fund, £41,447. 9s. 6d. The accompanying table and the curves (Fig. 14) show the traffic of the tramways for the past seven years.

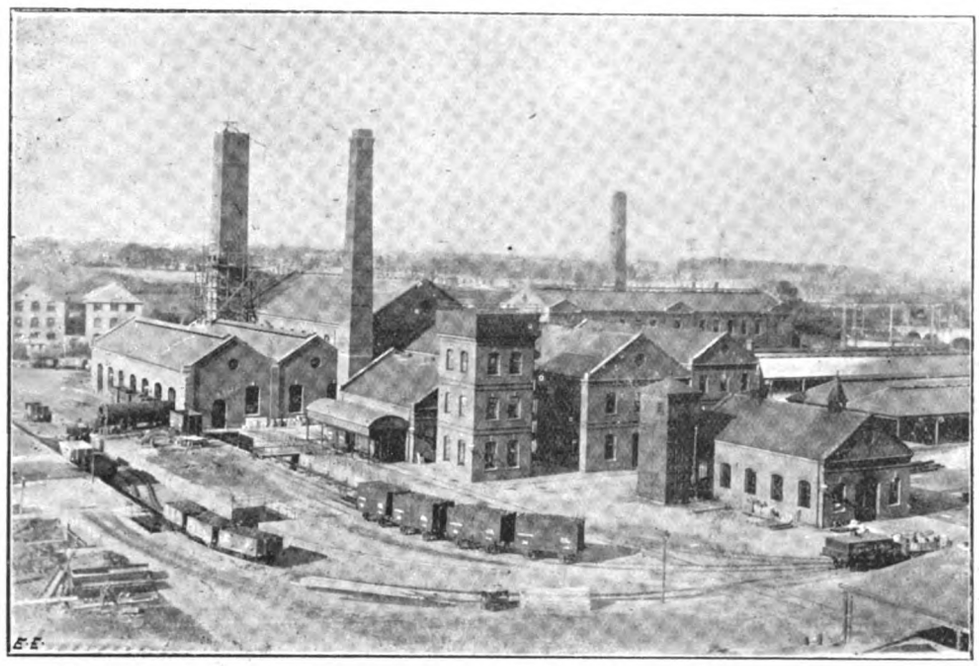

FIG. 6.—View of the Leicester Gas and Electricity Works.

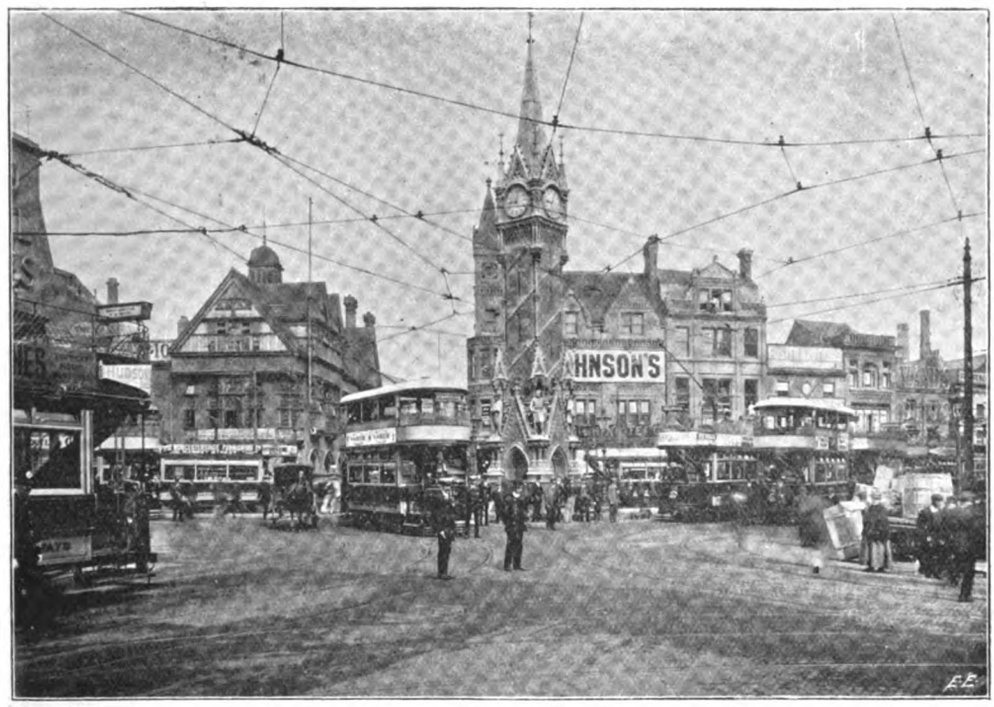

FIG. 8.—View of the Leicester Clock Tower, showing Tramway Centre. (Photograph by Messrs. John Burton and Sons, Leicester).

Financial year ended	Establishment of cars, 'buses, and brakes.	Establishment of horses.	Miles run.	Passengers carried.	Receipts.
Dec. 31, 1900	89	355	834,577	9,828,685	£42,191 18 6
,, 1901	73	385	868,347	10,090,832	43,377 0 11
,, 1902	76	403	948,525	10,943,841	47,074 19 6
,, 1903	69	403	960,934	10,813,430	46,325 6 6
,, 1904	99 electric cars		1,860,479	18,394,183	77,531 19 4
,, 1905	140	,,	3,342,248	25,890,030	108,111 2 11
,, 1906	140	,,	3,331,998	27,467,984	114,752 7 0

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These curves indicate the great improvement in the service due to the electrification of the lines, and also the way in which the traffic has increased in consequence. Mr. Mawbey is still responsible for any constructional work required, and is to be congratulated on the success of the tramway system designed by him. Mr. E. Manville, M.I.E.E., acted as consulting engineer for the original scheme. Mr. A. F. Lucas, as the tramway manager, has full charge of the running of the cars. We are pleased to see that in the accounts for the past two years there has been an ample amount put aside for depreciation, so that the undertaking is financially sound. Councillor Samuel Flint, J.P., is chairman of the Tramways Committee, and Alderman Thomas Smith, J.P., is the vice-chairman. Both these gentlemen have held office since the electrification was first proposed, and they have taken a keen interest in the reorganisation of the tramways. The fact that Alderman Smith is the mayor-elect shows that his services are highly appreciated by his fellow-citizens.

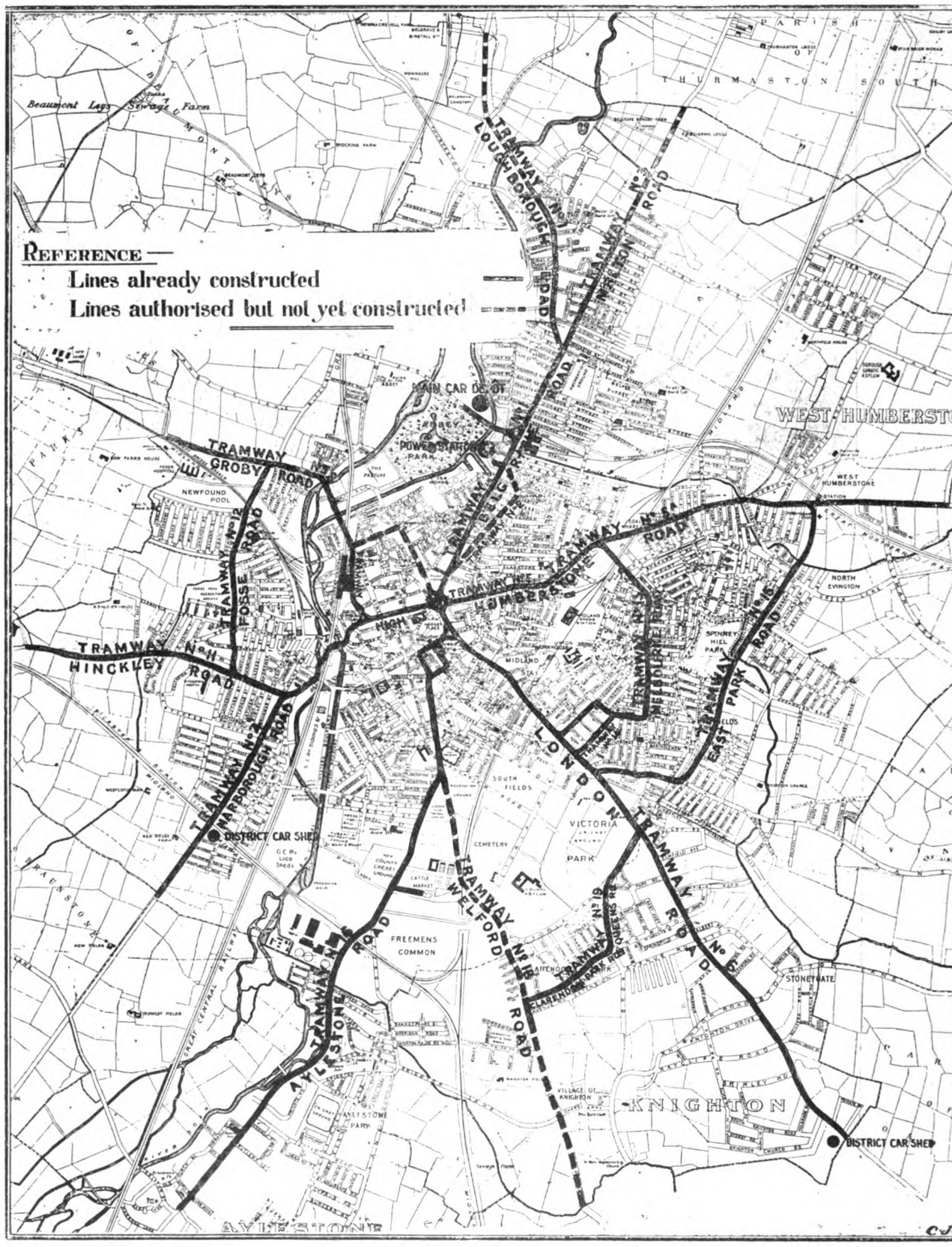

FIG 7.—Map of the Leicester Electric Tramways.

Presidential Address.

BY SIR DAVID GILL, K.C.B., LL.D., D.SC., F.R.S., HON. F.R.S.E., ETC.

To-night, for the first time in its history, the British Association meets in the ancient city of Leicester; and it now becomes my privilege to convey to you, Mr. Mayor

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and to the citizens generally, an expression of our thanks for your kind invitation and for the hospitable reception which you have accorded to us. Here in Leicester and last year in York the association has followed its usual custom of holding its annual meeting somewhere in the United Kingdom; but in 1905 the meeting was, as you know, held in South Africa. Now, having myself only recently come from the Cape, I wish to take this opportunity of saying that this southern visit of the association has, in my opinion, been productive of much good: wider interest in science has been created amongst colonists, juster estimates of the country and its problems have been formed on the part of the visitors, and personal friendships and interchange of ideas between thinking men in South Africa and at home have arisen which cannot fail to have a beneficial influence on the social, political, and scientific relations between these colonies and the mother country. We may confidently look for like results from the proposed visit of the association to Canada in 1909.

One is tempted to take advantage of the wide publicity given to words from this chair to speak at large in the cause of science, to insist upon the necessity for its wider inclusion in the education of our youth, and the devotion of a larger measure of the public funds in aid of scientific research; to point to the supreme value of science as a means for the culture of those faculties which in man promote that knowledge which is power, and to show how dependent is the progress of a nation upon its scientific attainment. But in recent years these truths have been prominently brought before the association from this chair; they have been exhaustively demonstrated by Sir William Huggins from the chair of the Royal Society, and now a

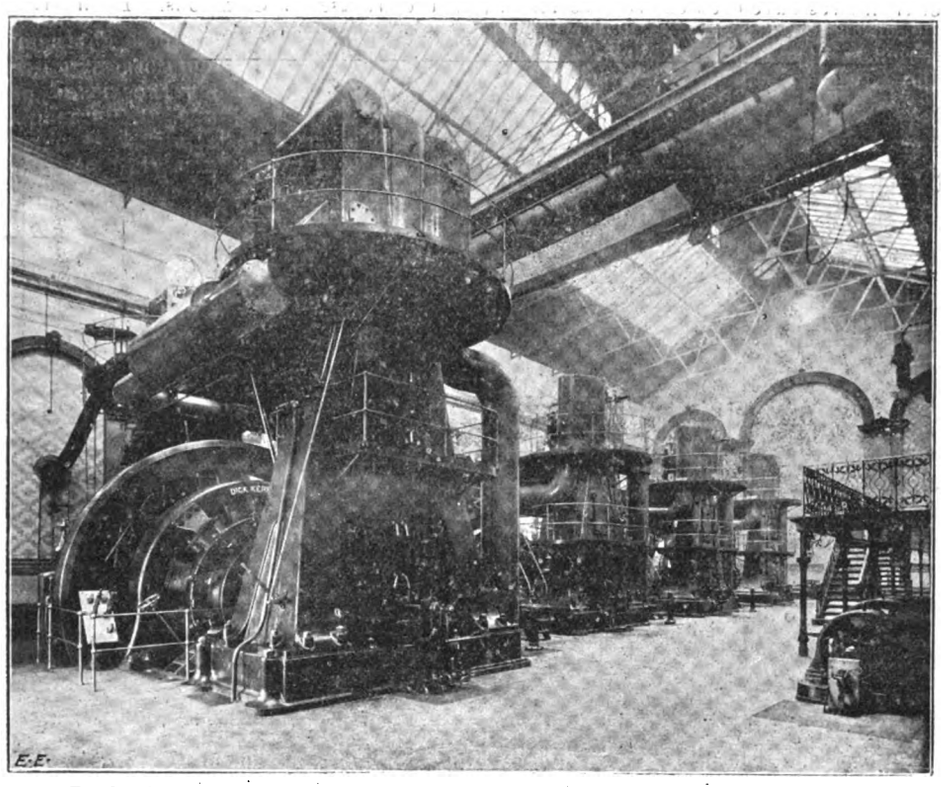

FIG. 9.—View of the Yates and Thom-Dick-Kerr Generators in the Leicester Tramway Power House.

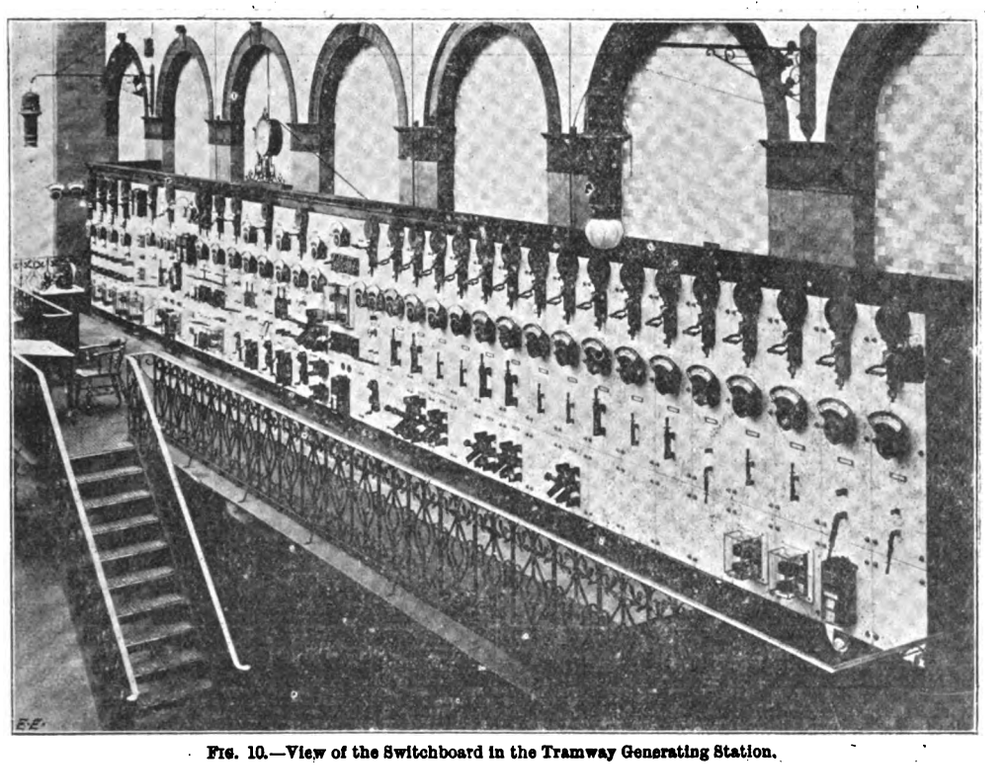

FIG. 10.—View of the Switchboard in the Tramway Generating Station.

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special guild (the British Science Guild) exists for their enforcement upon the mind of the nation. These considerations appear to warrant me in following the healthy custom of so many previous presidents—viz., of confining their remarks mainly to those departments of science with which the labours of their lives have been chiefly associated.

FIG. 11.—Entrance to Main Car Depot.

The Science of Measurement.—Lord Kelvin in 1871 made a statement from the presidential chair of the association at Edinburgh as follows: "Accurate and minute measurement seems to the non-scientific imagination a less lofty and dignified work than the looking for something new. But nearly all the grandest discoveries of science have been the reward of accurate measurement and patient, long-continued labour in the minute sifting of numerical results." Besides the instances quoted by Lord Kelvin in support of that statement, we have, perhaps, as remarkable and typical an exemplification as any in Lord Rayleigh's long-continued work on the density of nitrogen which led him to the discovery of argon. We shall see presently that, true as Lord Kelvin's words are in regard to most fields of science, they are specially applicable as a guide in astronomy. One of Clerk Maxwell's lectures in the natural philosophy class at Marischall College, Aberdeen, when I was a student under him there, in the year 1859, ran somewhat as follows:

"A standard, as it is at present understood in England, is not a real standard at all; it is a rod of metal with lines ruled upon it to mark the yard, and it is kept somewhere in the House of Commons. If the House of Commons catches fire there may be an end of your standard. A copy of a standard can never be a real standard, because all the work of human hands is liable to error. Besides, will your so-called standard remain of a constant length? It certainly will change by temperature, it probably will change by age—that is, by the rearrangement or settling down of its component molecules—and I am not sure if it does not change according to the azimuth in which it is used. At all events, you must see that it is a very impractical standard—impractical, because if, for example, any one of you went to Mars or Jupiter, and the people there asked you what was your standard of measure, you could not tell them, you could not reproduce it, and you would feel very foolish. Whereas, if you told any capable physicist in Mars or Jupiter that you used some natural invariable standard, such as the wave-length of the D line

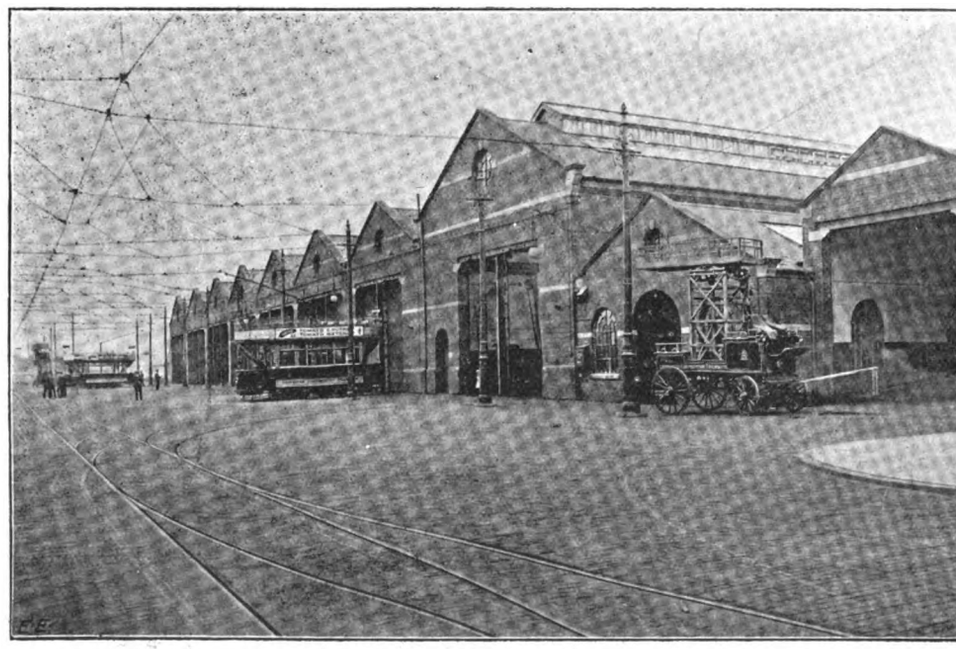

FIG. 12.—The Main Car Depot, Leicester.

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of sodium vapour, he would be able to reproduce your yard or your inch, provided that you could tell him how many of such wave-lengths there were in your yard or your inch, and your standard would be available anywhere in the universe where sodium is found." That was the whimsical way in which Clerk Maxwell used to impress some principles upon us. We all laughed before we understood; then some of us understood and remembered.

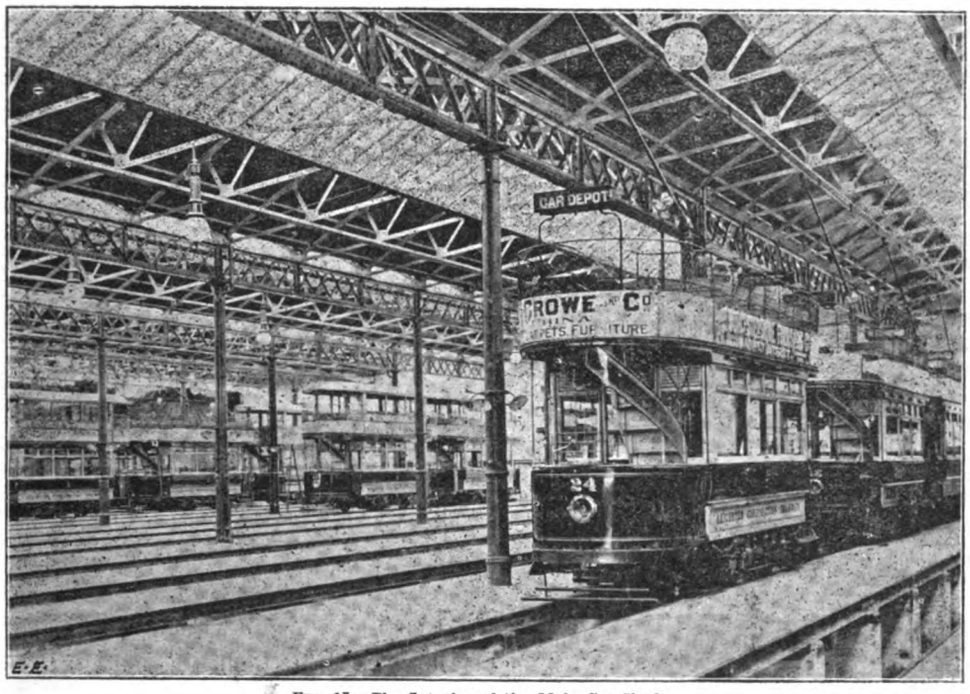

FIG. 13.—The Interior of the Main Car Shed.

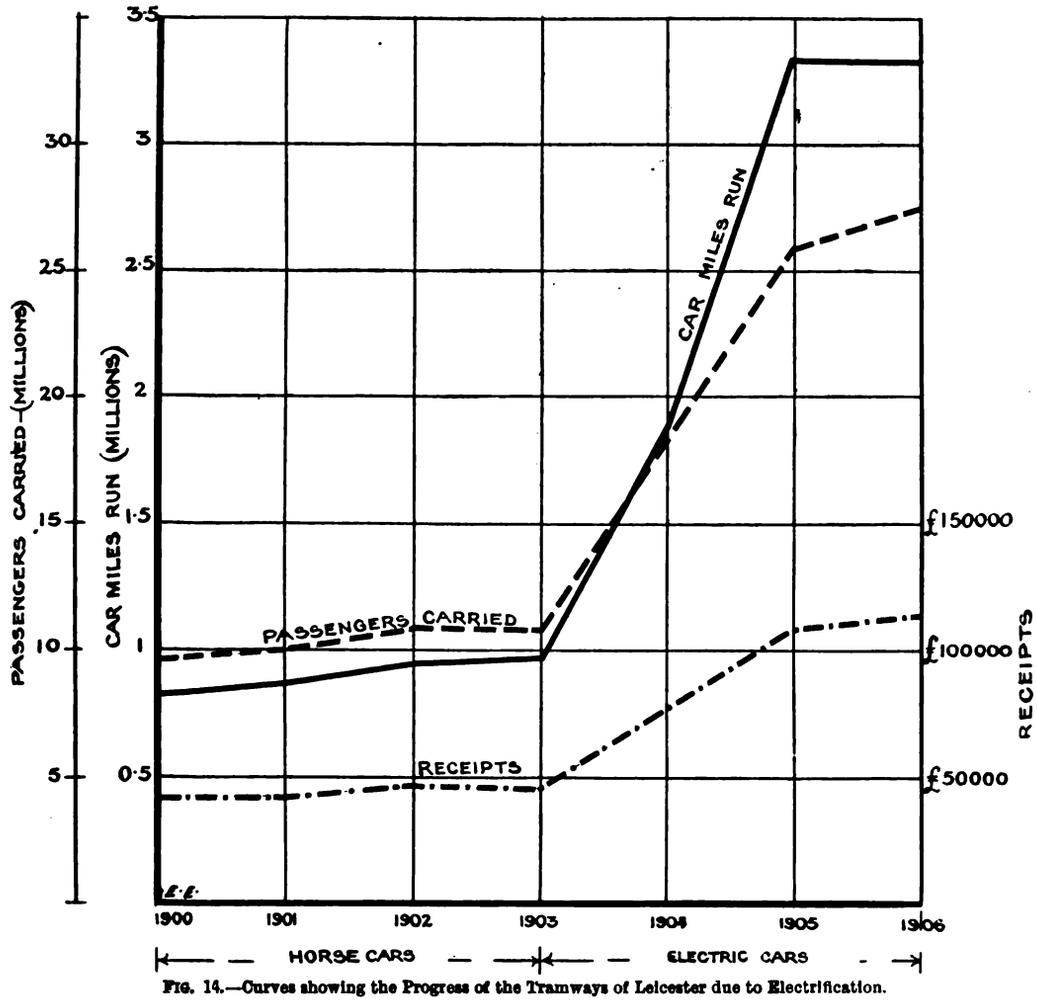

FIG. 14.—Curves showing the Progress of the Tramways of Leicester due to Electrification.

Now the scientific world has practically adopted Maxwell's form of natural standard. It is true that it names that standard the metre; but that standard is not one-millionth of the earth's quadrant in length, as it was intended to be; it is merely a certain piece of metal approximately of that length. It is true that the length of that piece of metal has been reproduced with more precision, and is known with higher accuracy in terms of many secondary standards, than is the length of any other standard in the world; but it is, after all, liable to destruction and to possible secular change of length. For these reasons it cannot be scientifically described otherwise than as a piece of metal whose length at 0deg. C. at the epoch A.D. 1906 is = 1,553,163 times the wave-length of the red

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line of the spectrum of cadmium when the latter is observed in dry air at the temperature of 15deg. C. of the normal hydrogen scale at a pressure of 760mm. of mercury at 0deg. C. This determination, recently made by methods based on the interference of light waves and carried out by MM. Perot and Fabry at the International Bureau of Weights and Measures, constitutes a real advance in scientific metrology. The result appears to be reliable within one ten-millionth part of the metre. The length of the metre in terms of the wave-length of the red line in the spectrum of cadmium had been determined in 1892 by Michelson's method, with a mean result in almost exact accordance with that just quoted for the comparisons of 1906; but this agreement (within one part in 10 millions) is due in some degree to chance, as the uncertainty of the earlier determination was probably 10 times greater than the difference between the two independent results of 1892 and 1906.

We owe to M. Guillaume, of the same International Bureau, the discovery of the remarkable properties of the alloys of nickel and steel, and from the point of view of exact measurement the specially valuable discovery of the properties of that alloy which we now call "invar." He has developed methods for treatment of wires made from this alloy which render more permanent the arrangement of their constituent molecules. Thus these wires, with their attached scales, may, for considerable periods of time and under circumstances of careful treatment, be regarded as nearly invariable standards. With proper precautions, we have found at the Cape of Good Hope that these wires can be used for the measurement of base lines of the highest geodetic position with all the accuracy attainable by the older and most costly forms of apparatus; whilst with the new apparatus a base of 20 km. can be measured in less time and for less cost than one of a single kilometre with the older forms of measurement.

Sir David Gill proceeded to deal with the subjects with which he is specially connected as an astronomer. The headings of the sections of the address show the wide range of reference. These were: "The Great African Arc of Meridian"; "The Solar Parallax"; "The Stellar Universe"; "The Comparative State of Astronomy in the Northern and Southern Hemispheres"; "The Constitution of the Universe"; "Stellar Parallax"; "Secular Parallactic Motion of Stars"; "Determination of Stellar Motion in the Line of Sight"; "The Velocity of the Sun's Motion in Space"; "The Mean Parallaxes of Stars of Different Magnitude and Proper Motion"; "The Distribution of Varieties of Luminosity of Stars"; "The Density of Stellar Distribution at Different Distances from our Sun"; "The Future Course of Research." He concluded:

The ancient philosophers were confident in the adequacy of their intellectual powers alone to determine the laws of human thought and regulate the actions of their fellow men, and they did not hesitate to employ the same unsupported means for the solution of the riddle of the universe. Every school of philosophy was agreed that some object which they could see was a fixed centre of the universe, and the battle was fought as to what that centre was. The absence of facts, their entire ignorance of methods of exact measurement, did not daunt them, and the question furnished them a subject of dispute and fruitless occupation for 25 centuries. But astronomers now recognise that Bradley's meridian observations at Greenwich, made only 150 years ago, have contributed more to the advancement of sidereal astronomy than all the speculations of preceding centuries. They have learned the lesson that human knowledge in the slowly-developing phenomena of sidereal astronomy must be content to progress by the accumulating labours of successive generations of men; that progress will be measured for generations yet to come more by the amount of honest, well-directed, and systematically discussed observation than by the most brilliant speculation; and that in observation concentrated systematic effort on a special thoughtfully selected problem will be of more avail than the most brilliant but disconnected work. By these means we shall learn more and more of the wonders that surround us, and recognise our limitations when measurement and facts fail us.

Huggins's spectroscope has shown that many nebulæ are not stars at all; that many well-condensed nebulæ, as well as vast patches of nebulous light in the sky, are but inchoate masses of luminous gas Evidence upon evidence has accumulated to show that such nebulæ consist of the matter out of which stars—*i.e.*, suns—have been and are being evolved. The different types of star spectra form such a complete and gradual sequence (from simple spectra resembling those of nebulæ onward through types of gradually increasing complexity) as to suggest that we have before us written in the cryptograms of these spectra the complete story of the evolution of suns from the inchoate nebula onwards to the most active sun (like our own), and then downward to the almost heatless and invisible ball. The period during which human life has existed on our globe is probably too short—even if our first parents had begun the work—to afford observational proof of such a cycle of change in any particular star; but the fact of such evolution, with the evidence before us, can hardly be doubted. I must fully believe that, when the modifications of terrestrial spectra under sufficiently varied conditions of temperature, pressure, and environment have been further studied, this conclusion will be greatly strengthened. But in this study we must have regard also to the spectra of the stars themselves. The stars are the crucibles of the Creator. There we see matter under conditions of temperature and pressure and environment, the variety of which we cannot hope to emulate in our laboratories, and on a scale of magnitude beside which the proportion of our greatest experiment is less than that of the drop to the ocean. The spectroscopic astronomer has to thank the physicist and the chemist for the foundation of his science, but the time is coming—we almost see it now—when the astronomer will repay the debt by wide-reaching contributions to the very fundamenta of chemical science.

By patient, long-continued labour in the minute sifting of numerical results, the grand discovery has been made that a great part of space, so far as we have visible knowledge of it, is occupied by two majestic streams of stars travelling in opposite directions. Accurate and minute measurement has given us some certain knowledge as to the distances of the stars within a certain limited portion of space, and in the cryptograms of their spectra has been deciphered the amazing truth that the stars of both streams are alike in design, alike in chemical constitution, and alike in process of development. But whence have come the two vast streams of matter out of which have been evolved these stars that now move through space in such majestic procession? The hundreds of millions of stars that comprise these streams, are they the sole ponderable occupants of space? However vast may be the system to which they belong, that system itself is but a speck in illimitable space; may it not be but one of millions of such systems that pervade the infinite? We do not know. "Canst thou by searching find out God? canst thou find out the Almighty unto perfection?"

Address to the Engineering Section.

BY SILVANUS P. THOMPSON, D.SC., F.R.S., PAST-PRESIDENT I.E.E, PRESIDENT OF THE SECTION.

It would be impossible for any assembly of engineers to meet in annual gathering at the present time without some reference to the severe loss which the profession has so recently sustained by the death of Sir Benjamin Baker. Born in 1840, he had attained while still a comparatively young man to a position in the front rank of constructive engineers. His contributions to science cover a considerable range, but were chiefly concerned with the strength of materials, into which he made valuable investigations, and with engineering structures generally. His name will doubtless be chiefly associated with the building of great bridges, to the theory of which he contributed an important memoir, entitled "A Theoretical Investigation into the Most Advantageous System of Constructing Bridges of Great Span." In this work he set forth the theory of the cantilever bridge. Upon the plan there laid down he built the Forth Bridge, besides many other large bridges in various parts of the world. With that memorable structure, completed in 1890, his name will ever be associated; but he will be remembered henceforth also as the engineer who was responsible for the great dam across the Nile at Assouan, a work which

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promises to have an influence for all time upon the fortunes of Egypt and upon the prosperity of its population. Sir Benjamin Baker was, moreover, closely associated with the internal railways of London, both in the early days of the Metropolitan Railway and in the later developments of the deep-level tubes. He was elected a Fellow of the Royal Society in 1890, became president of the Institution of Civil Engineers in 1895, and was a member of council of the Institution of Mechanical Engineers, besides being an active member of the Royal Institution and of the British Association. He was also a member of the council of the Royal Society at the time of his death. He enjoyed many honorary distinctions, including degrees conferred by the Universities of Cambridge and Edinburgh. In 1890 there was conferred upon him the title of K.C.M.G., and in 1902 that of K.C.B. He had but just returned from Egypt, whither he had gone in connection with the project for raising the height of the Assouan dam so as to increase its storage to more than double the present volume, when he died very suddenly on May 19, in his sixty-seventh year.

The Development of Engineering and its Foundation on Science.

We live in an age when the development of the material resources of civilisation is progressing in a ratio without parallel. International commerce spreads apace. Ocean transport is demanding greater facilities. Steamships of vaster size and swifter speed than any heretofore in use are being built every year. Not only are railways extending in all outlying parts of the world, but at home, where the territory is already everywhere intersected with lines, larger and heavier locomotives are being used, and longer runs without stopping are being made by our express trains. The horsed cars on our tramways are now being mostly superseded by larger cars, electrically-propelled, and travelling with greatly increased speeds. For the handling of the ever-increasing passenger traffic in our great cities, electric propulsion has shown itself a necessity of the time; witness the electric railways in Liverpool and the network of electrically-worked tube railways throughout London. In 10 years the manufacture of automobile carriages of all sorts has sprung up into a great industry. Every year sees a greater demand for the raw materials and products, out of which the manufacturer will in turn produce the articles demanded by our complex modern life. We live and work in larger buildings; we make more use of mechanical appliances; we travel more, and our travelling is more expeditious than formerly; and not we alone, but all the progressive nations. The world uses more steel, more copper, more aluminium, more paper; therefore requires more coal, more petroleum, more timber, more ores, more machinery for the getting and working of them, more trains and steamships for their transport. It requires machines that will work faster or more cheaply than the old ones to meet the increasing demands of manufacture; new fabrics; new dyes, even new foods; new and more powerful means of illumination; new methods of speaking to the ends of the earth.

We must not delude ourselves with imagining that the happiness and welfare of mankind depend only on its material advancement, or that moral, intellectual, and spiritual forces are not in the ultimate resort of greater moment. But if the inquiry be propounded what it is that has made possible this amazing material progress, there is but one answer that can be given—science. Chemistry, physics, mechanics, mathematics, it is these that have given to man the possibility of organising this tremendous development. And the great profession which has been most potent in applying these branches of science to wield the energies of Nature and direct them to the service of man has been that of the engineer. Without the engineer how little of all this activity could there have been; and without mathematics, mechanics, physics, and chemistry, where were the engineer?

If looking over this England of Edward the Seventh we try to put ourselves back into the England of Edward the Sixth—or for that matter of any pre-Victorian monarch—we must admit that the differences to be found in the social and industrial conditions around us are due not in any appreciable degree to any changes in politics, philosophy, religion, or law, but to science and its applications. If we look abroad, and contrast the Germany of Wilhelm the Second with the Germany of Charles the Fifth, we shall come to the like conclusion. So also in Italy, in Switzerland, in every one, indeed, of the progressive nations. And it is precisely in the stagnant nations, such as Spain or Servia, where the cultivation of science has scarcely begun, that the social conditions remain in the backward state of the Middle Ages.

Interaction of Abstract Science and its Applications.

In engineering, above all other branches of human effort, we are able to trace the close interaction between abstract science and its practical applications. Often as the connection between pure science and its applications has been emphasised in addresses upon engineering, the emphasis has almost always been laid upon the influence of the abstract upon the concrete. We are all familiar with the doctrine that the progress of science ought to be an end in itself, that scientific research ought to be pursued without regard to its immediate applications, that the importance of a discovery must not be measured by its apparent utility at the moment. We are assured that research in pure science is bound to work itself out in due time into technical applications of utility, and that the pioneer ought not to pause in his quest to work out potential industrial developments. We are invited to consider the example of the immortal Faraday, who deliberately abstained from busying himself with marketable inventions arising out of his discoveries, excusing himself on the ground that he had no time to spare for money-making. It is equally true, and equally to the point, that Faraday, when he had established a new fact or a new physical relation, ceased from busying himself with it, and pronounced that it was now ready to be handed over to the mathematicians. But, admitting all these commonplaces as to the value of abstract science in itself and for its own sake, admitting also the proposition that sooner or later the practical applications are bound to follow on upon the discovery, it yet remains true that in this thing the temperament of the discoverer counts for something. There are scientific investigators who cannot pursue their work if troubled by the question of ulterior applications; there are others no less truly scientific who simply cannot work without the definiteness of aim that is given by a practical problem awaiting solution. There are Willanses as well as Regnaults; there are Whitworths as well as Poissons. The world needs both types of investigator; and it needs, too, yet another type of pioneer—namely, the man who, making no claim to original discovery, by patient application and intelligent skill turns to industrial fruitfulness the results already attained in abstract discovery.

There is, however, another aspect of the relation between pure and applied science, the significance of which has not been hitherto so much emphasised, but yet is none the less real—the reaction upon science and upon scientific discovery of the industrial applications. For while pure science breeds useful inventions, it is none the less true that the industrial development of useful inventions fosters the progress of pure science. No one who is conversant with the history, for example, of optics can doubt that the invention of the telescope and the desire to perfect it were the principal factors in the outburst of optical science which we associate with the names of Newton, Huygens, and Euler. The practical application, which we know was in the minds of each of these men, must surely have been the impelling motive that caused them to concentrate on abstract optics their great and exceptional powers of thought. It was in the quest—the hopeless quest—of the philosopher's stone and the elixir of life that the foundations of the science of chemistry were laid. The invention of the art of photography has given immense assistance to sciences as widely apart as meteorology, ethnology, astronomy, zoology, and spectroscopy. Of the laws of heat men were profoundly ignorant until the invention of the steam-engine compelled scientific investigation; and the new science of thermodynamics was born. Had there been no industrial development of the steam-engine, is it all likely that the world would ever have been enriched with the scientific researches of Rankine, Joule, Regnault, Hirn, or James Thomson? The magnet had been known for centuries, yet the study of it was utterly neglected until the application of it in the mariners' compass gave the incentive for research.

The history of electric telegraphy furnishes a very striking example of this reflex influence of industrial applications. The discovery of the electric current by Volta and the investigation of its properties appear to have been stimulated by the medical properties attributed in the preceding 50 years to electric discharges. But, once the current had been discovered, a new incentive arose in the dim possibility it suggested of transmitting signals to a distance. This was certainly a possibility, even when only the chemical effects of the current had yet been found out. Not, however, until the magnetic effects of the current had been discovered and investigated did telegraphy assume commercial shape at the hands of Cooke and Wheatstone in England and of Morse and Vail in America. Let us admit freely that these men were inventors rather than discoverers: exploiters of research rather than pioneers. They built upon the foundations laid by Volta, Oersted, Sturgeon, Henry, and a host of less famous workers. But no sooner had the telegraph become of industrial importance, with telegraph lines erected on land and submarine cables laid in the sea, than fresh investigations were found necessary. New and delicate instruments must be devised, means of accurate measurement heretofore undreamed of must be found, standards for the comparison of electrical quantities must be created, and the laws governing the operations of electrical systems and apparatus must be investigated and formulated in appropriate mathematical expressions. And so, perforce, as the inevitable consequence of the growth of the telegraph industry, and mainly at the hands of those interested in submarine telegraphy, there came about the system of electrical and electromagnetic units, based on the early magnetic work of Gauss and Weber, developed further by Lord Kelvin, by Bright and Clark, and last, but not least, by Clerk Maxwell. Had there been no telegraph industry to force electrical measurement and electrical

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theory to the front, where would Clerk Maxwell's work have been? He would probably have given his unique powers to the study of optics or geometry; his electromagnetic theory of light would never have leapt into his brain; he would never have propounded the existence of electric waves in the ether. And then we should never have had the far-reaching investigations of Heinrich Hertz; nor would the British Association at Oxford in 1894 have witnessed the demonstration of wireless telegraphy by Sir Oliver Lodge. A remark of Lord Rayleigh's may here be recalled, that the invention of the telephone had probably done more than anything else to make electricians understand the principle of self-induction.

In considering this reflex influence of the industrial applications upon the progress of pure science it is of some significance to note that for the most part this influence is entirely helpful. There may be sporadic cases where industrial conditions tend temporarily to check progress by imposing persistence of a particular type of machine or appliance; but the general trend is always to help to new developments. The reaction aids the action; the law that is true enough in inorganic conservative systems, that reaction opposes the action, ceases here to be applicable, as, indeed, it ceases to be applicable in a vast number of organic phenomena. It is the very instability thereby introduced which is the essential of progress. The growing organism acts on its environment, and the change in the environment reacts on the organism—not in such a way as to oppose the growth, but so as to promote it. So is it with the development of pure science and its practical applications. In further illustration of this principle one might refer to the immense effect which the engineering use of steel has had upon the study of the chemistry of the alloys. And the study of the alloys has in turn led to the recent development of metallography. It would even seem that through the study of the intimate structure of metals, prompted by the needs of engineers, we are within measurable distance of arriving at a knowledge of the secret of crystallogenesis. Everything points to the probability of a very great and rapid advance in that fascinating branch of pure science at no distant date.

History of the Development of Electric Motive Power.

There is, however, one last example of the interaction of science and industry which may claim closer attention. In the history of the development of the electric motor one finds abundant illustration of both aspects of that interaction. We go back to the year 1821, when Faraday, after studying the phenomena of electromagnetic deflection of a needle by an electric current (Oersted's discovery), first succeeded in producing continuous rotations by electromagnetic means. In his simple apparatus a piece of suspended copper wire, carrying a current from a small battery, and dipping at its lower end into a cup of mercury, rotated continuously around the pole of a short bar magnet of steel placed upright in the cup. In another variety of this experiment the magnet rotated around the central wire, which was fixed. These pieces of apparatus were the merest toys, incapable of doing any useful work; nevertheless, they demonstrated the essential principle, and suggested further possibilities. Two years later Barlow, using a star-wheel of copper, pivoted so that the lowest point of the star should make contact with a small pool of mercury, found that the star-wheel rotated if a current was sent through the arm of the star while the arm itself was situated between the poles of a steel horseshoe magnet. Shortly afterwards Sturgeon improved the apparatus by substituting a copper disc for the star-wheel. The action was the same. A conductor, carrying an electric current, if placed in a magnetic field, is found to experience a mechanial drag, which is neither an attraction nor a repulsion, but a lateral force tending to move it at right angles to the direction of flow of the current and at right angles to the direction of the lines of the magnetic field in which it is situated. Still this was a toy. Two years later came the announcement by Sturgeon of the invention of the soft-iron electromagnet, one of the most momentous of all inventions, since upon it practically the whole of the constructive part of electrical engineering is based. For the first time mankind was furnished with a magnet the attractive power of which could be increased absolutely indefinitely by the mere expenditure of sufficient capital upon the iron core and its surrounding copper coils, and the provision of a sufficiently powerful source of electric current to excite the magnetisation. Furthermore, the magnet was under control, and could be made to attract or to cease to attract at will by merely switching the current on or off; and, lastly, this could be accomplished from a distance, even from great distances away. How slowly the importance of this discovery was recognised is now a matter for astonishment. To state that Sturgeon died in poverty 26 years later is sufficient to indicate his place among the unrequited pioneers of whom the world is not worthy. Six years elapsed, and then there came a flood of suggestions of electric motors in which was applied the principle of intermittent attraction by an electromagnet. Henry in 1831 and Dal Negro in 1832 produced see-saw mechaniams so operated. Ritchie in 1833 and Jacobi in 1834 devised rotatory motors. Ritchie pivoted a rapidly commutated electromagnet between the poles of a permanent magnet—a true type of the modern motor—while Jacobi caused two multipolar electromagnets, one fixed, one movable, to put a shaft into rotation and propel a boat. A perplexing diminution of the current of the battery whenever the motor was running caused Jacobi to investigate mathematically the theory of its action. In a masterly memoir he laid down a few years later the theory of electric motive power. But in the intervening period, in 1831, Faraday had made the cardinal discovery of the mechanical generation of electric currents by magneto-electric induction, the fundamental principle of the dynamo. Down to that date the only known way—save for the feeble currents of thermo-piles—to generate electric currents had been the pile of Volta, or one of the forms of battery which had been evolved from it. Now, by Faraday's discovery, the world had become possessed of a new source. And yet again, strange as it may seem, years elapsed before the world—that is, the world of engineers—discovered that an important discovery had been made. Not till some 30 years later were any magneto-electric machines made of a sufficient size to be of practical service even in telegraphy, and none were built of a sufficient power to furnish a single electric light until about the year 1857. In the meantime, in America, other electric motors, to be driven by batteries, had been devised by Devonport and by Page. The latter's machine had an iron plunger to be sucked by electromagnetic attraction into a hollow coil of copper wire, thereby driving a shaft and flywheel through the intermediate action of a connecting rod and crank. Page's was, in fact, an electric engine, with 2ft. stroke, single-acting, of between 3 h.p. and 4 h.p. The battery occupied about three cubic feet and consumed, according to Page, 3lb. of zinc per horse-power per day. This must have been an under-estimate; for if Daniell's cells were used the minimum consumption for a motor of 100 per cent. efficiency is known to be about 2lb. of zinc per horse-power per hour.

Electric Motive Power Impossible in 1857.

Upon the state of development of electric motors 50 years ago information may be gleaned from an exceedingly interesting debate at the Institution of Civil Engineers upon a paper read April 21, 1857, "On Electromagnetism as a Motive Power," by Mr. Robert Hunt, F.R.S. In this paper the author states that, though long-enduring thought has been brought to bear upon the subject, and large sums of money have been expended on the construction of machines, "yet there does not appear to be any nearer approach to a satisfactory result than there was 30 years ago." After explaining the elementary principles of electromagnetism, he describes the early motors of Dal Negro, Jacobi, Davenport, Davidson, Page, and others. Reviewing these and their non-success as commercial machines, he says: "Notwithstanding these numerous trials . . . it does not appear that any satisfactory explanation has ever been given of the causes which have led to the abandonment of the idea of employing electricity as a motive power. It is mainly with the view of directing attention to these causes that the present communication has been written." He admits that electromagnets may be constructed to give any desired lifting power: but he finds that the attractive force on the iron keeper of a magnet of his own, which held 220lb. when in contact, fell to 36lb. when the distance apart was only 1-50in. To this rapid falling off of force, and to the hardening action on the iron of the repeated vibrations due to the mechanical concussion of the keeper, he attributed the small power of the apparatus. Also, he remarked upon the diminution of the current which is observed to flow from the battery when the motor was running (which Jacobi had, in his memoir on the theory, traced to a counter E.M.F. generated in the motor itself), and which reduced the effort exerted by the electromagnets; this diminution he regarded as impairing the efficiency of the machine. "All electromagnetic arrangements," he says, "suffer from the cause named, a reduction of the mechanical value of the prime mover, in a manner which has no resemblance to any of the effects due to heat regarded as a motive power." Proceeding to discuss the batteries, he remarked that as animal power depends on food, and steam power on coal, so electric power depends on the amount of zinc consumed; in support of which proposition he cited the experiments of Joule. He gives as his own results that for every grain of zinc consumed in the battery his motor performed a duty equivalent to lifting 86lb. 1ft. high. Joule and Scoresby, using Daniell's cells, had found the duty to be equivalent to raising 80lb. 1ft. high, being about half the theoretical maximum duty for one grain of zinc. In the Cornish engine, doing its best duty, one grain of coal was equivalent to a duty of raising 143lb. 1ft. high. He put the price of zinc at £35 per ton as compared with coal at less than £1 per ton, which makes the cost of power produced by an electric motor—if computed by the consumption of zinc in a battery—about 60 times as great as that of an equal power produced by a steam-engine consuming coal. He concludes that "it would be far more economical to burn zinc under a boiler and to use it for generating steam power than to consume zinc in a battery for generating electro-magnetical power."

In the discussion which followed several men of distinction took part. Prof. William Thomson, of Glasgow (Lord Kelvin),

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wrote, referring to the results of Joule and Scoresby: "These facts were of the highest importance in estimating the applicability of electromagnetism, as a motive power, in practice; and, indeed, the researches alluded to rendered the theory of the duty of electromagnetic engines as complete as that of the duty of waterwheels was generally admitted to be. Among other conclusions which might be drawn from these experiments was this: that until some mode of producing electricity as many times cheaper than that of an ordinary galvanic battery as coal was cheaper than zinc, electromagnetic engines could not supersede the steam-engine." Mr. W. R. Grove (Lord Justice Sir William Grove) remarked that a practical application of the science appeared to be still distant. The great desideratum, in his opinion, was not so much improvement in the machine as in the prime mover, the battery, which was the source of power. At present the only available use for this power must be confined to special purposes where the danger of steam and the creation of vapour were sought to be avoided, or where economy of space was a great consideration. Prof. Tyndall agreed with the last speaker, but suggested that there might be some way of mitigating the apparent diminution of power due to the induction of opposing E.M.F.'s in the machine itself. Mr. C. Cowper spoke of some experiments made by himself and Mr. E. A. Cowper, showing the advantage gained by properly laminating the iron cores used in the motor. He put the cost of electric power at £4 per horse-power per hour. He deprecated building electric motors with reciprocating movements and cranks, described the use of silver commutators, and mentioned the need of adjusting the lead given to the contacts. There was, he said, no reason to suppose that electric motors could be made as light as steam-engines. Even in the case of small motors of 1/10 h.p. or 1/100 h.p. for light work, where the cost of power was of small consequence, a boy or a man turning a winch would probably furnish power at a cheaper rate. Mr. Alfred Smee agreed that the cost would be enormous for heavy work. Although motive power could not at present be produced at the same expense on a large scale by the battery as by coal, still they were enabled readily to apply the power at any distance from its source. The telegraph might be regarded as an application of motive power transmitted by electricity. Mr. G. P. Bidder considered that there had been a lamentable waste of ingenuity in attempting to bring electromagnetism into use on a large scale. Mr. Joule wrote to say that it was to be regretted that in France the dilusion as to the possibility of electromagnetic engines superseding steam still prevailed. He pointed out, as a result of his calorimeter experiments, that if it were possible so to make the electric engine work as to reduce the amount to a small fraction of the strength which it had when the engine was standing still, nearly the whole of the heat (energy) due to the chemical action of the battery might be evolved as work. The less the heat evolved, as heat, in the battery, the more perfect the economy of the engine. It was the lower intensity of chemical action of zinc as compared with carbon, and the relative cost of zinc and coal, which decided so completely in favour of the steam-engine. Mr. Hunt, replying to the speakers in the discussion, said that his endeavour had been to show that the impossibility of employing electromagnetism as a motive power lay with the present voltaic battery. Before a steam-engine could be considered, the boiler and furnace must be considered. So likewise must the battery if electric power were to become economical. Then the president, Mr. Robert Stephenson, wound up the discussion by remarking that there could be no doubt that the application of voltaic electricity, in whatever shape it might be developed, was entirely out of the question, commercially speaking. The mechanical application seemed to involve almost insuperable difficulties. The force exhibited by electromagnetism, though very great, extended through so small a space as to be practically useless. A powerful magnet might be compared to a steam-engine with an enormous piston, but with exceedingly short stroke—an arrangement well known to be very undesirable.

In short, the most eminent engineers in 1857 one and all condemned the idea of electric motive power as unpractical and commercially impossible. Even Faraday, in his lecture on "Mental Education" in 1854, had set down the magneto-electric engine along with mesmerism, homœopathy, odylism, the caloric engine, the electric light, the sympathetic compass, and perpetual motion as coming in different degrees amongst "subjects uniting more or less of the most sure and valuable investigations of science with the most imaginary and unprofitable speculation, that are continually passing through their various phases of intellectual, experimental, or commercial development, some to be established, some to disappear, and some to recur again and again, like ill weeds that cannot be extirpated, yet can be cultivated to no result as wholesome food for the mind."

Fifty Years Later.

Fifty years have fled, and Hunt, Grove, Smee, Tyndall, Cowper, Joule, Bidder, and Stephenson have long passed away. Lord Kelvin remains the sole and honoured survivor of that remarkable symposium. But the electric motor is a gigantic practical success, and the electric motor industry has become a very large one, employing thousands of hands. Hundreds of factories have discarded their steam-engines to adopt electric motor driving. All travelling cranes, nearly all tramcars, are driven by electric motors. In the navy, and in much of the merchant service, the donkey engines have been replaced by electric motors. Electric motors of all sizes and outputs from 1/20 h.p. to 8,000 h.p. are in commercial use. One may well ask, What has wrought this astonishing revolution in the face of the unanimous verdict of the engineers of 1857?

The answer may be given in terms of the action and reaction of pure and applied science. Pure science furnished a discovery, industrial applications forced its development, that development demanded further abstract investigations, which in turn brought about new applications. It was beyond all question the development of the dynamo for the purposes of electrotyping and electric light which brought about the commercial advent of the electric motor. For about that very time Holmes and Siemens and Wilde and Wheatstone were at work developing Faraday's magneto-electric apparatus into an apparatus of more practical shape, and the electric lighthouse lamp was becoming a reality which Faraday lived to see before his death in 1867. That eventful year witnessed the introduction of the more powerful type of generator which excited its own magnets. And even before that date a young Italian had made a pronouncement which, though it was lost sight of for a time, was none the less of importance.

(To be continued.)

PERSONAL.

The Lords Commissioners of the Treasury have appointed Sir Henry W. Primrose, K.C.B., C.S.I., to be chairman of the Pacific Cable Board, in succession to the late Sir Spencer Walpole, K.C.B.

Mr. C. E. D. Greenhalgh, assistant station superintendent, Wakefield electricity works, has been appointed working assistant to the chief electrical engineer and manager, Mr. W. J. Rendell Baker, by the Malvern Urban District Council.

Mr. Walter Kidner was presented with a pair of framed photographs, tobacco pouch, and pocket-book by the staff of the Leatherhead and District Electricity Co. on the occasion of his leaving Leatherhead to take up the position of chief assistant at the Horsham Urban District Council's electricity works.

Mr. W. E. Curnock, M.Sc. (Victoria) and B.E. (Liverpool) has been appointed head of the department of mechanical engineering and building trades at the Battersea Polytechnic. Mr. Curnock served his apprenticeship with the Liverpool Engineering Co., and has also had practical experience with Messrs. Siemens and Co. and other firms. He was formerly chief assistant in the engineering department of the Northampton Institute, and for the past three years he has held the position of head of the engineering department in the Technical College, Huddersfield.

Mr. H. E. Brain, whose resignation of the post of electrical engineer to the Buenos Ayres and Pacific Railway was announced in these pages, is now in London in connection with his business in Buenos Ayres. He will be glad to hear from English manufacturers of electrical and other machinery desirous of being represented in the Argentine Republic. His intimate knowledge of the country and its requirements will be of considerable value to firms seeking to obtain an entrance into or to extend their business with this important market. Letters may be sent to Mr. Brain at 44, Bernard-street, Russell-square, W.C.

Mr. Maurice Graham informs us that he has, as from July 15 last, resigned all his interest in the firm of Messrs. Graham, Morton, and Co., engineers and contractors, Leeds, as he has decided to devote the whole of time to his consulting work in the special study of the transmission and handling of materials by labour-saving machinery, he having designed many large installations of loading, unloading, and conveying plants throughout the world amounting in value to over 1¼ million pounds sterling. On Oct. 19 next Mr. Graham leaves England by the P. and O. Co.'s s.s. "Caledonia" for a 12 months' tour round the world (visiting Egypt, India, Burma, Australia, New Zealand, the Philippines, China, Japan, United States, and Canada), and he intends inspecting the latest methods of labour-saving machinery for handling heavy materials. On his return to London in October, 1908, he will establish his office in Westminster. Mr. C. A. Goodall and Mr. W. B. Leech (both of whom have been with Mr. Graham for the past 10 years) have taken over and will carry on the business of the Leeds firm.

FORTHCOMING EVENTS.

British Association.—July 31 to Aug. 7, meeting at Leicester.
Iron and Steel Institute.—Sept. 23-25, meeting at Vienna.

APPOINTMENTS VACANT.

Temporary Engineering Draughtsman, Stepney Borough Council. Salary, £5 per week. Applications by Aug. 10. See advertisement.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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Bound Volumes of "The Electrical Engineer," *containing half-year's copies, bound in Dark-Blue Cloth, Gold Lettered, price 8s. 6d. New Volume, January to June, 1906 now ready.*

ENGINEERING AND SCIENCE.

The address of Prof. Silvanus P. Thompson to the Engineering Section of the British Association at Leicester contains so much information and so many suggestive references to important matters, and, on the whole, commends itself so unreservedly to our minds, that we are almost tempted to say "ditto" and leave it without further comment. Yet we feel that we have a duty to perform, or, if you will, a hobby to run—a hobby, we venture to think, on the most important question before civilised humanity. Our theme would require a volume, not an article, yet it is merely a variant of the old, old story—that the looker-on sees most of the game. The tendency of busy men of late years has been to specialise, and in this haste to specialise, fundamental laws—more rigid than those of the Medes and Persians—are absolutely forgotten and ignored. Hence the many failures of civilisation. Prof. Thompson says: "The world uses more steel, more copper, more aluminium, more paper; therefore requires more coal, more petroleum, more timber, more ores, more machinery for the getting and working of them, more trains and steamships for their transport." Quite true; but why, why, why is this? The learned author goes on to preach the text, "Interaction of Abstract Science and its Application." What he says has the ring of truth, but does not advance us towards a full comprehension of the laws that interact to compel all this engineering progress. These laws are only to be determined by a study of economics. Far too little attention has been paid to the economical considerations. More steel is wanted. Why? Simply because the use of steel in some way economises time and money, and helps to produce something at a less cost than it was produced before. Broadly speaking, all engineering progress and demand is for greater economy in production and distribution of food supply. In 1863 the British Association met at Newcastle-on-Tyne, and a series of papers, subsequently published in book form, were communicated on the industrial resources of the district. Among these papers was one on railways and locomotion. The cost of transport, when transport was by means of the pack-horse, was compared with the cost of railways as common in 1863, and it was stated, "We have reduced the cost to one three-hundredth part of that by pack-horses." Hence we gather the increased area over which distribution might take place without increasing cost, and also the increased population which could be supplied Every step of progress diminishing the cost of rail or water distribution acts and reacts by increasing the demand for the machinery and apparatus by means of which this distribution is effected. We thus see the value of abstract science, which enables further and better application, which provides the laws of the applied work, and enables the worker to obtain a definite knowledge as to the effectiveness of his machine. Generally the nearer practice gets to theory the better. Prof. Thompson naturally goes to the field of electric engineering to show the interaction between abstract science and its application Volta, Oersted, Sturgeon, Henry discovered, while Cooke and Wheatstone, Morse and Vail invented, and thus we got the telegraph and the cable. But having got these, the great need for other things was felt, and so Gauss, Weber, Kelvin, Clark, Bright, Clerk Maxwell, and others called into being instruments and accurate systems of measurement. The history of electric motive power again shows the close connection between the abstract and the applied in the development of apparatus. It is no great incentive to devote time to abstract investigations when we are told that "Sturgeon died in poverty." Indeed, the history of science shows how difficult it is to persuade the Gamaliels

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of science that something new is worth consideration. Franklin found this, for his early papers to the Royal Society were so little to the mind of the savants of that day that they were not printed in the *Transactions*, and probably we are indebted solely to Cave, the editor of the *Gentlemen's Magazine*, for their preservation But to resume. After proving the close connection between pure and applied science, Prof. Thompson speaks eloquently for proper technical education. Unfortunately, we have never yet met with a sufficiently close grappling with the fact that the engineering profession is made up of masters and men—mostly men—and the training required by them is not necessarily the same. Attention seems too much devoted to the higher positions, and too little to the lower. Is this quite as it should be? Is there not a danger that we may even have too much of a good thing—technical colleges, for example—and too little of manual dexterity?

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE TELEPHONE QUESTION.

SIR,—The postponement of the third reading of the Post Office Money Bill, which asks for some £6,000,000 for telephonic purposes, affords an admirable opportunity for an inquiry into the administration of the Post Office telephone service, and the meaning and drift of Post Office telephone policy.

The conduct of the Post Office in connection with telephone matters has been to the highest extent questionable, practices having been indulged in which it would be difficult to defend on any accepted doctrine of probity and honour. The strictest account ought to be obtained in advance as to how the six millions are to be disposed of. The Post Office have never yet been known to be right on the subject of telephones, and in all probability very unexpected revelations would follow an inquest as to the application of this huge sum.

When the Post Office were instructed in 1899 to provide a telephone system for London, their staff possessed practically no experience of the designing and construction of telephone systems. Their largest exchange—Newcastle-on-Tyne—consisted of only 600 subscribers, the next—Cardiff—of 250. The remaining exchanges scarcely averaged 10 subscribers each, and all, great and small, were unfavourably known for their inefficiency. The position of the Post Office engineers when they were ordered to telephone London may be compared to that of a barge-builder on the Thames if suddenly commanded to design and construct a 10,000-ton Atlantic liner. In their perplexity they gave *carte blanche* to an American firm of manufacturers to put in the American common-battery system, and this was done regardless of expense. The result was disappointing, as, after an existence of only some three years, the same American firm were entrusted with another order to build a second exchange on the same premises, to which, when completed, all the subscribers connected to the first exchange, which had cost some £98,000 and had been confidently expected by the Post Office engineers to prove a tremendous advance on anything hitherto known, were transferred. This second exchange cost another £100,000, while the abandoned one was rebuilt at an unknown expense.

The Post Office has been very severe, and most unjustly so, on the plant put in by the different municipalities, but no municipality could have survived a fiasco of this magnitude. The fatuity of the Post Office system is such that it compels the abolition of the convenient hand microphone, in which the transmitter and receiver are combined in one handle joined to the instrument by a long cord, so that the subscriber may stand, sit, or recline in any position while talking at his ease, with his mouth automatically spaced the most advantageous distance from the transmitter. Urged by the disabilities of the system they have chosen, and obediently submissive to their American masters, the Post Office are everywhere putting in the type of instrument which was standard 27 years ago—*i.e.*, with a fixed mouthpiece on the wall or on a stand and a movable earpiece—so that the subscriber has to keep his mouth glued to the transmitter (for it will only work when spoken to closely) and hold the detachable 'phone to his head. This, in itself, is an enormously retrograde step.

Then, instead of enjoying the silent circuit which modern science renders easily practicable, and which the municipalities provide, the subscriber's ear has to suffer all sorts of noises, groans, scrapings, splutterings, and other discords made familiar by the motor 'bus, often painful in intensity; while the frequent sound of other subscribers' voices on the wire warns him that Post Office telephones are not adapted for confidential communications. The efficiency and usefulness of the extension instrument from the clerks' into the principal's office have been sacrificed, for on a Post Office extension the conversation of a principal can be overheard by his clerks and office boys.

But the Post Office policy is attended by even greater evils than inefficient service and primeval instruments, as they have ordered matters so that foreign manufacturers must benefit from telephone extensions in Great Britain. By the Purchase Act the Post Office will in 1911 only give full price for what accords with their adopted standard, which is the common-battery system already criticised. The National Telephone Company acquired the British rights of the American common-battery system years ago, and in so doing bound themselves to use no other. The position, therefore, is: (1) Post Office insist upon the company putting in common battery; (2) company are bound to use the American make only; (3) all extensions made by the company between 1905 and 1911 must go to American manufacturers. And the price can only be reckoned in millions of pounds, because the company, sure of their money in 1911, are naturally, and from their point of view properly, extending the use of the common battery as far as possible. In 1911 there will be little else in the country. And so St. Martin's-le-Grand actually legislates in favour of Chicago!

The cost of purchase in 1911 will prove so tremendous—20 or 25 millions instead of the ten so glibly talked about when purchase was agreed—that doubts have for some time been expressed as to whether any transfer will really take place. It is quite on the cards that the British taxpayer will refuse to foot the bill, and that the National Telephone Company's licence will be renewed for the greater part of the country, the Post Office taking only London, Glasgow, and a few other places where exceptional conditions prevail. This outcome is being played for.

One of the points for inquiry in connection with the six millions would be how much of it is to be devoted to the purchase of American plant for the National Telephone Company under Clause 9 (5) (*b*) of the purchase agreement. These ruinous expenses are not necessary, and it is not fair or honest to plead them in justification of the increases in the charges for telephonic communication which the Post Office are determined to effect by abolishing the flat rate and imposing charges for junction calls within the local areas.

The municipalities have demonstrated, and are willing to prove their case if an inquiry be granted, that inclusive rates of from £5 to £6. 6s. are all that is necessary to make an efficient service remunerative. The continued existence of the municipal exchanges threatened the success of the Post Office policy. It was, therefore, necessary to suppress them, and to discredit their efforts by affixing the stigma of failure. This has been managed by arrangement between the Post Office and the Local Government Board, whose approval to municipal loans is necessary. Three municipal exchanges have already been engineered out of the way, while a fourth—Portsmouth—whose thoroughly sound and efficient undertaking has been brought to a standstill for the past three years by the Local Government Board refusing and delaying the loans necessary for its existence—is in serious jeopardy. Mr. John Burns personally encouraged the Portsmouth people to undertake a telephone system, but is now content to remain a silent spectator of their oppression and spoliation.

I have touched upon only a few of the scandals of

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telephone politics, but, your space being a potent autocrat from whose requirements there is no appeal, I now conclude by again urging the necessity of a drastic inquiry, and in hoping that Mr. Harold Cox will persist in withstanding the proposed grant until its proper application has been demonstrated.—Yours, etc., A. R. BENNETT.

London, S.W., July 29, 1907.

TELEPHONE TARIFFS.

SIR,—Mr. Bennett insists on dealing always in personalities, and he must be the best judge of the weapons with which he is most expert. It is tolerably well understood in electrical circles that I do not take Mr. Bennett seriously on telephone matters, and that he considers me a malicious and prejudiced person because I do some work for the greatest telephone organisation in the world—which may be assumed to know something of the telephone business. I think we might leave the personal question at that. It is not for lack of ammunition, or of ability to use it, that I do not reply to Mr. Bennett in kind, but because such a style of argument is neither dignified nor useful.

It is a little difficult for one who takes a serious subject on its merits to argue with a controversialist whose chief method is general and violent abuse of all with whom he differs. But, perhaps, you will allow me to check a few of the statements by which Mr. Bennett in his latest letter supports his efforts to obscure fact and reason.

He says my letter of July 19 "attacks him at considerable length." It did nothing of the sort. It was mainly devoted to showing what is a reasonable and practical telephone tariff, and to quoting examples and authorities. If Mr. Bennett considers this to be attacking him, he again justifies my statement that in practical telephone matters he is a minority of one against the rest of the telephone world.

Mr. Bennett says that the sale of several of the municipal systems has been due to "the hostile attitude of the Post Office and of the Local Government Board." The only municipal telephone system of any importance has been that of Glasgow. In Glasgow the Local Government Board has no more jurisdiction than the Governor of Jamaica. The "hostility" of the Post Office is shown by the fact that the Post Office gave £30,000 more for the Glasgow system that the price at which it was valued. Glasgow sold out because Scotsmen dislike doing business at a loss. I am impelled to say here, in deference to Mr. Bennett's liking for biographical details, that his abuse of the National Telephone Company is always highly amusing to me, because since the passing of the Telegraph Act of 1899 Mr. Bennett has been the best friend the National Telephone Company has had. If municipal telephony had been run in a generally up-to-date manner, it would have made quite a different history by now. With a modern plant, a practical tariff, and an efficient telephone organisation, Glasgow could have "wiped the floor" with the National Telephone Company—which was the express desire and intention of the Glasgow Corporation. The actual result has been exactly the reverse. The fundamental cause of the reverse was the general misconception of the requirements of modern city telephone work current in municipal telephone circles.

Mr. Bennett says that "municipal telephones" cannot spread "simply because the municipalities cannot trust Post Office promises of good faith." This is mud-slinging of the most unworthy kind. As a matter of fact, the Post Office officials have been extremely indulgent towards the municipal telephone systems. Had they seriously exercised their powers of supervision, they could have harassed the municipal telephone concerns very considerably; but they have left them alone till called to the rescue.

Mr. Bennett says that the Post Office took up the London telephone service "for the express purpose of stopping reform!" It is this kind of statement that makes it so impossible to take Mr. Bennett seriously. The Post Office started a competing service in London in obedience to an Act of Parliament and to the policy of the Government; for the Act and for the policy the late Mr. Hanbury—Mr. Bennett's pet authority—was responsible. The Post Office London telephone system is substantial and modern, and has added to London's telephonic facilities. This is certainly not "stopping reform."

Mr. Bennett is very fond of talking about "mis-statements" when he means that he disagrees with the opinions or conclusions of another, but I repeat that the municipal telephone systems have only shown us how not to do it. Municipal telephony is as dead as last year's pantomime, and no amount of strong language will revive it. Moreover, I venture to say that the last people who would want to revive it on the lines advocated by Mr. Bennett are the municipal officials who have had experience.—Yours, etc.,

HERBERT LAWS WEBB.

35, Old Queen-street, Westminster, London, S.W.
July 29, 1907.

THE ELECTRICAL CONSTRUCTION COMPANY.

SIR,—We have read your report of the Electrical Construction Company's meeting in your last week's issue, and would point out a mistake which was made by the chairman in his speech. We take considerable exception to this statement, which reads as follows: "It is but small consolation to know that such absence of profit is not exceptional nor confined to this company, for I cannot find that any electrical manufacturing concern of importance, carrying on a purely manufacturing and competitive business similar to ours, can show any better result, and some show a great deal worse."

We may say that the average dividend which we have paid on our ordinary shares for the last six years is 8½ per cent. During 1906 we made more profit than 1905. These dividends were paid after a substantial depreciation was allowed for. Our profits were stated in the prospectus issued a few weeks ago. The writer also knows several other firms in this country who are making a reasonable profit.

We maintain that our business is practically similar to that of the Electric Construction Company, as it is purely manufacturing, and we have over 800 employés. We have, of course, a few specialities, but the bulk of our profits are obtained from standard direct-current and alternating-current motors and generators. The average size of our productions is probably somewhat smaller than those of the Electrical Construction Company, but we make a range of machines from 1 h.p. to 1,000 h.p. We must say, however, that we consider the prices which are obtained at the present time are much too low, and we entirely sympathise with the remarks made by the chairman *re* the failure of the co-operative scheme.

We would also draw your attention to Messrs. Crompton and Co.'s report, in which they declare a dividend of 5 per cent., and place a substantial sum to reserve.

It may also interest you to know that at the present time we are exporting a considerable number of machines to Italy, France, and Germany, notwithstanding the high import tariff.—Yours, etc.,

LANCASHIRE DYNAMO AND MOTOR COMPANY, LIMITED.
(A. P. Wood.)

METAL-FILAMENT LAMPS.

SIR,—Our attention has been called to the article on "Metal-Filament Lamps" by Mr. R. Milward Ellis in your issue of the 19th inst., in which it is stated that the price of the Osram lamp is 3s. Being the owners of the combined Osram and Just-Hahnemann patents in this country, and sole agents for the Osram (tungsten) lamp for Great Britain and the Colonies, we should be glad if you would kindly insert in your next issue a short note correcting this statement. The prices of our Osram (tungsten) lamps in the three sizes made at present are as follows:

Approx. C.P.	Price.
30	4s. each.
50	4s. 3d. ,,
100	6s. 6d. ,,

These prices are, of course, net to the public, but are subject to a discount to the trade.

In asking you to make this correction, we are anxious that the public or our trade customers should not be incon-

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venienced in any way by an extract of this article with the incorrect price being copied in the public Press. We would also mention that the efficiency of our Osram (tungsten) lamp is 1·1 watts per Hefner candle-power, which is equal to 1·25 watts per English standard candle-power.—Yours, etc,

THE GENERAL ELECTRIC COMPANY, LIMITED.
(D. M. McLagan, Sales Superintendent.)

POWER SUPPLY FOR LONDON.

SIR,—You were good enough in your last issue to refer to my letter to the *Times Engineering Supplement* of July 17 last dealing with the question of power supply for London.

In your concluding remarks you have, curiously enough, fallen into the error of confusing the 35 per cent. of horse-power obtained by the whole of the existing undertakers with the 75 per cent. of users secured in a particular area of supply, which, of course, is quite another point.

The first point deals with the percentage of electrical horse-power secured by all the existing undertakers in proportion to the total horse-power of all kinds installed in the county of London, while the second point deals with the percentage of power users secured as customers by the County of London Electric Supply Company in their own areas of supply.

In view of the many misleading statements current on this subject, I shall be much obliged to you if you would find space for this letter in your next issue.—Yours, etc.,

H. B. RENWICK,
Manager, County of London Electric Supply Company, Limited.

THE BECK "REGLER."

This automatic resistance for maintaining constant current for arc lamps, electric furnaces, etc., is the invention of Mr. H. Beck, of Frankfort, but is being manufactured and sold in this country by the Beck Flame Lamp, Limited, of Hayes, Middlesex. Fig. 1 shows the construction of these "Reglers," which consists of special resistance wires enclosed in glass tubes which are filled with a special gas chosen for its properties of conducting heat. The regulating properties of this resistance wire are clearly shown in Fig. 2. In this the curve B D B indicates the current which one of these "Reglers" in series with two arc lamps will pass when the voltage across it is varied from 0 up to 40. It will be seen that when 8½ amperes has been reached the voltage can be doubled without appreciably affecting the current in the circuit. As a contrast to this, the curve A E shows the results with an ordinary resistance. In both cases the voltage across the resistance when 8·8 amperes is flowing is 20 volts. The scale on the left gives the volts across the resistance, and that on the right the lamp voltage. Supposing the lamp voltage, instead of being at its normal value of 2 × 45 = 90 volts, falls to 80 volts. Drawing a horizontal line through the 80-volt point, it will be seen that the line cuts curve *a* at *e* and curve *b* at *f*, showing that with the ordinary resistance the current would rise to 12·1 amperes, whilst with the "Regler" it would only rise to 9·1 amperes. A great additional advantage of the "Regler" is the fact that the objectionable effect of the voltage drop in the carbon rods is neutralised. The rush of current on switching on arc lamps, especially after new carbons have been fitted, is also largely prevented.

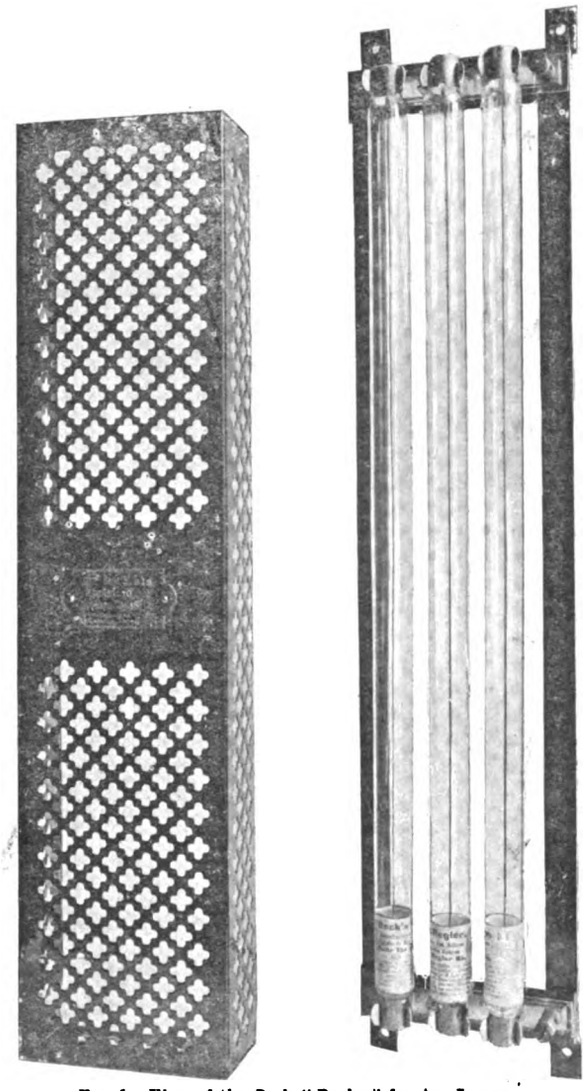

FIG. 1.—View of the Beck "Regler" for Arc Lamps.

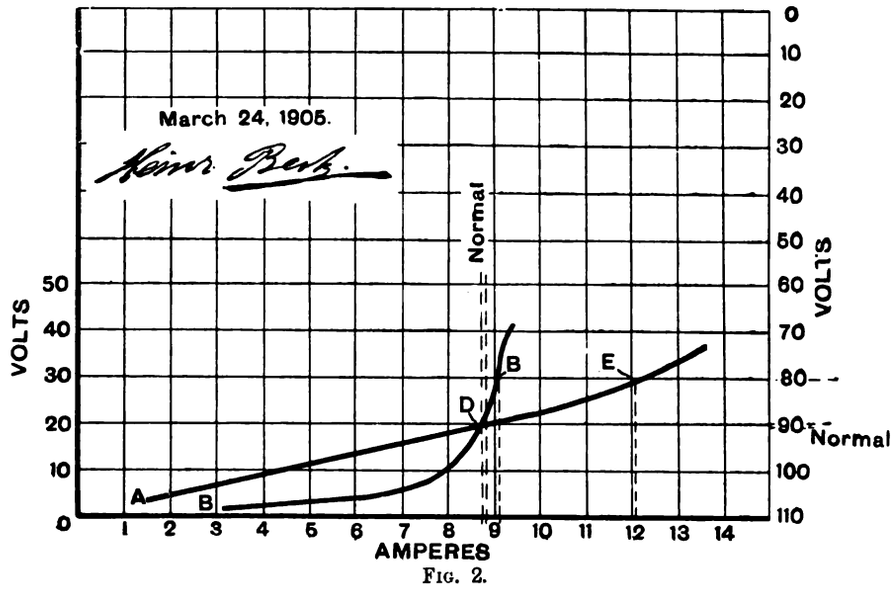

FIG. 2.

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Besides their suitability for Beck arc lamps and for arc lamps of every other description, these resistances are eminently fitted for use in all cases in which a constant current with variable volts or resistance in the circuit is desired. Space, however, will not permit of a detailed description of these various applications. The resistance can be built without difficulty for currents of any amount between 3½ amperes and 400 amperes or more, and for any desired voltage.

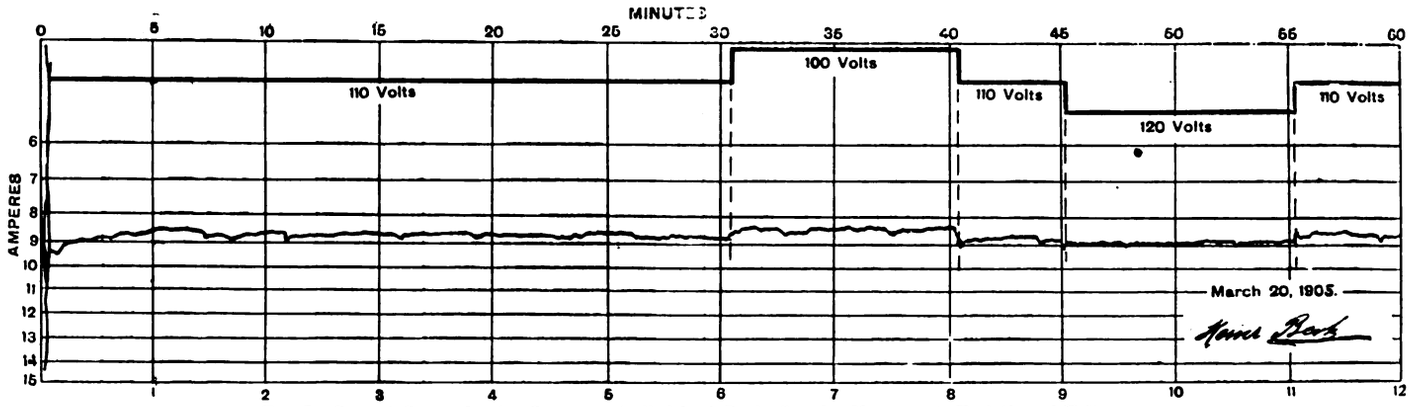

FIG 3.—Cur ent Curves for Arc Lamps controlled by "Regler" under 20 per cent. Variation of Voltage.

Fig. 3 shows the steady current obtained by using a "Regler" when the voltage supplied to the lamps was purposely varied from 110 down to 100 volts and then up to 120 volts. The change in the current curve is no more than would be due to the slight inequality in the burning of the carbons. Fig. 4 shows the effect of a similar voltage variation in an arc lamp circuit having ordinary resistance in series with the lamp. The current then varied from seven amperes at 100 volts up to 11·5 amperes

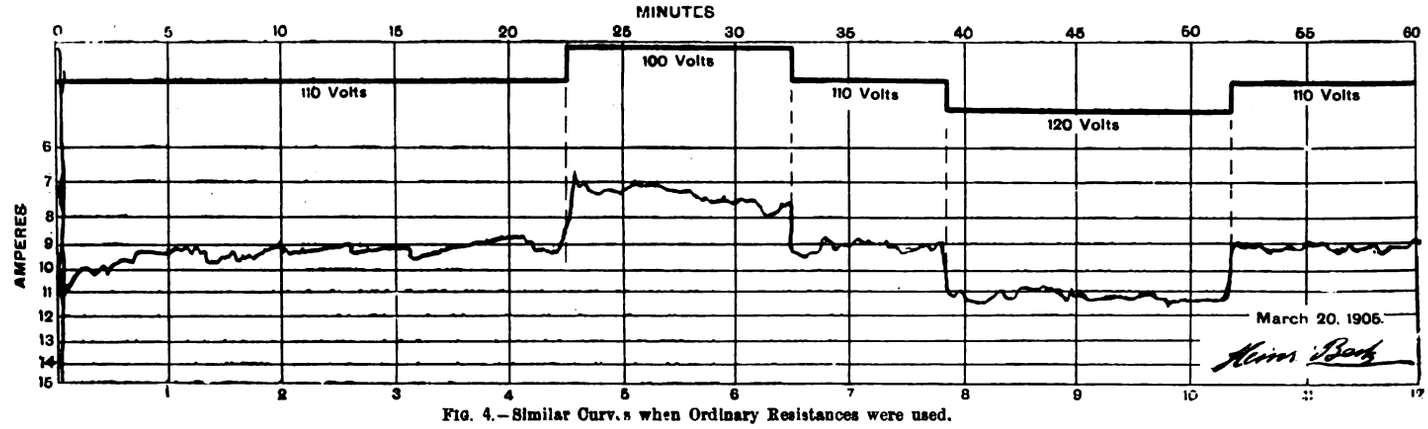

FIG. 4.—Similar Curves when Ordinary Resistances were used.

when 120 volts was applied. These two curves indicate the great advantage to be derived from the use of these automatic resistances on circuits where the voltage variation is considerable.

ELECTRIC LIGHTING DEMONSTRATION IN THE CITY.

The Court of Common Council have resolved to accept certain proposals for demonstrating improved electric lighting in several of the main streets of the City. The City of London Electric Lighting Company are to provide lighting on the Holborn Viaduct by means of flame arcs on standards; in Farringdon-street, including part of Old Bailey and Holborn Circus, by enclosed arc lamps; and in Newgate-street by smaller lamps. The charges for these lamps are to be at the rate of £17. 10s. per annum each for the flame arcs instead of £26 per lamp, and for the smaller lamps £12. 10s. and £10. 10s. each per annum respectively. The Charing Cross, West End, and City Electricity Supply Company's proposals include lighting in Cannon-street (between St. Paul's-churchyard and Budge-row), by means of centrally-hung flame arc lamps, at £17. 10s. each per annum. All costs of the installations are to be defrayed by the companies, who provide, at their own expense, standards, lamps, etc., while the cost of maintenance is also to be undertaken by the companies. The demonstrations are to be continued until March next.

BRISTOL.

Alderman Pearson at the Council meeting on Tuesday last made one of the most exhaustive speeches that it was possible to make on the annual report of the Bristol Electrical Committee. We have referred many times to the Bristol undertaking—an undertaking which has received the keenest criticism and has been subjected to the most exhaustive examination by parties who have more interest in the wrecking of a concern than in its success. Alderman Pearson, as is well known, is one of the ablest of the men elected to represent local authorities in whose hands has been the guidance and control of a vast undertaking. Here is the report of what he says as given in the *Western Daily Press* of July 31:

Alderman Pearson, in moving the annual report of the Electrical Committee, explained, at the outset of his remarks, that everything he was about to say was qualified by the information that years ago the Electrical Committee did, as a fact, take £13,904 out of the ratepayers' pockets to maintain the electrical undertaking during the first three years. Therefore, when he talked about profits and things of that kind, they must correct his figures by this £13,904 received in the first instance. Dealing with the growth of the undertaking, the alderman said the revenue in 1906 was £70,664, while in the year that had just closed it was £72,439, an increase of £1,775. The gross profit in 1906 was £39,879, and it had risen to £41,086, an increase of £1,207. Customers had increased by 173, against an increase in 1906 of 150; while lamp connections had increased by 16,993, in comparison with 9,791 in the earlier period. The year 1906, it was fair to say, was the worst they had had for some time, and the 1907 increase was not so good as it appeared; it was a good average increase. For power purposes, the increase had amounted to 1,833 h.p., and that amount was more than double the growth of the previous year. Having regard to the fact that in 1900 they had only 111 h.p. on their mains, and that in 1907 they had 5,805 h.p., it might be said there was fairly good evidence that the undertaking was doing what the public needed in the supply of electricity for power purposes. The number of electric motors had increased by 192. It would be seen that their power load had increased at a greater ratio than the light load. It was very gratifying that, while the output increased, the cost of the output gradually decreased. The figures of the increased output were very interesting, and really very instructive. He would give figures for 1905 to 1907, but must explain that the cost did not include interest or sinking fund. In 1905 it cost the committee 1·379d. per unit to generate electricity. In 1906 they reduced it to 1·188d. per unit, and in 1907 it worked out

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at 1·093d. The revenue in 1905 was 3·144d. per unit, in 1906 it was 2·835d., and in 1907 2·629d. Results stated in decimals, like this, did not, Alderman Pearson remarked, convey much to him, and probably might not convey much to the ordinary public. He proposed, therefore, to put the thing in his own way, and state the effect in money totals. The cost of generation and distribution in 1905 was £31,935, and in that year they sold 5,217,528 units. In the year 1907 the cost of generation and distribution was £31,353, and the number of units sold was 6,418,146. The cost of generation and distribution in 1907, as against that of 1905, was £582 less than in 1905, while the units sold were 1,200,518 more. They had generated during the year 1907 1,200,618 units for £582, less than nothing. That meant that the economies at the works had been so great, and the reduction in cost, owing to large plant, so great, that they actually in 1907 generated 1,200,618 units more and yet spent £582 less on this branch of the work than before.

If he could believe what he saw going on, and what their engineers said, the possibilities of economies were by no means ended yet. They had not extended their mains very much. They had only added 17 miles, which seemed to show that they had been able to get their increase more on their existing mains than usual. He did not think the public quite understood what their mains meant. They had 301·22 miles of cable in the streets. If these cables were joined up, they would just cable the Great Western Railway from Bristol to London and on to Brighton and back. That gave some idea of what the length of the cables meant. The profit during the past year had gone down. Last year they carried forward £5,987, while this year the sum was only £8,657, or £2,670 more. They might ask him what had become of the money they had not to carry forward. He would tell them. They had paid £973 more interest. They had paid to the sinking fund a contribution £2,159 in excess of last year, and they had now carried a full year's loss of the reduction of ½d. per unit, equal to about £1,500 more. That amounted to £4,632, and that was where the profit had gone. It was clear from this that the increase in their customers, owing to the reduction from 5d. to 4½d. per unit, had not yet quite made up the loss which they incurred in giving up that halfpenny, and which was equal to about £4,500. In addition to that, during the past two years, under the advice of Prof. Dicksee, they had put £5,000—£2,500 per year—to what he called "Prof. Dicksee's sinking fund," it being in excess of the sinking fund required by Government. During the past year they had spent in ordinary everyday repairs, of which they took no notice, £3,618. As the result of their year's trading they had put to depreciation £15,908, they had paid to reserve (on the advice of Prof. Dicksee) £2,500, and they were carrying forward £2,670, in addition to the sum brought from the 1906 account.

To-day, therefore, the concern had improved its position by £21,078, and it was that much better off in ready money, but as against that they were poorer by one year's user of their plant. Alderman Pearson then laid down the principle he had enunciated before—viz., that the duty of the committee in this matter was to act as trustees between the consumer and the ratepayer. They had to see that the consumer paid sufficient for his current to protect the ratepayer against possible loss. The ratepayer, having carried his burden in the first three years, had a right to be kept free in future. He, therefore, proposed to examine what they had taken from the pockets of the consumer, in addition to the costs of merely running the station. These costs must, of course, be paid, otherwise the electricity could not be supplied. But in excess of that, they had taken from the pockets of the consumers in the time the committee had been in existence £2,609 for repairs, £30,109 for reserve, and £106,023 for sinking fund. This included interest upon sinking fund, and the increase at compound interest. In addition, they had placed to "Prof. Dicksee's depreciation fund" £5,000, and carried forward £8,657. In other words, they had taken out of the pockets of the consumers in 14 years, in addition to the costs of running the station and delivering the current, £177,398, and he thought they had done about as much as they ought to. The question then arose, What had become of this sum? How much had the committee to protect the ratepayer against any possible call on him? They had, first, £106,023 sinking fund; £5,000, the "Dicksee reserve"; £16,868, balance of reserve for renewal fund; and carried forward, £8,657. In other words, they had in possession to-day, or in the sinking fund (which meant that loans had been repaid), the amount of £136,548 to stand between the ratepayer and any possible loss in respect of the gross mortgage debt of £718,244. The committee had invested in Bristol stock £15,000 as part of the reserve fund, and having regard to the fact that they had not been seeking large profits, but that during the whole course of their existence they had been endeavouring to give an efficient and cheap supply, they considered the financial position was fairly sound.

Street lighting would be the next matter dealt with by them. They had recently decided upon starting a business branch, for the purpose of pushing the concern, and establishing an office in a fairly central situation. They would have fine showrooms, where various appliances could be seen, both for lighting and power. They hoped by that means to increase their output. Alderman Pearson then called attention to a paragraph in the report of the committee, saying that the balance was liable to a charge of £3,765. 1s. 2d. in the event of the failure of an appeal, now awaiting decision, in respect to the wages of workmen engaged in capital work. That amount represented the sum of money spent in labour in works absolutely proper to form the subject of a capital charge, but owing to the fact that the workmen, instead of being casual labourers, were men in the committee's permanent employ, the commissioner, Mr. Ross Hooper, struck out this amount from the loan. In that respect £2,079 was disallowed. The committee's account had brought this up to March, 1906, but, as work was also done during 1907, the whole of the wages in this category up to March 31, 1907, had been included, bringing the figure up to £3,765. 1s. 2d. There were several other points raised by Mr. Hooper to which the committee took exception, and, luckily, on July 24 they heard from the Local Government Board on this matter. In respect to the various questions the committee raised, with one exception, they had granted the appeal of the committee. This meant that the wages of workmen in permanent employ were allowed up to March, 1906, £2,079, and he had no doubt the balance to March, 1907, would in due course be allowed also. The point upon which the Local Government Board had not given way was in respect of an engine which had been put out of use, and in respect of which £1,400 was struck off their loan, as being estimated loss, by Mr. Ross Hooper. But in regard to that machine, they were prepared to reconsider the matter in the event of the committee deciding to re-erect the engine. The short outcome of that was that, so far as Bristol was concerned, the Local Government Board had granted the prayer of the Council to a greater extent than he personally expected, and the result would be that it was enabled to discuss the question of permanent workmen, quite apart from anything in the nature of a personal question arising between the Local Government Board and Bristol.

RADIO-TELEGRAPHIC CONVENTION.

In the House of Commons on Tuesday Sir Ed. Sassoon obtained leave to move the adjournment of the House in order to call attention to the report of the Select Committee on the Radio-Telegraphic Convention, and the declared intention of his Majesty's Government to proceed to ratification without affording the House an opportunity of discussing the subject. Sir Edward contended that the convention would hinder the development of the existing wireless system in England. Mr. R. B. Haldane, in the absence of the Postmaster-General, replied to the hon. baronet, and maintained that the Government had done quite right in following up and carrying to a completion the work of previous Governments by entering into an international convention for the interchangeability of wireless telegraph messages. He declared that no hardship was being inflicted upon the Marconi Company, for under the agreement with the Post Office of August, 1904, the company accepted the obligation of intercommunication should the Post Office subscribe to the convention. The Government, he added, thought it expedient in the interests, not only of public convenience and international amenities, but in the interests of business and of humanity, that there should be the freest possible interchange of messages between ships and stations. They proposed to enter into a convention which left the control in their own hands. The Government could withdraw from the convention on giving notice, but they were satisfied that the rules were workable, and they were endeavouring to get other nations to agree to the convention.

OPENINGS FOR CONTRACTORS.

BARNARD CASTLE—Stationmaster's house for North-Eastern Railway. Company's architect, Mr. Wm. Bell, York.

BILLERICAY—Additions at workhouse. Architect, Mr. W. J. Wood, 26, Alexandra-street, Southend-on-Sea.

BIRMINGHAM—Alterations to hotel at Snow-hill Station for Great Western Railway Company. Secretary, Mr. G. K. Mills, Paddington Station, London.

BISHOP'S STORTFORD—Alterations at Council offices. The District Surveyor, Bishop's Stortford.

BLACKPOOL—Library on the Raikes Hall estate for the Town Council.

BOLTON—Extensions to Croft-lane Mills for Messrs. Marson and Co.

BRADWALL Schoolroom, etc., at the reformatory. Architects, Messrs. Alfred Price and Son, Sandbach.

CARLISLE—Billiard hall for Mr. J. Dobson. Architect, Mr. H. H. Hodgkinson, 64, Lowther-street, Carlisle.

CARLISLE—Schoolmaster's house at Culgaith. Architect, Mr. Joseph Graham, Bank-street, Carlisle.

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CAERPHILLY—Residence. Architect, Mr. D. N. Davies, 24, Cardiff-road, Caerphilly.

CAETHRO—Farm buildings at Caethro, near Welshpool.

CAVERSHAM—Workshops at the Council depôt in Harley-road. Surveyor, Mr. A. J. Smith, 11, Bridge-street, Caversham, Oxon.

COCKERMOUTH—Fever hospital. Mr. J. B. Wilson, 11, Main-street, Cockermouth.

CORK—161 cottages for the Rural District Council. Apply to Clerk.

CUDWORTH (YORKS)—Club premises in Pontefract-road. Architect, Mr. G. Moxon, 26, Church-street, Barnsley.

DARLINGTON—Machinery for the waterworks. Borough surveyor and waterworks engineer, Mr. G. Winter, Town Hall, Darlington.

DARLINGTON—Business premises for the Corporation. Borough surveyor, Mr. George Winter, Town Hall, Darlington.

DODWORTH—Alterations to the Cross Keys Inn. Architect, Mr. J. Robinson, Wombwell.

DORCHESTER—Villa in Maumbury-way for Mr. A. Pope. Mr. F. T. Maltby, surveyor to South Court estate, Dorchester.

DRAX (YORKS)—School buildings. Architect, Mr. H. B. Thorne, Goole.

DUNSTABLE—Council school. Architects, Messrs. Goch and Saunders, Bank-chambers, Kettering.

EBBW VALE—Congregational church. Architect, Mr. Henry Waters, Ebbw Vale.

ELLENBOROUGH—Reading and recreation rooms. Mr. J. Clark, 82, Main-street, Ellenborough, Cumberland.

FERRYHILL.—Repairs, etc., to town hall property. Clerk, Mr. R. Willey, Providence House, Ferryhill, Durham.

FREEMANTLE—Wesleyan school chapel in Howard's-road (to be electrically lighted). Architect, Mr. G. E. Smith, Southsea. Builder, Mr. J. Nicholl, Bitterne-park.

FULHAM—Electric lighting for four flats at 6, Beaumont-crescent. Two transformers for sub-stations (£131) for the Corporation.

GAINSBOROUGH—Market buildings. Clerk, Mr. D. M. Robb, Council Offices, Gainsborough.

GLASGOW—House in Richmond-park, and conversion of building. Office of Public Works, 64, Cochrane-street, Glasgow.

HERTFORD—Alterations at corn exchange (including electric lighting) for the Corporation. Borough Surveyor's Office, The Wash, Hertford.

HERTFORD—Addition to County Council asylum. Architects, Messrs. G. T. Hine and Co., 35, Parliament-street, Westminster, S.W.

HIGH HARRINGTON (CUMBERLAND)—Seven dwelling houses. Mr. J. Dodds, Fernbank, High Harrington.

HOLLINGWORTH—Council school. Architect, Mr. C. T. Adshead, Leinster-chambers, St. Anne's-square, Manchester.

HUDDERSFIELD—Municipal secondary school. Borough engineer, Mr. K. F. Campbell, 1, Peel-street, Huddersfield.

HUNTINGDON—Addition to grammar school. County surveyor, Mr. Herbert Leete, High-street, Huntingdon.

IPSWICH—Additions to municipal secondary school in Bolton-lane. Mr. E. T. Johns, Tower-chambers, Tower-street, Ipswich.

IVYBRIDGE—Additions to school for the Devon County Council. Architect, 1, Richmond-road, Exeter.

KENDAL—Tannery for W. and J. J. Little. Architect, Mr. S. Shaw, 45, Highgate, Kendal.

KINGSTON-ON-THAMES—Children's home for the Guardians. Clerk, Mr. J. Edgell, Union Offices, Coombe-lane, Norbiton, Kingston-on-Thames.

LINCOLN—Warehouses, wharves, etc., for the Great Northern, Midland, and Great Central Railway Companies. Chief engineer for the works, Mr. C. A. Rowlandson.

LLANNON—Extension of Red Lion Inn for the Felinvoel Brewery, Limited. Architect, Mr. W. Griffiths, Llanelly.

LONDON—Lift at St. John's-road Workhouse, Islington, for the Guardians.

LONDON—Music hall at] Finsbury Park. Architects, Messrs. F. Matcham and Co., 9, Warwick-court, High Holborn, W.C.

LONDON—Buildings at Colney Hatch Asylum, New Southgate, N. Clerk of Asylums Committee, London County Council, 6, Waterloo-place, London, S.W.

LONDON—Boiler-house and workshops at Fever Hospital, Tottenham. Engineer-in-chief, Mr. W. T. Hatch, Metropolitan Asylums Board, Embankment, London, E.C.

LONDON, S.E.—Buildings for the Metropolitan Asylums Board at Peckham Rye (£17,571).

LONDON, W.—New station buildings, etc., at Hammersmith for the Joint Committee of the Great Western and Metropolitan Railways. Engineer, Paddington Station, London.

MALDON—Additions to house for Mr. H. Price, surgeon. Mr. R. J. Girling, Bath-road, Felixstowe.

MANCHESTER—Additions to Southall-street municipal school. Cheetham Education Offices, Deansgate, Manchester.

MIDDLESBROUGH—Alterations at workhouse for the Board of Guardians. Architects, Messrs. R. Lofthouse and Sons, 129, Albert-road, Middlesbrough.

MORPETH—Additions to county asylum. County Surveyor, Moot Hall, Newcastle-on-Tyne.

NEWPORT—Additions to grammar school. Mr. F. N. Hodges, clerk to the managers, High-street, Newport, Salop.

NORTHALLERTON—Grammar school. Architect, Mr. W. H. Brierley, York.

RHYMNEY—Shop and house. Architect, Mr. J. Llewellyn Smith, Aberdare.

ROTHERHAM—Destructor works for the Town Council. Apply, Town Clerk, Town Hall, Rotherham.

ST. JUST—Sunday school for the trustees of the Wesleyan Church, Trewellard, St. Just. Architect, Mr. T. Eddy, Church-road, Pendyn.

SCOTLAND—Erection of houses in King Edward-street and Mid-street, Fraserburgh. Architects, Messrs. Reid and McRobbie, Saltoun-chambers, Fraserburgh.

SETTRINGTON (YORKS)—Water-supply works. Engineer, Mr. R. Richardson, Town Hall, Malton.

STOCKPORT—Tramcar top covers, including lighting, wiring circuits, etc. Borough surveyor, Mr. J. Atkinson.

WAKEFIELD—New school at Silcoates. Messrs. Oliver and Dodgson, 18, Park-row, Leeds.

WELLS-NEXT-THE-SEA (NORFOLK)—Villa residence. Architect, Mr. L. F. Eagleton, King-street, King's Lynn.

WIMBORNE—Additions to Victoria Cottage Hospital. Mr. W. J. Fletcher, Wimborne.

LEGAL INTELLIGENCE.

MAGNETO-IGNITERS.

Before Mr. Justice Walton in the King's Bench Division of the High Court the hearing was concluded on Tuesday of the case of De la Valette *v.* Riches and Co., in which plaintiff claimed for balance of goods sold and delivered. Defendants admitted the claim, but brought a counterclaim for damages for breach of contract.

The case was proceeded with on the counterclaim, when it was alleged that in March, 1905, it was orally agreed between plaintiff and Mr G. T. Riches, on behalf of the defendants, that the latter should be the sole representatives of the plaintiff (a French firm) in Great Britain and Ireland for the sale of plaintiff's patent magneto-igniters and their parts until plaintiff's patent should be taken over by a company, and that in the meantime plaintiff should pay to the defendants commission on all goods sold to any customers within the area mentioned. It was stated that on Sept. 22, 1906, plaintiff by letter refused to continue the agency and to supply the defendants with the patent igniters, although the patent had not been taken over by any company.

The defence on the counterclaim was that the plaintiff did not make the agreement alleged, and that no period in which defendants should act as plaintiff's agent was mentioned.

Evidence as to the terms of the contract having been given, the jury found for the defendants on the counterclaim, and awarded £750 damages.

His Lordship reserved judgment until a point of law had been argued.

DAMAGE TO AN ELECTRIC CARRIAGE.

At Westminster County Court on Monday Judge Woodfall heard the case of the Electric Landaulette Co. *v.* Palmer.

In this case Lady Palmer admitted a claim of £23 for the garaging of her electric carriage, but counterclaimed for £25 damage done to the upholstery of the car by plaintiffs. She said that when she took the car away she found that the upholstery was damaged and worn, and she subsequently ascertained that this was caused by acid. She paid the company £30 a month for the storing and charging of her car, which was almost new. Expert witnesses said that the damage was caused by sulphuric acid used in charging the cells splashing on the cushions in some way.

For the defence it was stated that it was not necessary to go into the car to fill the cells, which was done from the bottom.

The company's witnesses put the amount of the damage at the utmost at £14 to £20.

Judge Woodfall allowed Lady Palmer eight guineas.

TAPPING ELECTRICITY METERS.

At the Morpeth County Petty Sessions last week, a woman, of Hirst, was summoned by the Northern Counties Electricity Supply Co. on a charge of having diverted the current and stolen electricity to the value of 1d. on May 6. An ingenious device had been in operation by defendant to divert the current, by means of a piece of wire and two pins. The pins had been inserted in the electric wires, with the result that the current, instead of passing through the meter, passed directly to where the light was wanted. The practice seemed to be becoming very common, and the case was brought as a warning.

Defendant was fined £1 and costs, and the chairman intimated that if there were any more cases of the sort the penalty would be heavier.

ROAD PAVING.

Last Friday at Bristol a local nurseryman was successful in a claim against the Bristol Tramways and Carriage Co. for injury to his plants, alleged to have been caused by the laying of creosoted wood paving. The judge held that the defendants were not protected by their Act of Parliament, for the reason that they might have used jarrah wood, and they need not have put it down in those months when the plants

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were being bedded. The jury upheld this view, and judgment was given for plaintiff. Counsel for the company intimated that he could not possibly allow the defendants' position to remain as it was by that verdict, which will be appealed against.

ST. MARYLEBONE COUNCIL SUED.

At the St. Marylebone County Court on Friday last, the St. Marylebone Borough Council were sued by Mr. Robert Napier Cunningham, electrical engineer, of Edgware-road and Brown-court, W., who claimed £86 odd in respect of various items said to be due for work done and goods supplied. Two amounts had been paid into court.

Counsel, in his opening statement, said that in 1905 the Council decided to change their voltage from 100 to 240, and it became necessary for them to conform to conditions imposed by the London County Council. The condition which bore on the present case was the one which made it incumbent upon the local authority to make good to the consumers all lamps, fittings, etc., which were rendered useless by the change. One item for which plaintiff sought to recover—£45—was for a motor-generator which had become necessary by reason of the change of voltage, and which he had purchased on defendants' order. The Council's defence to this part of the claim was that the plaintiff had been a consumer at Seymour-place and not at Brown-court, where the generator was fixed, and where plaintiff was supplied with current only after the change in system. The second item, one of £20, was in respect of new arc lamps which plaintiff, as a contractor to the Council, had supplied to an Edgware-road dealer on a Borough Council official's order, and the rest of the claim was for balance of different accounts for work done by the defendants.

PLAINTIFF said he did a large business in charging accumulators, and to do so it was necessary to break down the original 100 volts power supplied formerly. When the 240 volts power was put on, his position would naturally be made worse, and it was for this reason that the generator was suggested and finally ordered by defendant. One of the defendants' engineers gave plaintiff permission to order new arc lamps for the job he was doing for the Council at Edgware-road. The official had pointed out that, no matter what happened, the consumer must not be left without lamps, and that, if necessary, plaintiff must order new ones.

For the defence it was submitted that the generator was ordered to compensate plaintiff, as consumer at Seymour-place, for any inconvenience suffered in the change of system. As there was no current previously supplied to Brown-court, the Council would not have agreed to supply the generator, inasmuch as it would have been plaintiff's place, in starting the installation, to have put in all fittings, etc., necessary to such installation. The engineer denied having given plaintiff permission to order the four arc lamps for the work in Edgware-road, but said that a payment had been made for the loan of lamps at the address in question.

HIS HONOUR awarded plaintiff £25 odd—£18 for the arc lamps, £2. 19s. 11d. in respect of respect of the balance from accounts, and £5 for loss sustained at Seymour-place. He said he did not think plaintiff could recover for the generator, inasmuch as place seemed the essence of the contract between the parties. The verdict was irrespective of the sum paid into court.

COMPANIES' MEETINGS AND REPORTS.

ALUMINIUM CORPORATION.

The report of the Aluminium Corporation, to be presented at the statutory meeting on the 7th inst., states that the receipts amounted to £121,240 and the payments to £78,722. The preliminary expenses, including brokerage, are estimated at £10,900. In addition, underwriting commission is payable at the rate of 5 per cent. in cash and 14 per cent. in fully-paid ordinary shares in respect of 250,000 7 per cent. participating preference shares, the subscription of which was guaranteed before the issue of the prospectus.

CENTRAL LONDON RAILWAY.

The report of the Central London Railway Co. for the half-year ended June 30 last, to be submitted to the meeting on the 7th inst., states that the capital expended was £6,351, the principal items being for an additional cooling tower and water supply at Shepherd's Bush. There has been a decrease of £15,599 in the receipts and of £4,372 in working expenses, but rates and taxes have required £355 more. The balance is £74,950, or £11,227 less than in 1906. The passengers numbered 20,260,871, a decrease of 2,074,618 and £16,739. After providing for interest on debenture stock and other payments, there remains a balance of £70,891. The directors recommend a dividend on the undivided ordinary stock at the rate of 3 per cent. per annum for the half-year, and on the preferred ordinary stock at the rate of 4 per cent. per annum for the half-year. Dividend on the deferred ordinary stock is not payable until the result of the year's working has been ascertained. The balance remaining—£31,423—is, therefore, carried forward. After careful observation and inquiry, the directors decided, though with much regret, to abandon the system of charging a uniform fare, and to adopt the increased charge of 3d. for passengers travelling beyond seven or eight stations, adhering to the 2d. fare for all lesser distances. The alteration came into effect on July 1 last. It is proposed that a conference or committee, to consist of representatives of the Metropolitan, the District, and the North London Railways, the various tube and tram undertakings, and the omnibus and motor-'bus companies, should be established for the purpose of dealing with questions affecting their common interests, and of adjusting differences that may from time to time arise. The Company's Bill to authorise the construction of an additional line into the depôt yard at Shepherd's Bush, on which it is proposed to provide a station at the entrance to the Franco-British Exhibition, has passed both Houses of Parliament and has received the Royal assent. It is anticipated that a large traffic will arise in connection with this exhibition, and that the provision of this station will afford great convenience to the public and be remunerative to the Company.

DUBLIN UNITED TRAMWAYS (1896).

The report of the Dublin United Tramways Co. (1896) for the half-year ended June, 1907, submitted at the meeting on the 30th ult., states that, after charging against the revenue the balance of cost of reconstruction of portion of the Dalkey line, £3,157, and the cost of alteration from centre to side pole overhead construction in Merrion-square North, Lower Mount-street, and Brunswick-street, £998, the amount available for division is £41,715. The directors recommend a dividend at the rate of 6 per cent. per annum, free of income tax, on the ordinary shares, leaving £6,615 to be carried forward. Mortgage bonds charged on the Dublin United Co. to the amount of £30,900 have been paid off. Of these bonds £15,700 have been reissued at par as 4 per cent., redeemable in 1912.

CHILIAN ELECTRIC TRAMWAY AND LIGHT.

The report of the Chilian Electric Tramway and Light Co. for the year ended Dec. 31, 1906, states that, after deducting interest and redemption of debentures, London office, and other charges, there is a balance to debit of £23,736, from which must be deducted the balance to the credit of profit and loss carried forward from the previous year's balance-sheet—namely, £21,288—leaving a balance to the debit of this account to be carried forward of £2,448. The renewal fund, which was created in 1905, and amounted to £8,867, has been charged with the cost of the modifications and the restoration of the property damaged by the rioters in Santiago. Of this fund £2,274 remains unexpended. Owing to frequent traffic disturbances, caused by several serious breakdowns of the machinery at the power station and also owing to the occurrence of an earthquake in Santiago on Aug. 16, 1906, which stopped the service during 11 days, the total passengers carried was less than during the year 1905 by 9,098,550. For the same cause the tramway receipts showed a decrease of 329,365·80dol. against the figures for the year 1905. The power station is now in thorough efficient order and condition, and during the year various additions have been made to the machinery therein. The rolling-stock has also been added to. The Company has succeeded in obtaining a prolongation of the concession from the municipality of Santiago for a further 25 years. The concession will now run to the year 1953. The Nuñoa line was reconstructed from horse to electric traffic, and opened for operation for almost its whole length on Dec. 31, 1906. Owing to the fall in the rate of exchange, and in accordance with the clause in the concession, the fares on the system in Santiago were doubled on Dec. 17, 1906, and resulted in a great improvement in the gross returns. On Dec. 20, 1906, a contract was entered into between this Company and the Deutsch-Ueberseeische Electricitäts-Gesellschaft, of Berlin, for that company to supply this system in Santiago with current produced from water power at a rate much below the present cost of power, and when this installation is complete, and the Company commences to take its power from this source, the directors look for a substantial decrease in the operating expenses. The damage arising from the riots has been met by the funds locally set aside in Santiago for this purpose; consequently the directors have retransferred to the profit and loss account the sum of £10,000 set aside in the balance-sheet of 1905 as a reserve against this loss. The business of the electric lighting department also suffered during the year owing to the disturbances and breakdowns in the power station and the earthquake. In spite, however, of these disadvantageous circumstances, this department showed the following increases as compared with the year 1905: in private lighting, 32 per cent.; in public lighting, 1 per cent.; whilst the tramway service required 7 per cent. less current, so that, including the amount required for the Company's own consumption, the consumption in 1906 was 7,668,752 kw., against 7,688,277 kw. in 1905. The number of customers using power and light increased from 849 in 1905 to 1,360 at the end of 1906. The cost of the kilowatt was greatly increased, however, owing to the difficulties with the power-house machinery and the increase in the cost of coal. Wages and salaries also were greatly increased owing to the earthquake. The Board much regrets to announce the death of Mr. Samuel Kocherthaler, director, in July, 1905. In April, 1907, Mr. Emile Rathenau resigned his seat on the Board of the Company, and on May 9, 1907, Mr. Johann Hubert Müller, of Berlin, was duly elected in his stead.

BOMBAY ELECTRIC SUPPLY AND TRAMWAYS.

The second ordinary general meeting of the Bombay Electric Supply and Tramways Co. was held on the 24th ult., Sir Edward Sassoon, Bart., M.P. (chairman of the Company), presiding.

The CHAIRMAN, in moving the adoption of the report (*Electrical Engineer*, July 19), said the year's working obtained entirely from the horse tramways resulted in a balance to the credit of profit and loss account of £41,900, after deducting all expenses chargeable to revenue, including repairs and maintenance. The dividend on 6 per cent. cumulative preference shares paid to Aug. 15, and the dividend accrued to Dec. 31, 1906, together amounting to £15,642. 14s. 9d., had to be deducted, leaving a balance of £1,363. 11s. 6d., which the directors recommended should be carried forward to the next account. The first section of the tramways was opened electrically from Colaba terminus to Crawford Market in May, and a further section from Wari Bunder to Jamsetji Jeejeebhoy Hospital—1·81 miles—was opened

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on June 1, making a total of 4·39 route miles, nearly all double track, working electrically. On July 10 the section from the Jamsetji Jeejeebhoy Hospital to the Victoria Gardens—1·22 route miles—was opened for electric traction, making the total open 5·61 miles. Electric traction has, to the limited extent in which it has as yet been brought into operation in Bombay, proved very popular. Its influence on the Company's traffic receipts has during the short period the cars have been running resulted, comparing the earnings of the electric (13·85d.) with the horse cars (8·31d.), in an advance of over 50 per cent. in the earnings of the former per car mile, as you will see from the report. One satisfactory feature in connection with the new electric service has been the freedom from accidents. The former drivers of the horse tramway, who are all natives, are, after a few weeks of instruction, proving most efficient motormen. At present the work of the electrification of the tramways is to a large extent under compulsory suspension owing to the monsoon, which extends from June until the end of September. It is expected to have the entire system running electrically before the monsoon of next year. During the year under review the excess of expenses over receipts in the electricity supply department amounted to £1,639. 12s. 11d., which the directors have considered advisable to carry to suspense account, bringing the total up to £3,503. 3s., with a view to its being written off out of subsequent profits from that branch of the undertaking. The lighting and power supply branch of the business has made excellent progress during the year. Amongst the more important installations shortly to be added are the mint, the new post office, some of the large hospitals, the terminus of the Great Indian Peninsular Railway, and the experimental installation at the docks. The mains have now been extended to Malabar Hill, and a large business is looked for in that, the most wealthy residential quarter of the city. The Bombay electric traction licence was duly sanctioned on April 18, 1907, and the Bombay Tramways Amendment Act was passed on April 18, so that the Company has now obtained all the powers necessary for carrying on its business. The chairman then referred to the terms of the licence issued by the Government of Bombay to the promoters of the Tata hydro-electric scheme. The effect of the clauses cited was, in his opinion, to demarcate the sphere of operations of the hydro-electric enterprise as to preclude its proving injurious to the business of this Company. That being so, and there being no apparent likelihood of any friction arising between the interests of the two concerns, his feeling was that there should prove scope for their working in mutual amity and co-operation.

Sir CHARLES OLIVANT, K.C.I.E., seconded the motion, which was unanimously adopted without discussion.

BUENOS AYRES TRAMS.

The fifth ordinary general meeting of the Buenos Ayres Electric Tramways Co. (1901) was held on the 25th ult.

Mr. E. A. LAZARUS (chairman of the Company) presided, and, in moving the adoption of the report (*Electrical Engineer*, July 19), said the net profits amounted to £15,075, as compared with £13,286 the previous year. The debenture interest had been paid, £1,731 placed to the sinking funds, and £2,639 carried forward, which included the sum of £686 brought forward.

The motion was seconded by Mr. T. F. THOMPSON, and carried unanimously.

UNITED RIVER PLATE TELEPHONE.

The ordinary general meeting of the United River Plate Telephone Co. was held on the 23rd ult., Mr. J. Irving Courtenay, chairman, presiding.

In moving the adoption of the report (*Electrical Engineer*, July 19), the CHAIRMAN alluded to his recent visit to America. He reported that active work was going on in Buenos Ayres for replacing the overhead lines there by underground cables. In Rosario and Cordoba also a considerable number of overhead lines had been replaced by underground cables, and it was the Board's intention, so soon as the necessary arrangements had been completed, to make similar changes in the system in other important towns. The Company's relations with the Government and municipal authorities were of a friendly description. Argentina was developing in all directions, and there was no reason why the undertaking should not continue to share in this prosperity, provided that they continued to give the community a thoroughly good service at a reasonable rate. He then pointed out the immense field for profitable work that there was before them, and the constant need that existed for new capital. There would probably be an issue of ordinary shares in the late autumn. Dealing with the profit and loss account, he said that the receipts in the River Plate showed an increase of about £35,000, while maintenance charges and general expenses were about £21,000 more than for the previous year. The increase in the net profit amounted to £14,008, and he thought that the results generally would be considered satisfactory. The Board recommended the payment of a final dividend of 5 per cent. on the ordinary share capital, making, with the interim distribution, a return of 8 per cent. for the year, tax free.

Mr. F. GREEN seconded the resolution, which was unanimously agreed to.

SOUTH WALES ELECTRICAL POWER.

The fifth annual meeting of the South Wales Electrical Power Co. was held at the Park Hotel, Cardiff, on Saturday last, Mr. Robert Forrest, chairman of the Company, presiding.

The CHAIRMAN, in moving the adoption of the report and statement of accounts (*Electrical Engineer*, July 19), said the unfortunate circumstances in which the Company were placed were fully explained to the shareholders at the extraordinary meeting held on July 2, 1906. The Company had exhausted its capital, and the financiers who were deeply interested in the undertaking, and to whom the directors were looking for the capital to complete the work in hand, declined to find that capital unless power was obtained for the issue of prior lien debenture stock. At considerable cost and with great trouble the Company's Bill was redrafted, and received the Royal assent. Evidence was given before both Houses of Parliament by those representing the financial firms who had invested in the undertaking that if the powers were granted by Parliament there was every prospect of the necessary money being found to meet the Company's requirements. Unfortunately, that expectation had not been realised, and it was found impossible to secure the necessary horse-power required before the capital could be provided. In those circumstances the larger consumers of power had formulated a scheme for keeping the undertaking going. The principal creditors had agreed to accept preference shares of the nominal value of £150 in respect of each £100 of indebtedness. The directors greatly regretted the present position of the Company, which they had done everything in their power to avert. They confidently believed that the undertaking would be a most successful one, and they were encouraged in this belief by the opinions of experts who from time to time investigated the affairs of the Company on behalf of those who were investing money in the Company. It must be remembered that the Company was the first pioneer in the business, and some allowance must be made for the difficulties and problems which necessarily were met with in starting such an undertaking. The position largely arose from the delay on the part of consumers in connecting up with the Company. If that could have been got over the financial difficulties would not have arisen, and the undertaking, instead of being carried on for a long time at a loss, might have very quickly reached a profit-earning basis. It would be necessary for the meeting to elect directors in place of himself and others who were resigning.

Mr. HUGH WATTS seconded the motion, and the report was adopted without discussion.

The following directors were appointed in accordance with an agreement arrived at with the Treforest Electrical Consumers' Co., who will carry on the Treforest portion of the Company's works: Mr. Westgarth Forster Brown, M.E., Mr. J. W. Hutchinson (Trehafod), Mr. William Cope (Bridgend), Mr. W. Gascoyne Dalziel, Mr. T. Griffiths (Cymmer), Mr. W. L. Madgen (Streatham, London), Mr. G. T. Hutchinson Buckingham-gate, London), and Mr. T. O. Callender (Abbey Wood, Kent), in the places of Mr. W. S. B. M'Laren, Mr. T. H. Weguelin, Mr. W. W. Hood, Sir R. H. Sankey, K.C.B., R.E., Mr. Hugh Watts, Mr. H. Ruffer, and Mr. Robert Forrest.

The retiring chairman (Mr. Forrest) was thanked for his services to the Company.

An extraordinary meeting of the proprietors was then held, Mr. W. G. Dalziel being voted to the chair for that meeting.

Mr. C. S. D. SPENCER, solicitor, Cardiff, explained the agreement which had been entered into with the Treforest Electrical Consumers' Co., which had been registered with a capital of £100,000. That company would find at least £30,000, for the purpose, in the first place, of meeting Crown debts due by the Company and bringing the machinery of the Treforest station up to date and guaranteeing power to those consumers who still remained connected with that station. With few exceptions, the creditors of the Company had consented to take £150 in preference shares for every £100 due to them. The total indebtedness of the Company was about £82,000, and creditors for £77,000 out of that sum had consented to accept preference shares. The price which the new Company would charge for power must not be less than in the opinion of the Board would produce such a sum as would pay all expenses, including repairs and keeping the mains and cables in good working order. It was hoped that a fund would be formed to keep down the debenture interest which had accumulated. If at any time the working of the Company proved so satisfactory that it would be in the interest of the financial people in London to come forward with larger sums of money for further development, that agreement would allow them to do so. With regard to the Cwmbran power station, it was proposed that a subsidiary company should be formed, and so far as the Neath and Bridgend stations were concerned negotiations were proceeding for the sale of the works to the local authorities. If those sales were brought about a considerable sum of money would be realised, which could be used in developing the Treforest station or in minimising the prior lien debenture bonds. With regard to the lease of the Treforest station, the Marquess of Bute had reduced the rent from £300 to £100 a year in perpetuity and practically freed the lease from onerous conditions.

On the motion of the CHAIRMAN, seconded by Mr. MADGEN, the agreement was approved.

Mr. MADGEN said the late Board were entitled to the fullest sympathy of every shareholder and of the community of South Wales. He did not think that blame attached to them.

The CHAIRMAN announced that Mr. Chamen, the manager of the Company, was to be retained. He had, he said, displayed the greatest possible tact, and to that in a great measure was to be attributed the position they had reached that day. Mr. Tutcher, secretary to the power company, was also to be retained for the secretarial duties of the Treforest and existing company, and that, the chairman thought, was a guarantee that everything would be done in proper order.

GENERAL ELECTRIC.

The ordinary general meeting of the General Electric Co. was held on Friday last at the offices, 71, Queen Victoria-street, E.C., Mr. G. Byng, the chairman of the Company, presiding.

The CHAIRMAN, in moving the adoption of the report, said the accounts did not differ materially from those of last year, and were, therefore, to be considered satisfactory. The Company had added to their properties to the extent of £19,200, which had gone entirely

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into extensions of works, buildings, and machinery. That sum, though not as large as it had been during the last few years, proved that even in quiet years a manufacturing concern constantly required additional capital outlays. The sum written off for depreciation was about the same as last year, and was based upon the scale agreed upon with their auditors. Their stocks again showed an increase, due largely to dearer raw materials—copper, iron, lead, timber, cotton, rubber, and other materials which they had to buy having gone up. There seemed to be some idea in the minds of many that their trade system enabled the Company to obtain cheap raw materials. All facts experienced in the course of business during the last few years had, he said, proved just the contrary. English manufacturers possessed no means whatever—they seem even to have lost those means they had in the past—of influencing the prices of raw material. The course of last year had been marked by the introduction of an important invention affecting the electric lighting industry. The aim at which the Company had worked for a great many years—namely, that of improving the efficiency of the incandescent lamp—had been obtained by the introduction of a lamp having the wolfram (tungsten) metallic filament as a basis. He was of opinion that the advent of that lamp would have a most beneficial effect upon their industry, and they had from the beginning done everything to assist the development of the new lamp. They had come to a sound business arrangement with the holders of the first and what they were convinced were the master patents of the lamp, and in connection with their Robertson lamp factory had made arrangements for its manufacture in England. In the meanwhile they had secured for immediate sale in this country a considerable proportion of the output of the German works. Their works had been kept busy throughout the year. The carbon works had done fairly well, and they had again to acknowledge the great help which the Home and Colonial Governments had given in that undertaking, but he could not help complaining of the action of many municipalities in this country. For the sake of, sometimes, a few per cent., many an order for town lighting had gone abroad. Prices for heavy work had been kept low, mainly through internal competition. Foreign competition had been less active during the year, but there were indications that business on the Continent was getting slacker, and that dumping would soon begin here again. He instanced a case that had recently occurred in the West of England. The uncertainty as to foreign competition was, he said, worse for the English manufacturer than the actual competition itself. They were entirely at the mercy of the foreign manufacturer, who left them alone or dumped upon them whenever it pleased him, and all experience and circumspection were useless. He did not call that a natural state of affairs. The Company's profits were less than last year by about £2,000. To that extent they had been obliged to reduce the amount which they had placed to the credit of their reserve account. The reserve stood now at £118,000. The ordinary shares had been increased by £96,000 since the formation of their business into a public company. The security behind the preference shares had therefore increased by £214,000, or 85 per cent. Their preference shares should be called gilt-edged, and, no doubt, would be were they living in normal times; but, unfortunately, he did not think they were. The conservative financial policy of the Company made them independent, to a large extent, of the financial situation; yet much legitimate expansion was prevented, and many profitable foreign undertakings went abroad in consequence of the lack of reasonable financial assistance. England's industries used to be assisted formerly by abundant capital. Very little of such capital was available at present, but their foreign competitors enjoyed that advantage now. Another great evil was the abuse of their limited company laws. The tendency of every little man to turn himself into a limited company, with £7 share capital and £5,000 debentures, was becoming daily more accentuated. It made the giving of credit most precarious, and interfered with the legitimate trader. Though their balance-sheet was considered satisfactory, he was far from satisfied with the results of the Company's efforts. On comparison with their competitors in England, they could even congratulate themselves, as, unfortunately, many of them had shown almost disastrous results; but when they looked abroad, they found their competitors were, almost without exception, in a most flourishing state. That and many other indices pointed conclusively to the fact that the unsatisfactory state of their industry was due to the support foreign governments gave to their producing industries, and which was denied to them here. He wished the Government would allow the manufacturer some sense of honesty and some knowledge of his own affairs. Manufacturers held it to be a truth, based upon daily experience and knowledge, that the regulation of foreign importation by customs duties would cheapen their cost of production. The official representatives of their Government, however, held the contrary view, and their reply was that the imposition of customs duties would increase the cost of production to the manufacturer.

Mr. H. HIRST seconded the resolution, which was agreed to unanimously and without discussion.

The payment of a 5 per cent. dividend on the ordinary shares was agreed to.

The retiring director (Mr. H. Bevis) was re-elected, and the auditors were also reappointed.

DIRECT UNITED STATES CABLE.

The half-yearly ordinary general meeting of the Direct United States Cable Co. was held on Friday last.

Mr. E. M. UNDERDOWN presided, and, in moving the adoption of the report and accounts (*Electrical Engineer*, July 26), stated that their traffic was going on well, and up to the present period they had not suffered from any misfortune. The revenue for the six months ended June 30 last, after deducting the outgoing payments, amounted to £57,056, while the working and other expenses, including provision for the pension fund and income tax, but excluding the cost of maintenance, amounted to £24,699, leaving a balance of £32,357 as net profit. This, with the amount of £17,032 brought forward, made a total of £49,389, and had been appropriated by payment of three interim dividends of 4s. per share, and they proposed to pay a final dividend at the rate of 4s. per share, together with a bonus of 2s. 6d. per share. They had transferred £15,000 to the reserve fund, and carried forward to the next account £2,516. The revenue showed a slight improvement compared with the corresponding period of 1906, although that was a very active period. The working of their Atlantic cables and stations showed a small increase in consequence of greater activity. The reserve account had been credited with £8,790, being interest on reserve fund investments, while an amount of £2,367, being profit on the sale of securities, had also been placed there. They had debited £4,484, being cost of maintenance, to this account, as well as £40,000, being provision for the depreciation in the quotation of their securities. Their investments had been increased during the half-year by £36,219. The total receipts for the year were £117,435, less expenses and ordinary payments £50,080, leaving a balance of £67,355, out of which they had paid £56,156 in dividends, while they had placed £15,000 to the reserve fund.

Sir JOHN PENDER seconded the report, which was unanimously adopted.

METROPOLITAN RAILWAY.

The half-yearly meeting of the proprietors of the Metropolitan Railway was held on the 25th ult., Sir Charles McLaren, Bart., M.P. (chairman of the Company), presiding.

The CHAIRMAN, in moving the adoption of the report, said several causes had contributed in a greater or less degree to the diminution in their receipts. They still felt the effects of the motor-omnibus competition, although they had every reason to believe that the omnibus companies would abandon the policy of cutting fares and adopt more remunerative charges, which would ensure a fair return to all concerned. That was all they wanted—a fair return to everybody—and he thought the public would be quite prepared to pay. Another cause for the decline in the passenger receipts was to be found in their having ceased to work their trains over the East London line, which was not equipped for electric traction. The East London Co. was pressing the question of electrification, but whether anything would come of it they were not yet in a position to say. Their goods traffic had been less during the half-year, principally from the fact that some large building and other contracts had been completed, and these various causes accounted for the falling off in receipts. As to their passenger traffic, he said the total number, including season ticket-holders, showed a falling off of 745,432. The decline in ordinary passengers was 839,936, whilst season ticket passengers increased by 94,204. The loss on passengers to and from the East London line alone was 248,026. As shown in the percentages of the respective classes carried by the Company, he stated that the first-class came out at 9·31, compared with 9·87; second-class, 3·87, compared with 7·09; and third-class, 86·82, compared with 83·04. Touching upon the transit problem in general, Sir Charles said it was a matter of history now that, with the new forms of locomotion, very low fares, and such as had never previously been charged in this country, were put into operation in several parts of London on routes competing with their railway. After much negotiation they had some meetings with the representatives of the District Railway, the Central London Railway, and the other tube lines a few months ago, with a view to getting the fares from Hammersmith and other stations in the West of London to the City put on a more remunerative basis. An agreement was unanimously come to on the subject, and the fares were raised to a moderate extent on July 1, both on their line and on the Central London, and certain alterations were made in the fares on the tubes and District Railway. The effect of increasing the fares had so far quite come up to their expectations, and they had every reason to suppose that the result would continue to be satisfactory. As he had stated at the last meeting, they had in contemplation to considerably enlarge Baker-street Station, and to provide, amongst other things, for a junction between the St. John's Wood line and the Circle, with a view to running a through train. The plans for these alterations had been matured during the last few months, and preliminary steps were being taken with a view to a commencement of the work. In conjunction with the District Railway, they had lately reconstructed the joint stations at High-street, Kensington, Gloucester-road, and South Kensington, and had made a vast improvement in their property there. They had set aside a short time ago a considerable sum of money for the purpose of cleansing and renovating their stations generally on the introduction of electric traction.

Sir WILLIAM BIRT seconded the adoption of the report, which was unanimously adopted.

BUENOS AYRES GRAND NATIONAL TRAMWAYS.

The annual general meeting of the shareholders in the Buenos Ayres Grand National Tramways Co. was held on the 24th ult., Mr. J. Irving Courtenay (chairman of the Company) presiding.

The CHAIRMAN, in moving the adoption of the report (*Electrical Engineer*, July 19), stated that during the year ended March 31 last there had been expended in London and Buenos Ayres on electric construction and equipment £266,367. As regarded the revenue account, comparisons were not of much value, owing to the transition from horse to electric working, but he drew attention to the chief differences in the results between last year and the previous year. Over the corresponding figures for 1905-6 the gross receipts from working for 1906-7 show an increase of £68,660, or 28·18 per cent., the working expenses £27,496, or 14·25 per cent., and the net receipts £41,163, or 68·95 per cent. The percentage of working horse and electric together for 1906-7 was 68·60, as against in 1905-6 76·36, or a reduction of

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7·76 per cent. The percentage of working by electric traction only for 1906-7 was 62·75 per cent. The number of passengers carried was in 1906-7 35,874,902, and in 1905-6 27,810,737, or an increase of 28·99 per cent. Passenger car miles run were in 1906-7 7,014,999, and in 1905-6 6,676,738, or an increase of 5·07. The passenger gross receipts per car mile were in 1906-7 51·85 cents, in 1905-6 42·36 cents, or an increase of 22·17 per cent., while the expenses per car mile in 1906-7 were 35·63 cents, as against in 1905-6 33·03 cents, or an increase of only 7·87. The net receipts for the year exceeded those for the previous year by £41,163, or 68·95 per cent. Their relations with the municipality were most cordial. The latter had consented to the discontinuance of all the horse cars, thus eliminating a source of unproductive expenditure. The number of miles of single track converted to electric traction was 75¾ miles. He added that the position of the Company had greatly improved, and he proposed the payment of a final dividend at the rate of 3s. per share, less income tax on the 5 per cent. cumulative preference shares for the year ended March 31 last.

Mr. E. A. LAZARUS seconded the motion.

In answer to certain questions, the CHAIRMAN stated that the difference in the length of line which had been converted and which had still to be converted might be taken as between 75¾ miles and 113 miles, which they took as the total length of the system as at present projected, including the concessions applied for. At the present time 66½ miles were being worked by electric traction. Under the concessions they had up to 1910 to finish the system, but he could not specify any particular date when the work would be completed.

The resolution was carried unanimously.

TELEGRAPH CONSTRUCTION AND MAINTENANCE.

The half-yearly meeting of the Telegraph Construction and Maintenance Co. was held on the 23rd ult., Mr. W. Shuter, chairman of the Company, presiding.

After referring to the satisfactory financial position of the Company the CHAIRMAN dealt with the contracts carried out and in hand. The most important work of the half-year had been the making and laying of a cable between New York, Cuba, and Panama, a length of over 2,300 nautical miles. The contract for this cable was made in January last with the Central and South American Telegraph Co. of New York. This work was taken in hand in January last and completed four hours before the expiration of the agreed time—viz., July 15. He thought it worth mentioning this, as it had always been the Company's policy to respect its contract dates, and it spoke well for the efficiency of their staff and of their organisation, both at the works and in their ships, that their contracts were carried out with such promptitude and success. He had no resolution to submit, as no report or accounts were presented to that meeting, but in accordance with their usual custom he had to announce that the warrants for the interim dividend of 5 per cent. would be posted that day.

CROMPTON AND CO.

The annual general meeting of Crompton and Co. was held last week, Mr. John Trotter, chairman, presiding.

In moving the adoption of the report (*Electrical Engineer*, July 26), the CHAIRMAN congratulated the shareholders upon the greatly improved state of affairs. The works had been fully occupied, and the net profit had amounted to £38,291, which enabled them to pay a 5 per cent. dividend, being double the amount paid last year. The sum of £1,500 was set aside for contingencies and doubtful debts, and £10,712 was placed to reserve account, increasing that fund to £20,000. A balance of £5,840 remained to carry forward. The growth of the business was so great that the directors asked the shareholders to agree to an increase in the borrowing powers of the Company from the present limit of £150,000 (in which was included the debenture issue of £100,000) to £200,000. The outlook for the current year was satisfactory, good orders and contracts having already been received.

Colonel R. E. B. CROMPTON seconded the resolution, which was agreed to.

A resolution sanctioning the increase of the borrowing powers of the Company by £50,000 was also agreed to.

ANGLO-AMERICAN TELEGRAPH.

The half-yearly meeting of the Anglo-American Telegraph Co. was held on Friday last, Mr. Francis A. Bevan, chairman of the Company, presiding.

In moving the adoption of the report (*Electrical Engineer*, July 19), Mr. BEVAN stated that the net gain in revenue was £4,100. The directors thought it right to resume the operation carried out for some years of setting aside £20,000 out of the annual receipts towards making-up the renewal fund to the value of one million. There was a depression in British securities which it seemed that nothing could remove, and it was mainly in these that their funds were invested. The Board was in communication with the Government authorities concerning the damage done to the shore ends of their cables by trawlers, and the authorities were taking the matter into earnest consideration.

The report was unanimously adopted.

BLACKPOOL AND FLEETWOOD TRAMWAYS.

The half-yearly meeting of the proprietors of the Blackpool and Fleetwood Tramroad Co. will be held on Thursday, Aug. 22, and the directors' report and statement of accounts will then be presented. The revenue account for the half-year ending June 30 shows that the traffic receipts amounted to £10,449. 5s. 5d., as compared with £10,778. 16s. 6d. for the corresponding half of last year. The expenditure on the maintenance of the permanent way and works was £715. 3s. 10d., as compared with £575. 15s.; engine power cost £1,531. 4s. 6d., as against £1,591. 6s. 8d.; repairs to cars were £650. 4s. 11d, as compared with £851. 18s. 8d.; traffic expenses, £2,214. 12s. 4d., as compared with £2,112. 3s. 8d.; general expenses £664. 13s. 6d., as compared with £823. 3s. 10d The depreciation reserve account stands at £9,582. 8s. 4d., the relaying the track being £1,133. 15s. 6d., and the renewal of cables having cost £1,133. 15s. 6d., these being defrayed out of the depreciation reserve account, which stood at £11,000. In rates, taxes, and insurance the Company paid for the half-year £1,298. 12s. 11d. The car mileage for the half-year was 226,166, as compared with 234,019. The number of passengers carried during the half-year was 873,924.

ELECTRIC SUPPLY CORPORATION.

The fifth annual meeting of the Electric Supply Corporation was held on Wednesday, Mr. Carleton F. Tuffnell, chairman of the Corporation, presiding.

The CHAIRMAN, in moving the adoption of the report and accounts (*Electrical Engineer*, July 26), said that the Company had made good progress during the year. The increase in the number of lamps connected at Chelmsford amounted to 1,174, at Jedburgh 739, at Melrose 316, at Dalkeith 1,151, at Dollar 298, at Totnes 660, at Exmouth 1,992, and at St. Andrews 4,791. The tramway within the burgh of Dumbarton was now completed, and the line opened for traffic. The gross revenue, including the dividend from the Chelmsford Co., amounted to £7,285, and, after providing for debenture interest and other items shown in the net revenue account, there remained a net profit of £151. During the year the supply of electricity had been commenced in Dumbarton, Hitchin, and Falmouth, and 6,853 lamps connected to the mains in these towns. The Totnes undertaking was now working at a profit, the guarantors having paid the sum necessary. A final dividend for the year 1906 was paid to the shareholders in January last, and they would now provide the amount sufficient for the payment of an interim dividend at the rate of 5 per cent. per annum for the six months ended June 30 last.

The report and accounts were adopted.

NEW COMPANIES REGISTERED.

Sungei Salak Rubber Co.—Registered July 25. Capital, £70,000 in £1 shares. Objects: to plant, prepare for market, and deal in indiarubber, guttapercha, balata, and other gums, etc.

Molbydenite, Limited.—Registered July 17. Capital, £5,000 in £1 shares. Objects: to acquire, deal with, and turn to account options, lands, buildings, mines, mining rights, and leases, concessions, licences, patents, etc. No initial public issue.

Electrical Manufacturing Co.—Registered July 23. Capital, £13,000 in £1 shares. Objects: to acquire the business of P. Walters and Co., of 240 and 251, Kensal-road, to adopt an agreement with W. Powles, and to carry on the business of electricians, etc. No initial public issue. Registered office: 249-51, Kensal-road, London.

G.D.B. Syndicate, Limited.—Registered July 24. Capital, £10,000 in £1 shares. Objects: to acquire any invention for treating complex ores (including complex sulphide ores), and in particular certain inventions of G. de Bechi and R. W. Rucker, and to carry on the business of miners, metallurgists, smelters, refiners, etc. No initial public issue.

Treforest Electrical Consumers' Co.—Registered July 25 by Jordan and Sons, 120, Chancery-lane, W.C. Capital, £100,000 in £1 shares. Objects: to adopt an agreement with the South Wales Electrical Power Distribution Co. (incorporated by Act of Parliament) and Stanley Boulter, to promote or concur with the last-named company or with the Cwmbran Electrical Consumers' Co., or any other company or person, in promoting any parliamentary Bill or provisional order which may seem desirable, etc.

Liens Registered.

Clark's Machine Tool Co. (1907), Limited, Luton.—£8,000 first and £2,375 second 4 per cent. debentures, created and dated July 11, 1907, have been registered. Property charged: the company's undertaking and property, present and future, including uncalled capital. No trustees.

Holloway Electric Supply Co., Limited.—Issue on June 29 of £3,200 5 per cent. debentures, part of series created Dec. 28, 1900, to secure £20,000. Charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £15,000.

Newquay Electric Light and Power Co., Limited.—Issue on July 12 of £300 5 per cent. debentures, part of series created July 30, 1906, to secure £4,000, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £3,700.

Scottish House-to-House Electricity Co., Limited.—An additional charge for £500, dated July 8, 1907, has been registered. Property charged: the company's undertaking and property, present and future, including the Coatbridge and Airdrie undertakings. Holders: County of London Electric Supply Co., Moorgate-court, E.C.

Bi-Centric Insulating Co., Limited (Birmingham).—Issue on July 11 of a 5 per cent. debenture for £50, part of series created Feb. 21 1907, to secure £200. Charged on the company's under

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taking and property, present and future, including uncalled capital. No trustees. Holder: R. S. Mason, 7, Anderton-road, Sparkbrook, Birmingham. Total amount previously issued of same series, £150.

North-Eastern Electrical Stores, Limited, Newcastle-on-Tyne. A first debenture, dated July 10, and a second debenture, dated July 12, 1907, securing £175 and £165 respectively (both with 5 per cent. interest), charged on the company's undertaking and property, present and future, including uncalled capital, have been registered. Holder: A. Dunbar, Stanger-road, South Norwood, S.E.

F. and C. Osler, Limited, Glass Manufacturers, Birmingham.—Particulars of £50,000 debentures, created by resolution of June 26, 1907, and secured by a trust deed of even date, have been filed pursuant to Section 14 (4) of the Companies' Act, 1900. The above-mentioned trust deed has also been registered. Property charged (by debentures): the company's undertaking and property, present and future, including uncalled capital; (by trust deed) certain freehold and leashold land, buildings, and hereditaments in Freeth-street, Broad-street, Tennant-street, and Granville-street, Birmingham, and the company's undertaking and other property, present and future. An issue on the same date of £30,000, part of above series, has also been registered.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Leghorn.—The Municipality invite tenders for electric lighting. Tenders by Sept. 21.

Salford.—Tenders are invited for 14 cars and four salt wagons for the Corporation Tramways Department. Tenders by Aug. 12.

Vienna.—Tenders are invited for a central electric power station at Czernowltz for the Austrian State Railways. Tenders by Aug. 31.

Madrid.—The Public Works Department invite tenders for the construction of electric tramways in Valencia. Tenders by Aug. 12.

Madrid.—Tenders are invited for the construction of electric tram way at Saragossa for the Public Works Department. Tenders by Aug. 7.

Barnes.—The Urban District Council invite tenders for mechanical stokers and cables for the Electricity Department. Specifications £1. 1s. each. Tenders by Aug. 12.

Companario.—Tenders are invited for the electric lighting of the town for a period of 20 years. Particulars from the Ayuntamiento Constitucional. Tenders by Aug. 24.

Sofia.—Tenders are invited for the supply of an accumulator battery for the Postal Department. Tenders to the District Finance Commissioners, Sofia. Tenders by Aug. 8.

Portsmouth.—The Tramways Committee invite tenders for best large smokeless steam coal. Mr. V. G. Lironi, engineer, Frattongrove, Portsmouth. Tenders by Aug. 5.

Brussels.—Tenders are invited for the equipment of three electricity sub-stations for the Société Nationale des Chemins de fer Vicinaux, 14, Rue de la Science. Tenders by Aug. 12.

Kettering.—The Urban District Council invite tenders for 315-kw. engine and dynamo set and pipe connections, also switchboard panel. Tenders by Aug. 28. See advertisement.

Mansfield.—Tenders are invited for the annual maintenance of the electric installation at the town hall, for the Town Hall Committee. Tenders to Mr. J. Harrop White, town clerk, by Aug. 6.

Madrid.—Tenders are invited for the construction of two electric tramway lines in Madrid, and one from Baeza to Linares. Particulars from the Public Works Department, Madrid. Tenders by Aug. 5.

Hull.—The Corporation invite tenders for pipe work, ejector type condenser and pump. Particulars from Mr. H. Bell, city electrical engineer, Hull. Tenders by Aug. 2. See advertisement in last issue.

Brisbane.—The Postmaster-General invites tenders for the supply and delivery at Brisbane of four sections of a common battery switchboard and 650 subscribers' telephones to specification No. 145. Tenders by Sept. 2.

Dublin.—The Lighting Committee of the Dublin Corporation are prepared to consider proposals for the supply of motors to their consumers on the hire-purchase system. Particulars from the Secretary. See advertisement in last issue.

Grimsby.—Tenders are invited by the Corporation for the supply of one 500-kw. continuous-current dynamo coupled to a triple-expansion engine. Specification and particulars from the Borough Electrical Engineer. Tenders by Aug. 19.

Acton.—The Urban District Council invite tenders for the wiring and fixing of fittings under their assisted wiring schemes. Full particulars from the electrical engineer, Mr. J. Martin Blair, 130, Churchfield-road, Acton, W. Tenders by Aug. 20.

London, S.W.—The Crown Agents for the Colonies, acting on behalf of the Central South African Railways, invite tenders for the supply of 27,000lb. hard-drawn copper wire. Tenders to the Crown Agents for the Colonies, Whitehall-gardens, S.W., by Aug. 20.

Blackburn.—The Electricity Committee invite tenders for the supply and delivery of steam coal for nine months ending June 30, 1908. Specifications, etc., on application at the Electricity Works, Jubilee-street. Tenders by Aug. 3.

Croydon.—The Electricity Committee invite tenders for the supply of the following: (*a*) flame arc lamps; (*b*) transformers for the same; (*c*) lowering gear. Full particulars to be obtained from the Borough Electrical Engineer, Electricity Works, Factory-lane, Croydon.

Adelaide.—The Deputy Postmaster-General invites tenders for a common battery switchboard and subscribers' telephones. Specification No. 166. Particulars may be obtained from the Commonwealth Offices, 72, Victoria-street, London, S.W. Tenders by Jan. 8, 1908.

London, W.—The Paddington Guardians invite tenders for an electrical installation of fire-alarms at their workhouse in the Harrow-road. Specification and form of tender may be obtained of Mr. H. F. Aveling, clerk, Guardians' Offices, 313-319, Harrow-road, W. Tenders by Aug. 12.

Portsmouth.—The Town Council invite tenders for (Contract No. 24) supply, delivery, and erection of one high-tension switchboard; (25) supply, delivery, and erection of steam, exhaust, circulating water, and sundry other pipework. Tenders to the Town Clerk by Aug. 14.

Crewe.—Tenders are invited for a 12 months' supply (about 2,000 tons) of best quality open burning slack, to be delivered in quantities as ordered at their electricity works, for the Electric Lighting Committee. Tenders to Mr. H. H. Denton, Corporation Electricity Works, Crewe, by Aug. 17.

Winnipeg.—The Point du Bois Hydro-Electric Development invite tenders for an electrical equipment and for constructional work. Specifications, etc., from the Power Engineer's Office, Carnegie Library Buildings, Winnipeg, or at 35-36, Bedford-street, Strand, W.C. Tenders by Sept. 3.

Newcastle-upon-Tyne.—The Tramways Committee invite tenders for the supply of the various, points, crossings, rails, and other materials in connection with the renewal and extension of a three-road double turn-out junction of tramways at Market-street and Pilgrim-street, Newcastle-upon-Tyne. Tenders by Aug. 3.

Stockport.—Tenders are invited for providing and fixing top covers to 10 double-deck cars, Nos. 31 to 40 including lighting, wiring circuits, and fittings, trolley base, and connections to power cable. Particulars from Mr. J. Atkinson, borough surveyor, Stockport. Tenders to the Chairman of the Tramways Committee by Aug. 9.

Alexandria.—The Harbour Authority invites tenders for the electric installation for the port, comprising five large and seven small transporters, six four-ton cranes, 36 two-ton cranes, 25 capstans; also cables and accessories, construction and installation of central power station. Particulars from the Directeur Général des Ports at Phares. Tenders by Nov. 1.

Sheffield.—The Electric Light Committee invite tenders for (Contract No. 47) constructional steelwork for carrying coal shoots, coal bunkers, and railway sidings over same at the Neepsend power house. Specification, etc., from Mr. S. E. Fedden, general manager and engineer, Electric Supply Department, Commercial-street, Sheffield. Tenders by Aug. 6.

Queensland.—Tenders are invited by the Postmaster-General for the supply and delivery at the Post and Telegraph Stores, Brisbane, of the following telegraph and telephone material: (1) lead-covered cable; (2) stores and battery material; (3) line material; (4) telegraph and telephone instruments; (5) coin attachments. Tenders to be sent to the General Post Office, Brisbane, by Sept. 9.

South Australia.—The Postmaster-General, Adelaide, invites tenders for the supply of lead-covered telephone cables as follows: 7½ miles 208 pair, paper-insulated, lead-covered, 12½lb. conductors; 3½ miles 156 pair ditto; 4 miles 104 pair ditto; 2½ miles 78 pair ditto; 7 miles 52 pair ditto; 2½ miles 26 pair ditto; and 700 yards 104 pair light lead-covered, silk and cotton insulated. Particulars may be obtained from the Commonwealth Office, London. Tenders to the Deputy Postmaster-General, Adelaide, by Sept. 25.

Victoria.—The Postmaster-General, Melbourne, invites tenders for the supply and delivery of telegraph and telephone material as under: (1) 3,000 binders, copper, 200lb. wire, to sealed pattern No. 217; (2) 5,500 insulators, No. 5, to sealed pattern No. 23. (3) 5,500 pins, insulator, wooden, to sealed pattern No. 116; (4) 3,000 tapes, copper, 200lb. wire, to sealed pattern No. 216; (5) 23 tons wire, hard-drawn copper, 200lb. per mile, to specification No. 3. Tender forms, specifications, etc., may be obtained at the Stores Branch, General Post Office, Melbourne, and at the Post Offices at Sydney, Brisbane, and Adelaide. Tenders to the Deputy Postmaster-General, Melbourne, by Aug. 20.

Gothenburg.—The Commercial Intelligence Branch of the Board of Trade are notified by his Majesty's Consul at Gothenburg that tenders are invited for supply of the electrical equipment for the Government power station at Trollhattan, comprising three electric generators for direct current, each of 350 kw.; one accumulator battery of 4,800 ampere-hours capacity; four three-phase generators, each of a maximum of 11,000 kilovolt-amperes; 12 transmitters, each of a maximum of 3,670 kilovolt-amperes; connections; regulators; and control tables. Sealed tenders, marked "Anbud a elektrisk utrustning for Statens kraftverk," should be sent to the Managing Director of the Royal Trollhattan Canal and Waterworks, Trollhattan, Sweden, by noon on Oct. 1 next. Tenders are binding until Jan. 1, 1908. Delivery is to be completed by Sept. 1, 1909. Further information may be obtained from the Managing Director, from whom a copy of the programme can be had against a deposit of 50 kronor, which will be returned on receipt of a tender in accordance with the programme.

RESULTS OF TENDERS.

Paisley.—Messrs. Bruce Peebles and Co. have received a repeat order from the Paisley Corporation for a 750-kw. high-tension alternator.

Victoria.—The Postmaster-General has accepted the tender of R. B. Hungerford, 163, Pitt-street, Sydney, at £716. 13s., for the supply and delivery of 2,000 relays.

Luton.—The Town Council have accepted the tender of J. Wilson and Co., 49, Lime-street, London, E.C., for the supply, delivery, and fixing of pipework, etc., at the generating station for £647. 5s.

Rochester.—The Town Council have accepted the tenders of Dick, Kerr, and Co. at £33,568. 17s. 5d. for permanent way, and at £3,417. 18s. for overhead equipment in connection with the tramways.

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Blackpool.—The tender of J. Foster and Sons, Soho Foundry, Preston, has been accepted for the supply and fixing of one new steel Lancashire boiler, 30ft. by 8ft. 6in., for the Electricity and Tramways Committee.

Ayr.—The Corporation have placed an order with the Paterson Engineering Co. for one Paterson combined exhaust heater, softener, and grease eliminator of 4,000 gallons hourly capacity, fitted with quartz sand filter.

Barnsley.—The Corporation have placed an order with the Paterson Engineering Co. for one Paterson combined grease eliminator and make-up softener of 3,500 gallons hourly capacity, fitted with quartz sand filter, for the electricity works.

Derby.—The following tenders have been accepted for the supply of small steam coal to the Electricity Department: Derby Coal Co., Derby, 4,000 tons; T. and G. Walker, Derby, 3,200 and 3,000 tons; Mapperley Coal Co., Derby, 3,000 tons.

London.—The tender of Shelby and Co., at £423. 10s., for the supply of oil tanks, filters, etc., and that of Spencer and Co., Melksham, Wilts, at £2,314, for the supply of coal and ash conveyors for the London County Council Greenwich electricity generating station, are recommended for acceptance.

London.—The London County Council have received the following tenders for the supply of materials for wiring and fitting the Stockwell, Forest Hill, Tooting, and Lewisham sub-stations:

General Electric Co., London*	£375	1	2
Edison and Swan United Electric Light Co., London	379	7	1

* Recommended for acceptance.

Birmingham.—The Corporation are having installed at their Summers-lane generating station a Paterson condensation water-purifier with quartz sand filters capable of removing all trace of oil from 350,000lb. of condensed steam per hour. This order is placed by Belliss and Morcom, who have had a Paterson grease eliminator in continuous operation at their Ledsam-street works for the last three years.

Stepney.—The following tenders have been received by the Borough Council for the supply and delivery of time switches for the year ended June 30, 1908:

Reason Manufacturing Co.*	£188	0	0
Venner and Co.	294	10	0
Johnson and Phillips	371	0	0

* Recommended for acceptance.

Stepney.—The following tenders have been received by the Borough Council for the supply and delivery of meter cases for the year ending June 30, 1908:

W. Badger*	£99	5	0
J. and W. Shale	118	17	6
J. Richmond and Co.	121	17	6
Buck and Hickman	132	5	0

* Recommended for acceptance.

Islington.—The Lighting Committee have reported to the Borough Council that they have ordered the necessary materials from Callender's Cable and Construction Co. in connection with street works necessitated by the reconstruction of tramways, at £182. 12s. 6d., which cost will be borne by the London County Council. They recommend the acceptance of the following tenders: Fraser and Fraser, repairs to boilers, £99; E. Le Bas and Co., repairs to pipes, £49. 9s. 6d.; J. Hopkinson and Co., for the supply of valves, £70. 11s.

Storage Batteries.—The D P. Battery Co. have during the past fortnight secured contracts for the erection of electrical storage batteries (over 1,300 cells of 1,270,000 watt-hours) at Fleetwood, Tadcaster, Ilford, Brechin, Montrose, and Alderley Edge, amongst other places, and have during the past month completed power installations at Southampton Docks for electric cranes; at Portsdown, Gosport, and Pontefract for electric tramways; at Letchworth (Garden City), Stratford-on-Avon, Mansfield, and several smaller contracts for the Admiralty and War Office.

Newport (Mon.).—The Electricity and Tramways Committee have accepted the following tenders for (1) low-tension switchboard; (2) two motor-alternators (direct-current to alternating-current single-phase); (3) one battery; (4) extensions to switchboard gallery; (5) cooling tower (steel); (6) battery reversible booster. W. Alger and Sons, Newport, switchboards; General Electric Co., Witton, alternators; Lancashire Dynamo Co., Manchester, booster; Worthington and Co., London, water-cooling tower; E.P.S. Co., London, battery; W. A. Baker, Newport, switchboard gallery.

London.—The London County Council have received the following tenders for electric lighting, etc., at the Central School of Arts and Crafts, Holborn:

Mercer, Rance, and Co., 301, Marylebone-road	£2,025	0	0
W. Barton and Sons, 11, Forrest-road, Edinburgh*	2,120	0	0
C. C. Pudney, 11, Guildhall-street, Bury St. Edmunds	2,480	0	0
Pinching and Walton 52, Cannon-street	2,496	14	6
Vaughan and Cook, 293 and 300, Goswell-road	2 525	0	0
Beaven and Sons, 27, Victoria-street	2,700	0	0
H. J. Galliers, 32, St. James's-street, Brighton	2,714	0	0
F. Suter and Co., 66, Berners-street	2.767	3	8
J. O. Grant and Taylor, 63, Queen Victoria-street	2,821	0	0
Cox-Walkers, North-Eastern Electric Works, Darlington	2,854	5	5
Aberdeen Electrical Engineering Co., 17, Belmont-street, Aberdeen	2,918	0	0
S. G. Cozens, 63, Queen Victoria-street	3,128	0	0
F. A. Glover and Co., Vine-street, Clerkenwell-road	3.150	0	0
W. G. Cannon and Sons, 107, London-road	3.199	10	7
D. Hulett and Co., 55 and 56, High Holborn	3.294	0	0
Barlow Bros. and Co., 237, Shaftesbury-avenue	3,466	0	0

* Recommended for acceptance.

Pontypridd.—The Urban District Council have received the following tenders for supply of feeder and distributor cables:

Lahmeyer Electrical Co., London, W.C. (accepted)	£2,998	4	6
W. T. Henley's Telegraph Works Co., London, E.C.	3,597	11	7
Johnson and Phillips, Charlton, Kent	3,666	8	4
Siemens Bros. and Co., London, S.W.	3,672	8	6
Callender's Cable and Construction Co., London	3,678	14	1
British Insulated and Helsby Cables, Prescot, Lancs.	3,707	10	6
W. T. Glover and Co., Manchester	3,711	9	0
Western Electric Co., London	3,757	16	5
St. Helen's Cable Co., Warrington	3,767	17	8

Stepney.—The following tenders have been received by the Borough Council for the supply of testing equipment:

A. W. Penrose and Co.*	£362	10	0
Union Electric Co.	393	3	0
Johnson and Phillips	415	0	0
W. White and Co.	423	3	6
Switchgear Co. (J. G. Statter and Co.)	427	2	6
Electric Construction Co.	446	0	0
Edison and Swan United Electric Light Co.	455	0	0
Pooley and Austin	468	9	0
Kelvin and J. White	539	16	5
British Thomson-Houston Co.	542	0	0
General Electric Co.	575	0	0

* Recommended for acceptance.

BUSINESS NOTES.

TRACTION.

Newcastle-on-Tyne.—The city engineer has been asked by the Tramways Committee to prepare a report and estimate of the cost of doubling the tramrails along North-terrace.

Taunton.—The Bill to confirm a provisional order of the Board of Trade relating to Taunton tramways extension has been read a second time in the House of Commons, and referred to a Select Committee for consideration.

Maxeville (Mourthe-et-Moselle).—An electric tramway is to be constructed between Maxeville and Champigneulles. The department of Meurthe-et-Moselle has been authorised to undertake the construction and working of the line.

Luton.—After long years of negotiation and debate the Town Council have decided definitely to accept the offer of Messrs. J. G. White and Co. to work a system of electric tramways for Luton. The agreement gives the Council the option of taking over the scheme after five or fifteen years.

Boulogne.—An electric tramway is to be constructed in the department of the Pas-du-Calais, between Boulogne and Outreau. The Boulogne Electric Lighting Co. have been authorised to add to their concession for the distribution of electricity that of constructing and working the aforenamed line of tramways.

Newport.—The third annual report of the Corporation tramways and electricity undertaking, issued on Tuesday, shows that the tramway undertaking has produced satisfactory financial results. The receipts for the past year were £33,388, compared with £31,244 in 1906, and 7,760,404 passengers were carried.

York.—A meeting of the York Tramways Committee was held on Tuesday night, Alderman Wragge presiding. A report was presented by the electrical engineer as to the capacity of the plant in relation to tramways, and it was ultimately decided that, before taking any further steps, all the information on the subject should be circulated among the Council.

London Underground Electric Railways.—An illustrated booklet has been issued showing the way to the numerous pleasure resorts of London by the tubes, or by the District Railway and the London United Tramways working in conjunction with the tubes. Copies of the booklet will be sent on receipt of a postcard by the Passenger Agent (Tube Railways), 75, London-road, S.E.

Accrington.—The borough engineer reporting on the work of electrification of the tramways, states that serious delay has been experienced in obtaining material for the overhead work, but this is now coming to hand. Negotiations are being conducted with Haslingden Town Council with reference to an arrangement for the through running of the cars.

Egypt.—The British Consul at Alexandria states that an extension of the tramways, which already knit up the eastern suburbs of Alexandria, to Dekhela, a point some 12 miles westward, where it is proposed to build a casino and summer residences, is under consideration. It is further proposed to carry the lines along the quays and to the Nouzha Public Gardens, which have recently been renovated by the municipality.

Hull.—The Tramways Committee have decided to recommend the City Council to seek powers during the next session of Parliament for extensions of tramways as follows: Beverley-road, from present terminus to Inglemire-lane; Cottingham-road, from Newland-avenue to first entrance to Newland Park; Spring-bank, from cemetery gates to a point near Chanterlands-avenue; from Queen Victoria-square to Paragon Station.

Blackburn.—A trial run was made last week with a new type of car, of which half a dozen have been obtained by the Corporation for general use on the borough lines. Considerably lighter than the cars hitherto in use, they have no upper deck, but will accommodate 38 passengers, and are divided into three compartments, with special seats for smokers. Adequate ventilation is secured by windows in the arched roof of the cars.

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Leeds.—The Leeds City Council have before them a recommendation of the Tramways Committee to the effect that, subject to the necessary powers being obtained, and to the District Councils of Rawdon, Yeadon, and Guiseley jointly agreeing to contribute £400 a year towards the cost of the maintenance of the roadway for a period of 11 years, the Council shall agree to extend the Leeds tramways from Horsforth to the three places named.

Traction in Germany.—U.S. Consul J. I. Brittain, of Kehl, Germany, advises that a new electric railway has just been opened for traffic from the Alsatian town of Munster to the Schlucht, the summit of the mountains dividing Germany and France. This 6·7-mile line was built at a cost of £57,000, and connects the Schlucht with a similar line extending to Gerardmer, France. The electric omnibus is killing the livery business in many of the towns of Alsace-Lorraine and Baden.

Derwent Valley Light Railway.—The Riccall Rural District Council, who, jointly with the Escrick Rural District Council, are promoting the light railway which it is proposed shall commence at Cliffe Common, near Selby, and run on to Stamford Bridge, have received intimation that the draft order has been amended, and will be issued in a short time. The Board of Trade have endeavoured to find out a way by which the scheme will not result in any financial loss to the Councils, while the securities to the landowners are also to be slightly altered.

Railways and Competition from Electric Tubes.—In calling attention to the large decrease of traffic in the London area, the chairman of the South-Eastern Railway Co. said that the electrification by the London County Council of tramways in the Brixton, Camberwell, and Clapham districts had drawn away a large number of passengers from the trains. He was glad to note that the tube railways had increased their fares, and he expressed the hope that the London County Council would revise their fares, so that other forms of locomotion might have some chance in the public favour.

Edinburgh.—The *Financial Times* is informed by its Edinburgh correspondent that a proposal has been made by a syndicate to buy out the Edinburgh and District Tramways Co., to electrify the lines, and to take them over on a 60 years' lease. The syndicate is prepared to pay to the Town Council the whole of the capital expenditure on the tramways, to come to an arrangement which will be satisfactory to the directors and the shareholders, to convert the whole system on the overhead electric principle and to add 10 or 12 miles to it. The proposed 60 years' lease is stated to be out of the question.

Wolverhampton. — The Tramways Committee of the Wolverhampton Town Council recommend that a tramway be constructed from Queen-square *via* Worcester-street to Penn Fields on the Lorain system. Important public improvements are to be made in Queen-square, Victoria-street, and Worcester-street, and it is believed that there will be a great demand for a tram service. Application is to be made to the Board of Trade for consent to any alteration to the original plan as to turnouts and other matters. Tenders are to be invited for the construction of the permanent way. The estimated cost is set down at £18,300.

Middlesex Light Railways.—Sir Francis Cory Wright, Bart., drove the first car (previous to public traffic) over a further section of the county of Middlesex light railways on July 31. The section is an extension of the portion of the county of Middlesex light railway system passing through the districts of Wood Green and Southgate. The portion opened extends to the Green Dragon Hotel, Green Lanes, Southgate, and forms the opening of another stage of the system towards Enfield, which it is hoped will be reached by a further extension at no very distant date. Extensive road widenings to a width of 60ft. throughout have formed part of the contract for the works, which have been carried out under the direction of Mr. H. T. Wakelam, M.I.C.E., the county engineer.

Liverpool.—The Tramways and Electric Power and Lighting Committee recommend that the sum of £500 be paid to the legal personal representatives of the late Mr. C. R. Bellamy, general manager of the Corporation tramways, in consideration of their granting to the Corporation the full right for all time to manufacture, use, and apply the whole of the patents belonging to the late Mr. Bellamy, and in full satisfaction of any claim they may have against the Corporation in respect of the manufacture and use by the Corporation of articles manufactured by the Corporation under the said patents, this arrangement to be embodied in an agreement to be prepared by the town clerk, and that, if required, the fees for renewing the lamp patents, amounting to £96. 10s., be paid by the Corporation.

Continuous-Current Traction.—An Austrian contemporary presents a table of the most important continuous-current railways in operation, from which there appears a tendency to employ high tensions. The first line to employ continuous current was the line at the Berlin exhibition of 1879, with a tension of 150 volts. The tension employed on the La Mure St. George is 1,200 volts, and on the trial lines of the Vienna Metropolitan Railways the tension is 1,500 volts. The longest continuous-current line yet built is the Toledo-Indiana, in the United States, which is 200 km. in length, and was opened last year. Our contemporary concludes from this that the system of traction by continuous current is far from being abandoned, and that it will continue to hold its own against all other systems.

London Traffic Conference.—In connection with the recently-constituted London Passenger Traffic Conference, a meeting of representatives of railway, omnibus, and tramway companies, carrying exclusively passenger traffic in London, was held on Monday, under the presidency of Sir George Gibb, chairman of the Metropolitan District Railway. The proceedings were private, but it is understood that it was decided to undertake an analysis of the returns of the various routes, section by section, with a view to ascertaining what changes are desirable with a view to putting an end to the unremunerative fares at present in operation. Several routes were selected for examination, and a small committee was appointed for the purpose. The following are the railway companies which have joined the conference: Metropolitan, Metropolitan District, Central London, North London, Great Northern and City, City and South London, Baker-street and Waterloo, the Great Northern, Piccadilly, and Brompton, and the Charing Cross, Euston, and Hampstead. In addition, the London United Tramways Co. and several omnibus companies have identified themselves with the conference.

Steamship Propulsion.—Owing to the advance of the steam-turbine, the question of propulsion is prominently in the minds of shipbuilders, shipowners, and the general public whenever a new steamer is announced, and although some companies have adopted the turbine system in its entirety, a general agreement has not yet been arrived at to dispense with the system of reciprocating engines. It was recently announced that Mr. Ismay had placed an order with Messrs. Harland and Wolff, on behalf of the Dominion Line, for a large passenger steamer to be constructed at Belfast for the trade between Liverpool and Canada, and later it was announced that this steamer would be quickly followed by another. It is of interest to learn that in the first of these steamers a new principle in marine engineering has been decided upon in a combination of turbine machinery and reciprocating engines. The proposal which has just been adopted is to fit two sets of quadruple-expansion engines balanced by the builders' usual system with the addition of one low-pressure turbine. Each will be quite independent of the others, and will have its own shaft and propeller, so that the steamer will have three distinct installations of machinery and three separate propellers. It is expected that this combination will have many advantages for ocean liners embracing the merits of quadruple engines carrying a high steam pressure, and the benefit obtainable from a greater expanse of steam in a low-pressure turbine.

Tramway Accidents.—An electric tramcar belonging to the Sunderland and District Tramcar Co., while going down a steep hill at Silksworth on Monday night, got out of control and dashed into a stone wall at the bottom of the hill. The car went right through the wall, and the forepart became embedded in a plantation. Nine passengers and the motorman received injuries of a more or less serious nature. About two hours later another car got out of control while descending the same hill, and dashed into the wreckage of the first car. The accidents are supposed to be due to the slippery state of the lines.—An alarming tramway accident occurred in Bradford on Wednesday morning, in which many persons were seriously injured. A car was proceeding down Church Bank, the steepest gradient in the city, when the trolley pole left the cable overhead, and the driver was thus unable to apply the electric brakes, which are necessary at this point, with the result that the car dashed down the Bank, left the metals at the bottom, and, crashing into a warehouse, overturned. There were 12 passengers in the car at the time, and all were more or less seriously injured, while the car was completely wrecked.—On Wednesday an Exeter Corporation electric tramcar carrying 13 passengers got out of the driver's control, and, leaving the metals, narrowly escaped collision with the Great Western Railway offices. The car was disabled, and several passengers received minor hurts, but the driver was the only one sufficiently injured to be taken to the hospital.

Birkenhead.—The report of the Tramways Committee for the year ended March 31 last shows that the income has reached a total of £55,408, an increase over the previous year of £812, but there has been an almost like increase in operating expenses, which were £33,710, or £800 more than in the year before, the gross surplus being £21,697. Of that interest and sinking fund charges, income tax, and other items absorbed £21,380—or £593 more than in 1906—leaving a net profit of £317, and this has been placed to the renewals fund, as in former years, which fund now amounts to £11,024. Mr. Wyld states that, although the gross income has increased by £812 on last year, the net profit had fallen from £898 to £317. He explains that the increase of £800 in working expenses is due partly to an increase of £480 in the upkeep of permanent way and partly to power costing £371 more, that being entirely due to the higher price of coal. The extra £593 for interest and sinking fund charges is mainly accounted for by the doubling of the line between Central Station and Whetstone-lane, which has, however, greatly increased the efficiency of that portion of the system. The traffic expenses have increased by £30, although 5,664 additional car miles have been run, a saving of ·105d. per car mile having been effected. The increased holiday allowance to workmen has cost £180, but there was a saving of £112 on overhead line work. There has been an increase on all routes except the New Ferry, which shows a decrease of £971. The introduction of 1½d. stages have been productive of good results. The issue of scholars' tickets at 18 for 1s. commenced in November, and by the end of March 29,484 such tickets had been sold and £81 taken in cash. The service has continued to be wonderfully free from serious accidents, the only case of importance during the year being that of a boy who fell under the hind wheel at the side of one of the cars. Six people were picked up by the lifegards on the cars, and found to be uninjured. Altogether, 11,696,691 passengers have been carried, an increase of 341,408, and 1,324,743 car miles were run, an increase of 5,669 miles, but 23,338 fewer units of electricity had been used. The average traffic per car mile was 9·82d., against 9·70d., and the average total revenue per car mile was 10·03d., against 9·93d. The average working expenses per car mile, including power costs, was 6·10d., against 5·98d. Each passenger paid on an average 1·11d., against 1·15d., and 8·82 passengers were carried per mile, as compared with 8·37, whilst the average journeys per head of the population was 100·83, as against 95·27. Towards the reduction of the capital debt of £357,991 there has been paid £50,964, and £5,740 capital expenditure was incurred during the year. The average fare charged per mile to ordinary passengers was ·64d., and to workmen ·40d.

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LIGHTING AND GENERAL.

Gloucester.—The electric mains are to be extended in Bristol-road at an outlay of £45.

Islington.—The Borough Council have abandoned the extension scheme, which was to cost £21,000.

Change of Address.—Messrs. J. P. Beckett and Co. have removed from Chantry-lane to 102-4, Victoria-street, Grimsby.

Hackney.—The London County Council have granted a loan of £14,000 for an extension to the electric lighting undertaking.

Hammersmith.—The London County Council have granted a loan of £11,145 to the Borough Council for electric lighting purposes.

Poplar.—The London County Council have granted a loan of £5,600 to the Borough Council for extensions to the electricity business.

Aston Manor.—A Local Government Board inquiry is to be held on the 8th into an application by the Council for sanction to borrow £17,519 for an electricity supply.

Peterborough.—A Local Government Board inquiry is to be held on Aug. 8 into the application of the Council for sanction to a loan of £3,000 for electricity extensions.

Walton-on-Naze.—At the last meeting of the Urban District Council it was decided to accept the Coast Development Co.'s offer to light the Council-chamber with electric light.

British Electric Traction Co.—The directors of the British Electric Traction Co. have declared the half-yearly dividend on the preference shares at the rate of 6 per cent. per annum.

Westminster Electric Supply Co.—The directors have declared an interim dividend for the half-year ended June 30 at the rate of 10 per cent. per annum, less income tax, payable on Sept. 1 next.

Fulham.—The Corporation have decided to extend the electricity mains to 6, Beaumont-crescent at a cost of £17. 10s. It has been decided to purchase two transformers for sub-stations at a cost of £131.

Plant Electro-Culture.—At the meeting of Fellows of the Royal Botanic Society of London, which took place at the Botanic Gardens, Regent's Park, last Friday, Mr. B. H. Thwaite, A.M.I.C.E., read a paper describing the new experimental installation now established in the society's gardens.

Stretford.—A Local Government Board inquiry has been held into the application of the Urban District Council for sanction to the borrowing of £53,460 for purposes of their electricity undertaking. After hearing the evidence the inspector adjourned the inquiry until the first week in October.

Release of Trustee.—The *London Gazette* announces that H. L. Howell, 132, York-road, Westminster Bridge, S.E., has been released from trusteeship in the estate of A. Parker, Jones and C. Hellyar, electrical engineers and contractors, and trading as A. Parker and Co. at 130. Upper Richmond-road, East Sheen, Surrey.

Southwark.—At the last Council meeting the Electric Light Committee reported having received from the borough treasurer the accounts of the electric light undertaking for the year ended March, 1907, and had given instructions for copies to be circulated. Councillor Wilson said the gross profit of the undertaking was £5,276.

Londonderry.—At the committee of management of the Londonderry Lunatic Asylum held at Coleraine on the 26th ult., Colonel J. J. Clarke, D.L., presiding, the specification submitted by Mr. R. V. Macrory, A.M.I.E.E., for spare dynamo and other electric plant at Gransha were submitted, and it was decided to consider tenders at the September meeting.

Coventry.—The accounts of the Corporation electricity department for the past year show a net profit of £5,114. 14s. 1d. It is proposed to use a thousand pounds of this in relief of rates, and to place the balance to reserve. The profit is the largest in the history of the undertaking. A considerable revenue is derived from the letting out of electric motors on hire.

Metal-Filament Lamps.—The Deutsche Gasglühlicht Aktiengesellschaft ask us to state that, pending the erection of a factory for the manufacture of metal-filament lamps in England in conjunction with the General Electric Co., of 71, Queen Victoria-street, London, E.C., they have handed the sole sale of their Osram (tungsten) lamp for Great Britain and colonies to that company.

Oldham.—At the last meeting of the Corporation Electricity Committee the engineer's report showed that the units sold during the fortnight totalled 29,048 for lighting and power and 143,330 for traction, a total of 172,378 against 148,293 in the corresponding fortnight last year. The lamps, etc, connected to date were equivalent to 99,477 lamps of 8 c.p., an increase of 438 on the fortnight.

Business Amalgamation.—We are asked to state that with a view to facilitating the amalgamation of the two businesses, and also for family reasons, Messrs. Rownson, Drew, and Co. and the Clydesdale Ironfoundry Co. have been converted into a limited liability company under the registered name of Rownson, Drew, and Clydesdale, Limited, with registered offices at 225, Upper Thames-street, London, E.C.

Metropolitan District Railway Co.—The dividend announced for the past half-year on the 4 per cent. guaranteed stock is at the rate of 1⅞ per cent. per annum. For the first half of 1906 the dividend was at the rate of 1½ per cent. per annum, in respect of which period £49,359 was charged to capital account, the net earnings to June 30, 1906, having been £39,984 short of rental charges and debenture interest.

Stepney.—The Council have passed a resolution to proceed with the development of the Blyth's Wharf scheme. The borough electrical engineer has been instructed to execute the work upon whichever method may be agreed upon at the Princes-street Synagogue, conditionally upon the said consumer entering into the necessary agreement to be prepared by the town clerk, and that, should the work be executed upon the hire-purchase basis, the expenditure be met out of the funds of the electricity undertaking.

Dartford.—At the last meeting of the Urban District Council the Electric Lighting and Tramways Committee reported that Messrs. Fuller, Wigram, and Co., of London, had been retained to inspect and value the electric lighting undertaking in connection with the increased assessment. They had also been engaged to advise on the lives of the various component parts of the undertaking, with a view to arriving at the amount which should be set apart each year for depreciation. The fee for the two matters has been fixed at 25 guineas. The report was adopted.

Platinum Substitutes, Limited.—The opening of this firm's works at Shoreditch took place last Friday by the Lord Mayor of London. The company has taken up the invention of Mr. George Calvert, who has hit upon the ingenious expedient of enamelling strips of copper wire in such a fashion as to enable the wire to be hermetically sealed into the lamp without oxidisation. The process of enamelling these strips is exceedingly simple, and offers a great field for the employment of crippled or juvenile labour under the healthiest and most satisfactory conditions.

Liquidations.—According to the *London Gazette*, the Brockie-Pell Arc Lamp, Limited, has been wound up voluntarily, and Mr. R. Warner, 10, Walbrook, E.C., and Mr. D. Watson, 102, Charing Cross-road, London, W.C., appointed liquidators. A general meeting of the members of the London Electrical Syndicate, Limited (in liquidation), will be held at 54, New Broad-street, London, E.C., at 10 a.m. on Aug. 30 for the purpose of having an account laid before them, showing the manner in which the winding up has been conducted and the property of the company disposed of.

Grimsby and Mansfield.—A Bill to confirm certain provisional orders made by the Board of Trade under the Electric Lighting Acts, 1882 and 1888, came on the 25th ult. before an unopposed committee of the House of Commons. The necessary formal proofs were given, and the Bill was allowed to pass the committee stage. In due course it will be reported to the House for third reading. Among the provisional orders included in the Bill were two authorising the Corporation of Grimsby to extend their electric supply, and also enabling the Corporation of Mansfield to extend their supply to the urban district of Mansfield Woodhouse.

Belfast.—Happily there was no need for the precautions taken to avert the threatened cessation of electric power in Belfast, where the labour war is still in full swing. The coalmen went to work last Saturday, and numerous works which had closed down through want of coal resumed work. At the electric station, where the stock was dangerously low, a tramline was laid so as to tap the railway, which passes closely, and from which coal could have been taken. Hardly had this peril been passed, when a number of motormen and conductors threatened to go on strike in connection with the reinstatement of some dismissed men, but this peril was also averted. The constabulary are going on strike on Saturday if their demands are not granted, so that the citizens of Belfast are having a lively time of it all round.

Luton.—At the last meeting of the Council the electrical engineer reported that since June 24 48,251 units had been generated, an equivalent of 142 8-c.p. lamps and two motors of 8 h.p. connected, making a total of 403 consumers with 22,958 lamps and 191 motors of 1,149 h.p. The units generated showed an increase of 138 per cent. over the number generated during the corresponding period of last year, and at the present time applications were in for over 900 additional lamps and 130 h.p. in motors. The report was received as being satisfactory. The electrical engineer reported further upon the tenders received for the supply of coal, and it was resolved that the tender of Messrs. Godden and Rudd be accepted for the supply and delivery of 500 tons of coal for a period of 12 months ending June 30, 1908, at the prices following—viz., 11s. 7d. per ton up to Dec. 31 next, and 11s. 1d. thereafter until the expiry of the contract. The electrical engineer reported that he had received applications for the supply of current to properties situate in the Dunstable and upper portion of Westbourne roads. It was decided that the mains be extended as may be necessary at an estimated cost of £446.

Bristol.—At the last meeting of the Electrical Committee the secretary reported the receipt of three supplemental sanctions from the Local Government Board to the borrowing of £2,335, items deducted by the Board from the estimate submitted to them in September last, the principal amount being in respect of the wages paid to permanent employés in respect of time they were engaged on capital work, which the committee contended, and successfully, was a proper charge against the loan account. A communication from the Bristol Ratepayers' Protection Association was received asking to be allowed to inspect the report from the Local Government Board which accompanied their sanction to the last application for a loan. The committee find that no "report" was received, the sanction bring accompanied by a letter, and as the points of difference between the Local Government Board and the Electrical Committee are still under discussion they are not prepared to accede to the request, but in due course they propose to report to the Council on the whole matter. Applications for the reduction in the price charged for current for electric sky signs having been from time to time received, the committee have given the matter consideration, and, finding that other corporations and companies give a special rate of charge for signs, etc., they decided to reduce the charges from 4½d. to 3½d. per unit. Short extensions of the mains were authorised at River-street and Pile-street.

Middlesbrough.—The council of the Middlesbrough Chamber of Commerce at their last meeting decided to support the protest that is to be made at the Liverpool meeting of the Associated Chambers against the principle involved in the new tariff of the National Tele-

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phone Co. The council consider that the proposed scale of charges for all calls over and above the very small free minimum of 500 in a limited area is excessive, and directly opposed to the interests of trade and to the convenience of the public. An instance was given where it was calculated that the charges that now amount to £9 per annum would reach over £40. The Chamber was asked to oppose Clause 7 of the Patents and Designs Bill, which proposes to give to the controller at the Patent Office power to refuse altogether the issue of a patent if, in his (the controller's) opinion, the applicant's invention has been wholly anticipated. The council could not see their way to oppose the Bill, as it was considered that the measure would only carry out what chambers of commerce had for years been advocating. It was held that the Government Patent Office should not take an inventor's money and let him find out for himself that his invention had been anticipated and was of no value to him. The Associated Chambers of Commerce reported that a deputation had waited on the Home Secretary to urge that it is desirable that an official inquest should be made by the coroner into the origin of all serious fires. The deputation sought the extension to the whole country of the system now existing in the city of London. It was pointed out that the public have to pay for fraudulent fires and claims, and that if there were no such claims fire insurance premiums would probably be 20 per cent. less than at present.

Haverton Hill.—A special meeting of the Billingham Parish Council to consider the question of the public lighting of Haverton Hill and Port Clarence was held at the Church Schools, Haverton Hill, on Tuesday. The report of the committee appointed in the matter was read as follows: "After full and careful consideration your commitcee recommend doing away with the present system of lighting by means of oil lamps, and substituting a system of lighting by electricity—first, because the existing method is costly and inefficient; second, because gas was found to be unavailable when the Council inquired into the matter two years ago; and, third, because electricity is available, and would be less costly and more efficient than either gas or oil. The Cleveland and Durham Electricity Co. have furnished estimates based on measurements taken from Ordnance sheets, which show that the capital outlay will be £1,500, and they would be prepared to supply alternating current at 250 volts for public lighting purposes at the rate of 1½d. per unit, the points of supply being the sub-stations at Casebourne's Cement Works and Anderson's Foundry. This works out at about 15s. per lamp per annum, the summary of the cost being as follows: capital outlay, £1,500, redemption in 15 years, and 4 per cent. interest, annual charge £132; 100 lamps at 15s. a year, £75; attendance, say £1 a week for six months, £26; upkeep and sundry expenses, £25—total annual cost, £258. This estimate, your committee is satisfied, would be the maximum cost, and may well actually work out at a less amount. The present lighting of Haverton Hill and Port Clarence is costing £329 a year; thus by the adoption of electric lighting a considerable saving would be effected, and the district would be lighted. At the end of 15 years, when the capital outlay has been cleared, there would be a further saving of over £100 a year. It is understood that the electric power company have not power to supply electricity for lighting purposes, and this authority would, therefore, have to take current in bulk. This raises the question of the supply of current for private lighting, and your committee are not in a position to formulate any proposal hereon, inasmuch as the powers are in the hands of the Rural Council. This matter must be left over for ulterior consideration, in the event of it being decided to adopt electric lighting. If, however, current can also be supplied to private consumers, the cost of public lighting would to some extent be reduced, on account of the increased consumption."

Walthamstow.—Some time ago the Walthamstow Urban District Council sought permission of the Local Government Board to borrow £26,395 for purchasing electrical plant at the generating station. At the inquiry on April 30 this sum was objected to as being excessive, and the electrical engineer was asked to bring up a reduced estimate. As a result the Council have applied for sanction to borrow £17,349 for plant at the electrical station. They also asked permission to borrow £1,278 to defray excess expenditure in connection with their refuse destructor, and £126 for the provision of a weighbridge and shed at the electricity works. On Wednesday in last week Mr. H. R. Hooper held an inquiry concerning the revised application. The Clerk explained that the electrical engineer had gone into the matter and reduced the estimate. They were to have two instead of three boilers, the size of the economiser had been reduced, and a set of 600 kw. had been left out. Alterations in the tenders had been made, which now amounted to £15,573. The rest of the amount was to be spent in building alterations. It was imperative to put this plant in because of the increased demand. In December, 1904, the maximum load was 726 kw.; in December, 1905, it was 1,104 kw.; and last December, 1,250 kw. The engineer estimated this year the maximum load would reach 1,400 kw. The number of units generated during the last week showed an increase as compared with the corresponding week last year. Since April many applications had been received for light. The additional plant was also required because of an injunction against the Council to abate a nuisance caused by the fumes from the gas-engines. Mr. Spurr (electrical engineer) then went into the details of the scheme. The plant would not be put in till Christmas. It would not be safe to go on without the additional plant. The Inspector asked if the gas plant first put in had been up to the standard, would it have been necessary to come for this loan? Mr. Spurr said that it would have been sufficient if the gas plant was as reliable as steam plant. This was the only large gas plant in the country. These gas-engines were put in before he came to the station. They were, he believed, sold for a capacity of 1,600 kw., and so would not work 1,800 kw. as now required. If the plant had been as required, there would have not been the necessity for the loan. They would get better results from a combined steam and gas plant. The Inspector asked whether the gas-engines were such as the engineer would accept. Mr. Spurr said he would accept the engines such as they were at the present, but he should not accept the dynamos. The Inspector said that he should adjourn the inquiry so far as these engines were concerned for the attendance of the consulting engineer and the late electrical engineer to the Council. One of the reasons given for this new loan was because of these engines, and it was very necessary those two gentlemen should be there.

PROVISIONAL PATENTS, 1907.

JULY 22.

16705. Improvements in high-tension distributors for use in connection with the electric ignition systems of internal-combustion engines. The Electric Ignition Company, Limited, and Frederick Harold Hall, 24, Temple-row, Birmingham.

16710. Improvements in dynamo-electric machines. Bruce Peebles and Co., Limited, and Jens Lassen la Cour, 34, Castle-street, Liverpool.

16719. Improvements in lamps, especially applicable for signalling purposes and as searchlights. George Forbes, 24, Southampton-buildings, London.

16731. Improvements in and relating to conduits, particularly conduits for electric tramways. Walter Manders, 70, Chancery-lane, London.

16732. Improvements in and relating to conduits, particularly conduits for electric tramways. Walter Manders and George Hodge, 70, Chancery-lane, London. (Complete specification.)

16735. Improvements in or relating to the electrolytic or chemical deposition of metals, or for making metallic articles by electro-chemical deposition, and apparatus therefor. Herbert Champion Harrison, Birkbeck Bank-chambers, Chancery-lane, London.

16736. Improved method of melting or fusing glass or like vitreous material around and on to electric conductors. Charles Orme Bastian, George Calvert, and James Hutchinson Sanders, Birkbeck Bank-chambers, Southampton-buildings, London. (Complete specification.)

16745. Improvements in wall cabinets for electrical apparatus. Ernest Ross le Manquais, 18, Southampton-buildings, London. (Complete specification.)

16763. Improvements in and relating to electric heating apparatus. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

16766. Improvements in and relating to electric arc lamps. Julius Heinrich Kaesen and Ludwig Jacob Scheidel, 77, Chancery-lane, London. (Complete specification.)

16778. Improvements in printing telegraph receivers. John Edward Wright, 2, Norfolk-street, Strand, London. (Complete specification.)

16780. Improved apparatus for magnetic separation of ore. Metallurgiska Patentaktiebolaget, Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Patents Act, 1901, July 28, 1906, being date of application in Sweden.) (Complete specification.)

16781. Improved method of regulating the electric potential of a network supplied by a generator driven at very variable speeds and apparatus therefor. Otto Schaller, Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Aug. 11, 1906, being date of application in Germany. (Complete specification.)

JULY 23.

16779. Improved accumulator. Charles Henry Montgomery, 3, Gunner-street, Portsmouth, Hants.

16813. Improvements in electric switches. August Eckstein and Arthur Cecil Heap, Waverley Mills, St. Simon-street, Salford.

16837. Electric automatic weigher. Harold Alexander Danne, 79, Charlotte-street, London.

16847. Improvements in electrical therapeutic apparatus for giving high-frequency currents. Marconi's Wireless Telegraph Company, Limited, and Frederick Charles Prentice, 24, Southampton-buildings, London.

16854. Improvements in and relating to telephonic apparatus. Victorien Tardieu, 118, Holborn, London. (Date applied for under Patents Act, 1901, Jan. 12, 1907, being date of application in France.) (Complete specification.)

16862. Improved means for automatically operating gas or other valves or electric switches at predetermined times. Arnold Hare, 111, Hatton-garden, London. (Complete specification.)

JULY 24.

16910. Improvements in non-arcing fuse devices. Alfred Herbert Mayes, The Cottage, Hassocks, Sussex.

16911. Improvements in or relating to electric ignition apparatus for internal-combustion engines. The Electric Ignition Company, Limited, and Frederick Harold Hall, 24, Temple-row, Birmingham.

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16912. Improvements in or relating to magneto-electric ignition apparatus for internal-combustion engines. The Electric Ignition Company, Limited, and Frederick Harold Hall, 24, Temple row, Birmingham.

16942. Electric current generating and motive power machine. Walter Shelverton Frost, 135, High-street, Homerton, London.

16952. Improvements in or relating to electric welding. Oscar Kjellberg, 111, Hatton-garden, London. (Complete specification.)

16956. Improvements in and connected with arc lamps. Herbert Edward Angold and the Maxim Electrical Company, Limited, 18, Southampton-buildings, London.

16968. Improved electrical resistance device for use with lamps and for other purposes. Harold Sheen Martin, 6, Lord-street, Liverpool.

16974. Improvements relating to direct-current electric motors. Société Anonyme Westinghouse and Raoul Brun, Westinghouse Building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, July 26, 1906, being date of application in France.) (Complete specification.)

16984. Improvements in magnetic clutches. Henry Leitner, 4, South-street, Finsbury, London.

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Aug. 15.)

1906.

11772. Safety cut-out for electric motors and the like. Moore and Hirst.

11853A. Means for compensating load variations in electrical installations. Johnson. (Felten und Guilleaume-Lahmeyerwerke Akt.-Ges.) Date applied for under Rule 5, Patents Rules, 1905, May 21, 1906.)

12183. System of wireless telegraphy. Gardner.

14163. Electric traction systems. Johnson.

14429. Electrical resistance furnaces. Cornelius and Fehn.

16582. Fittings for electric lamps. Boult. (Baron.)

16627. Electrical harmonic signalling systems, particularly applicable to telephone systems. Wheatley. (Firm of C. Lorenz.)

17272. Apparatus applicable to electric signalling, and especially applicable for use in fire-alarm installations. Walker.

18609. Electrodes for use in the treatment of gases by arc discharges. Pauling.

20328. Process of charging lead-peroxide-zinc storage batteries. Ziegenberg.

21071. Vapour-electric devices. Le Tall. (Cooper Hewitt Electric Company.

22807. Ligneous separating diaphragms for electric accumulators. Leitner.

25306. Electric cables. Siemens Bros. and Co. and Dieselhorst. (Siemens und Halske Akt.-Ges.)

26454. Spring fuses for electrical work. Turner.

26537. Regulating electric motors. Sefton-Jones. (Stebbins.)

27060. Means for operating composing and type-setting machines by means of electric currents controlled by register strips. Drewell.

27956. Transmitting apparatus for wireless telegraphy. Pedersen. (Date applied for under International Convention, Dec. 8, 1905.)

28848. Automatic voltage regulator for dynamos. Neeley.

28849. Automatic regulator for direct-current dynamos. Neeley.

1907.

1333. Electric traction systems. Potterat.

5025. Current collector for use in stud-contact systems of electric traction. Grilliths and Bedell. (Date applied for under International Convention, March 3, 1906.)

5890. Means in connection with electric coils having self-induction for shortening the time of energising and de-energising such coils. Felten und Guilleaume-Lahmeyerwerke Akt.-Ges.) (Date applied for under International Convention, April 20, 1906.)

6358. Electric terminals or couplings. Arnold and Bumpsteed.

6502. Process for the regeneration of the electrolyte employed in the extraction by the electrolytic process of copper from old bronze and bronze waste. Thirot and Mage (called Nouguier). (Date applied for under International Convention, March 26, 1906.)

6966. Direct-current dynamo-electric machines provided with auxiliary poles. Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, March 29, 1906.)

6555. Electric current interrupters. Soc. des Garages Kriéger et Brasier. (Date applied for under International Convention, April 26, 1906.)

9143. Electricity meters. Isaria Zähler Werke Ges. (Date applied for under International Convention, April 27, 1906.)

10356. Electrical commutator machines. Schmidt. (Date applied for under International Convention, May 3, 1906.)

13071. Electrode for searchlights. Geb. Siemens und Co. (Date applied for under International Convention, June 8, 1906.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	–	⅛-⅜
—— Ord., 1 125,000	1	..	¼-½
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	–	9/16-11/16
British Aluminium Co., Ordinary, 2,001-40,000	5	..	4¼-5¼
—— 7 per cent. Cum. Pref., 1-40,000	5	..	5-5⅛
—— "A" 6 per cent. Cum. Pref., 1-20,000	5	..	5-5⅛ xd
—— 4 per cent. Funding Certificates, 1-20,000	5	..	3⅞ 4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	100-103
—— 5½ per cent. Loch Leven Deb. (Reg.), Red., 1-3,000	100	..	98-101
British Insulated and Helsby Cables, Ord., 1-100,000	5	–	6¾ 7¼
—— 6 per cent. Cum. Pref., 1-100,000	5	–	5⅞ 6¼
—— 4½ per cent. Mortgage Debentures	100	–	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	–	87-91
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	5	..	1-1½
—— 4 per cent. Mortgage Debenture Stock	100	..	58-63
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	1-1⅜
—— Non. Cum., 6 per cent. Pref.	2	..	1⅜ 1½
—— 4½ per cent. 1st Debenture Stock	100	..	88-91
—— 4½ per cent. 2nd Debenture Stock	100	..	7 -74
Callender's Cable, Debentures	100	–	105½-107½
—— Ordinary	5	–	9½-10½
—— 5 per cent. Pref.	5	..	5⅜-5⅝
Consolidated Electrical Co., Ordinary, 1-110,000	1	..	7/16-9/16
Crompton and Co.	5	..	1⅝-2⅜
—— 5 per cent. Debentures	100	–	96-99
Dick, Kerr, and Co., Ordinary, 1 260,000	1	..	1⅜-1⅝
—— 6 per cent. Cum. Pref., 1-305,000	1	..	1-1⅛
—— 4½ per cent. Debenture Stock, Red.	100	..	101-104
Edison and Swan United, "A" Shares, 1-89,261	5	–	1⅝-1⅞
—— "A" Shares, 01-017,139	5	–	2⅛-2⅜
—— 5 per cent. Debentures	100	–	84-92
—— 4 per cent. Deb. Stock, Red.	100	–	83 85
Electric Construction, Nos. 1 to 112,100	2	–	5/16-7/16
—— 7 per cent. Cumulative Pref.	2	–	1⅛ 1⅜
—— 4 per cent. Perp. 1st Mort Deb.	100	–	77 81 xd
Electrolytic Alkali Co., Ordinary, 1-202,218	1	..	⅛-⅜
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	–	—
General Electric Company (1900), 5 per cent. Cum. Pref.	10	–	8-8½
—— 4 per cent. 1st Mort. Deb. Stock	100	–	82 86
W. T. Henley's Telegraph Works, Ordinary	5	–	11¼-12½
—— 4½ per cent. Preference	5	–	⅝-¾
—— 4½ per cent. Debentures	100	–	105½ 107½
India Rubber, Gutta Percha, and Telegraph Works	10	–	5 6
—— 4 per cent. Debentures	100	–	97-99
National Electric Construction Co., 1-170,000	1	..	27/32-31/32
Parker, Thos., Limited, Ordinary	10	–	10-10¼
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5	..	3¼-4
Telegraph Construction and Maintenance	12	–	31-33
—— 5 per cent. Bonds	100	–	99 02
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	..	9¼-9⅝

Electric Lighting and Supply.—

Name.	Amount paid.		Last price
	£		£
Adelaide Electric Supply Co., 6 p. c. Cum. Pref., 1-10,000	..	..	4⅜-5¼
Bournemouth and Poole, Ordinary	10	–	10 ⅛
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	–	9⅜ 10¼
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	–	10¼ 0⅜
—— 4½ per cent. Debenture Stock, Red.	100	–	99 1⅜
Bromley (Kent) Electric Light and Power Co.	5	–	4⅜ 4½
—— 4½ per cent. 1st Debenture Stock, Red.	100	–	98 100
Brompton and Kensington, Ordinary	5	–	7⅜ 8⅜
—— 7 per cent. Preference	5	–	7½ 7⅝
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	–	6⅜ 7⅛
—— Nos. 80,001-100,000	4	–	6¼ 7¼
Cambridge Electric Supply Company, £10 Ord.	8	–	1⅝-1⅞
Canadian General Electric Co., Common Shares	$100	..	121-125
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	–	99-102
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	–	3½ 4
—— 4½ per cent. Cum. Pref., 1-80,000	5	–	3⅜ 4¼
—— 4 per cent. Debenture Stock, Red.	100	–	95 98
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	–	3¼ 3⅜
—— ditto (1903) 40,001-80,000	5	–	3¼ 4¼
Chelsea Electricity Supply	5	–	3¼ 4¼
—— 4½ per cent. Debentures	100	–	101-104
Chicago Edison Co, 1st Mt. 5 p. c. 30-yr. Gld. Bds., Red., 1-1,200	$1000	..	98-101
City of London, Ordinary	10	–	9- 0 xd
—— 6 per cent. Cumulative Pref.	10	–	10⅜-11⅜ xd
—— 5 per cent. Debenture Stock	100	–	121-124
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	–	96-99
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1,553	50	–	50-53
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100	..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-'0,000	5	..	4½-5
—— 5 per cent. Preference, 1-50,000	5	..	4½-5
County of London Electric Supply, Ordinary	10	–	7 8
—— 6 per cent. Cum. Pref.	10	–	10½ 11½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	–	106 109
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	–	94 97
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5	–	½ 1
—— 6 per cent. Cum. Pref.	5	–	1-2
—— 4½ per cent First Mort. Deb	100	–	76 81 xd
Electrical Development Co of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, 10,751-15,75)	—	..	78-80 p.c.
Electric Lt & Traction Co of Aust., 6 p c Cm Pf , 1 30,000	5	–	2½ 2⅝
—— 5 per cent Debenture Stock Red	100	–	85½ 89½
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red	100	–	91½ 95½
Folkestone Electric Supply, Ord. Nos. 1-10,000	5	–	4½ 5⅜
—— 4½ per cent. First Deb. Stock, Red.	100	–	98 101
Hove Electric Lighting, Ord., 1-13,000	5	–	6⅜ 7¼
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100	..	103-106
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk. Red.	100	–	94-97
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	–	—
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5	–	8½-9⅛
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	–	96 99
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9⅜-1⅛
London Electric, Ordinary	5	–	1⅝-2⅛
—— 6 per cent. Pref.	5	–	4½-5⅛
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	–	93-96

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Name.	Amount paid.		Last price
	£		£
Madras Electric Supply Corporation, 5 per cent. Construction Deb. Stock., Red. (Prov. Certs.), all paid	—	..	94-97
Metropolitan Ordinary, 100,001-300,000	5	—	5⅛ 6⅜
——— 4½ per cent. First Mortgage Debenture Stock	100	—	103 107
——— 4½ per cent. Cum. Pref.	5	—	4⅜ 5⅛
——— 3½ per cent. Mortgage Debenture, Red.	100	—	87-92
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds., 1935, C 1-1,000 ($100), D 1-5,000 ($500), M 1-4,400 ($1,000)	—	..	74½-76 p c.
Mexican Light and Power Co., Capital Stock	$100	..	45-47
——— 5 per cent 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14,000 ($1,000)	—	..	84½-86½
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	—	95-98
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,000	5	..	7⅛ 7⅜
——— do., 57,001-75,000	5	..	7⅛-7⅜
——— do., 75,001-87,500 (issued at £2 prem., 16s. paid)	4	—	6-5½
——— 5 per cent. Pref., 1-57,000	5	—	5 0
——— do., 75,001-87,500 (issued at 10s. prem., 4s. paid)	4	..	4-4¼
Notting Hill Electric Lighting	10	—	1 ½ 12½ xd
——— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	—	96 99
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	—	5⅛ 5⅜
——— 4 per cent. Debenture Stock	100	—	95 97 xd
River Plate Electricity Co., Ord., 1-119,687 & 120,501-120,507	1	..	⅞-1
——— 6 per cent. Non-Cum. Pref., 1-100,000	1	..	⅞-1
——— 4 per cent. Debenture Stock, Red.	100	..	95-98
Rosario Electric Co., 6 per cent. Cum Pref., 1-20,000	5	..	5-5½
——— 6 per cent. Cum. 2nd Pref., 1-15,000	4	.	5-5½
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	—	96 98
Shawinigan Water and Power Co., 5 p c. Cons. 1st Mt. Bds.	—	..	99 101 p.c.
Smithfield Markets Electric Supply, Ord. 1-12,000	5	—	¼-1¼
——— 4 per cent. Debenture Stock	100	—	73 77
South London, Ordinary	5	—	1⅛ 2⅜
South Metropolitan Electric Light and Power, Ord.	1	—	⅜ ⅝
——— 7 per cent. Cum. Pref.	1	—	1⅛-1⅜
——— 4½ per cent. 1st Mort. Deb.	100	—	100-103
St. James's and Pall Mall, Ordinary, 101-20,000	5	—	8 9
——— 7 per cent. Pref.	5	—	6½ 7⅛
——— 3½ per cent. Deb.	100	—	86 91
Urban Electric Supply Co., Ordinary, 8-30-007	5	—	1½ 2⅛
——— 5 per cent. Cumulative Preference, 50,001-80,000	5	—	2-3
Westminster, Ordinary	5	—	9 10
——— 4½ per cent. Cum. Pref., 110,101-138,251	5	—	5-5½

Electric Tramways.—

Name.	Amount paid.		Last price.
	£		£
Anglo-Argentine, 5½ per cent. Cum. Pref., 1-250,007	5	—	6-6½
——— Ord.	5	—	8 7/16-8 11/16
——— Permanent 6 per cent. Debenture Stock, 1888	100	—	131-134
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	—	102-105
Barcelona Tramways, Ord., 1-20,000	10	—	—
——— 6 per cent. Cum. Pref. Shares, 1-10,000	10	—	—
——— 5 per cent. Deb., Red., 1-500	100	—	—
——— 4½ per cent. Red. Deb. Stock	100	—	—
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1	—	¾ ⅞
——— 5 per cent. Cum. Pref. Shares, 1-59,394	1	—	29/32-1 1/32
Birmingham and Midland Trams., 4½ p c. 1st Db. Stk., Red.	100	..	94-99
Blackpool and Fleetwood Tramroad	10	..	13⅜-13⅝
Bombay Elec. Supply & Trams. Co., 6 per cent. Cum. Pref.	8	..	7⅛-8⅛
——— 4½ per cent. Deb. Stock, Red.	100	..	96-97
Brisbane Tramway Invest., Ord., 1-75,000	5	—	3 3½
——— 5 per cent. Cum. Pref., Nos. 1-75,000	5	—	4⅜-5
——— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	—	96 100
British Columbia Electric Railway Co., Ord. Def.	100	—	127-132
——— Ord. Pref.	100	—	110-114
——— 5 per cent. Cum. Perpetual Pref. Stock	100	—	103-106 xd
——— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	—	100-103
——— 4½ per cent. Vancouver Power Deb.	100	—	100-102 xd
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	—	2½-3
——— 6 per cent. Cm. Pf., 30,001-60,000	10	—	7⅛-7⅜
——— 5 per cent. Perpetual Debenture Stock	100	—	98-102
——— 4½ per cent. 2nd Deb. Stock	100	—	78-81
Buenos Ayres and Belgrano Trams.	5	—	4⅛-4⅜
——— "A" 6 per cent. Cm. Pf., 1-40,000	5	—	4⅜-4⅝
——— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	4⅜-4⅝
——— 5 per cent. Deb. Stock, Red.	100	—	105-115
——— Prov. Cert., all paid	100	—	100-103
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100	—	92-97
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb. Bonds, Red., 1-1,500	100	..	99-103
——— 6 per cent. Deb. Bonds, Red., 1-2,275	100	..	101-106
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	93-96
Calcutta Tramways, 1-105,000	5	—	7⅛-7⅜
——— 105,001-137,610	5	—	7⅛ 5⅜
——— 4½ per cent. 1st Deb. Stock, Red.	100	—	102 106
Cape Electric Tramways, Nos. 1-480,000	1	—	5/16 7/16
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	—	4⅜ 5
——— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100	—	98 101
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	..	5 3/16-5 7/16
——— 4 per cent. Deb. Stock, Red. 1935	100	..	97-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	00	—	94 98
Cork Electric Tramway and Lighting Co., Ordinary	10	—	13½-14½
——— 6 per cent. Cum. Pref.	10	—	13-14
——— 4 per cent. Debentures	100	—	99-100
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	—	13½-14½
——— 6 per cent. Pref., Nos. within 1-60,000	10	—	13-14
——— 3½ per cent. Mort. Debs., 1-3,000 Red.	100	—	93-97
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100	..	98-101
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6,957	$1,000	—	83-88 xd
Imperial Tramways, Ordinary	all	—	18-19
——— 6 per cent. Cum. Pref.	all	—	14-14½
——— 4½ per cent. Deb. Stock	100	—	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5	—	1 1½
——— 4 per cent. 1st Mt. Db. Stock, Red.	100	—	66-71
Kalgoorlie Electric Tramways, 1-250,000	1	..	5/32-5/32
——— 5 per cent. "A" Deb. Stock	100	..	88-93
——— 6 per cent. "B" Deb. Stock	100	..	78-82
Kidderminster and District Lighting and Traction, Pref.	5	—	8-8½
Lancashire United Tramways Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	—	94-97
——— £296,500 2nd Mort. Deb. Stock	—	—	—
——— £83,330 Deferred Deb. Stock (all fully paid)	—	—	—
Lisbon Electric Tramways Limited, Ord., Nos. 1-594,188	1	..	1 1/16-1 5/16
——— 6 per cent. Cum. Pref., Nos. 1-425,553	1	—	1 1/16-1 3/16
——— 5 per cent. Mort. Deb., 1-5,000 Red.	100	..	95 98
London United Trys. (1901), 5 per cent. Cum. Pref.	10	—	7⅜ 8⅜
——— 4 per cent. 1st Mt. Db. Stock, Red.	100	—	84-88
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Rd.	100	—	96-99

Name.	Amount paid.		Last price.
	£		£
Manila Elec. R.R. and Lghtg. Corp., 5 p.c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000	..	93-95
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,625 and 23,436-25,000	5	..	4⅝-5⅛
——— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	97-100
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	—	3/32 5/32
——— 5 per cent. Cum. Pref., 500,001-1,000,000	1	—	27 32 31/32
——— 4½ per cent. Deb. Stock, Red.	100	—	94 97
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	—	..	83½-85½ p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	—	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 601-2,000 (1922)	100	—	103-105
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	—	⅜-½
Oldham, Ashton, and Hyde Tramway, Ordinary	10	—	18
——— 5 per cent. Cum. Pref.	10	—	8⅜-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100	—	100-104
Potteries Electric Traction, Ordinary, 1-245,000	1	—	5/16-9/16
——— 6 per cent. Cum. Pref., 300,001-545,000	1	—	9/16-13/16
——— 4½ per cent. Debenture Stock	100	—	95 98
Provincial Tramways Co., Ordinary, 1-24,912	10	..	4½-5
——— 6 per cent Cum. Pref., 1-10,000	10	..	10½-11½
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-30,000	5	..	5⅛-5⅜
——— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	97-99
Sao Paulo Tramway, Light, and Power Co.	$100	..	118-122
——— 5 per cent. 1st Mort. Deb., Red. 1929, 1-11,000	$500	..	93-95 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1	..	29 32-1 1/32
——— 4 per cent. Deb. Stock, Red. 1940	100	..	80-84
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs, Red., 1-1,600	100	..	84-88
Yorkshire (West Riding) Elec. Tram Co., Ord., 70,001-110,000	5	..	1-1½
——— 6 per cent. Cum. Pref., 1-46,261	5	..	3⅛-3⅜
——— 4½ per cent. 1st Deb. Stock, Red.	100	..	88-91

Electric Railways.—

Name	Amount paid.		Last price
	£		£
Central London, Ordinary	100	—	73-75
——— 4 per cent. Pref.	100	—	92-94
——— " " deferred	100	—	53-56
——— 4 p.c Deb. Stock (Prov. Script Certs., fully paid)	100	—	102-105 xd
City and South London, Consolidated Ordinary	100	...	46-48
——— 4 per cent. Debenture Stock	100		102-105
——— 5 per cent. Pref. Stock '91	100	—	117-121
——— " " " '95	100	—	115-118
——— " " " '01	100	—	110-113
Liverpool Overhead, 5 per cent. Pref.	10	—	10-10½
——— Ordinary, 1-50,000	10	—	3⅜-4⅛
——— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	—	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	...	64-67

Telegraphs and Telephones.—

Name.	Amount paid.		Last price.
	£		£
Amazon Telegraph Co., 1-25,000	10	..	3-3½
——— 5 per cent. Debs., Red., within 1-1,069	100	..	85-88
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000	$1,000	..	90-92
Anglo-American Telegraph Co., Ordinary	100	..	62-65
——— 6 per cent Preferred Ordinary	100	...	109-110
——— Deferred Ordinary	100	...	18⅛-19
Anglo-Portuguese Telephone Co., 5 per cent, 1st Mort Deb. Stock, Red.	100	...	101-104
Chili Telephone Co., 1-44,000	5	...	6⅜-7⅛
Commercial Cable Co., Ster. 500-year 4 p.c. Deb Stk., Red.	100	...	92-94
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	...	7⅛-8⅛
——— 10 per cent. Preference, 1-6,000	10	...	15⅜-16⅛
Direct Spanish Telegraph Co., Ordinary	5	...	3⅜-3⅝
——— 10 per cent. Cum Preference	5	...	9-9⅛
——— 4½ per cent. Debs., 1-600	50	...	98-101
Direct United States Cable Co.	20	...	15⅛-16
Direct West India Cable Co., 4½ per cent. Debs., Reg. within 1-1,200, Red.	100	...	99-101
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100	...	99-102
——— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8,000, 1913	25	...	98⅛-100⅛
Eastern Extension, Australasia and China, 1-300,000	10	...	12⅛-13⅜ xd
——— 4 per cent. Mort. Deb. Stock, Perp.	100	...	104-106
Eastern Telegraph Co., Ordinary Stock	100	...	134-139 xd
——— 3½ per cent. Preference Stock	100	...	88-90 xd
——— 4 per cent. Mortgage Debenture Stock	100	...	103-105
Great Northern Telegraph Co. (of Copenhagen)	10	...	34-36
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1,200, Red.	100	...	99-101
Indo-European Telegraph Co.	25	...	56-58
Marconi's Wireless Telegraph Co., 1-256,127	1	...	⅛-¼
——— 256,128-384,190	1	...	⅛-¼
Monte Video Telephone Co., Ordinary, 1-72,680	1	..	15/16-1 1/16
——— 5 per cent. Preference, 1-86,492		...	⅞-1
National Telephone, Preferred	100	...	109-111
——— Deferred Stock	100	—	108-110
——— 6 per cent. Cum. First Pref.	10	—	11½-13½
——— 6 per cent. Cum. Second Pref.	10	—	10-12
——— 5 per cent. Non. Cum. Third Pref.	5	..	5 7/16-5 11/16
——— 3½ per cent. Deb. Stock, Red.	100	—	95-97
——— 4 per cent Deb. Stock, Red.	100	—	100-102
Oriental Telephone and Electric Company	1	..	1⅛-1⅜
——— 6 per cent. Cum. Pref.	1	..	1 5/16-1 5/16
Pacific and European Tel., 4 p c. Guar. Debs., Red., 1-1,000	100	...	91-94
United River Plate Tele. Co., Ordinary, 1-100,000	5	...	7-8
——— 5 per cent. Cum. Pref., 1-40,000	5	...	5-5½
——— 5 per cent. Debenture Stock, Red.	100	...	—
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	...	98-101
West African Telegraph Co.	10	...	10-10½
West Coast of America, 1-30,000 and 53,001-53,003	2½	...	1⅛-1⅜
——— 4 p c. Debs., 1-1,500, Gua. by Western Telegraph	100	...	97-100
West India and Panama Telegraph Co., Ordinary	10	...	7/16 9/16
——— 6 per cent. Cum. 1st Preference	10	...	7⅛-7⅜
——— 6 per cent. Cum. 2nd Preference	10	...	6⅛-7⅛
——— 5 per cent. Debs., Red., 1-800	100	...	99-102
Western Telegraph Co., 1-207,930	10	...	13⅜-14⅛
——— 4 per cent. Debenture Stock, Red.	100	...	100-103

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.							Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1907.	1906.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Mile of track. Passenger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	July 21	1,751	1,757	- 106	— h	25½	25	May 31	64,071	15,530,361	1,379,723	0 93	11·14	2,5 2	6·45
Ayr Corporation	,, 27	5 4	512	+ 12	—	8	8	,, 15	14,328	3,316,380	353,945	[illegible]	9·71	1,830	5·16
Baker Street and Waterloo Ry.	,, 27	2 145	1,251	+1,194	+ 4,656	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 28	1,165	1,088	- 23	- 507	23 53	3·53	March 31	56,026	11,146,531	1,309 903	1·18	10 08	2,338b	6·03
Birmingham Corporation	,, 27	5 221	—	—	—	56½	—	,, 31	17,133	4,709,798	266,526	·86	14·5	8 866	—
Blackburn Corporation	,, 21	1,2 7	1,038	+ 118	+ 764	24	24	,, 25	48,875	8,661,720	986 953	1·35	11·29	2,036	7·44
Blackpool Corporation	,, 25	2 121	2,029	+ 92	- 1,568	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	,, 27	,,2:9	1,306	- 77	- 331	16½	16½	Dec. 31	31,846	2,525,677	573,264	3·28	13 19	—	7·27
Bolton Corporation	,, 28	2 387	2,251	+ 136	+ 1,4[illegible]5	42	40	March 31	95 766	20,205 196	2,161,130	1·13	10 63	2 394	6·14
Bournemouth Corporation	,, 21	1,883	1,752	+ 131	+ 173	17·41	16·82	,, 31	55,276	10,058,288	1,121,623	1·32	11 83	3 226	7·19
Bradford Corporation	,, 27	4,977	4,926	+ 51	+ 358	96	96	,, 31	230,085	47,1[illegible]8,000	5,053,392	1·172	10 927	2,29[illegible]	—
Brighton Corporation	,, 28	997	1,145	- 148	- 1,505	9½	9½	,, 31	50,339	11,321 160	1,153,828	1 6	10·48	2 914·8	8·014
Bristol Tramway Company	,, 25	5 1[illegible]4	5,433	- 304	—	51½	51½	Dec. 31	259,799	45.312,373	6 127,135	—	—	—	—
Burnley Corporation	,, 27	1,308	1 158	+ 150	—	40	40	March 31	57,932	11,092,704	1,197,772	1·31	11 61	5,388	8·17
Burton Corporation	,, 28	303	319	- 16	- 252	8½	8½	,, 31	17 950	3,878,269	454,082	1·07	9·21	2,0 8	6·76
Cardiff Corporation	—	—	—	—	—	32 62	† 32·26	,, 31	112,209	24,134,363	2,770,049	1·12	9 72	3,782	9·44
Carlisle Tramways Company	,, 27	216	216	—	- 359	8·5	8·5	Dec 31	10,713	2,935 002	359,756	—	7 14	—	5 18
Central London Railway	,, 27	5,164	5,536	- 432	- 1,579	6	6	,, 31	347,588	4,875,547	1,261,214	1 86	65·10	57,931	35 80
Charing X, Euston, & Hamp. Ry.	,, 27	2,515	—	—	—	8	—	—	—	—	—	—	—	—	—
City and South London Railway.	,, 28	3,123	2,709	+ 414	+ 2,610	6½	6½	,, 31	—	—	—	—	—	—	—
Colchester Corporation	May 8	195	195	—	—	8	8	March 31	10,588	2 457,553	720,788	·97	7 47	1,401	6·12
Cork E. T. and L. Company	July 25	573	592	- 18	- 450	15½	15½	Dec 31	24,896	5 814 376	882,256	1 01	6 64	—	4 69
Darwen Corporation	,, 26	253	278	+ 25	+ 15	7 23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	,, 20	254	296	- 40	- 476	4½	4½	,, 31	11,250	2 853 200	284,343	·94	9·49	2,500	—
Dublin and Lucan Electric Ry.	,, 25	157	145	+ 12	+ 134	6½	6½	Dec 31	6 358	402,511	110,738	3·79	13·78	942	7·33
Dublin U.T.	,, 26	7,166	5,679	+1,487	+ 6,730	48½	48½	,, 31	267,489	50,060,949	7,077,372	1·8	9·07	691	5 55
Dundee City Tramways	,, 24	1,319	1,333	- 13	+ 334	22	22	May 15	50,154	13 086 396	1,005 911	·906	11·96	2,180	7·42
East Ham Corporation	,, 27	951	959	- 8	- 403	14	14	March 31	36,652	3,689,658	863,816	·64	10 18	2 9·4	6 79
Glasgow Corporation	,, 27	15,661	14,818	+ 8 8	+ 1,485h	79½	79½	May 31	766 480	195,767,519	17,945 595	—	10 12	—	—
Gloucester Corporation	,, 10	278	304	- 26	—	15	15	March 31	15,465	3,[illegible]62,077	563,595	·0	6·58	939	5·32
G.N., Piccadilly, and Brompton	,, 27	4,130	—	—	—	9	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	37	37	,, 31	74 019	17,849,642	1,540 707	—	11 53	2,085	8·56
Huddersfield Corporation	,, 27	1 635	1,536	+ 99	+ 1,010	35	35	,, 31	69,938	12 838,150	1 664,262	1·24	9 71	1,923	—
Hull Corporation	,, 27	2,329	2,356	- 26	+ 1,347	26	26	,, 31	112,651	27,104,921	2,910,698	1	9 29	—	—
Ilford Corporation	—	—	—	—	—	10½	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 21	147	142	+ 5	+ 163	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	11,586	3,626,656	419,800	·727	6 62	1 480	5·22
Lancashire United Tramways	,, 24	1,526	1 098	+ 4 8	+ 9,560	38½	28	—	—	—	—	—	—	—	—
Leeds Corporation	,, 27	6,763	6,738	+ 15	+ 4,257	89½	89½	March 25	298,233	64 223,666	7,121,038	1 10	10·02	351	—
Leicester Corporation	,, 27	2,389	2 459	- 70	—	42	42	Dec. 31	26,011	12 039,252	1,229,507	1	9·79	—	4 82
Liverpool Corporation	,, 20	11,884	11,106	+ 778	+ 4,148	104	104	,, 31	547 625	116,642 663	12 166 419	—	—	—	—
Liverpool Overhead Railway	,, 28	1,613	1,554	+ 79	+ 562h	6·65	6 65	June 30	81,302	11 171,865	1,024 275	—	—	—	—
London County Council	,, 20	22,8 5	21,163	+3 308	+ 76,379	98	98	—	—	—	—	—	—	—	—
Lowestoft Corporation	—	—	—	—	—	6	6	Sept. 30	14,511	3,128 857	359,435	1 08	9 68	2 630	6 48
Maidstone Corporation	—	—	—	—	—	2	2	March 31	4,740	850 121	113,227	1 33	10 13	2,370	—
Manchester Corporation	,, 27	15,496	13 961	+ 1,534	+ 21,189	149	149	,, 31	631,866	126,800,875	14,125,124	1 19	10 73	4,289	6 99
Metropolitan District Railway	,, 28	7,676	7,607	+ 19	+ 9	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 28	14,263	14,446	+ 417	+ 2,453	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 27	164	152	+ 11	+ 18	2½	2½	,, 31	6,159	1,992,647	206,358	82	7 14	2,239	—
Newcastle-on-Tyne Corporation	,, 27	4,0 4	4,252	- 238	+ 299	50	50	,, 31	197,849	43,06 ,934	4,326,152	1 07	10 98	3,957	7·0
Newport (Mon.) Corporation	June 29	639	628	+ 11	+ 1,297	15½	15½	,, 31	30,356	7,252,535	783 435	—	9 29	—	6·4
Oldham Corporation	—	—	—	—	—	34	34	,, 25	65 553	15,466,245	1,504,740	1 16	10·45	1,885	—
Portsmouth Corporation	May 25	2,330	1 578	+ 752	+ 632	28½	28½	,, 31	95,702	19,625,329	197,489	1·17	11 63	—	—
Reading Corporation	July 26	634	718	- 84	- 456	33½	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	11·29	21·29	,, 31	14,881	2,837,110	386,547	1·24	9·24	1,102	7 82
Rotherham Corporation	—	—	—	—	—	9½	9½	,, 31	23,569	5 251,472	593,054	1 07	9 53	2,612	7·49
Salford Corporation	,, 23	4,741	4,680	+ 61	+ 1,627	70½	70½	,, 31	214,111	39,213 560	4,894,590	1 28	10 29	—	—
Scarborough Tramways Co.	—	—	—	—	—	4½	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 28	5 681	5,424	+ 257	+ 4,319	35½	35½	,, 25	240 545	63,952,283	6,049,899	·903	9 543	3,653	6·477
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,365	9 294,771	1,108,5[illegible]	1·27	11·02	—	7 83
Southend-on-Sea Corporation	,, 24	528	528	—	- 354	9	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	,, 31	39,550	6,766,031	1,027 730	—	9 23	—	4·75
Sunderland Corporation	,, 28	1,576	1,595	- 19	- 140	20	20	,, 31	64,858	15,364 463	1,495 785	1·004	10·36	—	6·37
Swinton Corporation	June 5	153	—	—	—	4½	4½	,, 31	4,937	1,315,757	102,751	0·87	11 53	1,371	—
Torquay Tramways	July 25	240	—	—	—	5 16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 27	950	947	+ 3	+ 278	13 68	12·43	,, 31	43,607	7,985,451	862,123	9·27	12 14	3,132	7 50
Warrington Corporation	—	—	—	—	—	9	9	,, 31	17,0[illegible]7	4,418 225	403 363	—	9 8[illegible]	—	6·33
West Ham Corporation	,, 25	2,422	2,357	+ 65	+ 1,125	14·7	14 7	,, 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	,, 24	853	841	+ 12	+ 255	20	20	,, 31	41,905	8 847,066	950,338	—	10 583	2,062	6·13

† And 98 miles of interlacing track. a Train mile. b Per mile of single track. h Half-year's figures. k Double track

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NOTES.

Institution of Civil Engineers.—The council of the institution are prepared to consider applications for a nomination to a Palmer scholarship. The nominee must be the son of a civil engineer; he must be desirous of matriculating and subsequently graduating at the University of Cambridge; and his circumstances must be such as to need the help afforded by the scholarship. The scholarship is of the annual value of £40, and will be vacant at the end of September next. Copies of the regulations may be had on application to the secretary of the Institution of Civil Engineers, Great George-street, Westminster, S.W.

The W. E. L. Gaine Memorial.—The *National Telephone Journal* in its issue for the current month states that the Memorial Committee have held a meeting to consider the question of the form in which Mr. Gaine's memory should be perpetuated. The suggestion which has met with practical unanimous approval is that, if the sum at the disposal of the committee be sufficiently large, the most appropriate and useful memorial would be to endow one or more beds at a consumptive hospital or sanatorium, so that a member of the staff from any part of the country having the misfortune to be afflicted with this insidious disease would be enabled to go to the hospital or sanatorium for cure.

Hawksley Centenary.—At the opening meeting of the Institution of Mechanical Engineers in Aberdeen last week, the president, Mr. T. Hurry Riches, announced that Mr Charles Hawksley had presented £1,000 to the institution for the foundation of a scholarship or premium in commemoration of the centenary of the birth of his late father, Mr. Thomas Hawksley, a past-president of the institution. Perhaps no worthier way of marking the centenary of Thomas Hawksley could be found than by providing the means for encouraging students to follow in the paths of engineering science laid by the great engineer, and the munificence of Mr. Charles Hawksley is only approached by the wisdom which has guided his choice of applying it.

Accumulators on Tramways.—Some of the tramcars on the Paris system are furnished with accumulators. But passengers on cars thus furnished complain that these accumulators give off penetrating acid vapours (due, it is stated, to short-circuiting), causing them great inconvenience. The matter has been brought before the Prefecture of Police, and the abolition of this particular system of traction has been called for. It seems likely that the demand will be complied with, but this cannot be accomplished at once, and the administration have promised to take steps to amend matters. Much improvement might be effected by providing those cars which are furnished with accumulators with adequate ventilating apparatus, thus avoiding extreme measures.

London Traffic.—The promise made by the President of the Board of Trade at the opening of the Hampstead Tube line that the Government proposed to take immediate steps for dealing with the London traffic problem is on the way towards fulfilment, for it is officially announced that the Board of Trade are about to constitute a special temporary branch for the purpose of dealing with matters relating to London traffic, so far as they come within the scope of the Board. The branch will be under the direction of Colonel Sir Herbert Jekyll, K.C.M.G., now assistant secretary in the Railway Department. The Board of Trade action has, however, been anticipated by the railway, omnibus, and tramway companies in the Metropolis, who met in conference last week and decided upon steps for ascertaining what changes are desirable in regard to transport arrangements.

The National Telephone Company. — It is reported that an agreement that will end the competition between the Post Office and the National Telephone Company in connection with the telephone service in London is under discussion, and will shortly be concluded unless some unexpected developments arise. The main reason for the negotiations which are now going on, as given by the *Evening Standard*, is to simplify the work of transferring to the Post Office 4½ years hence the system of the National Company, whose lease expires on Dec. 31, 1911. There is already in the competitive areas much duplication of plant, and if the independent development of each system continued the waste and confusion would greatly accumulate. By the new agreement, London, it is stated, will be mapped out into a number of areas, some of which will be exclusively developed by the Post Office and the rest by the company. In the rearrangement one or two of the older exchanges will disappear.

Patents and Designs Bill.—While the Patents and Designs Bill now before Parliament is welcomed by inventors, patentees, and manufacturers as a decided step towards the protection of their interests, one of its clauses is not altogether looked upon with favour, and its emendation would go a long way towards fulfilling the hopes of the supporters of the Bill The clause to which objection is taken is Clause 7, which provides that the comptroller, if satisfied that the invention claimed by an applicant has been wholly claimed or described in any specification to which the investigation has extended, may, in lieu of requiring references to be made in the applicant's specification, refuse to grant a patent. This provision is considered prejudicial to manufacturers, and an important deputation will present to the President of the Board of Trade a memorial which has been very extensively signed, and in which it is urged that Clause 7 would be most dangerous and undesirable in the public interests, and the memorialists express the hope that he will, therefore, use his influence in favour of the deletion of the clause from the Bill. The signatories include past-presidents of the Royal Society, the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Iron and Steel Institute, the Institute of Chemistry, the Chemical Society, and the Society of Chemical Industry, also many manufacturing firms, as well as many notable scientific men and inventors.

Publications Received.—"The Distribution of Electrical Energy," by J. F. C. Snell. (Thomas Reed and Co., Limited, Sunderland.) 18s. net. This book is the outcome of the author's paper on the subject read before the Institution of Civil Engineers in 1904. Practically the whole of the treatise, excepting that on high-tension overhead mains, embodies the results of Mr. Snell's experience in London and the provinces. The section on overhead lines is based largely upon the reports by the American Institute of Electrical Engineers, and upon papers read before the English engineering institutions. Other sections are devoted to underground cables for high pressures; substations; low-tension distribution systems; special cases of distribution (as for collieries, mines, tramways, etc.). The British, German, and other Government regulations are given as appendices to the treatise, which is profusely illustrated. We shall have occasion to deal with this work more fully in a future issue. Meanwhile, we can congratulate Mr. Snell on the technical and literary success of his first production as an author.—Messrs. Rentell and Co., Limited, 36, Maiden-lane, Strand, W.C., have now published the fifth edition of Mr. Frank Broadbent's "Dynamo and Motor Attendants and their Machines." Price 1s. 6d.

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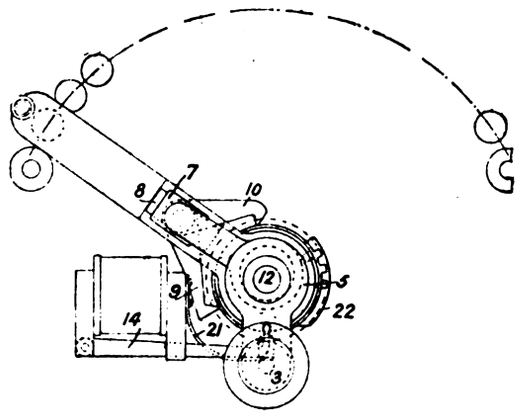
net. It would be unnecessary for us to repeat the praise which we awarded to previous issues of this really practical little book, the fact that it has reached a fifth and enlarged edition being sufficient testimony to its practical value. We are glad to note that, in addition to modifying one or two points, Mr. Broadbent has rewritten and amplified the chapter on alternating-current motors, and added a little new matter on the paralleling of alternating machines, and on starting apparatus. These additions and revisions bring the book thoroughly up to date.—The *Universal Directory of Railway Officials, 1907*, compiled under the direction of Mr. L. R. Blundstone, makes its thirteenth annual appearance from the office of the Directory Publishing Company, Limited, 3, Ludgate-circus, London, E.C. Price 10s. The edition bears traces of careful revision, and practically all tramways worked by power in the United Kingdom are included.

Starting Switches.—A patent has been granted to Messrs. Johnson and Phillips which relates to pawl-and-ratchet mechanism for actuating a rotary-arm switch so that too rapid starting-up is prevented. A combined spring and electromagnetic detent for the ratchet wheel is also described. Continuous rotary motion of a handle, 3, which is pivoted to a stud, 12, is converted into the reciprocating motion of a block, 7, which slides in a slot, 8, in the switch arm. This is effected by an eccentric strap, 5, on the handle boss, which is connected to the block. The reciprocating motion is then converted back



into rotary motion by means of pawls, 9, 10, pivoted to the block, which engage the teeth of a ratchet wheel loosely mounted on the stud, 12, and rotate it. When the ratchet wheel is held, the arm is forced to rotate over the resistance terminals. To hold the wheel, the tip of a magnetic detent, 14, is pressed at starting by a spring, 21, into a notch on a boss attached to the wheel. When the arm has been moved into starting position, a cam extension, 22, on it holds the spring off for the whole of the sweep of the arm, and the detent holds the wheel by the magnet only. On current being cut off the detent is released by the magnet, which may also be short-circuited in the usual way on overload. The use of the notched boss on the ratchet wheel allows the arm to be returned completely to the "off" position, which might be prevented if the detent engaged the teeth of the wheel.

Indian Train-Lighting.—The old method of train-lighting on the Indian railways is gradually giving way to the method of lighting by gas or electricity. Statistics published by *Indian Engineering* show that fair, if not considerable, progress has been made in the direction of electric lighting on Indian railways. At the close of 1905 the various lines had 9,782 of their coaching vehicles fitted for lighting with gas and some 648 vehicles were fitted for electric lighting, making a total of 10,430 vehicles equipped with up-to-date systems, while 7,408 vehicles, or 41·53 per cent. of the total, retained the old methods of oil lamps (kerosene, etc.). Dec. 31, 1906, finds the number of coaching vehicles fitted for gas lighting increased from 9,782 to 10,204, and for electric lighting from 648 to 1,535 vehicles, making a total of 11,739 against 10,430 in 1905, or a proportion of 63·38 fitted and 36·62 not fitted. Several of the railways are extending the use of electricity on their lines. The Great Indian Peninsula and Indian Midland Railways, for example, have now out of a total of 1,498 vehicles 60 fitted for electric lighting. On the metre-gauge Rajputana-Malwa (State) Railway the company had 815 coaching vehicles fitted with electric lamps, leaving 888 vehicles, or 52·14 per cent., still to be adapted for an improved method of lighting. The Rohilkhand-Kumaon Railway have electricity as a train illuminant under trial. The Bengal and North-Western Railway Company have adopted electricity for train-lighting only experimentally, 189 vehicles having been fitted for the purposes of a thorough trial before the remaining 939 vehicles are similarly adapted. The South Indian Railway had 106 coaching vehicles fitted for electric lighting out of a total of 1,012 vehicles, or only 10·47 per cent. This line gave a "lead" years ago to the other railways in the matter of the electric lighting of trains, and it is said that the company are moving shortly towards both an extension of the electrical system of lighting and upon an improved principle. Other companies as well as this one are contemplating electric lighting, and of the 36·62 per cent. of oil lamps still in use a large proportion should eventually be converted to electric lighting.

Trade Openings in Alexandria.—Electrical manufacturers are turning their attention to Egypt, which is found to be a favourable outlet for electrical enterprise. The reports which the British consuls stationed at the important commercial centres in Egypt send to the Foreign Office accurately describe the situation; that of the British consul in Alexandria (Mr. Greig) is no exception, for it shows clearly that in the past year there has been a considerable increase in his neighbourhood in the demand for electrical apparatus of all kinds. In 1905 the value of such imports amounted to £E.129,444, in 1906 to £E.167,135. The supply comes mainly from the United Kingdom, France, Germany, and Austria-Hungary. Although the United Kingdom contributed considerably more than any other country, the value of her imports of electrical goods amounted in the past year only to £E.58,320, as compared with £E.63,557 in 1905. On the other hand, substantial progress was made by Austria-Hungary and, in a lesser degree, by Belgium, whilst France and Germany also increased their share. Electricity, says the report, is in general use in Alexandria for lighting, transport, and other purposes. There is a demand for ventilation fans of all sizes. Germany supplies large quantities of wires, lamps, bulbs, etc., to all of which the consul advises British manufacturers to pay attention, while he adds the now stereotyped advice, that agents should be carefully chosen and preference given to men with some technical knowledge. Some useful notes are given concerning business methods. The British origin of goods is, states Mr. Greig, here, as elsewhere, an accepted guarantee of merit, and not a few critics in this country aver that British manufacturers might even enhance their success, advocating (1) the adoption of the metric system; (2) the frequent visits of commercial travellers; (3) general adaptability to local requirements; (4) the quotation of prices in c.i.f. or any other terms required; (5) the reduction of prices so far as possible; (6) the acceptance of small initial orders; (7) accurate adherence to specifications; (8) great care and punctuality in the packing and delivery of goods; and (9)

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subject to due precautions, longer credits. He also draws attention to the good work performed during the year by the Committee for the Protection of Creditors which was recently formed.

Brazil.—That there is an increasing demand in this country for electricity for power and lighting, and that the company engaged in furnishing this supply is keeping pace with the industrial developments of Brazil, is evidenced by the report of Mr. Consul-General A. Chapman on the trade of that country for the year 1906. The scheme of the Tramway, Light, and Power Company, which has already been outlined in these columns, includes the development of water power and its utilisation in the form of electric energy, principally in the cities of Rio de Janeiro and Nitheroy. Considerable outlay has been necessary in acquiring water power, tramlines, and concessions, and in overcoming opposition and competition, and so far the success of this undertaking is greatly due to unstinted payments and the energetic manner in which the initial work has been carried out. With the exception of the Jardin Botanico tramline, the company now control and have practically a monopoly of the whole of the tramcar, lighting, and telephone systems in Rio de Janeiro. The company have since last year installed electric energy from the provisional generating station at Ribeirao das Lages, a distance of some 50 miles, and have commenced the distribution of power in the city. The work on the principal generating station on the Parahyba River, a distance of some 80 miles from Rio de Janeiro, is progressing satisfactorily, and by 1908 the company hope to command some 60,000 h.p. from this source, and to be in a position to meet all requirements of the Federal district and of Nitheroy. The Villa Isabel tramcar line is now worked by electricity, and measures are progressing for the conversion to electricity of other mule-drawn lines and for the unification of the whole system. Electric lighting, both public and private, has increased and the demand is growing. The port of Rio de Janeiro is being improved on a most modern scale, and on the quays will be erected electric cranes. Already the first instalment of five cranes is being erected for service on the quays. The quantity of machinery and accessories for electric lighting imported during the year amounted to 2,840 tons, valued at £247,499, compared with 3,072 tons, valued at £289,655, during the previous year. These imports show a falling off of 232 tons and £42,156 in value. 1,393 tons and £159,075 came from the United States, 841 tons and £77,700 from Germany, 432 tons and £30,779 from the United Kingdom, and 76 tons and £10,007 from France.

Electricity in Horticulture.—A definite forward step has been taken in the application of electricity for stimulating the growth of fruit, flowers, and vegetables, and in one of the glasshouses in the gardens of the Royal Botanic Society, at Regent's Park, Mr. B. H. Thwaite is putting to a complete and practical test his patented system for accelerating plant growth by means of the actinic rays of the electric arc lamp, the mild electrolysis of the soil, carbon dioxide, and the necessary heat. These conditions are secured, so Mr. Thwaite explained in a lecture before the Royal Botanic Society, by means of a modern producer suction gas-engine coupled to a dynamo. The electric energy developed by this plant is allocated to the feeding of the arc lights in the glasshouse. An electrostatic machine is driven from the gas-engine crankshaft, and the electricity is discharged by points along the plants to electrify not only the air, but the plants and their roots as well. The arc lights are equipped with special reflector hoods, by which the beam of light is confined within narrow limits of concentration. The open end of the hood is closed in by a water screen—made up by a glass trough filled with water. This water screen, through which the light rays have to penetrate, is intended to secure as near an imitation of natural solar effect as possible, and to limit the effect of the rays, and if it is desired to screen from the plants any portion of the spectra, coloured water can be employed. The roof of the reflector is provided with a chimney to permit the escape into the roof of the glasshouse of the nitrous oxides that may be produced. It is arranged that the arc lights are automatically constantly and almost imperceptibly moving along the entire length backwards and forwards of the glasshouse, radiating a powerful beam of light on both sides of the house. The traveller is electrically driven, and the speed may be controlled. The installation will permit a wide range of experiments to be made, and should this system prove successful its supreme value will lie in the fact that it is, of course, independent of climatic and solar influences. Mr. Thwaite estimates that from three to four producing seasons in the year will be attainable, so that his invention promises to have a great commercial value. In any case the experiments now being carried out at the Botanic Gardens by Mr. Thwaite are to be welcomed as a stage in the development of the application of electricity to the science of horticulture.

St. Marylebone Electricity Undertaking.—So much adverse criticism has been levelled against the electricity undertaking carried on by the Borough Council, that the results of the first year's working must come as an agreeable surprise to many. The report of the Electricity Committee for the year ended March 31 shows that the gross revenue amounted to £158,459. 12s. 9d., while the expenditure on revenue account was £52,727. 15s. 9d., leaving a balance of £105,731. 17s. to meet capital charges. Interest on and expenses of obtaining loans, provisions for bad debts, etc., totalled £73,091. 8s. 3d. After the provision of £10,578. 16s. 2d. for redemption of loans and reduction of capital indebtedness, there remained a net balance of £22,061 on the year's working. The amount brought forward from the previous year's account amounted to £7,298. 13s. 10d., so that the balance available at March 31 last for the depreciation and renewals reserve fund was £29,360. 6s. 5d. The management costs (·30d. per unit sold) seem unduly high, but this is explained to be due to the very heavy burden placed upon the department incidental to the change of pressure during the earlier part of the year. There is, therefore, good reason for believing that during the current year an improvement on these costs will be achieved. Mr. Debenham, chairman of the Electric Supply Committee, in a letter to the *Times* points out that, instead of the loss which was anticipated in 1903 by a correspondent of £50,000 a year, the Council have made a profit of £29,359, and at the same time been able to reduce the price of current to consumers from 5·26 per unit (the estimated average price for 1906) to 4·70. This is a benefit to consumers of £17,500. They have been able to do this because their costs per unit sold, exclusive of capital charges, have worked out at 1·45 instead of 2·2, which was the estimated figure, and this in spite of an unfavourable load factor of 11·80. They have been able to borrow the whole of their capital from the London County Council at an average rate of 3·87 per cent., which, although not quite so good as the anticipated figure of 3·75 per cent., is better than the 4 per cent. which the *Times* special correspondent expected. On the advice of a firm of outside auditors (Messrs. Price, Waterhouse, and Co.), the Council have decided to place annually a sum of £12,250 to a reserve fund for renewal of plant and the replacement of

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obsolete units. This sum is in addition to the repayment of capital, and, with the sum which is to be repaid (about £33,000 a year), represents approximately 2¼ per cent. on the whole of the capital of the undertaking.

Individual Brush Adjustment on Multipolar Machines.—Most multipolar dynamos are fitted with as many sets of brushes as poles, and the brushes are usually arranged at exactly equidistant points round the commutator. Experience has, however, shown that even when the machine is perfectly symmetrical both mechanically and electrically, and when the brushes are set in the best sparkless position, quite considerable equalising currents may flow between the various positive or the various negative brushes. Such equalising currents naturally add to the heating of the armature, and so reduce its useful output. An interesting case of this nature is described by Herr M. Beck in *Elektrotechnik und Maschinenbau*. The machine was a four-pole 15-kw. shunt dynamo for 120 volts, and having a lap-wound drum armature. With equally spaced brushes an equalising current of 20 amperes was observed when the machine was doing full load. With a view to eliminating this current, experiments were made with the machine separately excited and fitted with ammeters in the positive and negative brush connections. On running the machine at full speed, but without external load, no equalising current could be observed. The machine was then loaded, and immediately the equalising current of 20 amperes was found to flow. On removing the load again, it was found that the equalising current fell to 12 amperes, and remained steady at this value, although previously there had been no equalising current on open circuit. This somewhat surprising result was checked by repetition, and the same result was obtained in each case. In explanation, the author suggests that, although the field (both main and leakage) is perfectly symmetrical when there is no current in the armature, this state of affairs may cease as soon as the armature carries current, for the distortion due to this current may affect the leakage from the saturated trailing pole-tip differently from that of the less saturated leading pole-tip, and so cause an unsymmetrical effect on the armature. Once this want of symmetry is set up it will continue, partially at least, even after the external circuit is opened, because of the armature reaction due to the equalising current itself. By shifting one of the positive and one of the negative sets of brushes independently of their fellows, it was found possible to stop the equalising currents entirely, and so increase the useful output of the armature. The corrected brush spacing differed considerably from the original equidistant arrangement.

The Density of Ether.—At the Leicester meeting of the British Association Sir Oliver Lodge presented a communication on the density of ether. He premised that (1) The theory that an electric charge must possess the equivalent of inertia was clearly established by J. J. Thomson in the *Phil. Mag.* for April, 1881. (2) The discovery of masses smaller than atoms was made experimentally by J. J. Thomson, and communicated to Section A at Dover in 1889. (3) The thesis that the corpuscles so discovered consisted wholly of electric charges was sustained by many people, and was clinched by the experiments of Kaufmann in 1902. (4) The concentration of the ionic charge, required to give the observed corpuscular inertia, can be easily calculated; and, consequently, the size of the electric nucleus, or electron, is known. (5) The old perception that a magnetic field is kinetic has been developed by Kelvin, Heaviside, FitzGerald, Hicks, and Larmor, most of whom have treated it as a flow among magnetic lines; though it may also, perhaps equally well, be regarded as a flow perpendicular to them and along the Poynting vector. The former doctrine is sustained by Larmor, as in accordance with the principle of least action, and with the absolutely stationary character of the ether as a whole, the latter view appears to be more consistent with the theories of J. J. Thomson. (6) A charge in motion is well known to be surrounded by a magnetic field; and the energy of the motion can be expressed in terms of the energy of this concomitant field, which again must be accounted as the kinetic energy of ethereous flow. (7) Putting these things together, and considering the ether as essentially incompressible—on the strength of the Cavendish electric experiment, the facts of gravitation, and the general idea of a connecting continuous medium—the author reckons that to deal with the ether dynamically it must be treated as having a density of the order 10^{12} grm. per cubic centimetre. (8) The existence of transverse waves in the interior of a fluid can only be explained on gyrostatic principles—*i.e.*, by the kinetic or rotational elasticity of Lord Kelvin. And the internal circulatory speed of the intrinsic motion of such a fluid must be comparable with the velocity with which such waves are transmitted. (9) Putting these things together, it follows that the intrinsic or constitutional vortex energy of the ether must be of the order 10^{33} ergs per cubic centimetre. The conclusion he arrived at was thus, that every cubic millimetre of the universal ether of space must possess the equivalent of a thousand tons, and every part of it must be squirming internally with the velocity of light.

Municipal Ownership in America.—We have referred in a previous issue to the preliminary reports upon municipal ownership prepared by the National Civic Federation, which revealed a wide difference of opinion upon the merits and demerits of the case. The final report has now been published, and, judged from the abstract that is telegraphed to the *Times* by its correspondent at Washington, it affords a very striking contrast to the preliminary reports. In the final report, says the *Times* correspondent, 19 of the 20 members of the commission affix their signatures to what practically amounts to a condemnation of municipal ownership as practised in the United States. In the first place they scout the idea that in it may be found a panacea for political evils, though they add "with the regulations we have advised, with the publication of accounts and records, and with systematic control, the danger of corruption of public officials would be very much reduced." Their recommendations include four important rules—namely, the appointment of an executive manager with full responsibility, holding his place during good behaviour; the elimination of all political influence; the separation of the finances of the venture from those of the rest of the city's business; and, finally, exemption from the debt limit of the necessary bond issues for revenue-producing utilities. Legislation by the various States is also recommended, by which cities will be empowered upon a vote and under reasonable regulations either to initiate public utility works or to take over any such works previously under private ownership. They further suggest that no stocks or bonds for public utilities be issued without the approval of some competent authority, and recommend the "consideration of a sliding scale, which has proved successful in some cases in England with reference to gas, and has been adopted by Boston." By this method official investigation settles the authorised capitalisation and a standard rate of dividend is fixed. The most important conclusions at which the commission arrives are that municipal ownership should never be undertaken solely for profit, and that "it should not be extended to revenue-producing industries which do not involve the public health

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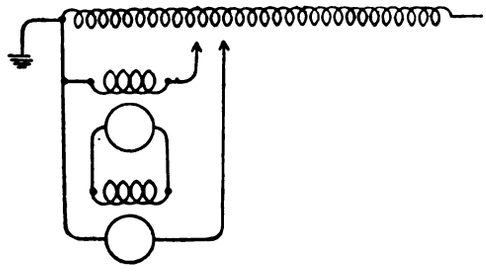
or safety, or transportation, or permanent occupation of public streets or grounds." It further considers that public utilities, whether in public or private hands, are best conducted under a system of legalised and regulated monopoly; that franchise grants to private corporations should be terminable after a fixed period, and should meanwhile be purchasable at a fair value; and, lastly, that corporations should be subject to public regulation and examination. The commission agrees that the municipal enterprises of Great Britain, where "a high type of municipal ownership, the result of many years of struggle and improvement, has been found," contrast favourably with those of the United States, where "we believe to be true the accusation that the political activity of a public service corporation has often been responsible for the unwillingness or inability of cities to secure a higher type of public services."

Regeneration with Single-Phase Railway Motors.—A method of using single-phase railway motors to restore energy to the generating system was described in one of the papers read before the recent Niagara convention of the American Institute of Electrical Engineers. One of the motors of the equipment is used as an exciter for the others. By providing the auto-transformer with suitable voltage outputs the value of the field current of the exciter is varied through a wide range. In this respect the conditions are very much more favourable than in the case of the direct-current motor, in which the only variations that can possibly be made are in the series-parallel combinations of the motors which are being used as generators. The arrangement of the motors and their connections is shown in the accompanying diagram. Assume a car or locomotive upon which the motors are mounted to be in motion, the armatures turning at a correspond-



ing speed. If the field circuit of the first machine be connected to the transformer an alternating E.M.F. will be generated by its armature, the value of which will be directly proportional to the speed. If the field circuit of the other motor be connected to the exciter armature an alternating current will pass through it, and the second armature will in turn generate an alternating E.M.F., the value of which varies about as the square of the speed—the excitation of the first machine remaining constant. The E.M.F. generated by the second armature will bear a very close time-phase relation with the E.M.F. of the transformer, for the reason that the current in the field circuit connected to the transformer lags approximately 90 time-degrees behind the E.M.F., as does the current in the field circuit of the second machine. This combination throws the generated E.M.F. of the second machine approximately 180 time degrees back of the transformer E.M.F., or by reversing the connections in the same time-phase relation. One other point that is worthy of note in connection with the operation of this system is the absolute safety and stability of the combination. While the machines being operated as generators are normally series machines, not one of the armatures is connected in series with its own field coils, and under no condition can there be any surging or building up of load. In case of momentary interruption of the supply circuit, the circuit again being restored, the system will again operate exactly as before the interruption, there being no surging or violent action of the machines.

Electric Heating.—With a conservativeness characteristic of his race, the Englishman submits very slowly to innovation; on the other hand, he looks at times with horror and no little indignation at the onward march of progressive forces which tend to denude the institutions of his grandfathers of their fossilised remains, and render those same institutions more in accord with modern ideas. Perhaps, nowhere is he more reactionary than in his own home, where he is beyond that stress of competition which soon bears down his prejudices in the outside world, and where old-fashioned ideas and methods still largely prevail. It is doubtless to this spirit that the slow progress made in the use of electricity for domestic purposes (other than lighting) may be attributed, although its advantages have often been shown. In this respect we are behind the States, which holds out many examples that we may profitably study. There, central stations are encouraging the introduction of electric heating appliances, and the rate of progress seems to be very good, especially in the smaller towns. A notable example is Grinnell, a small college town, the population of which is about 5,000. Our New York contemporary, the *Electrical World*, describes the progress made with electric heating devices in that town, which is shown by the following figures: electric flat-irons in service, 235; complete electric cooking outfits in service, six; complete electric cooking outfits under contract, four. Besides, there are a lot of electric cooking appliances in homes which do not have complete outfits. The experience of various customers as to the cost of electric cooking in different sizes of families under different conditions may interest central-station managers. In one family of five, where all the cooking was done electrically, the bills, at 2½d. per kilowatt-hour, for three months of 1907 were as follows: January, 15s. 7d.; February, 14s. 4d.; March, 22s. 8d. Another family of two has no other cooking arrangements than the electric. The gentleman, being a travelling man, is absent part of the time, and both members of the family are away at other times. The results are interesting, however, as showing the expenses under such conditions, where light housekeeping is done and where electric cooking is especially applicable: 1906—January and February, 26s. 5d.; March and April, 24s. 9d.; May and June, 36s. 2d.; July, 9s. 9d.; September, 9s. 2d.; October, 16s. 8d.; November, 10s. 10d. 1907—January, 6s. 9d.; March, 11s. 9d. In a family of six, where all of the cooking was done electrically for six weeks previous to this investigation, the bill was 29s. In a family of seven, part of the cooking was done electrically, most of the baking being done on a coal range, and the coal range also being used in winter to help heat the house. The results in this case are also of interest, and are as follows: 1906—May, 17s. 8d.; June, 9s. 6d.; August, 14s. 7d.; September, 14s. 6d.; October, 15s. 2d.; November, 6s. 3d.; December, 6s. 4d. 1907—January, 17s. 3d.; February, 4s 9d.; March, 4s. 9d. The list of utensils used in a typical home is one G.E. percolator, one G.E griddle, one Simplex waffle-iron, one American edgewise broiler, one G.E. oven, two two-quart G.E. cereal cookers, one G.E. frying-pan, one American 1,300-watt immersion coil for the slow cooker. This is a branch of business which is capable of enormous development, and the first step in that direction is in educating the public in the possibilities attending the use of electricity for domestic purposes and convincing them of the reasonableness of the cost.

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SOUTH METROPOLITAN ELECTRIC LIGHT AND POWER COMPANY.

The New Power Station.

Now that the general question of power supply in London, for the time being, at any rate, is shelved (for there is little or no possibility of the only Bill affecting the question now before Parliament—that promoted by the companies—making further headway this session), attention must needs be turned to the efforts of the existing undertakers to meet the increasing demand for a cheap supply of power in the metropolitan area. Though the advantages that were expected to accrue from the linking up of the various electricity undertakings must be postponed until the general question comes to be considered in a more reasonable and less partisan light, much inconvenience and waste can be mitigated by the enterprise of existing undertakers in producing a supply of energy under the most advantageous conditions, and encouraging a demand for it within their respective areas. That, apparently, is the policy which is being pursued by the South Metropolitan Electric Light and Power Company, Limited, in whose new station at Blackwall Point, East Greenwich, there was recently erected and put in operation the first instalment of the large power plant which it is hoped to have ultimately in operation.

Many will doubtless remember that the company was originally known as the Blackheath, Greenwich, and District Electric Light Company, which in 1900 commenced the supply of electricity in Greenwich, Blackheath, and Lee. The original area has been successfully extended, until at the present time some 27 square miles are supplied by the company. To convey some idea of the nature of the present area, it should be mentioned that it is bounded on the north by the River Thames, on the south by the urban district of Beckenham and the borough of Bromley, on the east by the borough of Woolwich, and on the west by the boroughs of Deptford, Camberwell, Lambeth, and Croydon. This area is, of course, largely residential, but it includes some very important industrial centres too. The extensions included in 1903 an adjoining area covered by the Lewisham and Penge electric lighting orders, and in 1904 the undertaking of the Crystal Palace and District Electric Supply Company was acquired. Parliamentary powers were also granted in 1903 to the company to supply energy in bulk to tramways and adjoining electric supply undertakers, and in 1904 the name of the company was changed to its present more comprehensive title. The company distributes alternating current throughout its area, and in this connection it is interesting to note that the future development of electricity supply points to the more extended use of polyphase alternating current for distribution purposes.

The new power-house has been designed to admit of easy and ready extensions at low cost. The north wing is intended to have a capacity of 10,000 kw., and the south wing 22,000 kw. The lay-out of the station has been designed for a 25 per cent. overload (continuous working), making the total capacity 55,000 h.p. The site, a view of which can be seen in Fig. 1, comprises 2½ acres, with good river frontage and facilities for cheap coaling, and an abundant supply of water for condensing, with further facilities for coal storage on adjacent land, extending to a further 1½ acres. At present the coal is unloaded from barges alongside the quay wall directly into bunkers at a cost of approximately 1½d. per ton, and when the quantity of coal to be handled is greater it is proposed to build a deep-water jetty, so that ships of 1,500 to 2,000 tons can be discharged. This is expected to effect a saving in fuel of approximately 1s. per ton.

The first equipment of the north wing has just been completed. This consists of two two-phase 2,500-h.p. turbo-alternators and 42in. river pipes, etc., which are sufficient for the whole of the north wing. It is proposed to extend the plant in this section by installing later two three-phase 3,500-kw. turbo-alternators, and in the south wing, which has not yet been erected, there will be installed four three-phase 5,500-kw. turbo-alternators, as well as complete boiler-house plant for same.

The new buildings are situated on the bank of the river in close proximity to the company's original station. The main building is constructed of steel framework, the walls being of reinforced concrete. It measures 118ft. by 116ft., and the height to the eaves is 40ft. from the floor level, the whole being erected on a concrete foundation float, 3ft. thick, supported on 12in. pitch-pine piles. The chimney (built by the Alphons Custodis Company) is 86ft. in height from the ground level and 10ft. in diameter, carried on a separate concrete float, 5ft. thick.

The boiler-house is equipped with three Babcock and Wilcox water-tube marine type boilers, each having an evaporative capacity of 20,000lb. of water per hour at 200lb. pressure. The overload capacity of each boiler is 25,000lb. per hour. Each boiler is fitted with a Babcock and Wilcox chain-grate stoker (driven through shafting by a 7½-h p. induction motor of the B.T.H. type), the speed of which can be varied from 6ft. to 27ft. per hour; Babcock and Wilcox superheaters are also fitted, provided with special damper gear for regulating the superheat from 40deg. to 200deg. F. There are three Green's economisers, each containing 160 tubes, with scrapers driven by a 3-h.p

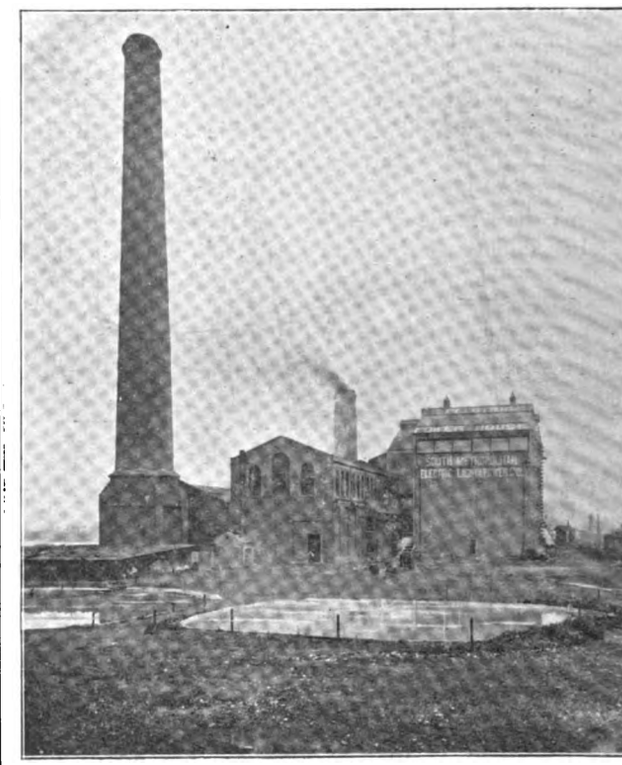

FIG. 1.—View of the Exterior of the South Metropolitan Electric Light and Power Co.'s Power Station at Blackwall Point, East Greenwich.

B.T.H. induction motor. The induced-draught fan is fitted between the main flue and chimney, capable of maintaining a suction draught of 2in. (water gauge); a 9-h.p. B.T.H. induction motor is employed to operate the fan. The coal bunkers are intended to supply the three boilers already installed and the three which will be placed opposite, and have a capacity of 600 tons each. The conveyors are of the Babcock and Wilcox silent gravity bucket type, each driven by a 5-h p. B.T.H. induction motor. These supply the bunkers with coal at the rate of 20 tons per hour, receiving it from barges by means of a crane and grab.

Two cast-iron wells (8ft. in diameter) are sunk on the wharf front, each containing gear for controlling the supply of condensing water from the river, consisting of one Gwynne's electrically-driven centrifugal pump (capable of delivering 5,000 gallons per minute) and the necessary pipes and valves. Two 42in. cast-iron pipes are laid from the wells to the bed of the river (a distance of 273ft.). At the river end of each pipe a suction box is fixed with special grating. The arrangement is such that either of these pipes can be used as suction or delivery; in other words, the flow can be reversed at will, having been specially designed to prevent accumulation of mud. As complete syphonic action is obtained, the work done by the circulating

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pumps is considerably reduced. From the wells to the turbine-house are laid two 24in. pipes, with a 15in. branch to each of the condensers.

So far two turbo-generators have been installed, a view of which is given in Fig. 2. The turbines are of the Willans-Parsons parallel-flow type, directly coupled to two 1,500-k.v a. Dick-Kerr alternators running at a speed of 1,500 r.p.m. Each unit is furnished with a direct-coupled exciter mounted on the generator shaft and produces two-phase current, 50 cycles, at 3,000 volts. The plant is designed for an overload of 25 per cent., and 50 per cent. for a period of two hours. Each turbine exhausts direct into a surface condenser of the Mirrlees-Watson type placed immediately beneath it, having a cooling surface of 4,600 square feet. The steam-piping (of solid-drawn steel), made and erected by Messrs. Babcock and Wilcox, consists of a 10in. main with 6in. branches from the boilers and 8in. branches to the turbines. The water supply is obtained from an artesian well 300ft. deep and 8in. bore. Pumping plant supplies the reserve tank at the rate of 10,000 gallons per hour. A water softener of the Lassen and Hjort type (capacity 2,000 gallons per hour) is used to feed the hot-well tank with the necessary softened make-up water. Two single-cylinder Weir boiler feed pumps are installed, each capable of feeding 10,000 gallons per hour, drawing from the hot-well and delivering through the economisers to the boilers A supply of water from the Metropolitan Water Board's public supply is available in case of emergency.

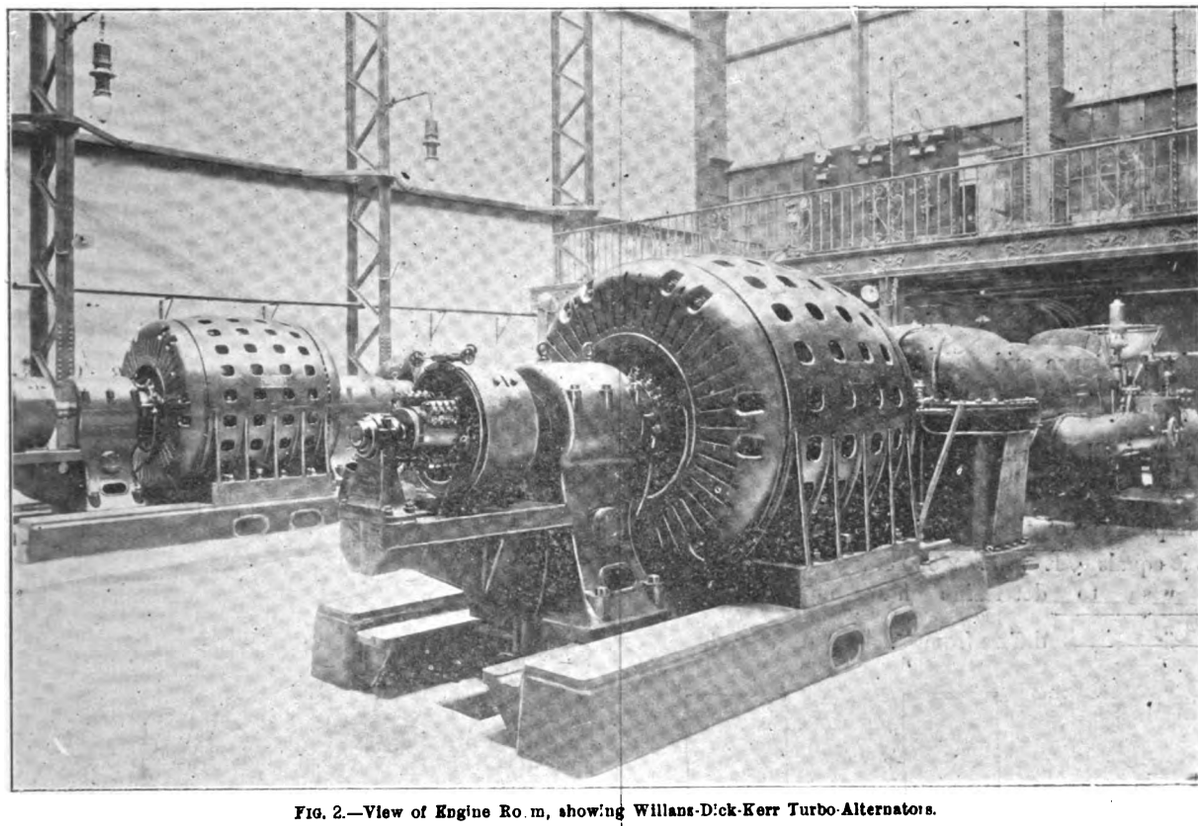

FIG. 2.—View of Engine Room, showing Willans-Dick-Kerr Turbo-Alternators.

The switchboard gallery is situated at one side of the engine-house, but the switchgear is at present practically unimportant, as it is only intended for the control of the two units and for electrical connection with the company's old station, which is close at hand. The board consists of three operating panels of the B.T.H. type, including two two-phase alternating-current generator panels, fitted with B.T.H. ammeters, wattmeters, voltmeters, and 3,000-volt main oil switches, with overload relays and field control switches. The third is an interconnecting panel, fitted with an oil-break switch, voltmeter, and synchronism indicator, which has been fixed so that the turbine sets can be run in parallel with the reciprocating plant in the west engine-house. The oil switches and 'bus bars are mounted in stone fireproof compartments behind the operating panels.

The foregoing description of the plant at the new station which we are enabled to give (thanks to the facilities offered us by Mr. H. W. Bowden, the engineer-in-chief, and Mr. J. A. Constable, one of the resident engineers) relates, of course, to only a small portion of the proposed equipment, which, when completed, should enable the company to cope with the demand of users as well as authorised undertakers both for light and power. The station is situated in the centre of an important industrial area, and there is no reason why, with energetic canvassing, factories in that area should not follow the practice of factories throughout the kingdom in "changing over" to electrical working, and take a supply which the South Metropolitan Company are able to produce under such advantageous conditions.

INSTRUMENT TRANSFORMERS.

BY CHARLES C. GARRARD, PH.D.

(*Concluded from page 72.*)

8. *Ratio Resistance according to Prof. Fleming.*—This is illustrated in Fig. 7, and its construction is fully described in Prof. Fleming's "Handbook for the Laboratory and Testing Room," vol. i, p. 446. In Fig. 7 two sets of frames are shown, each set being intended for use up to 2,000 volts, and having a resistance of 40,000 ohms. They can, however, be used up to 3,000 volts per set of frames, and as many frames can be put in series as may be necessary. These resistances are very satisfactory, and in practice have been found to remain extremely constant in resistance, whereas the form illustrated in Fig. 4 has given trouble in this respect, principally due to bad joints and the connections between sections coming undone. The chief disadvantages of the Fleming form are that it is expensive to make and cumbersome to use, and is easily damaged.

9. *Simple Form of Voltmeter Ratio Resistance.*—A form of resistance made by the present writer is illustrated in Fig. 8. This consists simply of a china tube wound with 4,000 turns of No. 46 S.W.G. Eureka wire. The wire is wound as closely together as possible, double silk-covered wire being used. No attempt is made to wind non-inductively or without capacity, the total resistance of each single tube being 283,500 ohms. Each tube is intended for a maximum voltage of 5,000 volts, three being used in series for 15,000 volts. After the tubes are wound, they are varnished and placed inside the outer wooden box, and the

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space between the outside of the porcelain tube and the inside of the wooden box filled up with paraffin wax. The inside of the china tube is left open to facilitate cooling. It will be recognised readily that a resistance constructed in this fashion is comparatively cheap to make, and is of a strong construction, capable of withstanding rough usage. A cross-sectional drawing of the resistance is given in Fig. 9

The theoretical source of error in a ratio resistance constructed according to Fig. 9 is that, owing to the self-induction, the ratio of the impedance of the tapped part to the impedance of the whole is not the same as the ratio of the ohmic resistances as measured on the potentiometer. Owing to the small voltage between turns, the capacity of the winding can be neglected. To take the worst possible case we will assume that the tapped portion (the end 120 turns) has not got any self-induction, and that the whole of the self-induction of the tube is in the untapped part.

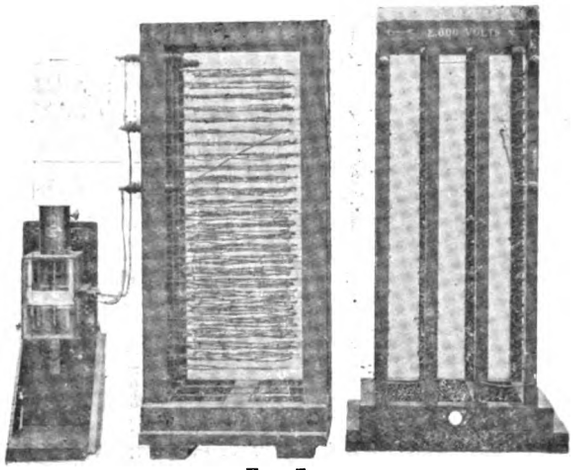

FIG. 7.

Let the resistance and self-induction of the whole tube be R ohms and L henries, and the resistance of the tapped portion r ohms.

We first of all determine the ratio $\frac{r}{R}$ on the potentiometer.

The impedance of the tube is $\sqrt{R^2+p^2 L^2}$, or for 50 periods it equals $\sqrt{R^2+4\pi^2 2{,}500 L^2}$.

We wish to determine how much the ratio $\frac{\sqrt{R^2+4\pi^2 2{,}500 L^2}}{r}$ differs from $\frac{R}{r}$.

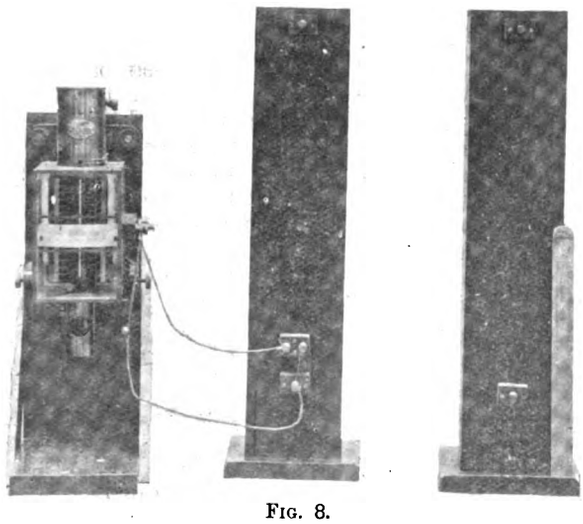

FIG. 8.

We can calculate the self-induction of the tube from the known dimensions, using the formula given by Mascart and Joubert—viz.:

$$L = 4\pi a N^2 \left[\left(1+\frac{3b^2+c^2}{24a^2}\right)\log_\epsilon \frac{4a}{\sqrt{b^2+c^2}} - \lambda_1 + \frac{b^2}{4\mu_1 a^2}\right]$$

where a = mean radius;
b = half the length of the wound portion of the tube;
c = half the diameter of the wire;
λ_1 and μ_1 are constants, in this case equal to ·5 and ·125 respectively.

The self-induction of the tube works out to 2·91 henries. We have, therefore,

$$\frac{\sqrt{R^2+\pi^2 L^2\times 10^4}}{r} = \frac{\sqrt{2{\cdot}835^2\times 10^{10}+835\times 10^3}}{r}$$

$$= \frac{10^5\sqrt{8{\cdot}04+{\cdot}00008}}{r} = \frac{283{,}500}{r} = \frac{R}{r}$$

within one part in 10,000. It will be seen, therefore, that the self-induction of the winding does not appreciably alter the impedance, and, therefore, the volt drop across the tube will be the same as if it were a pure non-inductive resistance. Provided, therefore, that the electrostatic voltmeter itself does not introduce any error, a resistance tube wound in the manner of Figs. 9 and 8 provides an accurate method of high-tension voltage measurements.

10. *Error introduced into Divided-Resistance High-Voltage Measurement Method by Capacity of Voltmeter.*—Prof. Fleming ("Handbook of Electrical Laboratory," vol. i., p. 449) points out that a possible source of error in the divided resistance method of measurement arises from

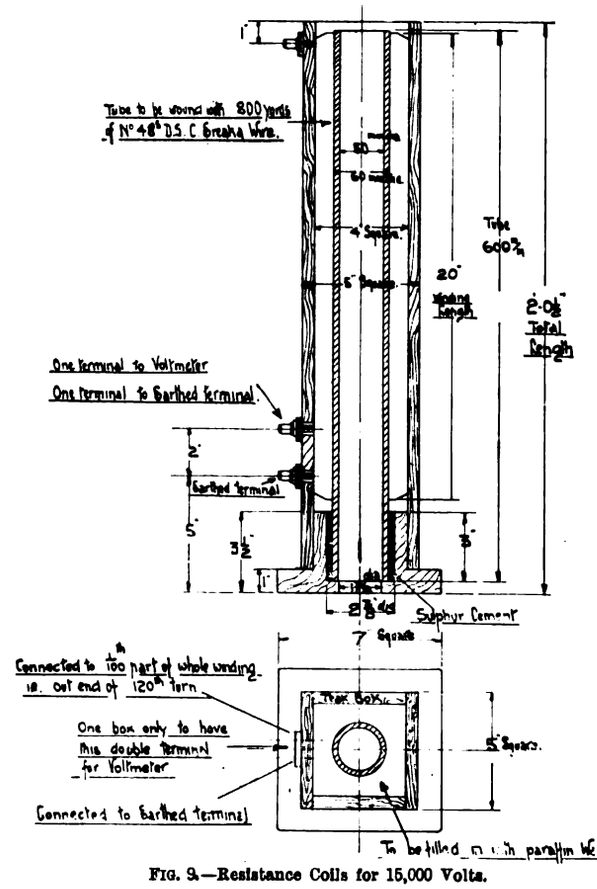
Tube to be wound with 800 yards of N°48 D.S.C Eureka Wire.
One terminal to Voltmeter
One terminal to Earthed terminal.
Earthed terminal
Sulphur Cement
Connected to 1/100th part of whole winding i.e. end of 120th turn
One box only to have this double terminal for Voltmeter
Connected to Earthed terminal
To be filled in with paraffin Wax

FIG. 9.—Resistance Coils for 15,000 Volts.

the capacity of the low-tension voltmeter. He gives the following formula, which takes this correction into account:

$$\frac{v}{V} = \frac{P_1}{\sqrt{K^2 p^2+(P_1+P)^2}};$$

where $P_1 = \frac{1}{R}$ (see Fig. 6);

$P = \frac{1}{r}$;

K = capacity of the voltmeter;

$p = 2\pi \times$ frequency.

We will now calculate what the capacity of the voltmeter must amount to to cause an error of 1 per 1,000 when using the resistance illustrated in Figs. 8 and 9 on 50 periods. The total resistance is, in round figures, 300,000 ohms, so that

R = 297,000 ohms. r = 3,000 ohms.

We have, therefore, $\frac{v}{V} = \frac{P_1}{\sqrt{(100\pi K)^2+(P_1+P)^2}} = \frac{{\cdot}999}{100}$,

which works out to K = ·048 microfarad.

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If, therefore, the electrostatic voltmeter has a capacity exceeding ·048 microfarad, an error in the measurement exceeding ·1 per cent. will be caused. In order to get some idea as to what size of air condenser ·048 microfarad corresponds to, we will calculate the dimensions of one having this capacity in which the distance between the plates is 1mm., which is rather under the clearance in the voltmeter itself. The capacity of an air condenser in electrostatic units is

$$\frac{S}{4\pi a} = \frac{S}{4\pi a} \times \frac{1}{3{\cdot}1^2 \times 10^{11}} \text{ farads.}$$

where S = area of dielectric and a = distance between plates = 0·1cm. We therefore get

$$\frac{S}{4\pi a\, 3{\cdot}1^2 \times 10^{11}} = \frac{{\cdot}048}{10^6},$$

from which S = 58,000 square centimetres, which is evidently a very much larger condenser than a multicellular electrostatic voltmeter. It follows that the error introduced by the capacity of the voltmeter is negligible.

11. *Comparison of Simple Form of Ratio Resistance with Fleming Ratio Resistance.*—In order to compare the resistance illustrated in Figs. 8 and 9 with the one illustrated in Fig. 7, the following tests were made: Two tubes, in series with each other, were connected in parallel with two Fleming frames (which were in series with each other) across a voltage of 4,000 at 50 periods per second. The ratios of the resistances were measured carefully previously with low-tension direct current, and were found to be 58·89 and 42·30 respectively. Across the tapping of each

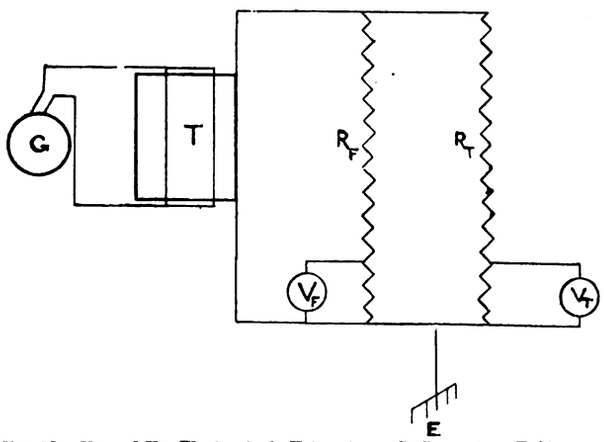

FIG. 10.—V_F and V_T, Electrostatic Voltmeters; G, Generator; T, Step-up Transformer.

resistance Kelvin low-tension multicellular voltmeters were connected, the calibrations of which were compared carefully with each other with low-tension continuous current. The connections of the test were as in Fig. 10.

If V_F be the reading of voltmeter V_F and V_T be the reading of voltmeter V_T, then $V_F \times 42{\cdot}30$ should equal $V_T \times 58\,89$, provided the ratios as measured in the low-tension tests apply on the high-tension test.

The percentage error, if any, is

$$\frac{V_T \times 58{\cdot}89 - V_F \times 42{\cdot}30}{V_F \times 42{\cdot}30} \times 100 = 139{\cdot}2\,\frac{V_T}{V_F} - 100.$$

The following are the measurements made:

V_T	V	$139{\cdot}2\,\frac{V_T}{V_F}$	Percentage error.
71·8	100	99·9	−0·1
72	100·4	99·8	−0·2
72·1	100·4	99·9	−0·1
72·3	100·6	100·05	+0·05
72·3	100·8	99·8	−0·2
72·3	100·9	99·85	−0·15
60·8	84·8	99·85	−0·15
60·8	84·8	99·85	−0·15
60·8	84·8	99·85	−0·15
	Average percentage error		−·13

The percentage error found is well within the limits of the observational error, and it follows that the simple resistance illustrated in Figs. 8 and 9 enables measurements of high-tension alternating currents to be compared directly with a standard cell with a high degree of accuracy.

12. *Comparison of High-Voltage Measurement Methods with Official Standards.*—As the methods of measuring high-tension voltages herein described are used for calibrating wattmeters and other measuring apparatus for commercial use, it was highly desirable that the measurements should agree with the standards of high voltage kept by the official standardising and testing institutions. To this end a Kelvin vertical electrostatic voltmeter was compared very carefully at 6,600 volts 50 ~ with the resistance shown in Fig. 4. On sending the voltmeter to the National Physical Laboratory it was found that the calibration constant given by that institution agreed exactly with that found by comparison with the testing resistance. In order to get a comparison with the standard kept by the Board of Trade a portable transformer has been constructed which can be tested by the Board, and the writer has no doubt that when this has been done complete agreement will be found here also. Complete results of this test are not yet available.

13. *General Conclusion regarding High-Voltage Test-Room Measurements.*—Prof. Fleming, in his "Handbook of the Electrical Laboratory and Testing Room," vol. i., p. 449, says: "Although the use of the divided resistance is a convenient method of stepping from one voltmeter to another, it is necessary to take the precaution to check the high-tension voltmeter by the only unexceptionable method—viz., by connecting it to the terminals of a high known resistance through which a known measured current is passed." The present writer ventures to think, however, that this method is open to just the same objection as the divided resistance If the known resistance be measured on continuous current, one must be perfectly sure that there is no self-induction present, otherwise the alternating-current volt drop will not be equal to the current multiplied by the ohms. Of course, if one is under the necessity of reducing the voltage measurement to a standard of current measurement (ampere balance, for example), the method recommended by Prof. Fleming is the one to adopt. However, the modern standard cell, especially the Weston, leaves nothing to be desired as an ultimate standard. This is becoming recognised every day more and more, and many leading consulting engineers in their specifications define their voltages in terms of the standard cell. By adopting the standard cell as fundamental unit, the method of divided resistance enables the highest voltages to be easily and accurately measured. By calculating or measuring the self-induction capacity, etc, one can satisfy oneself that the errors introduced thereby are within the limit of accuracy aimed at. This is necessary to be done, however, in any method of high-voltage measurement whatsoever.

THE BRITISH ASSOCIATION.

Address to the Engineering Section.

BY SILVANUS P. THOMPSON, D.SC., F.R.S., PAST PRESIDENT I.E.E., PRESIDENT OF THE SECTION.

(Concluded from page 161.)

Antonio Pacinotti in 1864 described a machine of his own devising, having a specially wound revolving ring magnet placed between the poles of a stationary magnet, which, while it would serve as an admirable generator of electric currents if mechanically driven, would also serve as an excellent electric motor if supplied with electric currents from a battery. He thereupon laid down the principle of reversibility of action, a principle more or less dimly foreseen by others, but never before so clearly enunciated as by him. And so it turned out in the years from 1860 to 1880, when the commercial dynamo was being perfected by Gramme, Wilde, Siemens, Crompton, and others, that the machines designed specially to be good and economical generators of currents proved themselves to be far better and more efficient motors than any of the earlier machines which had been devised specially to work as electromagnetic engines. Moreover, with the perfection of the dynamo came that cheap source of electric currents which was destined to supersede the battery. That a dynamo driven by a steam-engine furnishing currents on a large scale should be a more economical source of current than a battery in which zinc was consumed, does not appear to have ever

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occurred to the engineers who, in 1857, discussed the feasibility of electric motive power. Indeed, had any of them thought of it, they would have condemned the suggestion as chimerical. There was a notion abroad—and it persisted into the eighties—that no electric motor could possibly have an efficiency higher than 50 per cent. This notion, based on an erroneous understanding of the theoretical investigations of Jacobi, certainly delayed the progress of events. Yet the clearest heads of the time understood the matter more truly. The true law of efficiency was succinctly stated by Lord Kelvin in 1851, and was recognised by Joule in a paper written about the same date. In 1877 Mascart pointed out how the efficiency of a given magneto-electric machine rises with its speed up to a limiting value. In 1879 Lord Kelvin and Sir William Siemens gave evidence before a parliamentary committee as to the possible high efficiency of an electric transmission of power; and in August of the same year, at the British Association meeting at Sheffield, the essential theory of the efficiency of electric motors was well and admirably put in a lecture by Prof. Ayrton. In 1882 the present author designed, in illustration of the theory, a graphic construction, which has been ever since in general use to make the principle plain. The counter E.M.F. generated by the motor when running, which Hunt and Tyndall deplored as a defect, is the very thing which enables the motor to appropriate and convert the energy of the battery. Its amount relatively to the battery's own E.M.F. is the measure of the degree to which the energy which would otherwise be wasted, as heat is utilised as power. Pure science stepped in, then, to confirm the possibility of a high efficiency in the electric motor *per se*. But pure science was also brought into service in another way. An old and erroneous notion, which even now is not quite dead, was abroad to the effect that the best way of arranging a battery was so to group its component cells that its internal resistance should be equal to the resistance of the rest of the circuit. If this were true, then no battery could ever have an efficiency of more than 50 per cent. It was supposed in many quarters that this misleading rule was applicable also to the dynamo. The dynamo makers discovered for themselves the fallacy of this idea, and strove to reduce the internal resistance of the armatures of their machines to a minimum. Then the genius of the lamented John Hopkinson led him to apply to the design of the magnetic structure of the dynamo abstract principles upon which a rational proportioning of the iron and copper could result. A similar investigation was independently made by Gisbert Kapp, and between these accomplished engineers the foundations of dynamo design were set upon a scientific basis. To the perfection of the design the magnetic studies of our ex-president, Prof. Ewing, contributed a notable part, since they furnished a basis for calculating out the inevitable losses of energy in armature cores by hysteresis and parasitic currents in the iron when subjected to recurring cycles of magnetisation. Able constructive engineers, Brown, Mordey, Crompton, and Kapp, perfected the structural development, and the dynamo within four or five years became, within its class, a far more highly efficient machine than any steam-engine. And as by the principle of reversibility every dynamo is also capable of acting as a motor, the perfection of the dynamo implied the perfection, both scientific and commercial, of the motor also. The solution in the eighties of the problem how to make a dynamo to deliver current at a constant voltage when driven at a constant speed found its counterpart in the solution by Ayrton and Perry of the corresponding problem how to make a motor which would run at constant speed when supplied with current at a constant voltage. Both solutions depend upon the adoption of a suitable compound winding of the field magnets.

A little later alternating currents claimed the attention of engineers, and the alternating-current generator, or "alternator," was developed to a high degree of perfection. To perfect a motor for alternating currents was not so simple a matter. But again pure science stepped in in the suggestion by Galileo Ferraris of the extremely beautiful theorem of the rotatory magnetic field, due to the combination of two alternating magnetic fields equals in amplitude, identical in frequency and in quadrature in space, but differing from each other by a quarter-period in phase. To develop on this principle a commercial motor required the ingenuity of Tesla and the engineering skill of Dobrowolsky and of Brown: and so the three-phase induction motor, that triumph of applied science, came to perfection. Ever since 1891, when at the Frankfort Exhibition there was shown the *tour de force* of transmitting 100 h.p. to a distance of 100 miles with an inclusive efficiency of 73 per cent., the commercial possibility of the electric transmission of power on a large scale was assured. The modern developments of this branch of engineering and the erection of great power stations for the economic distribution of electric power generated by large steam plant or by water turbines are known to all engineers. The history of the electric motor is probably without parallel in the lessons it affords of the commercial and industrial importance of science.

But the query naturally rises: If a steam-engine is still needed to drive the generator that furnishes the electric current to drive the motors, where does the economy come in? Why not use small steam-engines, and get rid of all intervening electric appliances? The answer, as every engineer knows, lies in the much higher efficiency of large steam-engines than of small ones. A single steam-engine of 1,000 h.p. will use many times less steam and coal than a thousand little steam-engines of 1 h.p. each, particularly if each little steam-engine required its own little boiler. The little electric motor may be designed, on the other hand, to have almost as high an efficiency as the large motor. And while the loss of energy due to condensation in long steam-pipes is most serious, the loss of energy due to transmission of electric current in mains of equal length is practically negligible. This is the abundant justification of the electric distribution of power from single generating centres to numerous electric motors placed in the positions where they are wanted to work.

Education and Training of Engineers.

Interplay of action and reaction make for progress not only in the evolution of the scientific industries, but also in the development of the individual engineer. In him, if his training is on right lines, pure theory becomes an aid to sound practice; and practical applications are continually calling him to resort to those abstractions of thought, the underlying principles which when known and formulated are called theories. Recent years have brought about a so much better understanding of education, in its bearing upon the professions and constructive industries, that we now seldom hear the practical man denouncing theory, or the theorist pooh-poohing practice. It is recognised that each is useful, and that the best uses of both are in conjunction, not in isolation. As a result of this better understanding distinct progress is being made in the training of engineers. Of this the growth of the engineering departments of the universities, and of the technical colleges and schools, affords striking evidence. The technical schools, moreover, are recognising that their students must have a sound preliminary education, and are advancing in the requirements they expect of candidates for admission. They are also finding out how their work may best supplement the practical training in the shops, and are improving their curricula accordingly. In the engineering industry, too, Great Britain is slowly following the lead taken in America, Germany, and Switzerland in the recognition afforded to the value of a systematic college training for the young engineer, though there is still much apathy, and even distrust, shown in certain quarters. Yet there is no doubt that the stress of competition, particularly of competition against the industry and the enterprise of the trained men of other nations, is gradually forcing to the front the sentiment in favour of a rational and scientific training for the manufacturer and for the engineer. As William Watson, in his "Ode on the Coronation," wrote in a yet wider sense of England:

> For now the day is unto them that know,
> And not henceforth she stumbles on the prize;
> And yonder march the nations full of eyes.
> Already is doom a-spinning. . . .

Truly the day is "unto them that know." Knowledge, perfected by study and training, must be infused into the experience gained by practice: else we compete at very unequal odds with the systematically trained workers of other nations. Nor must we make the mistake here in the organisation of our technical institutions of divorcing the theory from its useful applications. In no department is this more vital than in the teaching of mathematics to engineering students. For while no sane person would deny that the study of mathematics, for the sole sake of mathematics, even though it leads to nothing but abstract mathematics, is a high and ennobling pursuit, yet that is not the object of mathematical studies in an engineering school. The young engineer must learn mathematics, not as an end in itself, but as a tool that is to be useful to him. And if it is afterwards to be of use to him, he must learn it by using it. Hence the teacher of mathematics in an engineering school ought himself to be an engineer. However clever he be as a mathematical person, his teaching is unreal if he is not incessantly showing his learners how to apply it to the problems that arise in practice; and this he is incapable of doing if these problems do not lie within his own range of experience and knowledge. Were he a heaven-born senior wrangler, he is the wrong man to teach mathematics if he either despises or is ignorant of the ways in which mathematics enter into engineering. The fact is that for the great majority of engineering students, the mental training they most need is that which will enable them to think in physics, in mechanics, in geometric space, not in abstract symbols. The abstract symbols, and the processes of dealing with their relations and combinations, are truly necessary to them: but they are wanted not for themselves, but to form convenient modes of expressing the physical facts and laws, and the interdependence of those physical facts and laws. When the student loses grip of the physical meaning of his equations, and regards them only as abstractions or groupings of symbols, woe betide him. His mathematics amount to a mere symbol juggling. That is how paper engineers are made. The high-and-dry mathematical master who thinks it beneath

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him to show a student how to plot the equations $y = A \sin x$, or $r = b \sin \theta$, or who never culls an example or sets a problem from thermodynamics or electricity, must be left severely on one side as a fossil. Better a living Whitworth scholar than a dry-as-dust Cambridge wrangler. He at least knows that elasticity is something more real than the group of symbols $E = p \div \frac{\Delta x}{x}$, which any mathematician may "know," even though he be blissfully ignorant whether the force required to elongate a square-inch bar of steel by one one-millionth of its length is 10oz. or 10 tons.

One evidence of the wholesome change of opinion that is springing up concerning the training of engineers is the abandonment of the system of taking premium pupils into works with no other test or qualification than that of the money bag. Already many leading firms of engineers have been finding that the practice of taking sons of wealthy parents for a premium does not answer well, and is neither to their own advantage nor in many cases to that of the "pupil," whom it is nobody's particular business in the shops to train. Premium pupilage is absolutely unknown in the engineering firms of the United States or on the Continent of Europe. The firms who have abandoned it are finding themselves better served by taking the ablest young men from the technical schools and paying them small wages from the first, while they gain experience and prove themselves capable of good service. Messrs. Yarrow and Co. have led the way with a plan of their own, having three grades of apprenticeship, admission to which depends upon the educational abilities of the youths themselves. Messrs. Siemens have adopted a plan of requiring a high preliminary training. The Daimler Motor Company has likewise renounced all premiums, preferring to select young men of the highest intelligence and merit. Messrs. Clayton and Shuttleworth have quite recently reconstructed their system of pupil-apprenticeship on similar lines. The British Westinghouse Company and the British Thomson-Houston Company have each followed an excellent scheme for the admission of capable young men. Even the conservatism of the railway engineers shows signs of giving way, for already the Great Eastern Railway has modernised its regulations for the admission of apprentices. What the engineering staffs of the railway companies have lost by taking in pupils because of their fathers' purses rather than for the sake of their own brains, it is impossible to gauge. But the community loses too, and has a right to expect reform.

To this question, affecting the whole future outlook of engineering generally, a most important contribution was made in 1906 by the publication by the Institution of Civil Engineers of the report of a committee (appointed in November, 1903) to consider and report to the council upon the subject of the best methods of education and training for all classes of engineers. This committee, a most influential and representative body, consisting of leading men appointed by the several professional societies, the Institutions of Civil, Mechanical, and Electrical Engineers, the Institution of Naval Architects, the Iron and Steel Institute, the Institution of Gas Engineers, the Institution of Mining Engineers, and two northern societies, was ably and sympathetically presided over by Sir William H. White. Its inquiries lasted over two years and included the following sections: (1) preparatory training in secondary schools; (2) training in offices, workshops, factories, or on works; (3) training in universities and higher technical institutions; (4) post-graduate work. The findings of this committee must be received as the most authoritative judgment of the most competent judges. So far as they relate to preparatory education they suggest a modernised secondary school curriculum in which there is no one specialised scientific study, but with emphasis on what may be called sensible mathematics. They also formulated one recommendation so vital that it must be quoted in full: "A leaving examination for secondary schools, similar in character to those already existing in Scotland and Wales, is desirable throughout the United Kingdom. It is desirable to have a standard such that it could be accepted by the Institution [of Civil Engineers] as equivalent to the studentship examination, and by the universities and colleges as equivalent to a matriculation examination." One may well wonder why such a reasonable recommendation has not long ago been carried out by the Board of Education. Perhaps it has been too busy over the religious squabble to attend to the pressing needs of the nation.

The second set of recommendations relates to engineering training. It begins with the announcement that "long experience has led to general agreement among engineers as to the general lines on which practical training should proceed"; but goes into no recommendations on this head beyond favouring four years in workshops, on works, in mines, or in offices, expressing the pious desire that part of this practical training should be obtained in drawing offices, and suggesting that during workshop training the boys should keep regular hours, be subject to discipline, and be paid wages. It then lays down a dozen recommendations as to the "academic" training suitable for the average boy. He should leave school about 17. He should have a preliminary year, or introductory workshop course of a year, either between leaving school and entering college, or after the first year of college training. If the workshop course follows straight on leaving school, there must be maintenance of studies either by private tuition or in evening classes, so that systematic study be not suspended. For the average student, if well prepared before entering college, the course should last three academic years (three sessions). In some cases this might be extended to four or shortened to two. A sound and extensive knowledge of mathematics is necessary in all branches of engineering, and those departments of mathematics which have no bearing upon engineering should not claim unnecessary time or attention. The committee strongly recommends efficient instruction in engineering drawing. The college course should include instruction (necessarily given in the laboratory) in testing materials and structures, and in the principles underlying metallurgical processes. In the granting of degrees, diplomas, and certificates, importance should be attached to laboratory and experimental work performed by individual students, and such awards should not depend on the results of terminal or final examinations alone.

All this is most excellent. It will be seen that it is entirely incompatible with the premium-pupil system, which may, therefore, be regarded as having been weighed and found wanting. For two things clearly stand out: that the young engineer must be college-trained, and that when he goes to works he should be regularly paid. It would have been well if the committee could have been more explicit as to the proper course of workshop training; for instance, as to the systematic drafting of the young engineer through the shops—forge, foundry, pattern shop, fitting shop, etc.—and as to the proper recognition of the duty of the shop foreman to allocate work to the novice in suitable routine. These are doubtless among the matters in which "long experience has led engineers to general agreement." But this being so, it would have been well to state them authoritatively. A notable feature of this report is its healthy appreciation of the advantages of training, and an equally healthy distrust of the practice of cramming for examinations. As soon as any subject is crammed, it ceases to afford a real training. "Nature provides a very convenient safety valve for knowledge too rapidly acquired." It is even whispered that a new species of crammer has arisen to "prepare" candidates in engineering for the graduate examinations of the Institution of Civil Engineers. The distinguished framers of this epoch-making report on the education and training of engineers at least give no countenance to any such parasitical development. For the scheme of education and training at which the committee has aimed is genuinely scientific, a happy federation of the theoretical with the practical. It seeks to place the training on a broad basis, and to secure to every future engineer worthy of the name the advantage of learning his professional work in both its aspects. It seeks, in short, to take advantage of that reflex action between science and its applications in which lies the greatest stimulus to progress. Its adoption will utilise for the young engineer, and, therefore, for the engineering industry as a whole, the facilities for training now so widely afforded throughout the country. If the institutions, schools, and colleges where engineering training is offered are but rightly developed and co-ordinated, the engineers of Great Britain need have no fear as to holding their own against the trained engineers of other countries. It is for the employers to make use of these institutions, and to show that sympathetic interest in their efficiency which is essential to their full success.

THE ORIGIN AND PRODUCTION OF CORRUGATION OF TRAMWAY RAILS.*

BY W. WORBY BEAUMONT, M.I.C.E.

That which is known as "corrugation" of the surface of tramway rails has given rise to much speculation and some investigation concerning its cause. Although known as corrugation, it is hardly perceptible as of a form usually understood when so described. It consists of an approximately regular alternation of hard and soft, or of hard and less hard, patches of the surface rolled by the tramcar wheels. The surface of the hard patches is very slightly higher than the general surface, but it becomes sufficiently so to declare its existence by the noise made by the tramcar wheels as they roll along the rails as though running over a rack with teeth of almost no assignable height.

Corrugation declares itself variously as to time of its appearance after a rail is first used, as to position of rail, somewhat differently in different towns, but it has become general since the introduction of electrically-propelled tramcars, and particularly the latter-day heavy cars. It is

* Paper read before the British Association at Leicester.

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the cause of considerable annoyance, and considerable expense is incurred in grinding down the raised hard prominences by emery grinding blocks.

Many papers have been written upon this corrugation, offering almost as many suggestions and speculations as to its origin. None of them have, however, been accepted as being in accordance with the facts of the phenomena of the appearance and growth of corrugation, and some have invoked as causes conditions which are equally attendant where corrugation does not arise. These papers have been too numerous for reference here, and as the hypotheses appealed to, though in many cases very interesting, do not affect the conclusions of the author, he may be pardoned if for the present he only refers those interested to the *Journal* of the Tramway and Light Railways Association.

Although the physical and mechanical conditions involved in the origin of corrugation may be said to be somewhat complex, the mode of operation of the causes is simple, and for an explanation, simple phenomena of known recurrence and adaptation in engineering works may be appealed to for this purpose, and for some of these the author may refer to a paper he read before Section G at Liverpool "On the Causes of Fracture of Railway Rails": "When a piece of cold iron or steel is subjected to pressure exceeding the limit of elastic compression by a rolling or hammering action, or by both these combined, the result is spreading of the material and general change of the dimensions. This is equally the case with a plate pane hammered on one side or rolled on one side while resting on a flat surface, or with a rivet when hammered over. In all these cases, and many others, the hammering or rolling work done upon the surfaces tends to compress the material beneath it, but being nearly incompressible and unchangeable in density, the material flows, and change of form results.

"Generally the material thus changed in form suffers permanently no greater stresses than those within its elastic limit of compression or extension. When, however, the material is not free to flow or change its form in the direction in which the stresses set up would act, the effect of continued work done on the surface is the growth of compressive stress exceeding elastic resistance.

"In the case of railway rails the freedom for the flow of the material is very limited, especially when considered with reference to the rolling and hammering media and the surface contact between rails and wheels. Hardening of the surface takes place, and destructive compression of the surface material is set up. If the materials be cast iron, the destructive compression causes crumbling of the superficial parts and the consequent relief of the material immediately below it from stress beyond that of elastic compression; but when the material is that of steel rails the stress accumulates, the upper part near the surface being under intense compression, differentiating from a maximum at the surface."

The repeated running of the heavily-laden tramway wheel over the rail does thus gradually compress the surface of the crown of the rail. Of this stress transversely the material relieves itself partially by the detrusion at the edges of the rail, where it forms a lip both on the outside and the groove side. This lip remains on the outside of the rail, but is worn off on the inside by the wheel flange. In the longitudinal direction the stresses arising from the compression of the surface material are not thus relieved, and the result is the formation of an extremely hard surface in patches of various shapes and lengths. Sometimes this hard surface is continuous, with but slight breaks of intermediate slightly roughened surface. In many places the surface between the hard bright patches is pitted with various degrees of coarseness of pitting. Where the bright hard patches alternate with an approach to regularity with the dull and rougher surface patches, the result is known as corrugation. This character of surface may be found on every heavily-worked tramway under conditions of such impartial contrariety that it may be ascribed to conditions of origin which are general. They are found in straight level lines and on straight gradients. They are found on curves, and especially on curves of moderate and large radii, and they generally appear soonest on the outer rail of a curve.

The author offers the following, then, as an explanation of the origin and production of the corrugation of tramway rails:

1. The compression of the material of the table of the rail by the tramcar wheels; cold rolling.

2. The microscopic deformation of the surface of the rail on the small area of contact between wheel and rail, that deformation being attended by a depression under the wheel.

3. That the material of the surface in front of the wheel and the depression recurrently forms a slight ridge of unassignable height, over which the wheel mounts.

4. That the area of contact between wheel and ridge is minute, and the pressure, therefore, very great per unit of area, and hence the severe pressing of the ridge into the material of the rail table and its hardening or its crushing.

5. That the distance between each ridge thus formed by the rolling wheel will vary slightly with the strength, hardness, and toughness of the rail, and with the speed of the car wheels.

6. That the originating ridge forming the incipient hard patch is added to on the formative or rear side, thus gradually extending from a mere transverse line to an area of increasing length.

7. That the hard patch thus formed for a time resists the destructive deformation by the wheel, but that it increases the rate of local side detrusion, and that the extruded material is in some positions of the rail worn off by the flanges of the wheels, which are thereby pushed laterally against the other side of the rail groove, and make more or less distinctive marks thereon.

8. That a steel rail loses a large part, if not most, of its weight in wear by the separation of the compressed and crushed surface by minute exfoliation, the surface film exceeding the dimensions of the sub-surface, and separating itself by disintegration, flaking, or crumbling as shown by pitting.

9. That this disintegration of the surface partially relieves the surface film of the destructively compressed parts and the sub-surface of the corresponding tension.

10. That the hard bright patches depend for their duration upon the strength of their supporting materials, and in many cases should disappear, though they reappear in different position.

11. That the appearance of the hard patches on the outer curves of some lines where none appear on other of the rails of the same line is due to the heeling over of the cars on the curve and the extra weight thereby put on the outer wheels.

12. That it is possible that the final passes of some rails through the rolls at a comparatively low temperature may produce a condition in the rail conducive of initiation of corrugation, and thus accessory before the rail is laid.

13. That there are numerous circumstances and conditions in the working life of a tramway rail which produce great contrariety in results, including (*a*) its correct laying, which causes a greater or lesser width of the table to present itself to the wheel tread; (*b*) the grinding slip of the propelling wheels on one side of the car affected by the condition of the rail surface and by the heavier load on the outer rails on curves causing or permitting the wheels on the inner rails to slip; (*c*) the speed of the cars; (*d*) the character of the dirt and grit on the rails, the constitution of the rail, etc

14. The remedy appears to be: (*e*) lighter cars; (*f*) harder rails; (*g*) moderate speeds; and (*h*) larger wheels

15. Some excellent examples of the corrugation in numerous stages of production with long, short, narrow, wide, somewhat irregular, extremely irregular, and other illustrations of the vagarial appearance of the disease may be seen on the new tramway of the London County Council on the Thames Embankment between Blackfriars Bridge and the Temple Gardens.

Discussion.

Colonel R. E. Crompton expressed the indebtedness of the section to the author for his paper. It was exceedingly difficult to assign a definite cause for the fact in question, which had been noted on light railways and also on some main-line tracks. These roaring rails had given great trouble in India, and on the

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Darjeeling line, with an 18in. gauge, they had had to make one wheel on each axle loose. In America the idea was general that the corrugation of the rails was due to the unequal diameters of the wheels. However accurately they might be turned, the wear was not equal. The driving action accelerated the difference and helped to cause the corrugation. Recently he had noticed that the same effect was being produced on macadam roads by motorcars. The studded tyres helped in the wear. He agreed that the action of tyres on the surface of the rails described by Mr. Beaumont was a contributory cause. The idea of reducing speeds to prevent this action was not feasible. The public would prefer noise to low speed.

Mr. A. R. SENNETT thought that the want of uniformity in the wheel diameter caused corrugations. The rocking of the vehicles also assisted, and tended to shift the tread from one part of the wheel to another where the diameter was different.

Mr. C. HAWKSLEY asked if the first hump in the corrugation was found near a joint in the rail.

Prof. HUDSON BEARE confirmed the author's statement as to the hardening of the surfaces of the rails. He had tested a number of rails which had been used on the North-Eastern Railway. These resisted bending well if the pressure was applied to the upper surface. When the rails were turned over they had no strength, showing that the surface had been hardened and cracked by the traffic.

Prof. S. P. THOMPSON said that a periodic cause must be looked for to explain the periodic effect. He suggested that the twist in the axles might be the cause, and it certainly would explain the increase in the formation of corrugation when once set up. He asked if there was any evidence of a movement of the corrugations along the track.

Mr. W. W. BEAUMONT, in reply, attributed the corrugations in macadam roads to the steam-rollers. The fact that corrugations appeared on rails on straight lines discounted the idea that they were due to unequal slip on the wheels. Again, any slipping due to unequal diameter would not occur, he thought, at such frequent periods as corresponded to the corrugations. In reply to Mr. Hawksley, they started at any point on the line, and not at the joints particularly.

NOTE ON TUNING IN WIRELESS TELEGRAPHY.*

BY SIR OLIVER LODGE.

The principles of tuning were clearly explained by Mr. Duddell last Friday, and I shall assume them known, but it is not to be supposed that the application of these principles requires the arc. Sufficient tuning for all practical purposes can be obtained by using the right kind of spark. It is possible to require too long a train of waves, in which case the latter half of the train will undo what the former half has begun, in analogy with beats. Thirty or forty swings can be easily got by a spark, and that is enough for practical requirements.

Kind of Spark.—A non-tuned station puts all the energy into a single snap, so as to produce a single discontinuous pulse calculated to affect every kind of station within the range of its power. For a tuned station this sudden snappy spark is to be avoided. The ideal arrangement is a spark of a sufficient number of alternations of approximately equal strength, no one of which is sufficient to operate, but such that the accumulated influence of all of them is powerful. Instead, therefore, of the clean, polished metal knobs in fresh or compressed air, which are suitable for a snappy spark, a tuned station may employ a series of points enclosed in ionised air, so as to maintain conduction as long as possible. The maintenance is also assisted by using an alternator with a curve of the right shape—not a sine curve, but a high-shouldered curve—so as to keep up the stimulating potential for a sufficient time. It is this kind of spark which, at the Lodge-Muirhead station at Elmers End, was photographed by Mr Duddell in a revolving mirror, and exhibited on Friday night.

Effect of the Earth.—But attention to the spark alone is not sufficient: it is necessary to eliminate the influence of the earth. For the snappy or non-tuned emission, such as was employed by Mr. Marconi for great distances, it is convenient to use an elevated wire on the one hand, and the earth on the other; but for a tuned station this is not appropriate. A tuned station requires two capacity areas, both elevated above the earth, as published by me in 1897 These capacity areas are usually horizontal frames, of shapes devised by my friend and partner, Dr. Alexander Muirhead, who has found that there is a best position for the lower aerial, such that the capacity is a minimum. It was under these circumstances that the photograph above spoken of was taken, and the sending efficiency is most marked. If the lower aerial be too much raised, the radiating power diminishes; if it be lowered, the train of waves is shortened, until, when it is allowed to touch the earth—still more if it is connected with the earth—there is hardly any train of waves at all, and the discharge is almost dead-beat. There is a great advantage in thus getting rid of earth contacts, inasmuch as variations of moisture and uncertainties of the soil do not enter in to confuse the problem and throw the tuning out. But even if the earth remained constant it would be deleterious: it seems by its resistance to damp out the vibrations and shortens the train of waves, in so far as it is allowed to exert any influence.

Method of Receiving from a Distant Tuned Station.—The first thing is to tune up the receivers accurately. This can be done by a Duddell radio-micrometer, which measures the received energy satisfactorily, although it is very small. Tuning is altered until the reading on this micrometer rises to a high value, then the receiving apparatus is purposely made insensitive so that the coherer will only respond to this high value—in other words, to the top of the curve. The message can then be received from the desired station If the receiving apparatus were left sensitive it would be affected violently by the desired station, but it would pick up a number of disturbances from other stations. By working at the top of the curve it feels the desired station alone.

Perfection of Tuning.—In this way it was possible to receive at Hythe from Elmers End while a much more powerful and nearer station at Dover was making a disturbance, which was entirely eliminated. It is easy to hear the ships in the Channel, but it is also easy to tune everything out and listen to the desired station alone. A 5 per cent. change could be made to throw this out and throw a neighbouring one in, but in practice it would be undesirable to try to work quite so close as that. With changes of that order of magnitude, however, several neighbouring sending stations can be made to send to several neighbouring receiving stations without interference—that is to say, diplex telegraphy is possible, though not duplex.

Tuning at the Sending End.—In order to economise power, it is desirable to have every part tuned. The aerials connected through the secondary of a peculiarly-made Ruhmkorff coil constitute one oscillating system of a low frequency, to correspond with an ordinary commercial alternator which excites them. When the swing is worked up they burst through the spark gap, short-circuiting out the Ruhmkorff and giving excessively rapid oscillations, which are the ones transmitted. These are picked up by the receiving station and transferred at constant frequency into a closed air-condenser circuit, which, when its swings reach a maximum, overflows into the coherer. This is called the "overflow method," and was described by me in 1889 and 1891.

Ratio of Received to Emitted Energy.—Theoretical calculation shows that the energy received, compared with energy radiated, depends on the cube of the linear dimensions of emitter and receiver, if they are alike, and likewise on the cube of the distance between them. Measurements made with the radio-micrometer confirm this estimate approximately, the value in one series of experiments being 10^{-9}. Although this is a small fraction, the accuracy of tuning is such that messages are sent between Burma and the Andaman Islands—a distance of about 300 miles—with less than a horse-power.

Other Precautions —To get such a result, precautions must be taken to avoid damping out the oscillations, not only by elevation even of the lower aerial above the earth, but by using appropriate conductors for these excessively high frequencies. To this end the wires are finely sub-divided into insulated strands, and consist of a great cable or bundle of thinly-insulated No. 40 wires, and the various self-inductions and other arrangements for effecting tuning are similarly wound. The tuning capacities are also arranged

* Paper read before the British Association at Leicester.

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so as to be continuously adjustable, without pegs or discontinuities, and every kind of broken or uncertain contact is scrupulously avoided.

DISCUSSION.

Prof. S. P. THOMPSON, as chairman, congratulated the section on the valuable paper they had just heard. He thought it would give rise to a most valuable discussion on the advantage or otherwise of connecting the aerials to earth.

Sir W. H. PREECE did not agree that the system described by Sir Oliver Lodge dispensed with the earth. Although there was no direct connection, that did not prevent the earth being made use of in the transmission.

Sir OLIVER LODGE, in reply, was not surprised at the incredulity of Sir William Preece as to the earth being used. For very long transmissions the earth and sky played a most important part, and by alternative reflections enabled the waves to follow the curvature of the earth. He had proved, however, that for sending tuned messages there was a great advantage in having the lower aerial at some distance from the earth's surface. There was a critical position in which the best effect was produced. If the lower aerial was brought nearer to the earth than this, it reduced the number of waves in each train. It then became more difficult to get tuning.

THE ARC AND THE SPARK IN RADIO-TELEGRAPHY.*

BY W. DUDDELL, F.R.S.

The discovery by Heinrich Hertz between 1887 and 1889 of experimental means for the production of electric waves and Branly's discovery that the conductivity of metallic particles is affected by electric waves form the foundation on which, in 1896, Signor Marconi built up his system of wireless telegraphy. Many of the early investigators certainly had glimpses of a future system of being able to transmit messages without connecting wires, for as early as 1892 Sir William Crookes predicted in the *Fortnightly Review* the possibility of telegraphy without wires, posts, cables, or any of our costly appliances, and said, granting a few reasonable postulates, the whole thing comes well within the realms of possible fulfilment. Two years later Sir Oliver Lodge gave his memorable lecture on the work of Hertz, and carried the matter a step nearer the practical stage.

There will not be time to dwell to-night on the early history of the art and its development. It will be necessary, however, to explain some of the fundamental properties of signalling by means of Hertzian waves in order to be able to bring out clearly the relative advantages and disadvantages of the two rival methods now in practical use for producing Hertzian waves for wireless telegraphy. The fundamental part of the transmitting apparatus may be said to consist of a long conductor, generally placed vertically, in which an alternating or oscillating current is set up by some suitable means. Such a conductor radiates energy in the form of Hertzian waves at right angles to itself into space, in very much the same way that an ordinary candle sends out light in all directions. This radiation, though it is strictly in the nature of light, is invisible to our eyes, as the frequency is too low. If we set up any other conductor approximately parallel to the first, there will be produced in this second conductor alternating or oscillating currents having the same frequency as those in the first conductor, and which can be detected by suitable nstruments.

The simplest, and one of the earliest, methods for producing Hertzian waves for use in wireless telegraphy consisted in charging up by means of an induction coil a vertical insulated conductor, which was allowed to discharge itself to earth by means of a spark taking place between its lower end and another conductor which was connected to earth. To detect the Hertzian waves, Marconi employed an improved form of the Branly filings tubes, which is known as the "coherer." In order to transmit messages the radiation is started and stopped so as to form short and long signals, or dots and dashes of the Morse code, out of which the whole alphabet is built up in the well-known way.

* Evening discourse delivered before the British Association at Leicester.

As I have already stated, the radiation takes place round the vertical conductor approximately equally in all directions. Suppose that I set up my transmitting apparatus here in Leicester, a receiving station set up either in Nottingham, Derby, Rugby, or Peterborough would be able to receive the message equally well. Should I wish to send a message from here to Nottingham at the same time that Derby wishes to speak to Rugby, then the receiving station at Nottingham would receive both the message from Leicester which it should receive and the message from Derby which it was not required to receive. To get over this difficulty, known as "interference," a large number of devices have been patented. The most successful in practice is syntony, or tuning. In this method each station has allotted to it one definite frequency or tune, and the apparatus is so arranged at each station that it will only be affected by messages which are radiated by other stations on its own frequency or tune, and not by any other radiation. To take a musical analogy, supposing I had somebody who was either deaf to all notes of the piano except, say, the middle "C," or had such a musical ability that he could tell at once when I struck the middle "C"; then I could transmit to that person a message in the ordinary Morse code by playing on the middle "C," and that person, whom I shall call Mr. C, would not take any notice of the fact that I might also be playing on the notes D, E, F, G, etc., but Mr. C would confine his attention entirely to what is being done with the middle "C." It is conceivable that I might find a series of persons or train them so that they could each pick out and hear one note only of the piano, irrespective of what was being played on the other notes or of any other noises that were taking place. Taking an ordinary seven-octave piano and neglecting for a moment the black notes, this would give me 56 distinct notes on which I could transmit messages; so that, transmitting from Leicester, I might send messages simultaneously to 56 different towns.

The number of possible simultaneous messages depends on the number of octaves there are on the piano used, and on how close together the different notes are which can be used without producing confusion. For instance, it might be quite easy to train someone to distinguish with certainty between "C" and "E," and pick out signals on "C" at the same time that signals are being sent on "E." It is certainly more difficult to do this with two notes that are closer together, say "C" and "D," and still more difficult if the half-tones are used as well. The problem, therefore, in wireless telegraphy is to arrange the receiving apparatus so that it can hear, or perhaps I should say, more accurately, so that it can only see, notes of one definite frequency or pitch, and not be affected by any other notes, even though of but slightly different pitch. Another requirement to obtain good working is that we should use as little power as possible at our transmitting station consistent with obtaining enough power in our receiving instruments to work them with certainty.

I have a mechanical model to illustrate how we are able to make our receiving instruments very sensitive to one frequency and only slightly affected by frequencies which differ but slightly from its proper frequency. The transmitter in the model consists of a disc that can be rotated slowly at any speed I like, with a pin fixed eccentrically on its face. This pin can be connected to a vertical wire which moves up and down as the disc rotates. I shall assume that the movement of this wire corresponds with the movement of the electricity in the vertical conductor. As a receiving apparatus I have a pendulum, and representing the ether between the transmitter and receiver I have an elastic thread connecting the pin in the disc to the pendulum. When I set the disc rotating slowly the elastic thread is alternately stretched out and relaxed and the pendulum is a little affected. If I gradually increase the speed of the disc at one definite speed it will be found that the pendulum is set into violent oscillation, and by observation it will be found that when this is the case the disc makes one complete revolution in exactly the same time that the pendulum would make one complete swing if left to itself—that is to say, that the disc and the pendulum make the same number of swings per second or have the same frequency—in music they would be said to be in tune

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with each other. If instead of allowing the disc to rotate continuously I allow it to make only half a dozen revolutions, then the pendulum will be affected, but much less strongly. The greater the number of revolutions the disc makes up to a certain maximum number, the more the pendulum will be caused to swing. Instead of starting and stopping the disc I can keep the disc rotating, and start and stop the pulls on the elastic thread by moving the pin in the face of the disc in and out from the centre, which produces a movement which much more nearly corresponds with the actual current in the vertical wire, as used in spark telegraphy.

It is necessary here to explain the relationship that exists between the wave-length, the frequency, and the velocity of propagation of Hertzian waves. The waves travel with, as far as we know, the same velocity as light—namely, 300,000,000m., or 186,000 miles, per second. Between these quantities we have the relationship that the product of the wave-length by the frequency is equal to the velocity of propagation, or, as I have already mentioned, the velocity of light. The wave-lengths which are of practical use in wireless telegraphy at the present time range between 100m. and 3,000m., though, of course, it is quite possible to use for special purposes wave-lengths outside these limits. The corresponding frequencies in practice use are, therefore, between 3,000,000 and 100,000 complete periods per second. We require, therefore, to produce in the vertical conductor alternating or oscillating currents of any frequency within this range, and to have a sufficient number of oscillations following one another without interruption to allow of good syntony being obtained.

There are three methods of producing these currents—namely, the alternator, the spark, and the arc methods. There are great difficulties in the way of constructing an alternator to give such high-frequency currents, and I can best illustrate this by taking an example. Suppose that it is required to build an alternator to work at the lowest frequency—namely, 100,000 periods per second—and let us assume that we can drive this alternator by means of a turbine at the high speed of 30,000 r.p.m. This alternator could not have a diameter much above 6in. for fear of bursting, and, as it makes 500 revolutions per second, it would have to generate 200 complete periods for each revolution, so that the space available for the windings and poles for one complete period will be less than $\frac{1}{10}$in, a space into which it is quite impossible to crush the necessary iron and copper to obtain any considerable amount of power. In spite of the small space that we have allotted to each period, as there are 100,000 periods per second, the speed of the surface of the moving part works out at over 500 miles per hour. A small alternator has been built to give over 100,000 frequency, but the amount of power it produced was extremely small. Several experimenters have stated lately that they have built alternators giving these high frequencies and a considerable amount of power, but, so far as I am aware, there are no reliable data available as to the design of these machines. If it should prove possible to construct alternators for these very high frequencies, we shall be able to obtain a sufficient number of consecutive oscillations of the current in the aerial of definite frequency to enable very sharp syntony to be obtained. Not only will this greatly reduce interference troubles in wireless telegraphy, but such alternators will be of the greatest value for wireless telephony.

The earliest method of producing high-frequency oscillations was proposed by Lord Kelvin, who pointed out that if a Leyden jar or condenser be allowed to discharge through a circuit possessing self-induction or electrical inertia, then, under certain conditions, the discharge of the jar is oscillatory—that is to say, that the electricity flows backwards and forwards in the circuit several times before the jar or condenser becomes finally discharged. I think that perhaps the best way to make this matter clear is by demonstrating experimentally with an oscillograph the nature of the discharge of a condenser, and how it is affected by the resistance and self-induction in the circuit. As a mechanical analogy one may look upon the charged condenser as a weight attached to a spring which has been pulled away from its position of rest. To discharge the condenser we let go the weight, and it begins to oscillate backwards and forwards, and, after making a greater or less number of oscillations, finally comes to rests. The number of oscillations per second will depend upon the strength of the spring and the mass of the weight, which correspond with the capacity and self-induction in our electrical circuit. The number of oscillations before the weight finally comes to rest is determined by the friction which tends to stop the weight, or by the resistances and other losses in the electrical circuit.

In practice the aerial conductor acts as a Leyden jar or condenser. It is charged with electricity and allowed to discharge, the current oscillating backwards and forwards in the aerial during the discharge. In many installations Leyden jars or condensers are electrically connected to the aerial, so that the oscillations taking place in them are transmitted to the aerial. Any remarks, therefore, that I may make as to the oscillations which may be set up in condensers apply equally well to the oscillations in the aerial in wireless telegraphy. For wireless telegraphy it is usual to charge the condensers or aerial by means of an induction coil or an alternator to a very high voltage, and it is allowed to discharge by means of a spark between the two electrodes which form the ends, so to speak, of a gap in the electrical circuit. As long as the pressure is low the spark-gap is a perfect insulator; when the pressure becomes high enough the air between the electrodes breaks down and a spark passes the gap, becomes conducting, and allows the condenser to discharge. The property of the spark-gap of passing almost instantaneously from a condition of being an insulator for electricity to being an extremely good conductor for electricity is of the utmost value in the spark method of wireless telegraphy. The more perfectly the spark-gap insulated before the discharge takes place, and the more perfectly it conducts after the discharge has taken place, the better it is for our purpose. If I take two electrodes sufficiently far apart in air and gradually raise the electrical pressure between them, the first indication that anything is going to happen is the formation of fine violet aigrettes on the more pointed or rougher parts of the electrodes. This is known as the brush discharge. By gradually raising the pressure, this brush discharge extends further out into the air, until finally the air between the two electrodes becomes so strained that it breaks down and the real spark passes. The long thin spark that occurs in this case is not very suitable for wireless telegraphy, as its resistance is too high. Ordinary lightning flashes are good examples of long sparks on a very large scale. If instead of working with the electrodes far apart they are placed nearer together, and if the electrical pressure is supplied from a very powerful source, then directly the spark passes it forms a thick discharge having the appearance of a flame in which the nitrogen of the air is actually being burnt; a process which, it is hoped, in the future may have immense importance in the supply of artificial nitrates for agriculture. This flame-like discharge has a low electrical resistance, but has the effect that it so heats or modifies the air that it is difficult to get the air to insulate again, after one discharge, ready for the next.

If a large quantity of electricity is discharged through the spark-gap, and if the spark lasts a very short time compared with the interval between successive sparks, then a highly conducting spark can be obtained, as well as a good insulation between the sparking terminals when no discharge is passing. In order to help to bring the gap back to its insulating condition after each discharge, many devices are employed, such as subdividing the spark into several shorter sparks, cooling the electrodes, blowing air across the spark-gap, etc. When the condenser, or antenna, discharges through the spark-gap, oscillations are set up which radiate Hertzian waves. In practice in wireless telegraphy it is difficult to obtain a large number of oscillations during each discharge as corresponding with each oscillation; the antenna radiates energy. A large number of oscillations means, if we keep amplitude of each the same, that we are radiating a large quantity of energy. Besides this radiated energy, which is useful for transmitting messages, there is also energy wasted in heat in the spark-gap, in the conductors, in the glass, or other

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insulation of the condensers. It is this useless part which we require to make as small as possible. I have lately had an opportunity to determine how many oscillations actually take place in a certain wireless transmission. The experiment was made by photographing the spark as seen in a mirror rotated at a very high speed, and it was found that each spark consisted of nine or ten complete oscillations. If all the oscillations had been of equal strength or amplitude, and if the receiving circuit had been similar to my pendulum in my mechanical model, then there would be very little to be gained by increasing the number of oscillations. As the oscillations die away in the spark method, two or three times this number would probably be required for the best effect. As a matter of experiment, very good tuning was obtained with the wireless transmission referred to above.

As an example of the sharpness of tuning obtainable by the spark method, the following test, carried out on the Lodge-Muirhead installation at Hythe, may be of interest. The station at Hythe had to receive messages from Elmers End at a distance of 58 miles over land, in spite of the fact that the Admiralty station at Dover, only 9½ miles distance, was transmitting as powerfully as it could, in order to produce interference, and that the regular communications were going on in the Channel between the shipping. It was found possible with a difference of wave-length of 6 per cent. to cut out the interference from the Dover station. In the arc method of producing continuous oscillations we employ, as before, a condenser and self-induction; but, instead of charging the condenser to a high voltage and allowing it to discharge by means of oscillations which die away, and then repeating the process over and over again, we actually maintain the condenser charging and discharging continuously without any intermission, so that we practically obtained a high-frequency alternating current in the aerial.

To impress the difference on your minds, I have an incandescent lamp which I switch on and off rapidly about 10 times, and then after a short time I repeat the same flickering of the light, and so on. The flickering of the light corresponds with the oscillations in the ordinary spark method, and the time spaces between the flickers represent the times during which the condenser or antenna is being charged ready to produce a fresh series of oscillations. In practice we may have as many as, say, a couple of hundred discharges of the condenser a second, and during each discharge we may get, say, 10 complete oscillations, each oscillation lasting one millionth of a second, if the wave-length is 300m.; thus the total time that the condenser is discharging is only one one-hundred-thousandth of a second, or one five-hundredth part of the interval of time between two successive discharges. My lamp here flickers about five times per second, and makes 10 flickers before it goes out; the total time that it is flickering is two seconds, and the time before it should start to flicker again to correspond with the practical wireless case is, therefore, 1,000 seconds, or rather over a quarter of an hour. If now I represent continuous oscillations, such as are obtained by the arc method with this lamp, I shall simply keep the lamp flickering continuously, and there will be no intervals whatever.

The arc method of producing continuous oscillations is founded on my musical arc. In order to explain this I must demonstrate some of the properties of the direct-current arc. If I vary the current flowing through the arc very slowly and note the potential difference corresponding with each value of the current, keeping everything else constant, I obtain a curve generally spoken of as the characteristic of the arc. These curves under different conditions have been very thoroughly investigated by Mrs. Ayrton. With the carbon arc between electrodes in air the voltage decreases very rapidly when the current is gradually increased, starting from very low values. As the current becomes larger the rate of decrease of the voltage becomes less and less, until it is, comparatively speaking, quite small, with a current of 10 or 12 amperes. With the arc between metal electrodes similar results are obtained, except that the discontinuity in the curves, called the hissing point by Mrs. Ayrton, takes place at very small currents, generally well below an ampere. With arcs burning in hydrogen, Mr. Upson has found that the curves are generally much steeper for the larger values of the current than for the corresponding arcs burning in air. This point is of great importance as explaining the value of the hydrogenic atmosphere used by Poulsen and referred to later. In general I may, therefore, say for the above arcs that increase in current through the arc is accompanied by decrease of potential difference between its electrodes, and, *vice versâ*, decrease of the current causes increase in the potential difference. On the other hand, certain arcs, such as the arc between cored carbons, behave in an opposite manner—that is to say, current and potential difference increase and decrease together.

I demonstrated in 1900 that if I connect between the electrodes of a direct-current arc (or other conductor of electricity for which an increase in current is accompanied by a decrease in potential difference between the terminals) a condenser and a self-induction connected in series, I obtain in this shunt circuit an alternating current. I called this phenomenon the musical arc The frequency of the alternating current obtained in this shunt circuit depends on the value of the self-induction and the capacity of the condenser, and may practically be calculated by Kelvin's well-known formula. Besides the condition that an increase of current must be accompanied by a decrease in potential difference, it is necessary that the relative decrease in potential difference produced by a given increase in current—that is to say, the steepness of the characteristic—shall exceed a certain minimum value which depends on the losses in the shunt circuit. It is also necessary that an increase in current shall be accompanied by a decrease in potential difference, even when the current is varied very rapidly.

Let us consider what takes place when I connect this shunt circuit to an arc. At the moment of connection a current flows from the arc circuit into the condenser circuit, which tends to reduce the current flowing through the arc. This reduction of the current through the arc tends to raise the potential difference between its terminals, and causes still more current to flow into the condenser circuit, and I now have a condenser charged above the normal voltage of the arc. The condenser, therefore, begins to discharge through the arc, which increases the arc current and decreases the potential difference, so that the condenser discharges too much; the reverse process then sets in; the condenser becomes successively overcharged and undercharged, due to the fact that, instead of the potential difference between the terminals of the arc remaining constant and allowing the condenser to settle down with its proper corresponding charge, the potential difference actually decreases when the condenser is discharged and increases when it is charging, so as to help to keep up the flowing backwards and forwards of the current indefinitely. The oscillograph wave-forms show what is going on very clearly, and they show that in general the swing of the current in the condenser circuit attains such a magnitude that when the condenser is charging it takes the whole of the current away from the arc, so as to make the arc, although burning on a direct current, a pulsatory arc. The pulsation of the current through the arc causes the vapour column to grow bigger and smaller and the light to vary. When the vapour column grows bigger and smaller it displaces the air around it and produces a note the pitch of which is determined by the frequency of the current in the shunt circuit.

The values of the capacities of a series of condensers have been calculated by Kelvin's formula to give the frequencies corresponding with a musical octave, and the nearest values in an ordinary laboratory box of condensers have been taken and connected to a keyboard. The result shows how nearly Kelvin's law is obeyed. With this apparatus I can demonstrate the importance of tuning in electrical circuits and perform electrically some experiments which I have already performed mechanically earlier this evening. I use the large coil which forms the self-induction in the circuit shunting the arc as a transmitting circuit for wireless telegraphy by the magnetic induction or Preece method, and I have a receiving circuit consisting of a coil of wire connected to a small lamp and not connected in any way to the transmitting circuit. At a certain short distance

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between the transmitting coil and the receiving coils the indicating lamp lights if I cause my arc to sound *any* one of the notes of the octave, and so produce an alternating current of corresponding frequency in the transmitting coil. If I now tune the receiving circuit, by connecting a condenser in it, the lamp on the receiving circuit will light at about five times the distance, but it will only light when one definite note is sounded by the arc. These are the two distinct advantages of tuning—namely, greater distance and syntony, or responding to only one definite note.

For wireless telegraphy by means of Hertzian waves, based on my arc method, we require much higher frequencies in the shunt circuit. If we attempt to obtain this higher frequency from the ordinary arc burning between solid carbons in air, we find that above a certain limit the oscillations will no longer take place. This is due to the fact that we are varying the current through the arc at this higher frequency too quickly for an increase in current to be accompanied by a decrease in potential difference. I have demonstrated that if I only vary the current through the ordinary current arc sufficiently rapidly, then an increase in current is accompanied by a proportionate increase in the potential difference, and the arc behaves just like an ordinary resistance. If we work with very small current arcs we can obtain high-frequency musical arcs burning in air either between carbon or metal electrodes.

In a paper read before the International Electrical Congress at St. Louis in 1904, Mr. Poulsen showed that by placing the arc in a flame it was possible to obtain higher frequencies than when the arc was burning in air. Following this up, Mr. Poulsen came to the conclusion that the best results were obtained when the arc was burning in hydrogen, or a gas containing hydrogen, and he further added a magnetic field around the arc somewhat similar to that which has been previously used by Elihu Thomson. The arc burning in coal gas in a powerful transverse magnetic field was used by Poulsen in his early experiments to produce the high-frequency current necessary for wireless telegraphy between Lyngby and Esbjerg in Denmark. This apparatus has been further improved, and is now employed by the Amalgamated Radio-Telegraph Company in their station at Cullercoats and the other stations that they are erecting.

In both the arc and the spark methods of wireless telegraphy we employ a high-frequency alternating current in the aerial conductor. The essential difference between the two methods lies in the fact that with the spark method our alternating current in the aerial conductor first increased to a maximum value and then dies away rapidly, making only a limited number of oscillations, whereas in the arc method the oscillations are maintained continuously of unvarying amplitude. With the arc method we are further able to choose the number of consecutive oscillations which make up each signal sufficiently great to obtain the very best syntony. On the other hand, improvement in the arrangement and construction of the apparatus for the spark method has so increased the number of oscillations corresponding with each spark that it may be that we shall be able to obtain a sufficient number in each train to give as good syntony by this method as that obtained with the arc method. The arc method seems eminently suitable for very high speeds of working. As the oscillations are quite continuous, we can cut them up into groups to form the dots and dashes of the Morse alphabet, just as if we were working with a continuous current such as is used on land lines, so that there seems no reason why as high a speed of working should not be obtained from the arc method of wireless telegraphy as is obtainable by automatic signalling on land lines; for it is to be noted that the dot or shortest signal of the Morse alphabet, even at a speed of 300 or 400 words per minute, will last long enough to consist of many hundreds of oscillations of the current in the aerial, so that there will be plenty of oscillations in the group forming the dot to give good syntony.

Turning to the spark method for high working speeds, we find a difficulty in that the dot of the Morse alphabet must at least occupy the average time required to charge the condenser or aerial and produce one spark, and preferably sufficiently long for several. We are, therefore, obliged in the spark method to use a high rate of sparking for high-speed signalling. This difficulty has not become very serious with the present low speeds of sending. When we come to use considerable amounts of power to transmit messages over long distances, and we also require a high speed of working, the practical difficulty in constructing apparatus suitable for sufficiently rapid sparking will become serious. Mr. Marconi in 1905 claimed to have already reached a speed of 100 words per minute by the spark method, and lately there has appeared in the technical Press examples of high-speed signalling by the British Post Office over a distance of 15 miles, in which readable signals were received at a speed of 70 words per minute.

Turning to the receiving end, almost all the receivers that have been used in the spark method can be equally well used for the arc method; for it must be remembered that the transmission in either case is affected by Hertzian waves traversing space, and that the only fundamental difference consists in the number of oscillations in each train of waves. It must be noted, however, that in those methods in which a telephone receiver is used it is necessary to break up the continuous oscillations of the arc method into groups succeeding one another sufficiently rapidly to produce an audible sound in the receiver, for in the spark method the sounds we hear in the receiver correspond with the succession of impulses of the diaphragm, one for each spark at the transmitter. This chopping up of the continuous wave-train so as to produce audible signals in the receiving apparatus can be done either at the transmitting end or in the receiving apparatus. An example of this latter method is Poulsen's ticker.

The question whether receiving apparatus can be arranged so as to receive messages from stations equipped with the spark apparatus and from stations equipped with the arc apparatus is a matter of enormous importance at the present moment in view of the probable ratification of the Berlin Convention, which imposes an obligation on all commercial stations to intercommunicate without regard to the make or system of transmitting apparatus employed. I am of the opinion that there will be no difficulty in carrying this into effect provided that the stations using the spark method send out long trains of waves, as they should do to obtain syntonic working, which is also called for by the Berlin Convention.

An extremely interesting development which is now progressing rapidly owing to the possibility of producing continuous oscillations by the arc method is wireless telephony. Suppose that we can vary the intensity of the oscillations in a manner corresponding with the vibrations of the air which constitutes sound and speech, then we should obtain at the receiving stations a train of Hertzian waves whose amplitude varies in a corresponding way; by allowing these waves to act on a telephonic receiver which is sensitive to the intensity of the waves we shall obtain in the telephone a reproduction of the sounds. This has actually been carried into effect by employing on ordinary microphone to modify the current through the transmitting arc so as to vary the intensity of the oscillation current produced, and by employing what is known as a point detector and a telephone at the receiving station.

Another method which may be used consists in causing the microphone to vary the frequency of the oscillations of the generator, and by arranging the receiver so that it is more or less strongly affected according to the frequency of the received waves. I am informed that such good results have already been obtained on the experimental stations for wireless telephony that it is proposed to equip stations at Oxford and Cambridge for the further perfecting of this application. It is greatly to be desired that wireless telephony may develop rapidly, as it seems to me that for the purpose of communicating with ships wireless telephony will have great advantages over wireless telegraphy.

I am deeply indebted to Mr. Colson for all the facilities that he has placed at my disposal, and to his engineers for their assistance, which has enabled me to carry out the experiments in the lecture; and I have also to thank the tramway department for the special supply of current.

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DISCREET CURIOSITY.

It was Carlyle or someone equally eminent who told us that the way to get at the truth was to get people to talk. If we were to venture a criticism on such an august body of organisers as the council of the British Association, we should say that the organisation results in too many papers and too little talk. Of course, the papers themselves are in the nature of talk, but in many cases the fleeting ideas on a subject casually spoken in discussion are of more real value than the papers. Not always, only sometimes. Thus we rather admire such papers as that introduced by Mr. W. W. Beaumont to Section G on "The Corrugation of Tramrails." Mr. Beaumont's paper was a good peg to hang discussion upon, but the time was short and the audience scanty, so that due value was not received. The topic should interest all tramway authorities, and one would have expected an interested crowd in the section, for the matter is serious and touches the spot that is considered somewhat vital—viz., the pocket. However, the unfortunate part of the matter is that the pocket touched is not of the individual, but that of a community generally. Broadly speaking, all responsible officials have to estimate and afterwards to meet the costs of wear and tear. If, then, after installation some little understood effect is found to increase the losses of wear and tear, the officials have to meet a greater expense than was expected, and so their estimates suffer. Such an effect, too, plays its part in the question of depreciation. Now, since tramway work has become common it has been noticed that this corrugation effect is of greater magnitude in tramway than in railway experience, hence a greater percentage of deterioration through this effect in the one case than in the other. In the ordinary course of life the finding of an effect leads to a careful examination to find the cause, and that having been found a remedy must be sought. Corrugation here is the effect. What is the cause? Mr. Beaumont suggests any one of fifteen things, or any combination of any of these fifteen things. In the discussion other causes were suggested, such as "slip" and the rigid connection of wheels to the axle. It was pointed out, too, that the cause was probably periodic, and, again, that the periodicity of some suggested causes would not fill the bill as to facts. To us the case is simple and the solution fairly easy, but assuredly we shall probably go on talking for years, it may be centuries, without taking any practical step towards a solution. Our view is this, experiment and elimination. For example, small size of wheels. Is there any insuperable objection to, say, larger sizes and watch results? Again, rigidly fixed wheels. Is it absolutely necessary to stick to such rigidity? If not, why not change and watch effect? By proceeding thuswise elimination would take place, and we should soon get nearer to actual causes. Our suggestion will, of course, be pooh-poohed by the thoughtless, and we shall be asked as to the practicability of such experiments. "Fancy," says one man, "the cost of changing the axle gear of so-and-so companies' or authorities' cars," he not seeing that wholesale change is not required. In almost every system a few cars only pass over a section of line. If this part of the system happens to be troublesome through corrugation, all that has to be done to test the surmised cause is to adapt these few cars for the experiment, and let none other run over the affected line. The great difficulty is that everybody's business is nobody's. All are interested, but do not combine to solve, leaving solution, if it ever be obtained, to the investigation of an enthusiast. Scores of practical problems are waiting solution, and could be readily and easily solved by combination. It is difficult for the tram-

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way manager to go to his "board" or "committee" and suggest experimental work. Neither "board" nor "committee" want anything but paying works, and for either to spend money in the hope of something profitable happening is hardly possible. Why cannot the several tramway associations combine, formulate the unsolved problems that arise in practical working, and ask their respective authorities to contribute proportional amounts to the solution of the questions. We do not imagine there would be any difficulty in thus obtaining funds for the required investigation.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE TELEPHONE QUESTION.

SIR,—Mr. Bennett's long letter of July 29, printed in your issue of Aug. 2, is the dampest squib he has yet produced for the amusement of your telephone readers. The third reading of the Telegraph (Money) Bill, on the postponement of which Mr. Bennett hangs his hysterical appeal for another telephone inquiry (as if we had not had enough of them!), was taken on July 26. Therefore the Bill practically became law three days before the date of the letter! Mr. Bennett is evidently too busy compiling columns of telephonic twaddle even to read the daily news of events which apparently concern him so deeply.

As for the rest of the letter, your readers must be fairly well aware by this time that the common-battery system has been adopted by all the leading telephone administrations the world over. By his violent abuse of the Post Office for adopting what has become the standard system of telephone exchange working, Mr. Bennett again shows that on practical telephone questions he is a minority of one against the rest of the telephone world—European, American, and Asiatic.—Yours, etc.,

HERBERT LAWS WEBB.

35, Old Queen-street, Westminster, S.W.,
Aug. 2, 1907.

NOTE ON AN OSCILLOGRAPHIC STUDY OF LOW-FREQUENCY OSCILLATING ARCS.*

BY J. T. MORRIS, M.I.E E.

The present note collects together a few observations which have been made on direct and alternating current

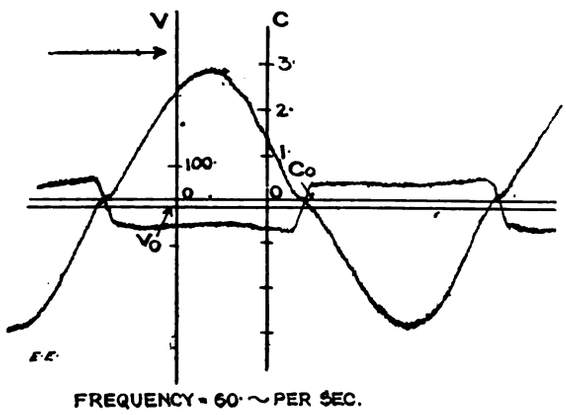

FIG. 1.

arcs, chiefly with the object of studying the effect of a change in the medium in which the arc is burning, and also to examine the effect, if any, produced on the arc by the application of a transverse magnetic field. It should be borne in mind that in no case were frequencies of more than 1,000 investigated. The work of Mrs. Ayrton, Blondel, Duddell, Simon, and others on alternating and direct current arcs is so well known by those interested in this subject that it is needless to do more than refer to it.

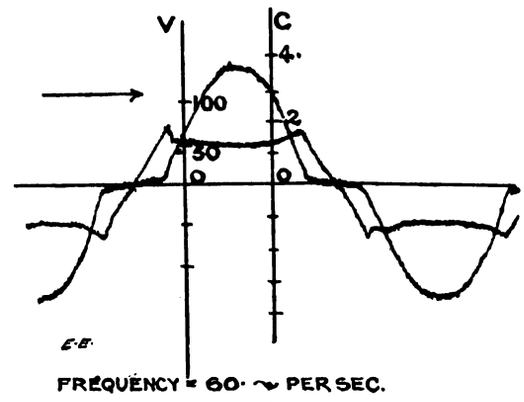

FIG. 2.

In view of the great interest that has recently centred on the production of electric waves by means of oscillations

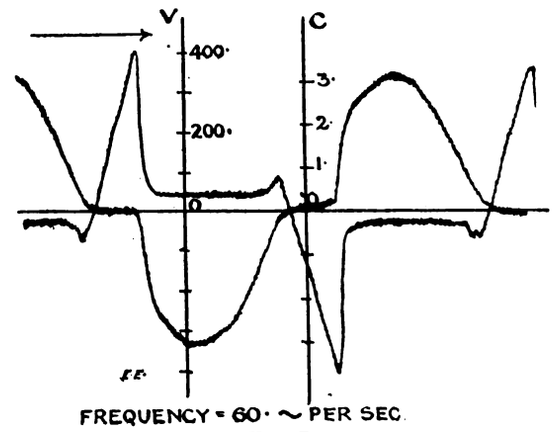

FIG. 3.

in direct-current arcs, the following experiments, which are somewhat fragmentary, were started last autumn in

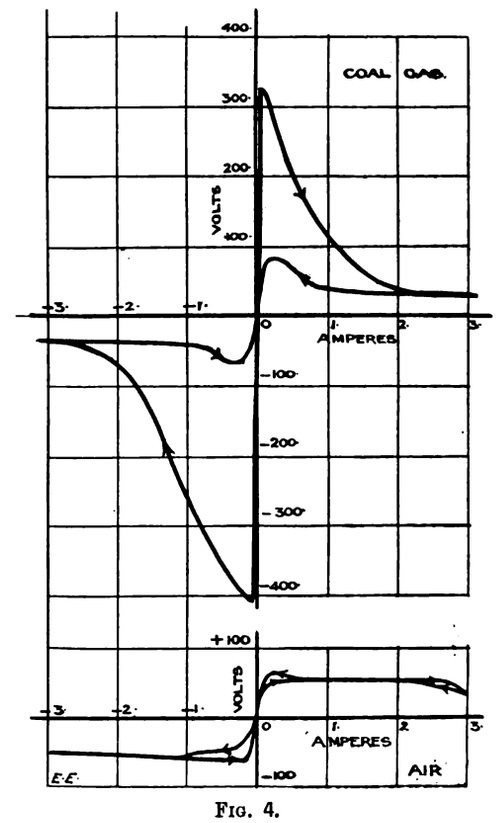

FIG. 4.

order to study at low frequencies the action of the separate factors which contribute towards the successful operation of the Poulsen arc.

* Paper read before the British Association at Leicester.

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EFFECT ON ARC OF CHANGE OF MEDIUM—COAL GAS AND AIR.

Alternating Arcs.—The fact that an arc is more easily extinguished when burning in coal gas than in air has been quite recently turned to account in more ways than one. Notably is this the case in the Poulsen arc. There are, however, minor applications, such as its use in certain forms of interrupters for induction coils, as in the "moto-magnetic" interrupter. The author himself has found that the mercury jet interrupter, which is usually worked

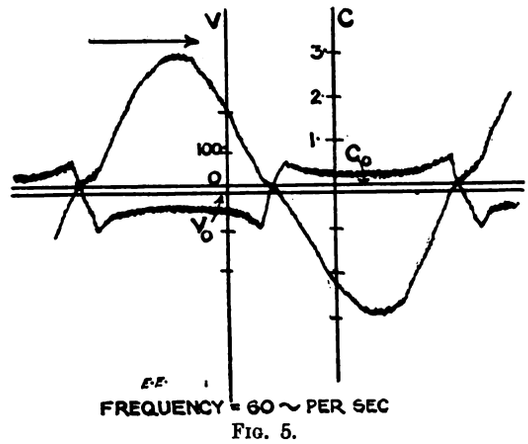

FIG. 5.

in paraffin oil and alcohol, is more efficient and far less trouble to use if the paraffin oil or mercury be replaced by an atmosphere of coal gas. To further investigate this action of arc extinction these experiments were carried out and oscillograms taken. In all experiments described below the arcs were taken between horizontal electrodes, and the length of the arc, except in those cases where it is specifically stated otherwise, was adjusted to 1mm.—this being correct to a tenth. The alternating current had a frequency of 60 ~. Where carbon electrodes were used they were solid and of 12mm. diameter.

In Fig. 1 is shown the behaviour of a 440-volt alternating arc in air. Fig. 2 has its voltage wave on the

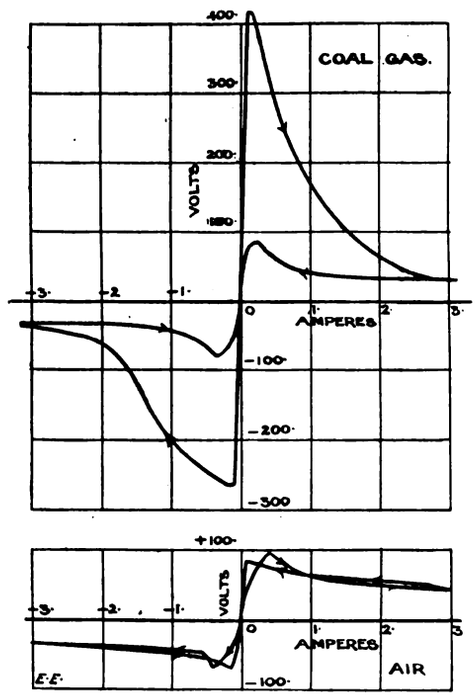

FIG. 6.

correct side of the zero with respect to the current, but in all other cases the current wave has been reversed intentionally in the oscillograms to prevent confusion between the volt and ampere waves. Fig. 2 shows a 110-volt arc under similar conditions. In Fig. 3 will be found the corresponding oscillograms for an arc under the same conditions, but working in coal gas (in reality this oscillogram was taken with the arc in a magnetic field; the slight modification this produces will be referred to later). The notable feature is the dissymmetry of the voltage wave that is produced when coal gas is employed, the voltage rising to 370 volts before the resistance of the arc breaks down. From these oscillograms have been plotted the "dynamic characteristics" for the arc shown in Fig. 4.

The dynamic characteristics were first made use of by M. Blondel in 1891, and recently their use has been greatly

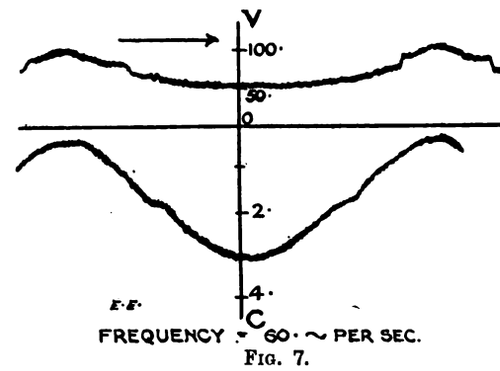

FIG. 7.

extended by Dr. Simon. It will be seen that the chief difference lies in the behaviour of the arc while the current is *increasing* from zero to its full value. Another way of expressing this result is to say that the approximate resistance when the arc is starting in air is some 500 ohms, whilst in coal gas it is some 6,000 ohms. These diagrams

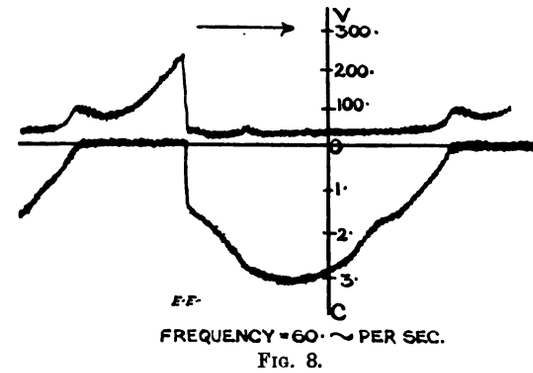

FIG. 8.

have been called by Dr. Simon hysteresis loops, and in general, other things being equal, the greater the area enclosed the more efficient is the arc for the purpose of producing oscillations.

Effect of Addition of Transverse Magnetic Field.—The above experiments were repeated with no modification save that the arc operated in a transverse magnetic field of about 3,330 C.G.S. units. The magnetic field at once produced the well-known two jets of yellow flame accompanied by

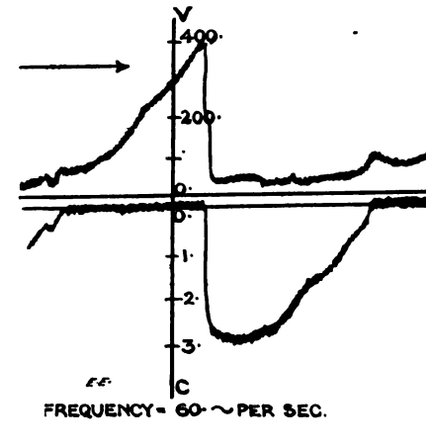

FIG. 9.

the characteristic noise. In coal gas it was noticed that these two jets of flame were absent. These experiments were conducted in a mica-walled enclosure though which coal gas was slowly passing, so that the arc could be inspected meanwhile. The oscillograms are shown in Figs. 5 and 3, and the dynamic characteristics in Fig. 6. On examination the effect produced by the magnetic field will be found to be small. Comparison of Figs. 4 and 6 shows, however, that the characteristic in air with magnetic field is steeper than when the field is absent; further, that

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the average maximum voltage when the current is stopping is greater with a magnetic field than without.

Coal gas, no field	74 volts.
,, strong field	83 ,,
Air, no field	61 ,,
,, strong field	77 ,,

Possibly this result may be explained by the fact that when the current is stopping, the current-carrying part of the arc—being bowed—is longer, and, therefore, requires, a greater voltage for the same value of current.

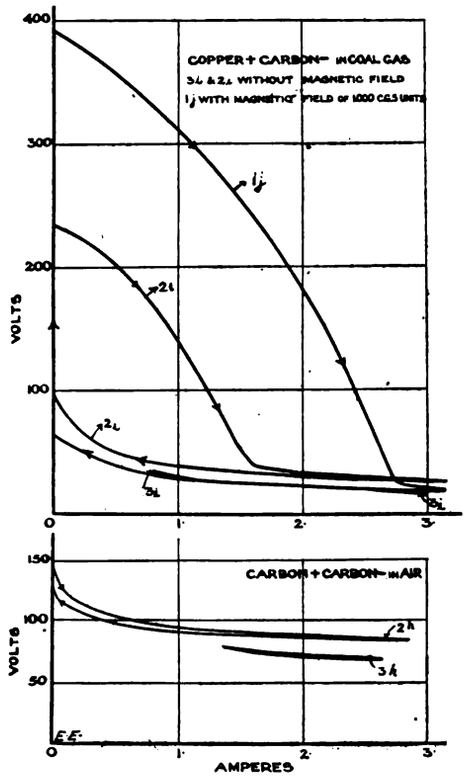
COPPER + CARBON— in COAL GAS
3¼ & 2¼ WITHOUT MAGNETIC FIELD
1¼ WITH MAGNETIC FIELD OF 1000 C.G.S. UNITS
VOLTS
CARBON + CARBON— in AIR
AMPERES
E.E.

FIG. 10.

Pulsating Direct-Current Arcs — Similar experiments have been carried out with solid carbons in air and with a copper positive pole and carbon negative pole in air and coal gas. Oscillograms for the copper-carbon electrodes are given in Figs. 7, 8, and 9, whilst Fig. 10 shows the dynamic characteristics. The effect of the introduction of the magnetic field has been largely to increase the

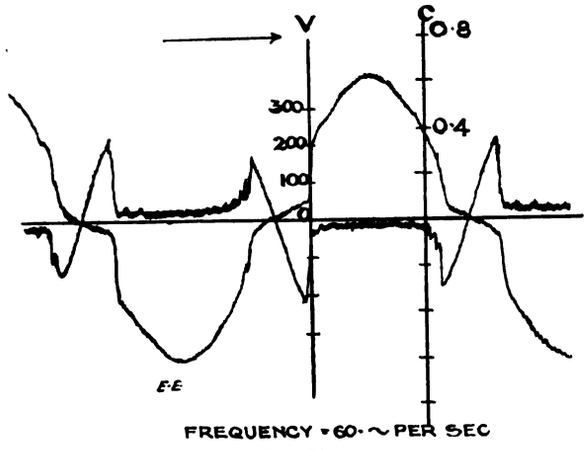

FIG. 11.

divergence between the characteristic for increasing and decreasing currents. As this result, however, is only based on a single experiment, too much weight must not be attached to it. At some future date the author hopes to be able to confirm this result.

ARC IN AMYL-ACETATE.

In some experiments on which the author has recently been engaged on the production of Hertzian waves, he has used the oscillator of Langwitz in which aluminium electrodes are used in paraffin oil, and has found that the substitution of amyl-acetate for the paraffin oil is a considerable improvement. It, therefore, seemed of interest to conduct a set of experiments on arcs in amyl-acetate

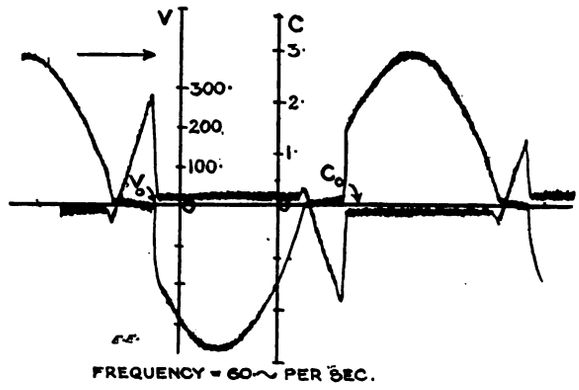

FIG. 12.

between aluminium electrodes. Figs. 11 and 12 are oscillograms for the arcs on 400 volts alternating, Fig 11 being an arc ·02mm. and Fig. 12 an arc ·05mm. in length.

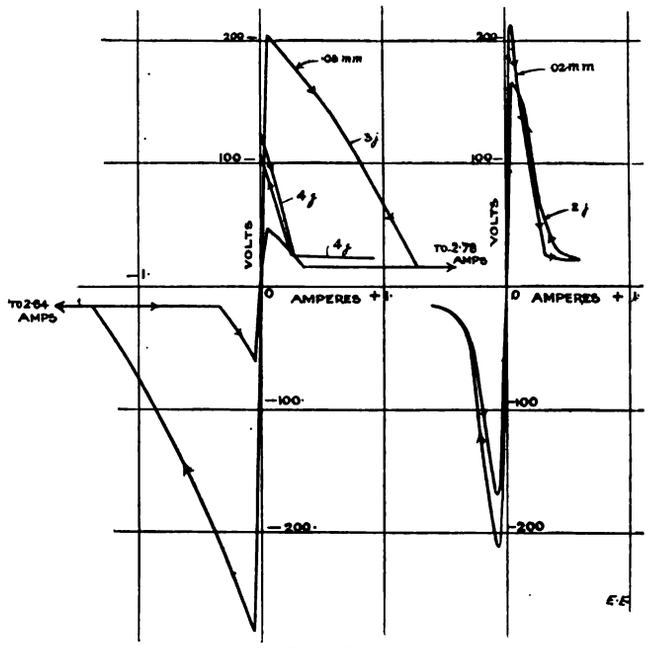

FIG. 13.

Their dynamic characteristics are shown in Fig. 13, as is also the characteristic for a small pulsating current.

(To be continued.)

WARNER STEERABLE TRAMCAR.

The Warner Engineering Company, of 11, Dartmouth-street, Westminster, have furnished us with the following details of some cars they have supplied to the Metropolitan Electric Tramways, Limited, to the approval of Mr. A. H. Pott, the engineer of the company.

Fig. 1 shows a single-deck car 25ft. over doors; wheel base, 8ft. 6in. This car is typical of a number which are being converted to demonstrate the running qualities of cars equipped with the Warner patented steering control, the patents for which are owned by the Warner Engineering Company. The Warner steering control embodies an entirely new principle in the connection of wheel and axles to bi-rail trucks or vehicles. Mr. J. S. Warner, the inventor of the system, claims to have demonstrated, by running over two years in regular service, and at the present time by cars in service on several systems, that, in order to avoid the excessive flange friction and excessive wear of wheel and rail treads which is giving so much concern to electric traction engineers at the present time, the planes of the wheels must be slightly changed continuously, or, in other words, that any two axles should never be parallel to each other except for an instant occasionally.

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The radial action of a car equipped with this steering control and a return to correct alignment on straight track is stated to be more perfect than with any other known device, although the actual set of the wheels on curves is dependent not only on the curvature, but on the weight, speed, wheel base, length, and height of the car. So delicate is the suspension of a car, as shown in the figure, that when standing still the whole vehicle may be swayed horizontally with an amplitude of 3in. or 4in. with one hand. The Warner Engineering Company claim that anyone riding on one of their cars will find that the car body runs with a minimum of shock and vibration in an almost mathematically straight line, it being impossible for the wheels which are being continually steered round the inequalities in the track (thus giving a maximum of rolling with a minimum of skidding) to communicate the slight track deviations to the car body, and, consequently, the passengers.

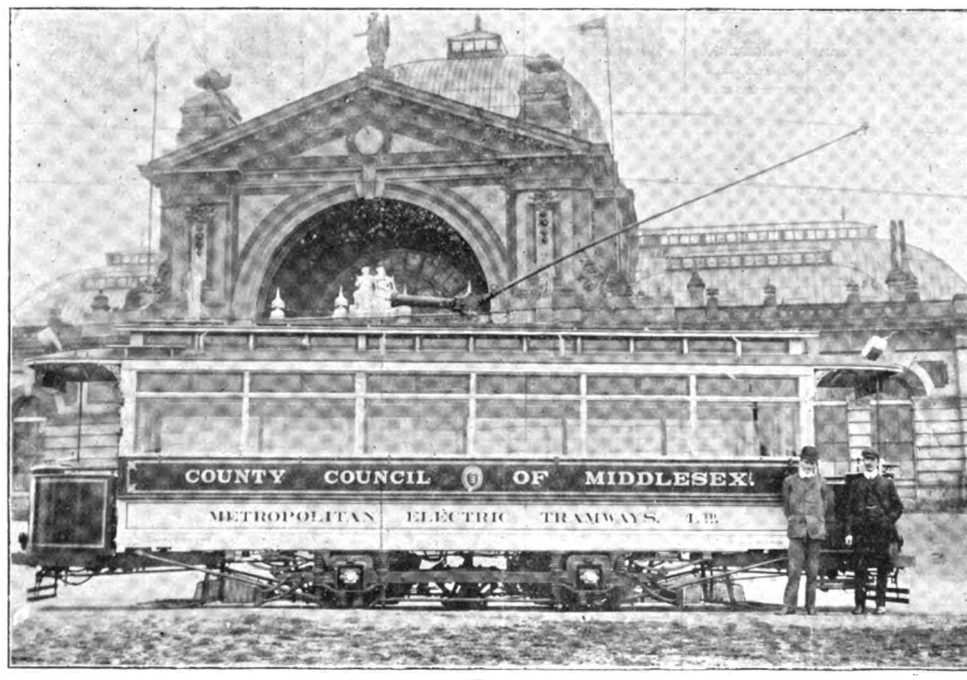

FIG. 1.

pressure has reached a certain maximum, or when a slight kink in the track is encountered, the front wheels of the car are skidded right over to the other side, and in a very short distance the reverse may occur. This action of parallel axles or rigid trucks can be easily observed by glancing along the side of most single-truck tramcars, and has become a serious problem, known as wave action, in the oscillation of bogies on practically all electric railways.

Fig. 2 shows the gear for connecting the axle boxes to the main frame of the car. The links shown on either side of the axle boxes swing at an angle to the main frame, passing through radial slots in the yoke bridge, which is the bar passing under the axle boxes, and connect to knuckle joints concealed inside the journal box springs. The pins passing through the lower ends of these links are set radially to the king pin in the centre of the car. In order to produce a movement which is the mechanical equivalent of this at the upper end of the links, where the space does not permit of the pins being set radially to the king pin, pins parallel to the axle are employed, passing through a bridge piece which rocks transversely on the axle box, while at the same time the axle box itself tilts or rotates to and fro upon its journal. When the car is standing still, and is swayed by hand, the peculiar and novel tilting action of these boxes can be distinctly seen. Mr. J. S. Warner is leaving for a short trip to the United States, where the first articulated bogie for 40ft. and 60ft. railway cars will be run.

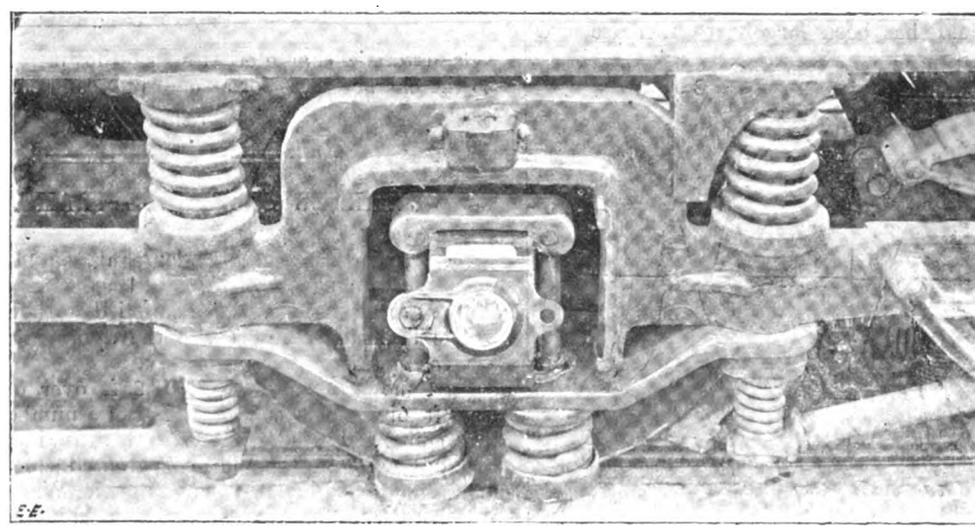

FIG. 2.

There is a great contrast between this arrangement and the attempt to combat rail corrugation by the exact squaring up of trucks and axles, accompanied by the considerable strengthening and cross-bracing of truck frames. An explanation given of the action of this steering control on straight track is the statement that a rigid four-wheel truck, with the gauge clearance necessary in practice, however equal the wheels or dead parallel the axles, will generally set on the track so that in a few yards it has run against the flanges to one side, and when the flange

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THE STARTING, REGULATING, AND STOPPING OF CONTINUOUS-CURRENT MOTORS.*

BY JOHN T. MOULD.

(Concluded from page 125.)

Owing to the slow uniform movement of the contact lever, it is necessary in this type of starter to arrange that for large motors the main current shall not be handled directly by the sliding contact lever, but by a number of solenoid switches controlled as relays by the contact lever (see Fig. 7). These solenoid switches have large ampere capacity, the contact being made by laminated brushes pressed against flat metal surfaces, and as they are reinforced by carbon circuit-breaking contacts and protected by magnetic blowout, and also have self-cleaning contact surfaces, they are capable of making and breaking heavy currents very frequently without damage. With a view to avoiding the cost of this multiple solenoid type in some cases, the author in 1903 patented a sliding-contact type of self-starter, in which the contact lever moves from each step to the next quickly, but pauses for a predetermined

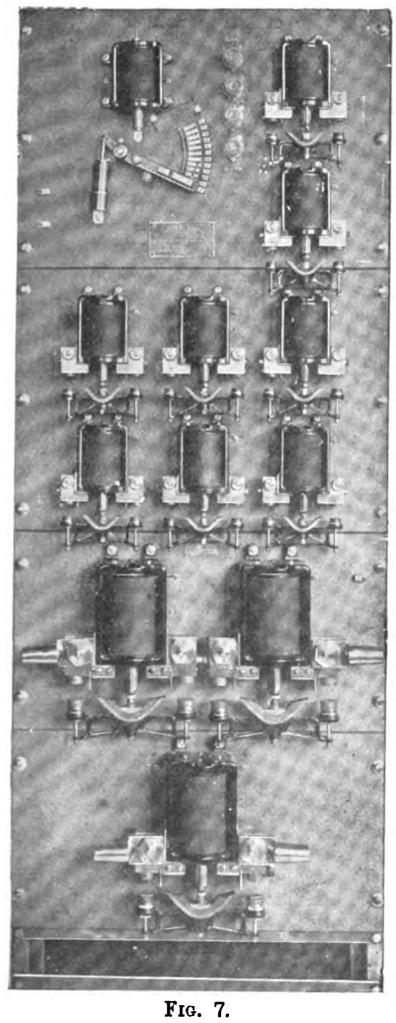


FIG. 7.

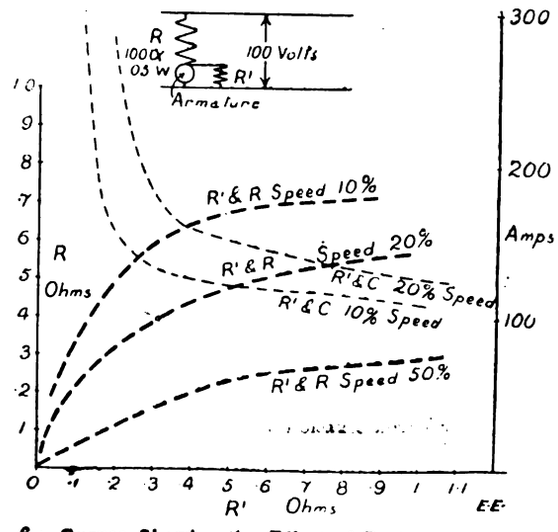
period on each step. This type can be satisfactorily used up to about 50 h.p., whereas the ordinary sliding-contact type becomes unsatisfactory at little over 20 h.p. It can also be used for much slower starting, because the pause per step can be adjusted to as much as 15 or 20 seconds, thereby enabling as much as five minutes to be occupied in cutting out the starting resistance. By this means such slow-starting machines as hydro-extractors can be started up without any expenditure of time and care on the part of the attendant, and with practically no excess of current over full-load running current.

Much diversity of opinion exists as to the necessity for enclosing starting switches. Board of Trade regulations make it compulsory for switches on circuits of 400 volts and upwards to be enclosed in such a way as to prevent the possibility of the attendant accidentally touching a live part. Some local authorities insist on covers for lower voltages, and I should advocate the use of covers almost universally, both to prevent accidents and to keep the switches clean and protect them against damage. All covers should, of course, be earthed.

* Paper read before the Association of Engineers-in-Charge on April 10, 1907.

Speed Regulation.—Since the normal speed of a continuous-current motor is the speed at which the rate of cutting of the magnetic lines of the motor field by the armature conductors is equal to the voltage of the circuit on which it is working, less the volts dissipated by the resistance in circuit, it follows that to vary the speed of the motor we must either (1) vary the volts dissipated by the resistance in the main circuit by altering the ohmic value of that resistance; (2) vary the number of the magnetic lines of the motor field by varying the excitation; (3) vary the voltage of supply; (4) increase or decrease the air-gap between the armature and the field magnets; (5) vary the number of conductors in the armature. The last-named method may be dismissed as impracticable. As to the fourth method, although I have seen motors constructed to permit of it, I have had no opportunity of observing them in use under normal working conditions, and, therefore, can only say that it appears obvious that it would produce an effect on the speed similar to that produced by method No. 2. Leaving (4) and (5) out of account, therefore, we are dependent for speed regulation on our ability to vary the volts of supply, or to vary the volts dissipated by series resistance, or to vary the field excitation. Any one of these three methods, however, may be accomplished in a number of ways, and when a considerable range of speed is required, a combination of several or all of the methods may be employed.

When speed regulation is effected by varying the volts dissipated by the resistance in the main circuit (method No. 1), the object is to induce the motor to run at speeds below normal, and this may be accomplished by (*a*) placing a variable resistance in series with the armature, or (*b*) placing a variable resistance in series with the armature, and a second variable resistance in series with the



No. 6.—Curves Showing the Effect of Resistance in Parallel with the Armature.

first but in parallel with the armature (Curve 6). When speed regulation is effected by varying the excitation of the field (method No. 2), the object is to cause the motor to run at higher speeds than normal, and this may be accomplished by (*c*) placing a variable resistance in series with the shunt field coils; or (*d*) diverting a portion or the whole of the series field current by means of a variable resistance in parallel with the series field coils; or (*e*) cutting out the series field coils, either as a whole or in sections. When we vary the volts of supply (method No. 3) we may make the motor run at speeds either less than or in excess of normal. This method is generally not solely relied upon, but is usually used in combination with one or both of the methods named above. It may be accomplished in any of the following ways: (*f*) using two or more motors, or a motor with two or more armatures, and placing the motors or armatures sometimes in series and sometimes in parallel with each other; (*g*) where a multiple-wire system is available connecting the motors so as to take advantage of the various voltages as demanded by speed requirements; (*h*) using one or more motor-generators and connecting the motor armature sometimes to the motor-generator and sometimes to the main supply circuit. With this system a variable resistance is generally employed in the generator circuit.

The decision as to which method of regulation is most suitable for any individual case depends, first, upon the type of motor employed, and, second, upon the characteristics of the machine or machinery that the motor has to drive and the conditions under which it has to be driven, and these characteristics and conditions have also to be considered in deciding how the motor shall be wound. The selection of the most suitable type of motor for any particular work is a most important point, because a mistake here will certainly prevent the maximum efficiency being attained. For work where the load is fairly

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TABLE A.

Class.	Characteristics.	Examples of machines driven.	Type of motor.	Method of control.
I.	Wide speed range, with long periods of running on any speed.	Machine tools. Test beds. Small printing presses requiring hurrying-up speeds.	Shunt wound.	Shunt field regulation alone. (The correct method being to combine or interlock the starter and regulator.)
II.	Wide range of speed, with slow starting speeds (especially against inert loads) and positive slow running speeds.	Newspaper printing presses. Certain textile machinery. Large lathes. Certain descriptions of machine tools.	Compound wound.	Series armature regulation, with shunt and series regulation and armature diverting resistance.
III.	Occasional speed reductions.	Fans and blowers.	Series wound.	Series armature regulation.
IV.	Frequent starting with full torque and intermittent speed control.	Cranes. Capstans. Winches. Small service lifts.	Series wound (not necessarily rated for continuous service).	Series armature regulation, with armature diverting resistance for very low speeds.
V.	Frequent starting at full torque. With or without speed control and with variable load.	Passenger lifts (or any large lifts). Planing machines and other heavy reversing machines.	Compound wound.	Shunt field regulation. Cutting out or diverting series field coils, and with armature diverting resistance where very low speeds are required.
VI.	High starting torque, with moderate speed regulation.	Railway, tramway, and similar work.	Series wound.	Series parallel, with regulating resistance in series with armature.

uniform, and approximately constant speed is required without the necessity of frequently starting under a heavy load, a shunt-wound motor should be used. For work requiring that the motor shall frequently start against a heavy load, and where it is necessary that the motor shall automatically adopt its speed inversely to variations of load (as in crane work), or where constant speed is required with an absolutely uniform load (as in direct-connected fans), a series-wound motor should be used, but this does not apply to cases in which it is possible for the motor to be left energised without any load against it, for under such conditions a series-wound motor would quickly attain a dangerous speed. Compound-wound motors combine to some extent the features of both series and shunt wound motors, and should, therefore, be used in cases where a good starting performance is required, or where very wide speed control is desired, or where the starting qualities of a series motor are required in combination with a shunt-wound motor's immunity from the danger of racing. Table A gives some examples of some classes of machines to which electric driving has been successfully applied, and shows the type of motor selected as well as the method of control adopted.

The table is necessarily very incomplete, and is only intended to indicate the general considerations on which a selection should be based. These may be modified by other special conditions in individual cases which may result in the selection of a different type of motor or system of control. It should also be stated that in any of the classes named above, multiple voltage control may be utilised if desired and if a multiple-wire system is available. In the table also no mention is made of the use of a motor in combination with a motor-generator, or of two motors—viz., a large one for high speeds and a small one for low speeds—yet both of these methods are very frequently and satisfactorily employed in connection with the machinery placed in Class II., and especially with large newspaper presses. In many respects the control of rotary printing presses is a specially interesting problem, and the conditions to be faced will repay consideration, because they present many difficulties not well understood, and, consequently, when a means of overcoming them is found it proves useful in many other similar cases arising in other fields. First, a very slow start with very even acceleration is absolutely essential in order to avoid tearing the paper when feeding it into the machine. The very slow speed must also be available for use during considerable periods while the machine is being prepared for printing—that is to say, when the controller is set upon a slow-speed step it must not be possible for the motor to accelerate to a speed in excess of that for which the particular step is intended. This is because during the operation of fixing the plates on the rolls the attendants must necessarily occupy positions in which an unexpected acceleration would almost certainly lead to personal injury. It must also be possible easily to "inch" the machine, and there must be absolutely no doubt about the possibility of stopping instantaneously at any moment, for a failure in this respect might be fatal. When the plates have been fixed on the rolls, and the machine prepared for printing, the machine may be accelerated to printing speed. The lowest printing speed is greatly in excess of the highest speed used in preparing (often as much as 90 per cent.), but between these two no speed regulation is required, except that violent acceleration must be avoided on account of the danger of tearing the paper.

Then a considerable variation of speed must be available for printing on account of the variable character of the work, the different varieties of paper used, and the necessity of meeting any abnormal demand that may suddenly arise, as when a special edition is required quickly as the result of some startling event of universal interest, or in the case of late but important news. An important factor also is that a very high starting torque is required—often four or five times in excess of running torque—and that, apart from starting, approximately full torque is required at the crawling as well as at the maximum speeds. Obviously the power required at maximum speed will be greatly in excess of that at crawling speed, and it is upon a recognition of this fact that the well-known "Holmes-Chatworthy" system of printing-press control is based. In this system two motors are used—viz., a small one (described as a "barring" motor), which is used only for low speeds, and a large one (called the main motor) for the high speeds. Both are geared to the press, but the gearing of the small motor is so proportioned that at its maximum speed it only drives the press at a low speed—say, 10 per cent. of maximum—while the gearing of the large motor enables it at maximum speed to drive the press at its maximum speed. The speed of both motors is controlled both by resistance in series with the armature and resistance in the shunt field circuit, securing a wide range of speed. When the small motor is running it drives the main motor as well as the press, so that when the main motor is connected to the supply it has already been accelerated to a speed equivalent to that at which the press is running. The gearing is so arranged that when the large motor speed exceeds the maximum of the small motor the latter is automatically thrown out of mesh and then disconnected from the supply. The whole control, from minimum to maximum speed, is effected by one rotary handle, which in later developments is driven by a small motor, thereby permitting of control from various points about the press by means of push buttons. The same method of driving and control is used in the "Kohler" system, the only difference being in the design of the controller.

In the system generally known as the motor-generator system, a motor-generator and a main motor are used. The main motor is directly geared to the press, and for starting as well as for slow speeds, it receives its armature current from the motor-generator, but for high speeds its armature is connected directly to the supply circuit. The fields of both the motor and the motor-generator are always excited from the main supply, and the voltage from the motor-generator (whose ampere output is equal to full-load current of the motor) is regulated from zero to about half the supply voltage by means of a field regulator. The speed of the main motor when connected to the supply circuit is regulated by resistance in series with the armature and field, and, if necessary, the series field coils can be short-circuited also. In this system the whole control may be effected by one rotary handle if desired. In the "Ward-Leonard" system also a motor-generator and a main motor are used, but the motor armature is always in series with the generator armature, so that all the current used in driving the motor must pass through the armature of the generator. A reversible field regulator is used in connection with the generator, so that the voltage generated may be varied from zero to a pressure equal to the supply voltage, and may be made to either oppose or assist the supply voltage. Consequently, the voltage at the motor terminals can be varied from zero to double that of the supply system. In this type of control the horse-power capacity of the motor-generator is half that of the main motor. In this system the only controller is the aforementioned field regulator.

In the "Igranic" system of the Adams Manufacturing Company only one compound-wound motor is used, and it may be directly geared to the press. The crawling speeds, which may be 5 per cent. of maximum, or even less, are obtained by means of a variable resistance which is in parallel with the armature and in series with a resistance which is also in series with the armature. The transition speeds between preparing and minimum printing speeds are obtained by resistance in series with the armature, while the higher printing speeds are produced by first cutting out the series field coils and afterwards introducing resistance into the shunt field circuit.

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The whole of the regulation, from minimum to maximum, is effected by one rotary handle (as will be seen from the illustration, Fig. 8), which need not be used for starting or stopping, the starting and stopping, as well as "inching," being accomplished by a small switch seen in the right-hand upper corner of the panel. Any number of these small switches may be fixed in convenient positions around the press, so that the press may be started, stopped, and "inched" from any of these positions, but when an alteration of speed is required, it must always be obtained by a use of the large regulator handle. By avoiding the use of more than one motor, or of a motor-generator, this method of control very considerably reduces the initial cost. Also it is an advantage to obtain all the continuous speeds without reliance on resistance in series with the armature, as, of course, when external resistance is in the armature circuit any variation of load will produce a corresponding variation of speed. The "Bergmann" system is similar in principle to the last named, but it entails the use either of two motors—one shunt and one series wound, or else (and this is more usual) the incorporation of two armatures in one motor—one revolving in a shunt excited field, and the other in a series excited field. The two armatures are in series for low speeds and in parallel for high speeds, and, in addition to the use of series resistance, the armature of the

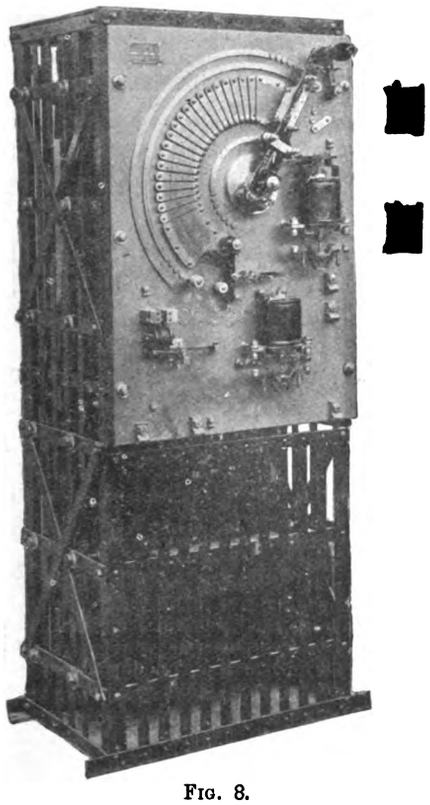

FIG. 8.

shunt resistance machine is sometimes diverted, and the shunt excitation is varied by resistance in the shunt circuit, and the series by diverting the series coils. The principal advantage of this system is the use of the shunt motor to control the speed of the series motor, but the expense of two motors on one special motor is a drawback, and the special drum-type controller must also be costly. All the above-mentioned methods give good results, and a choice should depend mainly on a consideration of cost.

I have described at some length the various systems of printing-press control, because nearly every system used for other duties is employed for this purpose, and there is hardly any other type of machine that calls for so wide a speed variation. Many very interesting points also arise in connection with the control of electric lifts where, owing to the frequency of starting under load, a high starting torque is essential coupled with uniform speed under variable loads. The strong torque at starting necessitates a series field winding which may be cut out after starting, thus securing uniform speed by converting the motor into a shunt-wound one. Owing to the tendency, frequently encountered in lift work, of the load to drive the motor, and thus convert it into a generator, resistance in series with the armature should never be used for speed regulation, but only for starting, because, of course, if the motor is generating, the insertion of resistance into its armature circuit, instead of diminishing its speed, will have the effect of increasing it. The speed of a lift motor, therefore, should always be controlled by varying the shunt field or diverting the armature, or both. If while a lift motor is acting as a generator, the supply circuit is suddenly opened (not by the lift controller, but by some other switch in the supply circuit), a curious effect will occur if the lift is not self-sustaining. The motor continues to be driven by the load, and as the current generated by the armature is driven through high-resistance circuits in parallel therewith (generally the shunt field and the brake solenoid), very little energy will be dissipated, and the lift will continue to gather speed until it is abruptly stopped (perhaps when running at a very dangerous speed) by the control rope or switch, or the limit switch, or the stopping may even be effected by the roof or floor. This state of things is one that has come within the writer's personal experience. It may be prevented by either of two methods—viz.: (1) a centrifugal device to open circuit automatically when normal speed is exceeded; (2) an excess voltage relay switch to automatically open circuit when normal voltage is exceeded.

Stopping.—Although the majority of machines will stop sufficiently quickly if the motor circuit be opened, it is necessary in the case of heavy loads that acquire a momentum to use some additional means. The most ordinary and simple method is to apply a mechanical brake, and this may be electrically operated by means of a solenoid. Where it is safe to apply the full strength of the brake as soon as the motor circuit is opened (as in a crane), the brake solenoid may be series wound and placed in the armature circuit. If it is necessary to apply the brake gradually, the solenoid may be shunt wound and its pull regulated by the insertion of a variable resistance controlled by the starting switch. For lift work, where the running current varies very considerably, and often falls to zero, a series-wound solenoid is unsuitable, and, although no variation of the pull is called for, a shunt winding becomes necessary. To ensure economy in an apparatus so frequently used, the best practice is to use a compound winding, the shunt coil having a very high resistance and just sufficient power to hold the brake off. The starting current (always heavy in a lift) will pass through the series coil and help the shunt coil to release the brake, and this series coil may be connected between two of the steps of the controller so as to be cut out of circuit with the starting resistance.

But in many cases it is necessary to have something more reliable than a friction brake, where positive retardation is necessary before stopping. For this purpose two methods are available, one being to divert the armature current through a variable resistance placed in parallel with the armature. The ohmic value of this resistance must be reduced to decrease the speed, and as it may eventually become a dead short-circuit round the armature, it is obvious that a current-limiting resistance must be placed in the main circuit. This is a very reliable method, and with it a crane may be made to hold its full load suspended without the use of a mechanical brake. The second method is to disconnect the armature from the source of supply, and, while leaving the shunt field excited, to connect a resistance across the armature terminals, and gradually out this out until the armature is short-circuited. Under these conditions, the motor while it continues to revolve will act as a generator, and as the resistance across its terminals will constitute the only limit to the energy dissipated, a powerful braking effect may be obtained. When this method is used in connection with a series-wound motor, the field coils must be connected across the armature terminals in series with the variable resistance, so that the field may be excited by the current generated in the armature, and it is also necessary, before closing the circuit between the armature terminals, to reverse the field coils in relation to the armature. If this were not done, the current in the field coils would be reversed, causing the field to be demagnetised, and even supposing that sufficient residual magnetism remained to enable the armature to re-excite the field, considerable damage might be done before the field built up again. On the screen I propose to show a picture of three very large crane controllers (325 h.p. each) recently supplied by the Adams Manufacturing Company, Limited, to Messrs. Craven Bros., of Manchester, in which the last described method of braking is used.

If any of my hearers remark that I have omitted the use of technical language and formulæ in this paper, I admit the charge, and agree at once that in that respect it differs from what might have been considered suitable for an association of manufacturers or designers. In preparing the paper, however, I have tried to view the subject for discussion, not from the point of view of the manufacturer, but from that of an engineer-in-charge, and I trust that in this respect I have anticipated your wishes.

APPOINTMENTS VACANT.

Temporary Engineering Draughtsman, Stepney Borough Council. Salary, £5 per week. Applications by Aug. 10. See advertisement in last issue.

Instrument Maker, Lecture Assistant, and Lecturer in Electric Wiring. Royal Technical Institute, Salford. Salary, £100 per annum. Applications by Aug. 20. See advertisement.

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THOSE BEFORE US.

Once on a time it was work and brain,
Once it was labour and thought;
The hard-won skill of a practised hand,
The skill that might not be bought.

Once on a time there were engineers
Who had learned their trade by their need;
Who were taught their tools without aid of schools—
Men with the brain in their breed.

Once on a time both fathers and sons
Were born with a love of their trade;
Were filled with the pride that held them high,
Most practical, undismayed

They knew of no work, no task too great,
And their labour was not in vain;
They were taught by their failures here and there,
And the fruits of their work remain—

Remain to be plucked by another's hand,
(And the world has gained in its wealth);
By his who is ruled by the rules they found,
But takes their dues to himself.

Nor at this time do we praise the men
Whose names we have none of us known:
The men who planted the giant tree
Where our own little branch has grown.

We have craftily written their knowledge in books,
We have rifled their lowly graves;
We have signed our names to the things they scribed,
We have acted as arrant knaves.

And this have we done that the world might praise,
That the crowd might deem us wise;
We have told great truths with a stolen tongue,
And have acted no end of lies.

And so we have reached great honour thereby,
And kept it with careful tact;
But the things we have found were all found before,
And we ought to acknowledge the fact!

Let us therefore, though tardily, honour our dead,
Give the race to the men who won;
For there is no thought that has not been thought,
And nothing new under the sun!

G. BASIL BARHAM.

LONDON ELECTRIC SUPPLY.

Companies' Bill Withdrawn.

On Wednesday night, in the House of Commons, Mr. F. L. Harris, on behalf of the promoters, announced the withdrawal of the London Electric Supply Bill, which he said at this late stage of the session could not be passed through Parliament. He complained that the measure had been killed by the hostile action of the Board of Trade. He suggested the constitution of some authoritative committee to go into the question, and said the President of the Board of Trade would find the companies interested in the present Bill had every desire to meet the right hon. gentleman in any proposals he had to make. Mr. Lloyd-George said the withdrawal was the only possible course under the circumstances. He agreed that the problem was very urgent, but controversy raged round it at the present moment. His own opinion was that it was impossible to arrive at any solution of the problem until the parties interested could come to some common understanding on some general principles. He did not think that was impossible. It was really a business proposition, but he did not see any hope at the present moment of the parties coming together, though he did not despair that even within the next few months something might be done.

FORTHCOMING EVENTS.

Association of Engineers-in-Charge.—Saturday, Oct. 10, at 3 p.m., visit to General Post Office Central Telephone Exchange, Carter-lane, E.C.

Iron and Steel Institute.—Sept. 23-25, meeting at Vienna.

LONDON COUNTY COUNCIL TRAMWAY PROPOSALS FOR 1908.

When the London County Council reassembles after the summer vacation it will be confronted with a report from the Highways Committee, recommending that power should be sought in the next session of Parliament for the extension and linking up of certain portions of the Council's tramways. The total capital expenditure involved in these schemes is estimated at £351,000, of which £229,000 represents the cost of constructing and equipping the proposed tramways, and £122,000 the gross cost of street widening.

Most of the proposals submitted are for the purpose either of providing junction lines in order to enable through services to be run or for diversions to obviate very expensive street widenings, which would otherwise be involved in the reconstruction of certain tramways for electric traction. Only two of the schemes involve any considerable extensions, and they are for the purpose of linking up the Council's existing or authorised tramways at Forest Hill and Norwood with the Crystal Palace. As regards the extensions to the Crystal Palace and the connecting line in Lea Bridge-road the overhead system of electric traction is proposed. In the remaining cases the underground conduit system of construction is recommended. Should, however, the Council at a later date find it preferable to use an overhead or surface-contact system on these tramways, there would be a considerable saving in the cost of construction. The proposals of the committee are as follows:

1. *Connecting Line between Gray's-inn-road and Caledonian-road over the King's Cross Metropolitan Railway Station.*—Length of tramway, about 4½ chains of double line. Estimated cost of construction and equipment for the conduit system of electric traction, £6,850.

2. *A Single Line of Tramways, vid Swinton-street, to connect the existing lines in King's Cross-road with the existing lines in Gray's-inn-road.*—Length of tramway, 1 furlong 4½ chains. Estimated cost of construction and equipment for the conduit system of electric traction, £5,840. The committee dealing with this matter state that an important service of cars is maintained between the Farringdon-road terminus and the Archway Tavern, *vid* King's Cross-road and Caledonian-road, and this proposed diversion *vid* Swinton-street will considerably facilitate the reconstruction of these tramways for electric traction.

3. *From Essex-road via Englefield-road and Stamford-road to Kingsland-road.*—Length of tramway, about 5 furlongs 5 chains of single line. Estimated cost of construction and equipment for the conduit system of electric traction, £19,509. 3A. *From Kingsland High-street to Mare-street via Ridley-road and Dalston-lane.*—Length of tramway, about 7 furlongs 5 chains of single line. Estimated cost of construction and equipment for the conduit system of electric traction, £29,589. These two proposals were included in the Council's Tramways and Improvements Bill for the session 1907, but could not be proceeded with owing to the objection of the Hackney Borough Council. The committee hope that the Borough Council will now see its way to agree to the proposals. 3B. *Junction between Kingsland-road and Dalston-lane.*—Length of tramways, 1½ chains of single line. Estimated cost of construction on the conduit system of electric traction, £700.

4. *Junction Line between Mitcham-road and Tooting High-street.*—Length of tramway, 3½ chains of double line. Estimated cost of construction on the conduit system of electric traction, £3,870. This junction is intended to enable a through service of cars to be run between the county boundary at Tooting Junction Station and the Thames bridges, and would enable passengers from the Mitcham Light Railway (South Metropolitan Tramways) to travel direct to London without again changing cars.

5. *Connecting Line in Southwark-street from Blackfriars-road to Southwark Bridge-road.*—Length of tramway, 3 furlongs 5 chains of double line. Estimated cost of construction and equipment on the underground conduit system, £23,304.

Proposals 6 and 7 are for connecting the Council's existing or authorised lines at Norwood and Forest Hill with the Crystal Palace, where they will also meet the South Metropolitan Tramways outside London which are worked in conjunction with the lines of the Croydon Corporation.

6. *From West Norwood to the Crystal Palace.*—Length of tramway, 3 miles 3½ chains (route miles). Estimated cost of construction and equipment on the overhead system of electric traction, £66,623. This proposal is to connect the existing tramways in Norwood-road (London Southern Tramways system) with the Crystal Palace. The route suggested is as follows: single lines along separate routes for up and down traffic from the existing lines in Norwood—viz., one line *vid* Chatsworth-road, Idmiston-road, and Rosendale-road to Park-road, and one line *vid* Robson-road (late Park-road) and Park-road, the two lines joining in Park-road and continuing as a double line along Park-road, thence along South Croxted-road and Dulwich-wood-park to the junction of Farquhar-road and

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Dulwich-wood-park, where it is proposed that the up and down lines should again divide and form a loop line *via* Dulwich-wood-park, College-road, Crystal Palace-parade, and Farquhar-road. The Council is seeking statutory authority in the session of Parliament of 1907, with the concurrence of the Lambeth Metropolitan Borough Council, to reconstruct, for the overhead trolley system of electric traction, the portion of the London Southern Tramways from Brixton and Camberwell to Norwood, and the new lines now proposed would meet lines constructed on the overhead system of traction outside London. In these circumstances, the committee propose that the new lines shall be constructed on the same system. The estimated results of the working of these lines show a small deficiency in the first year, after paying debt charges, which would, of course, diminish year by year. This does not take into account, however, the large amount of traffic which would probably be induced on the lines with which they would be connected, and which they would bring into direct relation with the Crystal Palace.

7. *From London-road (near Lordship-lane Railway Station) to the Crystal Palace.*—Length of tramway, 1 mile 5 furlongs 2 chains of double line. Estimated cost of construction and equipment on the overhead system of electric traction, £49,626. This scheme, which is for a double line of tramways between London-road and the Crystal Palace, would commence by a junction with the Council's authorised tramways in London-road at its junction with Sydenham-hill, passing along Sydenham-hill to the Crystal Palace-parade, and terminating in the last-mentioned thoroughfare at a point south of the central transept entrance to the Palace by a junction with the tramways authorised by the London County Council (Tramways and Improvements) Act, 1906, which will extend to the county boundary at Anerley-road. The proposed lines would connect the existing and authorised lines in Camberwell and Dulwich with the Crystal Palace, and also with the South Metropolitan Tramways outside London (which are worked in conjunction with the tramways of the Croydon Corporation), and the lines would, the committee are convinced, be of great service to the public. They are advised that, after paying debt charges, there is an estimated surplus on the working of the lines.

8. *Extension of Lea Bridge-road Tramway to Lower Clapton-road.*—Length of new tramway, about one furlong of double line. Estimated cost of construction and equipment on the overhead system of electric traction, £6,020. Considerable importance is attached to this connecting line now proposed, as it is hoped shortly to be able to make arrangements for the purchase and electrification of the short portion of the Lea Bridge, Leyton, and Walthamstow Tramways which is situated in Lea Bridge-road, and when these lines are connected up in the manner proposed, direct communication will be provided between the Mare-street and Upper Clapton-road lines and those of the Leyton Urban District Council, running through populous districts outside the county to Epping Forest and other parts.

The committee also propose that power be sought under the Bill for the removal of the restriction which prevents them from adopting the overhead system of electrical traction on the section of the authorised tramways from Hammersmith-broadway, *via* Fulham Palace-road, to Putney—a length of 2⅛ miles of double line—and from Putney to Harlesden.

The Finance Committee, in their report on the above, state that most of the schemes submitted by the Highways Committee are in the nature of short extensions of, and lines connecting with, existing tramways, and it is, no doubt, desirable that powers for these should be obtained in order that the works may be carried out at the same time as the reconstruction for electric traction of the existing horse lines. The value of these proposed new lines must be considered to a large extent from the point of view of affording greater facilities to the existing traffic and of convenience of working, which cannot readily be expressed in figures, and it is not possible to prepare an estimate of the return which these lines may be expected to yield. With regard to the two new tramways, one from West Norwood to the Crystal Palace and the other from Forest Hill to the Crystal Palace, it appears to the Finance Committee that there is every prospect of these lines ultimately paying their way, but the estimate is based upon the assumption that a four-minute service can be maintained earning 1s. a car mile, and the results obviously depend upon the actual traffic being at least up to this standard. If the Council decides to seek the legislation proposed, it will not be absolutely committed to the whole of the expenditure, as in the case of each tramway and improvement scheme estimates would have to be put forward for the Council's approval before the scheme could be proceeded with, and this would give an opportunity for further consideration of each proposal.

As regards the apportionment of the cost of the street improvements, the Improvements Committee state that they consider that several of the minor improvements are needed only for tramway purposes, and they, therefore, propose that the whole cost of such improvements, amounting to £8,440, should be charged to the tramways account. This accords with the principle laid down in the resolution of Nov. 20, 1906, passed on the joint recommendation of the Finance, Highways, and Improvements Committees. This resolution further provided that in any case where an improvement was desirable and urgently needed apart from any question of the construction or reconstruction of tramways along the thoroughfare, no charge should be made against the tramways account, and that in any case where the improvement, though desirable, could be postponed for a few years except for the reason that it is required for the purposes of a tramway, a contribution of a fixed sum, being one-eighth of the estimated net cost of the improvement, should be charged to the tramways account. In the other cases of improvements contained in the list now before the Council, the Improvements Committee are, however, recommending that the cost should be apportioned equally between the tramways account, the account of the improvement, and the local authority concerned, as they state that in their opinion the improvements, in addition to facilitating the tramway traffic, will also benefit the general and local traffic. Such an apportionment, the committee state, appears to them to be more equitable than that provided for in the resolution of Nov. 20, 1906, above referred to, and they are accordingly recommending the Council to suspend the operation of that resolution as far as is necessary. The total proposed charge to the tramways capital account in respect of the several improvements is estimated at £45,416, involving an initial annual charge on the revenue account for interest and repayment of £2,474, decreasing as the debt is paid off. The committee point out that the question of the apportionment of the cost of street improvements connected with tramways is one of the matters upon which the president of the Institute of Chartered Accountants has been asked to report.

LEGAL INTELLIGENCE.

ELECTRICITY AND FLOUR.

In the Chancery Division of the High Court on Wednesday, Mr. Justice Parker delivered judgment in the petition for revocation of the patent No. 14,006 granted to Mr. J. N. Alsop, an electrical engineer, for a process of bleaching and purifying flour.

His Lordship said that if a patent was taken out for a result which could not be produced the consideration failed, and if it was for a process for producing two results, and only one was, in fact, produced, the consideration practically failed. On that ground the patent in this case was invalid. The gases produced by a discharge of electricity were, according to the evidence, NO, a trace of ammonia, and, if copper electrodes were used, a slight trace of ozone. The NO in contact with air was partially oxidised, making NO_2, N_2O, or N_2O_3, and if the air contained vapour a little nitric acid. If copper electrodes had been used there might be yet another oxide, NO_3. The trace of ammonia was so slight that it might be ignored, and the specification did not insist on copper electrodes. The gaseous medium, therefore, consisted for practical purposes of four oxides of nitrogen with a little nitric acid, the whole diluted in air. NO, if used alone, certainly did not bleach flour; NO_2, N_2O_4, and N_2O_3 certainly did, and nitric acid did, if not directly, at any rate by reason of the production of nitrogen peroxides when it came in contact with atmospheric air. NO_2, N_2O_4, N_2O_3, and nitric acid were all oxides of nitrogen, producing nascent oxygen, and their use in air for bleaching purposes was, therefore, expressly disclaimed. They had, therefore, this curious result, that the patentee claimed a process of bleaching by the use of five constituents diluted in air, four of which would bleach flour and were disclaimed, while the other had no bleaching effect. The process medium was practically the same as that produced under Andrew's specification, and there was no subject matter for a patent in producing it electrically instead of chemically. It had been suggested that he should give leave to further amend the specification, but he thought no amendment which could be made would obviate the defect in the patent.

The petition was, therefore, granted with costs.

DUNDALK ELECTRIC TRAMWAYS CO. AND TRAMWAYS ACTS.

A petition was recently presented in the Irish Courts for an order that the sum of £2,041. 7s. 1d. New Consols, and £60. 12s. 1d. cash, standing credit, might be transferred and paid to Edwin Liller as liquidator of the company, or be applied as assets of the company for the benefit of the creditors. The application was grounded on the affidavit of the liquidator, which stated that the company had lodged in the Bank of Ireland New Consols of the value of £1,874. 3s. 3d., and there were now the sums mentioned standing to credit. Abortive efforts had been made to float the undertaking, and on March 20 last a special resolution, subsequently confirmed, was adopted to voluntarily wind up the company. It was further alleged that the liabilities amounted to £2,233, in addition to which there would be the costs of liquidation and the loss in Consols. All the subscribed capital had been expended. Arrangements were being made to pay off in full the debts of the company. The petitioner alleged that the company was insolvent, and that the undertaking had been abandoned.

Counsel who appeared for the Lords of the Treasury said they were served with a notice of the petition on the previous Friday, and in the ordinary course they were entitled to six days' notice. As the parties were anxious, however, to have the matter expedited, they had it sent to London at once, and had it before the Lords of the Treasury

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He was now present on their behalf to consent, and whatever else might be alleged it could not be delay.

Mr. JUSTICE BARTON said there were certainly no signs of somnolence on the part of the Lords of the Treasury. He would grant the order sought.

COMPANIES' MEETINGS AND REPORTS.

GREAT NORTHERN AND CITY RAILWAY.

The half-yearly meeting of the Great Northern and City Railway Co. was held on the 2nd inst., the Earl of Lauderdale presiding.

In moving the adoption of the report the CHAIRMAN stated that the Company's traffic was still on the increase, though not in the same proportion as last year. The total number of passengers carried during the half-year ending June 30 last was 8,269,435, against 8,087,700 for the corresponding period of 1906, an increase of 181,695, while the revenue derived therefrom was £46,920, against £46,560, an increase of £360. The gross amount of revenue was £49,838, an increase of £448. Were it not that their fares, in consequence of the severe competition surrounding them, had to be very low—viz., 1·33d. per passenger—they would no doubt be earning a much larger revenue. The inadequate amount of the fares they were receiving for the services they rendered to the public was more especially noticeable in the comparatively short distances. They carried a large proportion of passengers at 1d., and most of these travelled a distance of over two miles. It was chiefly the fact that the tramways above them, which were constructed at an infinitesimal cost as compared with the capital cost of this line, adopted the same fare for the same distance, which compelled this Company to do likewise. The directors hoped that as soon as an intelligent investigation of the actual expenses of working the tramways in London had been made, and a report issued, those responsible for the tramways would, by shortening distances, ensure a remunerative rate being arranged upon the tramway system, and on that basis he felt sure they would be able to compete. They naturally desired to secure a a fair return on the capital invested, but at present it was not possible to do so. They found themselves in the position of involuntary philanthropists, obliged to give to the public a service in every way excellent and efficient, which, from any point of view, was not a paying one, and the only present result of working their railway was little more than for the benefit of their employés and to pay fixed charges. After referring to the good relations which existed between the Company and their employés, the chairman referred to the growth of the 1d. fares and the decrease of the 2d. fares during the half-year, with the result that, while the number of passengers had increased by 2·2 per cent., the traffic revenue had only increased by 0·75 per cent. Compared with the traffic at this time last year, they were each week showing an increase.

Mr. C. STEEL seconded the motion, which was adopted.

CITY AND SOUTH LONDON RAILWAY.

The half-yearly meeting of the City and South London Railway Co. was held on the 31st ult., the Right Hon. C. B. Stuart-Wortley, chairman of the Company, presiding.

In moving the adoption of the report (*Electrical Engineer*, July 26), the CHAIRMAN said that the results of the half-year were that they had a 10 per cent. increase—10,148,780 against 9,045,120—in the number of passengers carried. Receipts per passenger were again lower, however, being 1·75d., against 1·80d., which followed from the same movement which resulted in the slightly smaller takings from season tickets, showing that to that small extent people seemed less inclined than they were to tie themselves down to any one of the various means of transit that were offered them. The most satisfactory feature of all was the fact that their working expenses stood in the improved proportion of 44·38 per cent. of the gross receipts, against 44·94 in the corresponding period. They had £6,120 more available for distribution. The result of the seven weeks for which they had been working to Euston and King's Cross looked as if they were going, without much difficulty, to maintain their existing dividends, and probably to increase them, when the public had had more acquaintance with the new facilities offered. In any case, in the 11 weeks ended July 28 they had had an average increase in receipts of £640 a week. Through bookings had been arranged with the Midland and Great Northern Railways and the Hampstead and Piccadilly and Brompton Tubes; also to Earl's Court, on the District Railway, including admission to the exhibition. Their more remote prospects had been improved by the fact that the new scheme of the London and North-Western Railway for an electric railway from Watford to Euston, with subway connection with this Company's station there, had passed both Houses of Parliament and received the Royal assent.

The report was adopted.

CHILIAN ELECTRIC TRAMWAY AND LIGHT.

The ordinary general meeting of the Chilian Electric Tramway and Light Co. was held last week, Sir J. Wernher presiding.

The CHAIRMAN moved the adoption of the report (*Electrical Engineer*, Aug. 2), and declared the past year as the most disappointing in the Company's record, due chiefly to a breakdown in the Company's machinery, and to earthquake. It was not surprising, therefore, that the accounts presented showed a profit of only £12,693. This amount, with the £21,288 standing to the credit of last year's profit and loss account, was absorbed by the service of the interest and redemption of the debentures, and the new year started with a balance of £2,447 on the wrong side. The future, however, was brighter, for the Company had reached normal conditions again, and, if the six months just gone by could be taken as a criterion for the rest of the year, their prospects were exceedingly favourable, and the results should more than counterbalance last year's failure. The Company had succeeded in obtaining a prolongation of their concession for 25 years, and the extension of the "life" of the franchise to the year 1953. The municipality of Santiago and the Company were at present engaged in a revision of the tariff, and he had no doubt that, with a give-and-take policy on both sides, the negotiations would ultimately be carried through to a successful termination. A favourable contract which had been concluded with a Berlin company for the supply of electric power from their works would enable their own Company to shut down their steam power station and to bring about considerable economies in the future in the matter of working costs.

Sir CHARLES EUAN-SMITH seconded the resolution, which was unanimously carried.

BRUSH ELECTRICAL ENGINEERING.

A separate general meeting of the ordinary shareholders of the Brush Electrical Engineering Co. was held on the 2nd inst. for the purpose of approving an agreement for reducing the capital of the Company from £660,000 to £489,512 by cancelling capital lost or not represented by available assets, to the extent of 13s. 4d. per share upon each of the 150,000 preference and 103,732 ordinary shares, and for increasing the non-cumulative dividend upon the preference shares from 6 per cent. to 7 per cent.

Lord VAUX OF HARROWDEN, chairman of the Company, presided. He explained that the resolution which he now proposed was in pursuance of the wishes expressed by shareholders that the figure at which patents and goodwill stood in the balance-sheet should be reduced in consequence of the depreciation in the Company's investments.

The resolution was carried, and an extraordinary meeting was afterwards held for the purpose of having the resolution passed by the whole body of shareholders. Lord Vaux again presided, and stated that the resolution really meant the reduction of each class of share by one-third, which would enable them to bring about a reduction of about £170,488. The resolution was carried with a few dissentients.

CENTRAL LONDON RAILWAY.

The twenty-fourth ordinary general meeting of the proprietors of the Central London Railway Co. was held on Wednesday, Sir Henry Oakley (chairman of the Company) presiding.

The CHAIRMAN, in moving the adoption of the report (*Electrical Engineer*, July 26), referred to the opening of the Franco-British Exhibition at Shepherd's Bush next year on a site exactly opposite one portion of the railway yard. The Company proposed, provided suitable arrangements could be made, to put a small station on this loop line, so that they might land the passengers there and take them from there—practically at the entrance—to the show. As to revenue, there had been a large diminution in the traffic of all the tube railways during the past six months, not a diminution resulting from any laches of the Company, or from any deterioration of the work, because the trains were as frequent, they were as well served, and there had been practically no accident during the half-year, and hardly a case of detention. There was no alteration in their fares, because the 2d. continued up to the end of the half-year, but still there was a steady and had been a steady and growing diminution in the number of passengers they carried. The decrease in the half-year represents 2,000,000, or about 10 per cent. of the total. The money loss in direct fares was £16,000. It was slightly lessened by an addition of sundry receipts. On the other hand, the expenses had been lessened by the amount of about £4,700, but they were somewhat spoiled by an addition of about £374 for rates and taxes. They had saved £4,000, and they had reduced the loss from the absence of passengers to that extent. The reason for the diminution of passengers was due to competition. The directors had ascertained that there were at least 20 per cent. more omnibuses and motorcars running between Holborn and the Marble Arch than there were a year and a half ago. The loss of passenger traffic at one or two intermediate points on the line had been something like 15 to 18 per cent., and others 10 to 13 per cent., and, of course, that reacted on the extremities, because if people went to the centre by omnibus they probably returned in a similar way. Therefore, there was a slight decrease at the extremities, but the main decrease was in the centre. This, he said, was due to the competition of pennies against their twopences. He referred to the committee recently appointed to consider the question of fares in London, and indicated that their hope was that by reasonable consideration and mutual concession some basis might be found that would restore the charges that were made to some fair relation between the work and the cost. Touching upon the recent raising of the long-distance fare from 2d. to 3d. he thought he was justified in saying that that experiment promised to be satisfactory. They were receiving through this additional penny something like £60,000 or £70,000 without any additional cost, and that to some extent compensated them for the loss in other directions. He added that they found that the loss was not continuing. Its ratio was diminishing, as if they had reached the bottom of the change resulting from the competitive fares. Although the result was not satisfactory, because they were obliged to recommend a dividend which was at the rate of 1 per cent. less than they paid in the corresponding period, still, although that represented £15,000 less divisible, it was fair to say that, after paying 3 per cent., they would carry forward £25,000 instead of £14,000 only, which they brought in from last half-year; so that though they had not divided the same last year by £15,000, they practically had in hand £11,000 of it.

Lord RATHMORE seconded the motion.

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Some discussion ensued, and the question of workmen's fares was raised. The CHAIRMAN, in reply, said the Company were required to carry a workman for 1d. a journey, but this had been modified to the extent that a man was required to pay 2d. whether he took the return journey or not. With regard to the cost, the Company received 1d. per journey, and the cost was ·85d. There was really, therefore, not a proper working margin of profit, but they could not help themselves in this respect.

The resolution was carried unanimously.

TYNESIDE TRAMWAYS.

The half-yearly meeting of the Tyneside Tramways Co. was held in Newcastle on Tuesday, Dr. J. T. Merz presiding.

In moving the adoption of the report, the CHAIRMAN apologised for the absence of Lord Armstrong, who was sitting on a Lords Committee in London. He remarked that the increase of traffic as compared with the corresponding period amounted to £693, though the increase of the ordinary traffic had been £749. The holiday traffic had not been quite so good as last year owing to the unfavourable weather at Whitsuntide. The increase of passenger traffic was 10 per cent., and the receipts per car mile 8·8d. against 8·3d. The whole of the repairs and maintenance had been charged to revenue, and as this is an increasing amount the cost would be increased by £386 over the corresponding half-year. More current had been also used owing to more frequent stoppages and owing to the traffic on Neptune Bank. The reserve had been raised to £4,000 by taking £900 out of the revenue, and the amount standing under formation and registration expenses had been reduced by £335. Referring to the issue of preference shares, the chairman pointed out that of the 3,000 issued 1,800 had been applied for, and half of that number by their own shareholders. This was, he said, a well-secured investment, paying 5 per cent., and not terminable as the debentures were. The money received on account of these shares was, he said, utilised in reducing the loans. He proposed that a dividend of 2 per cent. be paid.

Mr. J. H. ARMSTRONG, who seconded the motion (which was carried unanimously), said the issue of the preference shares would put the Company on a sounder financial basis.

DUBLIN AND LUCAN ELECTRIC RAILWAY.

The report of the Dublin and Lucan Electric Railway Co. for the half-year ended June 30 last states that, after providing for debenture interest, there is an available balance of £1,035, out of which the directors recommend the usual half-yearly dividend on the 5 per cent. preference shares, that £250 be paid to the contractors on account of the principal sum remaining due to them for electrical equipment, and that £93 shall be written off electric signal installation account, that amount having been paid for a new system of signalling during the past half-year, and that £217 be carried forward.

NEW COMPANIES REGISTERED.

Foster Arc Lamp and Engineering Co., Limited.—Registered July 29. Capital, £20,000 in £1 shares (5,000 6 per cent. cumulative preference). Objects: to adopt an agreement with M. V. Ely, E. R. Grote, and E. Dobson, and to carry on the business of arc lamp manufacturers, electrical engineers, electric lighting contractors, cable manufacturers, electric fittings, storage battery and carbon manufacturers, etc. No initial public issue. Registered office: Worple-arcade, Worple-road, Wimbledon.

British Bronze and Silvo Metal Co., Limited.—Registered July 26. Capital, £35,000 in £1 shares. Objects: to acquire the business of metal manufacturers carried on by M. S. Stevenson and J. Melland-Smith, at 50, Pritchett-street, Birmingham, as the Birmingham Foundry Co.; to adopt an agreement with the said vendors and R. F. Collinge, and to carry on the said business and that of manufacturers of alloys, combiners of metals, manufacturers, and producers of all kinds of metallic tubing substances and compounds, tube, rod, and wire drawers and rollers, metallurgists, etc. No initial public issue. Registered office: 16, Fleet-street, E.C.

Rhondda Tramways Electric Supply Co.—Registered Aug. 2. Capital, £100 in £1 shares. Objects: to build, construct, and equip a generating station for producing electrical energy, to supply electricity to the Rhondda Tramways Co. for the working of its undertaking, to adopt agreements with the Rhondda Tramway Co. and the National Electric Construction Co. Registered office: Queen Anne's-chambers, Westminster.

Liens Registered.

Yorkshire (West Riding) Electric Tramways Co., Limited, Westminster, S.W.—Particulars required by Sub-Section 4, Section 14, of the Companies' Act, 1900, registered July 26, relating to £30,000 second mortgage debentures. No trustees. Charged on the undertaking and the whole of the other assets, including the uncalled capital for the time being, subject to the amount outstanding of the £400,000 4½ per cent. first mortgage debenture stock.

North Wales Power and Traction Co., Limited, London, E.C.—Deed of modification registered July 16 (supplemental to a trust deed dated Aug. 15, 1905), by which an issue of £150,000 debenture stock, created in August, 1905, is now reduced to £80,000 by the cancellation of £70,000 of the above-mentioned debenture stock. Secured by a specific mortgage on certain land and buildings belonging to the company, and by a floating charge on the other assets generally, but the deed now registered releases various assets originally charged.

Leicestershire and Warwickshire Electric Power Syndicate, Limited, Westminster, S.W.—Lien registered July 29 for £650 6 per cent. debentures, part of £5,000 authorised. No trustees. Charged on the undertaking, property, and assets.

PERSONAL.

Messrs. Hansard and Watson, of Parliament-mansions, Victoria-street, Westminster, S.W., announce that they have dissolved partnership as from Aug. 1. Mr. Arnold G. Hansard, B.A., M.I.E.E., will carry on the business under his own name, and will be responsible for all debts of the late firm.

The following appointments have been made in the Birmingham Corporation electricity department: Mr. R. U. Bailey, of the Newcastle-on-Tyne Electric Supply Co., to be shift engineer; and Mr. George Scott, of the Handsworth Urban District Council electric supply department, to be boiler-house foreman at the Summer-lane generating station.

There are 20 applications for the post of manager of the Stirling Corporation electricity works, rendered vacant by the resignation, through ill-health, of Mr. A. C. Hanson, and the following candidates have been selected from which the final choice will be made: Messrs. Wm. Drysdale, at present chief assistant electrical engineer to the Corporation of Weymouth; J. Papworth, chief assistant engineer, Kilmarnock Corporation works; and A. White, station superintendent, Battersea Corporation electricity works. The salary is £200 per annum.

OPENINGS FOR CONTRACTORS.

ANNFIELD PLAIN (DURHAM)—New hall at Dimpton for the Annfield Plain Industrial Co-operative Society. Architect, Mr. T. B. Wilson, 22, Durham-road, Blackhill.

ASTON MANOR—Electricity supply undertaking (£17,500).

BANGOR (WALES)—College buildings. Secretary, Mr. J. E. Lloyd, M.A., University College, North Wales, Bangor.

BARNSLEY—High school in Huddersfield-road. Architects, Messrs. Buckland and Haywood-Farmer, Norwich Union-chambers, Congreve-street, Birmingham.

BELFAST—Repairs at the clerk of Guardians' office. Architects, Messrs. Young and Mackenzie, Belfast.

BELFAST—Villa residence. Architect, Mr. W. J. Moore, 35, Royal-avenue, Belfast.

BLAENAVON—Motor house and laundry at Park House. Architects, Messrs. Teather and Wilson, Andrew's-buildings, Queen-street, Cardiff.

BRADFORD—Nurses' home and isolation block at the City Hospital, Leeds-road. City architect, Whittaker-buildings, Brewery-street, Bradford.

BRIDGEND—New wings at Court Colman for Mr. R. W. Llewellyn. Architects, Messrs. Cook and Edwards, Masonic-buildings, Bridgend.

BURY—Alteration and extension to technical school (£18,000) New school for 900 scholars. Borough engineer, Mr. A. W. Bradley, Bury.

CHESHIRE—Improving and enlarging Upton Lunatic Asylum, near Chester (£124,500), and enlarging Parkside Lunatic Asylum, Macclesfield (£25,000), for County Council.

CLACTON-ON-SEA—Office buildings for Messrs. E. J. Gilders and Co., auctioneers. Joint architects, Messrs. Baker and Wrightson and W. J. Almond, Clacton-on-Sea.

COLDHOLME (BLACK HILLS)—Farm buildings. Architect, Mr. J. Wittet, Elgin.

CROYDON—Extension of mental hospital for the County Council. (£30,000).

DONCASTER—School at Balby-with-Hexthorpe for the West Riding Education Committee. Architect, Mr. F. W. Masters, St. Vincent, Doncaster.

DUMBARTON—Post office. H.M. Office of Works, Edinburgh.

DURHAM - New schools proposed for the County Education Authority.

GRINDLEFORD—Church costing £5,000. Particulars from the Rector of St. Lawrence, Eyam.

HALIFAX—Dwelling-house near Hebden Bridge. Architect, Mr T Kershaw, Lancs. and Yorks. Bank-chambers, Halifax.

HARWICH—Rebuilding town hall (£6,000) for Corporation.

LEEDS—Conversion of premises into offices and erection of warehouse in Oxford-row, Leeds. Messrs. Moseley, 6, Wormald-row, Leeds.

LEVEN (SCOTLAND)—Premises for the Leven Reform Co-operative Society, including gas-engine and suction plant, dynamo, and electric lighting. Architect, Mr. Wm. Dough, Kirkcaldy.

LONDON—Technical institute in S.E. London for London County Council.

LONDON—Technical institute in Wandsworth for London County Council.

LONDON—Enlargement of Fountain-road School, Wandsworth (£2,798), for London County Council.

LONDON—Enlargement of Franciscan-road School, Wandsworth (£2,418), for London County Council.

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LONDON—Equipment of Hammersmith technical institute (£1,100) for London County Council.

LONDON—Equipment of Westminster technical institute (£1,300) for London County Council.

LONDON—Alterations at the Frascati Restaurant, Oxford street. Architect, Mr. R. Blomfield.

LONDON—Alterations and extensions at Great Queen-street Theatre. Architect Mr. F. W. Foster.

LONDON—Boilers for cement works. Particulars from Mr. R. Atkinson, 39, Victoria-street Westminster, S.W.

LONGSIDE—Bakery. Architect, Mr. J. M. Whyte.

MACCLESFIELD—Infectious diseases hospital in Moss-lane. Borough Engineer, Town Hall, Macclesfield.

MEXICO—A tramway for the Compania Limitada de Tranvias Electricos de Mexico Concessionaires.

MISKIN—Shops, house, etc., for the Cymbach Industrial Co-operative Society. Architect, Mr. T. Roderick, Ashbrook House, Clifton-street, Aberdare.

MORLEY—Warehouse at Dearnfield Mills for Mr. James Barker. Architects, Messrs. T. A. Buttery and S. B. Birds, 1, Basinghall-square, Leeds, and at Queen-street, Morley.

NANTWICH—Cottage hospital (£2,000).

NORTH RIDING—Enlargement of county asylum (£20,000).

PENDOYLAN—House for Mr. B. Parsons. Architect, Mr. W. Morgan, 11, Bute-crescent, Cowbridge-road, Pontyclun.

PETERBOROUGH—Corporation electric lighting extensions (£3,000).

PONTYPOOL—Free library in Hanbury-road for the Urban District Council. Messrs. Spier and Bevan, Borough-chambers, Wharton-street, Cardiff.

RHYMNEY—Additions to brewery for Messrs. Buchan and Co. Architect, Mr. T. Roderick, Ashbrook House, Clifton-street, Aberdare.

ST. PANCRAS—Industrial dwellings in Gray's-inn-road (£18,000) for Borough Council.

STAFFORD—Isolation hospital for the Town Council (£2,550).

STOURBRIDGE—Enlargement of free library (£700).

TOTNES—Infirmary at the workhouse. Mr. W. F. Tollit, 10, High-street, Totnes.

WINCHESTER—Repairs at the old Guildhall premises for the Corporation. Apply City Surveyor.

WORLE—Street lighting of the parish. Clerk, Mr. R. K. Clay, Ashton Villa, Worle.

WORKINGTON—Additions to infirmary. Architects, Messrs. Oliver and Dodgshun, Carlisle.

WREXHAM—School for 1,000 scholars for the Education Committee.

YORK—Two dwelling-houses on Southlands Estate. Architect, Mr. J. H. Pegg, 23, Spurriergate, York.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Leghorn.—The Municipality invite tenders for electric lighting. Tenders by Sept. 21.

Vienna.—Tenders are invited for a central electric power station at Czernowitz for the Austrian State Railways. Tenders by Aug. 31.

Worle.—The Parish Council invite tenders for street-lighting. Specifications from Mr. Robt. K. Clay, clerk, Ashton Villa, Worle. Tenders by Aug. 10.

Thorne (near Doncaster).—The Parish Council invite tenders for lighting the town from Sept. 1 to April 30, 1908. Tenders to Mr. C. Waller, clerk, by Aug. 16.

Barnes.—The Urban District Council invite tenders for mechanical stokers and cables for the Electricity Department. Specifications £1. 1s. each. Tenders by Aug. 12.

Compahario.—Tenders are invited for the electric lighting of the town for a period of 20 years. Particulars from the Ayuntamiento Constitucional. Tenders by Aug. 24.

Kettering.—The Urban District Council invite tenders for 315-kw. engine and dynamo set and pipe connections, also switchboard panel. Tenders by Aug. 28. See advertisement.

Brisbane.—The Postmaster-General invites tenders for the supply and delivery at Brisbane of four sections of a common battery switchboard and 650 subscribers' telephones to specification No. 145. Tenders by Sept. 2.

Grimsby.—Tenders are invited by the Corporation for the supply of one 500-kw. continuous-current dynamo coupled to a triple-expansion engine. Specification and particulars from the Borough Electrical Engineer. Tenders by Aug. 19.

Acton.—The Urban District Council invite tenders for the wiring and fixing of fittings under their assisted wiring schemes. Full particulars from the electrical engineer, Mr. J. Martin Blair, 130, Churchfield-road, Acton, W. Tenders by Aug. 20.

London, S.W.—The Crown Agents for the Colonies, acting on behalf of the Central South African Railways, invite tenders for the supply of 27,000lb. hard-drawn copper wire. Tenders to the Crown Agents for the Colonies, Whitehall-gardens, S.W., by Aug. 20.

London, W.—The Paddington Guardians invite tenders for an electrical installation of fire-alarms at their workhouse in the Harrow-road. Specification and form of tender may be obtained of Mr. H. F. Aveling, clerk, Guardians' Offices, 313-319, Harrow-road, W. Tenders by Aug. 12.

Adelaide.—The Deputy Postmaster-General for Queensland invites tenders for a common battery switchboard and 3,000 subscribers' telephones. Specification No. 166. Particulars may be obtained from the Commonwealth Offices, 72, Victoria-street, London, S.W. Tenders by Jan. 8, 1903.

Portsmouth.—The Town Council invite tenders for (Contract No. 24) supply, delivery, and erection of one high-tension switchboard; (25) supply, delivery, and erection of steam, exhaust, circulating water, and sundry other pipework. Tenders to the Town Clerk by Aug. 14.

Crewe.—Tenders are invited for a 12 months' supply (about 2,000 tons) of best quality open burning slack, to be delivered in quantities as ordered at their electricity works, for the Electric Lighting Committee. Tenders to Mr. H. H. Denton, Corporation Electricity Works, Crewe, by Aug. 17.

Dundee.—The Town Council invite tenders for (1) the construction of nearly one mile of double line of tramway, and (2) steel tramway rails, points, crossings, etc. Specifications, etc., from Mr. Jas. Thomson, city engineer, Municipal Offices, 91, Commercial-street, Dundee. Tenders by Aug. 13.

Leven (Scotland).—Tenders are invited for gas-engine and suction plant, dynamo and electric lighting, etc., for new premises which are about to be built for the Leven Reform Co-operative Society. Particulars may be obtained from Mr. Wm. Dow, architect, Kirkcaldy, by whom tenders will be received up till Aug. 17.

Alexandria.—The Harbour Authority invites tenders for the electric installation for the port, comprising five large and seven small transporters, six four-ton cranes, 36 two-ton cranes, 25 capstans; also cables and accessories, construction and installation of central power station. Particulars from the Directeur Général des Ports at Phares. Tenders by Nov. 1.

Queensland.—Tenders are invited by the Postmaster-General for the supply and delivery at the Post and Telegraph Stores, Brisbane, of the following telegraph and telephone material: (1) lead-covered cable; (2) stores and battery material; (3) line material; (4) telegraph and telephone instruments; (5) coin attachments. Tenders to be sent to the General Post Office, Brisbane, by Sept. 2.

New South Wales.—With reference to an announcement inviting tenders for the supply and construction complete of a pneumatic tube service to the General Post Office, Sydney, from the Pacific Cable Board's Office, Royal and Stock Exchanges, etc., the Postmaster-General for New South Wales give notice that the date for the receipt of such tenders has been extended from July 10 to 2.30 p.m. on Wednesday, Oct. 16 next.

Stockton-on-Tees.—Tenders are invited for 1,500 tons of steam nuts for use on mechanical stokers, to be delivered in quantities as required at their electricity works, gasworks siding, North Shore, Stockton-on-Tees, between Oct. 1, 1907, and March 31, 1908, for the Electricity Committee. Forms of tender may be obtained on application to Mr. J. J. Smith, borough electrical engineer, and must be returned to Mr. Arthur B. Crosby, town clerk, by Aug. 14.

Erith (Kent).—The Urban District Council invite tenders for the supply and erection of the following plant at their sewage-disposal works, Manor-road Erith: an electrically-driven air-compressor, including three-phase motor, switchgear, cable connections and pipework. Copies of the specification, etc. (£2. 2s.), from Messrs. Hawtayne and Zeden, consulting engineers, 9, Queen-street-place, London, E.C., or from Mr. Charles H. Fry, clerk, Council Offices, Bexley. Tenders by Sept. 2.

South Australia.—The Postmaster-General, Adelaide, invites tenders for the supply of lead-covered telephone cables as follows: 7½ miles 208 pair, paper-insulated, lead-covered, 12½lb. conductors; 3½ miles 156 pair ditto; 4 miles 104 pair ditto; 2½ miles 78 pair ditto; 7 miles 52 pair ditto; 2½ miles 26 pair ditto; and 700 yards 104 pair light lead-covered, silk and cotton insulated. Particulars may be obtained from the Commonwealth Office, London. Tenders to the Deputy Postmaster-General, Adelaide, by Sept. 25.

Bristol.—The Electrical Committee invite tenders for the supply, delivery, and erection of one 300-kw. and two 500-kw three-phase to direct current converters (6,000 to 500 volts) with balancers and starters; extra high-tension, alternating-current, and low-tension direct-current switchgear; 10-ton hand travelling crane. Also the supply, delivery, laying, and jointing of 24 miles (approx.) of ·05 square inch three-core paper-insulated B.O.T. sheathed lead-covered cable, together with the necessary troughing and filling; and the construction of the necessary converter station, inclusive of foundations. Tenders to Mr. H. Faraday Proctor, City Electrical Engineer's Office, Temple back, Bristol. See advertisement.

Gothenburg.—The Commercial Intelligence Branch of the Board of Trade are notified by his Majesty's Consul at Gothenburg that tenders are invited for supply of the electrical equipment for the Government power station at Trollhattan, comprising three electric generators for direct current, each of 350 kw.; one accumulator battery of 4,800 ampere-hours capacity; four three-phase generators, each of a maximum of 11,000 kilovolt-amperes; 12 transmitters, each of a maximum of 3,670 kilovolt-amperes; connections; regulators; and control tables. Sealed tenders, marked "Anbud a elektrisk utrustning for Statens kraftverk," should be sent to the Managing Director of the Royal Trollhattan Canal and Waterworks, Trollhattan, Sweden, by noon on Oct. 1 next. Tenders are binding until Jan. 1, 1908. Delivery is to be completed by Sept. 1, 1909. Further information may be obtained from the Managing Director, from whom a copy of the programme can be had against a deposit of 50 kronor, which will be returned on receipt of a tender in accordance with the programme.

RESULTS OF TENDERS.

Limerick.—The Electric Light Committee have accepted the tender of P. Kennedy and Son, Limerick, for the building of an extension to the gas-house at the electricity works for £183.

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New South Wales.—The Department of Public Works, Sydney, have accepted the tender of the Australian General Electric Co., Sydney, for supply, etc., of four electric motors, together with equipments and accessories.

Rochester.—The British Thomson-Houston Co. have received an order from Messrs. Aveling and Porter, Rochester, for 95 of their new flame arc lamps for illuminating their works. The lamps are to have special compensators, each controlling two lamps, and arranged with middle terminal so that single lamps may be switched on and off.

Uxbridge.—The Urban District Council have received the following tenders for the public lighting of High-street, St. Andrew's, and certain other streets, there being some 55 lamps now in use: Uxbridge Electric Supply Co., £2. 5s. 6d. per lamp per annum for twin-light Osram lamps (accepted); Uxbridge Gas Co., £4 per lamp per annum.

Ealing.—The Town Council have accepted tenders for the following supplies for the electricity works: Vacuum Oil Co., York House, W.C., crank-chamber oil, bearing oil, and cylinder oil; W. H. Willcox and Co., 23, Southwark-street, S.E., paraffin oil, waste, and rags; Wiggins and Co., Chancellor's Wharf, Hammersmith, W., pipes and bends.

BUSINESS NOTES.

TRACTION.

Brisbane Electric Tramways Investment Co.—The traffic receipts of the Brisbane tramways for the month of July amounted to £12,775; corresponding month last year, £11,158—increase, £1,617.

Turkey.—Mr. Vice-Consul E. H. Mulock in his report on the trade of Salonica for the year 1906 states that a concession has been granted for the construction of an electric power station, of which the tramways will probably take advantage by the substitution of electric for horse traction.

Tooting.—The working-men of Tooting have organised a petition to the London County Council asking for an extension of the hours of the workmen's cars from 7.20 to 8 a.m., and further suggesting that an additional cheap fare service at 3d. per return from the bridges from 8 till 9 a.m. should be started.

Dundee.—The electrical engineer has been instructed to take in tenders for the supply and delivery of overhead equipment for the extension of the city tramways to Downfield and also to the railway stations. The cost of the whole work is estimated at about £10,000, and it has been decided that the erection of the overhead equipment be done by the employés of the electricity department.

Madras.—From a statement issued by the Madras Electric Tramways (1904) it is seen that the traffic receipts for the fortnight ended July 31, 1907, were Rs.17,062, an increase of 22·9 per cent. compared with the corresponding period of the previous year. The gross receipts from Jan. 1, 1907, were Rs.238,658, compared with Rs.199,442 for the corresponding period of the previous year, an increase of 19·6 per cent.

Wolverhampton.—Reference was made in these columns last week to the recommendation of the Tramways Committee that an extension of about 1½ miles of the Lorain surface-contact system of electric tramways be undertaken at a cost of about £18,000. This recommendation was to have been discussed at a meeting of the Town Council last Friday, but it was decided to postpone consideration of the scheme until the next Council meeting.

Board of Trade Inquiries.—The Board of Trade have appointed Lieut.-Colonel E. Druitt, R.E., to hold an inquiry into the circumstances of the accident which occurred on July 31 at Church Bank on the Bradford Corporation tramways. The Board of Trade have appointed Lieut.-Colonel P. G. von Donop, R.E., to hold an inquiry into the circumstances of the accident which occurred on July 29 at Botcherby Bank, on the Houghton-le-Spring and District tramways.

Cardiff.—A recent meeting of the Cardiff Trades' Council was attended by Mr. Arthur Ellis, manager of the tramways, who addressed the meeting on the subject of the reduction of cars, particularly those for workmen. Several questions were asked him, and he promised, as the workmen's car fares were uniform, that he would ask his committee to consider the advisability of adopting the transfer ticket system for workmen's cars. Mr. Ellis was thanked by the meeting.

Electrocution.—The Metropolitan Railway to Harrow has been singularly immune from accidents arising from the electrical installation of the line, which was undertaken three years ago. On Tuesday, however, a man, who was doing duty for a porter on sick leave at Harrow, lost his life by electrocution. He was engaged in coupling carriages, and it is supposed that while stooping he stepped on to the "live" rail. In the endeavour to release himself, it is probable that he stumbled and fell on his face on to the rail, with fatal results.

Thames Embankment Tramways.—The Cleveland Bridge and Engineering Co., of Darlington, have been entrusted with the order for the supply and erection of the steelwork required in the new tramway subway of the London County Council, which is to extend from Wellington-street, Strand, to the Thames Embankment. Two sets of tramway will be provided for, and the subway will have a uniform depth of 20ft. and a width of 23ft., the centre of the tracks being 10ft. apart. Some 800 tons of steelwork, consisting chiefly of stanchions and plate girders with troughing on top, will be required.

Tram Men's Brotherhood.—The St. Mark's Tram Men's Brotherhood of England held their first annual outing last week, Ipswich being the destination. The brotherhood, which was founded in connection with St. Mark's Church, Kennington, now has a membership of over 1,000, with branches in Portsmouth, Bolton, Bury (Lancs.), Newcastle-on-Tyne, and Bath, in addition to those in the London districts. The largest branch is that at Bolton, which has a membership of 240. An Ipswich branch was founded last February and its membership now totals about 30. The movement, which started with 80, now numbers 1,000 members. An enjoyable day was spent by those who attended the outing, and the attractions included sports in the afternoon. Mrs. F. Ayton, wife of the Ipswich tramway manager, presented prizes to the successful competitors.

Musselburgh.—As the outcome of a circular issued recently by the manager of Musselburgh Electric Co., a crisis has arisen in the service. The management wished to establish a new standard of wages, and engaged beginners at 4¾d. per hour (drivers) and 4½d. per hour (conductors), both receiving ½d. advance after six months' service. This has been strongly resisted by the men, who demand that conductors and drivers start on the equal basis of 5d. per hour, and receive 5½d. after six months' service. Many of the experienced hands, who are at present receiving 6d. per hour, object to beginners being put on the long Sunday shifts, when time and half is paid, while they are put on the short shifts. The men further demand that every driver and conductor on a constant shift work not less than 56 hours per week. The men came out on strike, and displayed their feelings in a violent manner.

Perth.—When the accounts of the Perth Corporation were presented to the Town Council last week, it was explained that the tramway department estimated for a loss on the present working of £1,193, and to meet the sum it had been arranged to increase the assessment from 1½d. to 2½d. per £1, thus reducing the amount considerably. The Lord Provost said he would like to explain what was said regarding the tramways this year. They had had a fair trial, and evidently they were not to pay. Of course, they all knew that the general expenditure of £2,000 for the old system was a dead weight, and had it not been for that the system would have paid its way. The only way to increase their revenue was to adopt a modified service on Sunday, but he was afraid the present Council would not entertain that idea. He wanted the citizens to understand that unless this year some other system was tried occupiers would have to face a burden of at least 2d. on the rates for the upkeep of the tramways.

London Motor Traffic.—In reply to a member who asked what orders are given to the metropolitan police with regard to the control of motorcars in London that, by reason of their noise and smell, or both, become a public nuisance, and whether penal regulations will now be more stringently enforced in cases where the nuisance is caused by neglect in cleaning the engines and by over-lubrication, the Home Secretary informed the House of Commons that the police would not take any action with respect to noise and smell against motorcars other than cabs and omnibuses. The only remedy was for the person aggrieved to take proceedings against the owner for a nuisance. This matter is dealt with in the report of the recent Royal Commission, and he understood that the Local Government Board proposed to amend the law when an opportunity for legislation could be found. Motor omnibuses and cabs, when unduly noisy, were required to have their defects remedied. During the year ended June 30 last, 3,137 of them were so dealt with for noise, and 257 for smoky exhaust.

Rotherham.—There is a proposal before the Council to rescind the following resolution relating to tramway extensions which was passed in June last: "That, subject to powers being obtained by the Council to construct a tramway in Broom-road from Badsley Moor-lane to the borough boundary in Wickersley-road and Broom-lane, a tramway be laid in Wellgate and Broom-road from the bottom of High-street to the top of Broom-road, and that the town clerk be instructed to take all necessary steps in order to obtain a provisional order authorising such additional tramway in the next session of Parliament." The Tramways Committee are recommending that the authorised tramway from Effingham-square, along Frederick-street, Bridge-street, College-road, Midland-road, and Wortley-road to Bradgate be constructed, and that the electrical engineer be instructed to prepare the necessary details for the carrying out of the work. Reporting upon the latter extension, the borough comptroller states that the expectation of an actual surplus in the tramways department at the end of the year will be dashed to the ground if unremunerative extensions are taken in hand, especially bearing in mind the present abnormally high price of all materials. The scheme, he says, if carried out, would probably be a disastrous one. The Tramways Committee have decided not to recommend the adoption of workmen's fares.

Accrington.—The formal opening of the completed portion of the tramway which has been electrified for the Corporation took place last week. The length of the completed line is about two miles, from Ellison-street to the Oswaldtwistle terminus, the rest of the lines from Accrington to Clayton-le-Moors, and the Baxenden and the Burnley-road sections have not yet been completed. Colonel Druitt, who inspected the line on behalf of the Board of Trade, expressed himself as highly pleased with the work, and gave permission to open the tramways for public traffic. The Board of Trade arbitration between Haslingden and Rawtenstall Corporations and the Accrington Steam Tramways Co., as to the sum each Corporation must pay in acquiring so much of the company's undertaking as belongs to their respective boroughs, was commenced in London last week before Sir Colin Scott Moncrieff, Board of Trade referee. A summary of the values claimed was put in, and it was explained that Haslingden agreed to these items: permanent way and paving, £4,572; depôt, exclusive of land, £3,417; plant, £300—making the total amount of agreed items, £8,289. The items in dispute were: parliamentary expenses, £3,093; paving, £5,827; land for depôt, £1,765; cars, £117; engines, £4,857. The total of agreed and disputed items was £24,678. As to Rawtenstall the agreed items were: permanent way, exclusive of paving, £1,901. Items in dispute: paving and permanent way, £2,242; parliamentary expenses, £1,193. With respect to engines and cars it was agreed that price per engine and per car should be based upon the average prices awarded in the Haslingden case.

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Walsall.—The following are particulars respecting the working of the tramways—viz.: Three weeks ending July 21, 1906—number of passengers, 284,270; receipts, £1,551. 3s. 5d.; car miles run, 35,365; receipts per car mile run, 10·53d. Three weeks ending July 20, 1907—number of passengers, 294,922; receipts, £1 637. 2s. 9½d.; car miles run, 33,495; receipts per car mile run, 11·73d. Wages paid (including repair of permanent way): three weeks ending July 19, 1906, £474. 10s. 5d.; three weeks ending July 18, 1907, £473. 4s. 1½d. The Tramways Committee have received a deputation from the Rushall Parish Council, who urged the desirability of the fare from The Bridge, Walsall, to Rushall being altered from 2d. to 1½d., but the committee do not feel justified in making any reduction in the fares. The committee have had under consideration a report from the manager with respect to ½d. fares, from which it appears that out of 78 municipalities only 15 have wholly adopted ½d. fares, and 14 have partially adopted them. In a number of these instances the published accounts show a deficit varying from £115 to £14,000, which is largely attributable to this cause, and the manager is of opinion that success can only be expected in the large cities and towns where the population is dense and a close service of cars is run. As an illustration the manager points out that in the case of the Pleck section, if a ½d. stage to Corporation-street was adopted, the Corporation would lose £830 a year, and that to make up for this loss, without taking into account the additional expenditure which would have to be incurred in the provision of more rolling-stock and the extra cost of working, it would be necessary to have an increased traffic of 400,000 per annum. He is convinced that the conditions prevailing in Walsall do not allow of a reduction in fares, as the traffic is largely commercial and domestic, and affected more or less by the state of trade. The committee have approved of the terms made by the manager with the Birmingham and Midland Tramways Joint Committee for the establishment of a system of through parcel traffic between Walsall and any portion of the Joint Committee's lines in the Midlands having connection with the Walsall system, the arrangement to be for one year as from Aug. 1. They have decided that on the Corporation tramways parcel system, in lieu of the present arrangement, the agents shall be allowed 1d. for each parcel delivered and 10 per cent. on all parcel tickets they sell, and to issue gummed tickets to the conductors and to give them 10 per cent. on their sale. The Streets Committee are to take a supply of current from the tramway circuit for working the machinery at the proposed pumping station at Parkbrook, subject to every precaution being taken for the non-interference with the working of the tramways, the current to be taken through a meter and paid for at 1½d. per unit. The sole right of advertising on the Corporation cars has been let to Mr. A. C. Burnley, the present contractor, for the further period of three years on the same terms and conditions as the existing lease.

LIGHTING AND GENERAL.

St. Marylebone.—The accounts of the electric undertaking for the year show a net credit balance of £22,061.

Metropolitan Electric Supply Co.—The directors of the Metropolitan Electric Supply Co. announce an interim dividend of 3 per cent.

Stock Exchange.—The Stock Exchange Committee has appointed Aug. 21 special settling day in Chemainus Copper Mine Co. (Non-Personal Liability) 66,666 shares of £1 each fully paid, Nos. 1 to 66,666.

Notice of Dividends.—According to the *London Gazette*, a first and final dividend of 10½d. in the £ has been declared in the estate of F. E. Williams, electrical engineer, 328, Coventry-road, Birmingham.

Beckenham.—At the last meeting of the Council a resolution to appoint a special committee to inquire into and report at the earliest possible moment upon the accounts, present condition, and management of the electricity undertaking was, after considerable debate, negatived.

Longton.—In the Corporation electricity department the number of units generated during the four weeks ending July 18 was 11,446, against 6,778 for the corresponding period of last year, being an increase of 68 per cent. During the four weeks 106 additional lamps were fixed.

Liquidation.—The *London Gazette* announces that Siemens Electric Appliances has been wound up voluntarily, and Mr. A. M. Hicks, of 8, Belmont-road, Wallington, Surrey, appointed liquidator, to whom creditors are requested to send particulars of their claims by Sept. 30.

Gloucester.—The report of the city electricity undertaking states that progress has been steadily maintained, and a satisfactory increase of consumers is shown. In March, 1901, the number of consumers was 190 and lamps installed 14,775; the previous year these figures were 503 and 41,344, and for 1907 535 and 47,735 respectively.

Morley.—At the last Town Council meeting the borough electrical engineer (Mr. J. E. Ellis) reported that the output from the electricity works for the month ended May 31 was 9,263 units, as compared with 5,260 the same period of last year, being an increase of 4,003 units. The quantity sold to consumers by meter was 7,222 units, as compared with 4,170 the same month last year, being an increase of 3,052 units.

Business Announcement.—The electrical engineering business carried on at Maidenhead, Berks, by Messrs. Holman James and Co. has lately been greatly strengthened by the addition to the Board of Mr. Jno. Budgen, J.P., of the firm of Messrs. J. Budgen and Co., ironmongers, High-street, Maidenhead. Mr. Budgen has taken a large financial stake in the company, and will be chairman in future. The services of Mr. Holman James will be retained by the company as managing director.

Association of Engineers-in-Charge.—This association will pay a visit on Saturday, Aug. 10, to the General Post Office Central Telephone Exchange, Carter-lane, St. Paul's, E.C., having received permission to do so from Major M. A. J. O'Meara, engineer-in-chief. The Western Electric Co are installing the plant, and the large and extraordinary collection of telephone apparatus which this includes should make the occasion one of especial interest. Members will assemble opposite the main entrance in Carter-lane at 2.45 p.m.

Surface Condensers.—Messrs. Willans and Robinson, of Rugby, have acquired the rights for the use of the "Contraflo" type of surface condenser, in addition to the "Vacuum Augmenter" system, which owes its introduction to the Hon. C. A. Parsons. Messrs. Willans and Robinson have during the past year or so obtained orders for over 50 complete sets of their ordinary type of surface condenser, and it is believed that the "Contraflo" and "Vacuum Augmenter" systems will enable them to further extend this branch of their manufactures.

Ferro-Concrete Foundation Work.—A proof of the extensive application of ferro-concrete in the United Kingdom is afforded by a list of contracts for the month ending June 29 for the execution of works in accordance with the Mouchel-Hennebique system of ferro-concrete. This new material was used for the foundation slab for the electric accumulators at Parkeston Quay extension (Great Eastern Railway), and for the foundation slabs for the steam turbo-generators for the South Metropolitan Electric Tramways and Lighting Co., Sutton, Surrey.

Bath.—The Electricity Committee have recommended the Council that the time for completion of the purchase of the electricity undertaking be extended to March 31, 1908; that a deposit of £2,500 be made by Mr. Schenk, such deposit to be accepted subject to the condition that it be returned to Mr. Schenk if the Corporation make wilful default in completing the agreement; and that the provisions of the draft agreement be modified so as to definitely substitute allowances of £500 each in current for the two bonuses of £10,000 each. The report has been adopted.

Brazil.—The British consul at Pará reports that separate concessions were some time ago given by the States of Para and Amazonas for the working of a system of wireless telegraphy within each individual State, and a company was formed in New York to work the concessions. A good deal of material has been sent out, and stations have been established at Pará, Breves, and Santarem, all in the State of Pará. The Federal Government appear, however, to have denied the necessary licence to operate between the two States, so that progress for the present is suspended. The system used is that of Schumacher.

Yarrow's Scottish Shipyard.—The work in connection with the new shipyard which Messrs. Yarrow and Co. are having built at Scotstown, on the Clyde, is now so far advanced that one or two of the departments are in operation. An interesting feature of the new establishment is that practically all the power used will be electric, supplied by the Clyde Valley Electric Power Co. The motors are of the alternating-current type, having a periodicity of 25 cycles, and the current supplied will be 400 volts alternating. Electric travelling cranes of varying sizes are erected in the workshops and on the quays.

Bridgend.—A deputation from the Bridgend Urban Council attended the last meeting of the Penybont Rural Council and explained the intentions of the Bridgend authority with regard to the purchase of the Bridgend generating station, cables, etc., of the South Wales Power Co. The Penybont Council were asked not to put obstacles in the way of the Bridgend Council obtaining a provisional order for the supply of electricity for light and power purposes in the parishes of Newcastle Higher, Coity Higher, and Ewenny, for which application is now being made. It was decided to ask the Bridgend authority if they would consent to the Penybont Council becoming partners in the undertaking.

Wednesbury.—At the last meeting of the Town Council various extensions of the electricity cable were sanctioned, the chairman of the committee explaining that the work was not being undertaken to supply any existing demand for current, but to enable the new system of supply to be introduced when the proper time arrived. The work would be carried out by their own staff. The chairman also proposed that tenders be invited for erecting a generating station and for supplying new machinery. He said this was in pursuance of the scheme the Council had approved, and the building to be erected would be sufficient to provide for the extensions it was hoped would become necessary in the immediate future. The recommendation was approved.

Sunderland.—At the Hylton-road generating station of the Sunderland Corporation important extensions, destined to materially increase the output and effect considerable economies in working expenses, are being carried out. Messrs. Willans and Robinson, of Rugby, have in hand a 2,000-kw. steam turbine coupled to a Dick-Kerr generator to deliver three-phase current, at 50 periods, at a pressure of 5,000 volts, and to run at a speed of 1,500 r.p.m. This steam turbine is to be coupled to a counter-current barometric jet condenser by Messrs. Klein, of Manchester, the condensing head being of the camel-back design. The boiler-house extensions consist of four Babcock and Wilcox water-tube boilers, complete with the same makers' superheaters and chain-grate stokers; the normal evaporation of each boiler being 25,000lb. per hour. This will work in conjunction with a Green's economiser and electrically-driven induced-draught fans of Messrs. Yates and Thom's make, and boiler feed pumps of Messrs. Hill's compound type. Messrs. Willans and Robinson are responsible for the complete plant, including turbine built under the Parsons patents, generator, condenser, two cooling towers, water softener, and pipework.

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Colombia.—It is stated that an American company has contracted for the establishment of telegraphic communication between Cartagena and Colon, and that it will soon commence to lay the cable in connection with the West India and Panama Telegraph Co. The imports of telegraph and telephone wire into the port of Barranguilla (Colombia) during the year 1906 is said by the British vice-consul to have totalled 82,124lb. and 160,005lb. respectively. By far the greater quantities came from Germany, Great Britain coming next with 26,376lb. telegraph and 28,844lb. telephone wire. France and the United States sent respectively 9,138lb. and 2,426lb. telephone wire.

Neath.—The Rural District Council have had under consideration a report of Mr. Ellis, of Cardiff, whom they have engaged to report upon the advisability of purchasing the generating station of the South Wales Electrical Power Distribution Co. at Court Sart, Neath, for the purpose of continuing and developing the Council's electric scheme. Mr. Ellis said that he had estimated an annual profit of £1,764, and he advised the Council very strongly to buy the existing power station for the sum of £7,000, a building, which, with its apparatus, originally cost over £42,000. There was also the site, which, in itself, was worth over £3,000. The Council decided to purchase the station.

St. Pancras.—A comparison of the cost of lighting the borough for the past 10 years is interesting, for while the expenditure on gas lighting in 1897 cost out of the local rates £13,461, and the expenditure on electric lighting in the same year totalled £3,827, making together £17,283, in the year ending March 31 last gas cost £6,946 and electric lighting £15,690, or a total of £22,636, the increase of £5,348 being equivalent to a ¾d. rate in the £. On the other hand, profits out of the local electricity undertaking during the past 10 years have been transferred in aid of rates amounting altogether to £18,000, including £8,000 since the charge for current to public lamps was reduced, but against this there is a set-off of £35,000 more for public lighting during the past seven years than for the previous seven years.

Enterprise and British Firms.—Messrs. J. C. Lyell and Co., of 55, Victoria-street, Westminster, draw our attention to an example of the lack of enterprise on the part of British firms. Messrs. Lyell were recently appointed sole buyers for machinery, material, boiler plates, tools, office fittings, etc., for one of the largest shipbuilding and general engineering firms in Italy, and a notice was widely circulated asking firms desirous of doing business to send on catalogues. They were most anxious to do all they could to increase the British trade, but were handicapped by the fact that very few firms had the enterprise to send lists. They ask whether it is surprising, under such circumstances, that the British manufacturer finds himself cut out by the more astute American or Continental rival, and then complains of bad trade and bad times?

Surbiton.—At the last meeting of the Council the solicitor to the Parliamentary Committee reported that the application for a further loan for electric lighting had been referred by the Local Government Board to the Board of Trade for their consideration as to whether Messrs. Callender's agreement was one which that Board could sanction, and he read a letter from the Board of Trade returning Messrs. Callender's agreement with their approval notified thereon. He further reported that he had at once written to the Local Government Board informing them of the fact, and asking that the question of this loan should be pushed forward at once. The Parliamentary Committee had instructed him to employ all necessary evidence in connection with the inquiry, which will probably be held at an early date by an inspector of the Local Government Board.

Croyden.—The County Council have adopted an agreement with the County of London Electric Supply Co. for the supply of electrical energy upon the following terms: (1) the company to bear the cost of the extension of the mains for the supply of energy; (2) the Corporation to provide the necessary meters for measuring the energy at the expense of the company; (3) the prices to be paid by the company to be calculated (subject to discounts) at the following rates—viz., 3d. per unit for energy supplied for the first two years from the date of the agreement, 2½d. per unit for energy supplied after the first two years from the date of the agreement; (4) the company to indemnify the Corporation against any proceedings which may be taken by any person or company in respect of such supply; (5) the agreement to be subject to six calendar months' notice, which may be given after the expiration of one year from its date; (6) the agreement to contain such other clauses and conditions as the town clerk considers necessary for safeguarding the interests of the Corporation.

Manufacturers' Lists.—An illustrated catalogue has come to hand from Mr. S. H. Heywood, Reddish, near Stockport, describing electric pulley blocks, which are made in various sizes, capable of lifting from 10cwt. to four tons. These blocks are of great advantage wherever expeditious and economical means of lifting and moving heavy weights is required in any works. They can be attached to jib cranes, suspended from derricks, and are constructed to run on the flange of a steel girder, the travelling motion being operated either by hand power or electrically, or they can be made to travel automatically between two or more fixed points. They can also be adapted to convert existing hand travelling cranes into electrical travelling cranes. They are self-sustaining, and are controlled by the simple movement of pulling a small hand-rope through a distance of a few inches, no skilled labour being required.—The Westphalian Steroxyle Co., 17, King-street, Cheapside, London, E.C., have issued a booklet on their "Steroxyle" telephone cabinets. They are cheap and artistic, and their special feature is that they can be taken to pieces, removed, and put up in another place without much trouble. This, together with their sound-proof qualities, should make them useful in factories, offices, and other such places. The cabinets may be had in any wood, stained and varnished, or polished, for walls or corners, with straight or convex fronts and gunmetal or brass fittings. As only wood (without joint) is used on the inside, and no padding or upholstering of any kind, the construction is the most sanitary that could be desired. They are made in various sizes, ranging from 28in. by 28in. to 40in. by 40in.

Aston.—The Electricity Committee have had under consideration applications for supply of current from several manufacturing companies who are building new works at Witton. They have also made arrangements with the Birmingham Tame and Rea District Drainage Board to supply the Board with alternating current to work additional machinery which they are about to install. In order to give a supply to firms in the Witton district, and also to meet the anticipated demands of the Drainage Board, it is necessary to strengthen the proposed high-tension trunk main to Erdington from the electricity works to Salford Bridge by substituting two high-tension cables of ·15 square inch sectional area for the two high-tension cables of ·075 square inch sectional area already sanctioned by the Council in connection with the Erdington lighting scheme, the extra estimated cost of laying these larger-sized high-tension cables from the electricity works to Salford Bridge being £1,650. In view of the fact that it is most essential, in order to save further cost, that this work should be carried out at the same time as the Erdington mains are laid, the committee have instructed the engineer to take the necessary steps for the substituting of the larger cables, and recommended the Council to make application for sanction to the borrowing the sum of £1,650. The recommendation has been approved. The electricity department is making marked progress in the supply of current. The units sold for the month of June was 190,555, against 125,711 in the corresponding month last year.

PROVISIONAL PATENTS, 1907.

JULY 25.

17012. Improvements in wall plugs and sockets for use in electric lighting, heating, and power circuits. Henry Bevis and Albert Julius David Krause, Peel Works, Adelphi, Salford.

17015. Improved portable electrically-driven machine for grinding and other purposes. Fred Marshall, Frank Crookes, and George Robson, 24, Norfolk-row, Sheffield.

17046. Improvements in and relating to the application of electricity for stimulating vegetable growth. John Ernest Newman and Lionel Lodge, 18, Southampton-buildings, London.

17058. Improvements in and relating to electric arc lamps. Edwin Rudolph Grote and Milton Victor Ely, trading as Foster and Co., Worple-road, Wimbledon.

17059. Improvements in and relating to electric arc lamps. Edwin Rudolph Grote and Milton Victor Ely, trading as Foster and Co., Worple-road, Wimbledon.

17060. Improvements in and relating to electric arc lamps. Edwin Rudolph Grote and Milton Victor Ely, trading as Foster and Co., Worple-road, Wimbledon.

17066. Improvements in or relating to holders or fittings for electric incandescent lamps. Alfred Loebl and the British Ever-Ready Electrical Company, Limited, 111, Hatton-garden, London. (Complete specification.)

17067. Improvements in or relating to electric hand-lamps. Alfred Loebl and the British Ever-Ready Electrical Company, Limited, 111, Hatton-garden, London. (Complete specification.)

17078. Improvements in electric signals. Alfred Charles Brown, 7, Queen's-square, Finsbury-avenue, London.

17079. Improvements relating to electric instruments for medical use. Jean Gschwend, 7, Southampton-buildings, London. (Complete specification.)

JULY 26.

17097. Improvements in and relating to switch mechanism for electrically-propelled vehicles. Allgemeine Elektricitäts Ges., 83, Cannon-street, London. (Date applied for under Patents Act, 1901, July 26, 1906, being date of application in Germany.) (Complete specification.)

17100. Improvements in or relating to electrical "intermitters" or "flashers" in use for advertising or other purposes. Albert Browne Mudie and Anthony Bland Gregson, Cambridge-street, Birmingham.

17102. Improvements in the production of electrodes for secondary batteries. James Taylor and Emmanuel Hancock, 65, Chancery-lane, London.

17127. Improvements relating to electric air suction apparatus. William Gordon Potter, 14, Engleton-street, Brixton-road, London.

17145. Electric time meter, hour counter, and electrically-driven clock. Percy Good and Walter Henry Bell, 11, Southwark-street, London.

17147. Improvements in or relating to electrically-operated fountains. Arthur Dudley Southam, 55, Chancery-lane, London. (Date applied for under Patents Act, 1901, Aug. 4, 1906, being date of application in United States.) (Complete specification.)

17178. Improvements in prepayment electricity meters. William Morris Mordey and Guy Carey Fricker, 46, Lincoln's-inn-fields, London.

JULY 27.

17192. Improvements in electric arc lamps. Lionel Bray Wilson, 5, John Dalton-street, Manchester.

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17193. Improved electrolytic cell. Henry Stafford Hatfield, 18, Palmeira-square, Hove.

17195. Improvements in or relating to magneto-electric machines. Piet Reinhouts van Haga, High-street-chambers, Coventry.

17245. Improvements in and connected with conduits for electric wires. Thomas Brown, Jacob Rowell, jun., and Robert Hindmarsh Rowell, 31, Bedford-street, Strand, London.

17257. Improvements relating to selective telegraphy or telephony. Siemens Bros. and Co., Limited, and George Sylvester Grimston, Birkbeck Bank-chambers, Southampton-buildings, London.

17258. Improvements in casing for electric conductors in buildings or the like. Louis Molle and Joseph Debedts, Birkbeck Bank-chambers, Southampton-buildings, London.

JULY 29.

17300. Improved combined electric connection plug and socket and switch. William Woodyer Buckton, 23, City-road, Finsbury-square, London.

17303. Electrical variable-speed device. Harry Stuart Caink, Vernon Park, Worcester.

17308. Improvements in interrupters for electric circuits. Reinhold Henry Wappler and Charles Frank Fayer, 78, Fleet-street, London. (Complete specification.)

17309. Improvements in electric lamp fittings. Arthur Bonnella and George James Bonnella, 40, Rosoman-street, Clerkenwell, London.

17326. Improvements in or relating to the construction of insulation for magneto-electric apparatus. Hermann Braun and Christian Bockmann, trading as Braun und Bockmann, G. m. b. H., 322, High Holborn, London. (Date applied for under Patents Act, 1901, March 26, 1907, being date of application in Germany. (Complete specification.)

17332. Improvements in or relating to electric transmission at a distance. Johann Mladek and Wenzel Mladek, 111, Hatton-garden, London.

17346. Improvements in or connected with electric lamps. Reuben Thomas Preston and Herbert Edward Theobalds, 77, Chancery-lane, London.

17355. Improved plug element for effecting temporary electrical connections. Antoine Vanden Berghe and Arthur Thomas Milnor Thomson, 22, Southampton-buildings, London.

17360. Improvements in methods of manufacturing conductive filaments for use in electric lamps or other apparatus. William David Coolidge, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Aug. 1, 1906, being date of application in United States.) (Complete specification.)

17361. Improvements in and relating to controllers for electric motors and the like. The Allgemeine Elektricitäts-Ges., 83, Cannon-street, London. (Date applied for under Patents Act, 1901, July 30, 1906, being date of application in Germany.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Aug. 22.)

1906.

14935. Dynamo-electric machines. Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, June 30, 1905.)

16971. Apparatus or device for electrically indicating at a distance whether billiard tables or the like are engaged or disengaged; also applicable for other signalling, indicating, or advertising purposes. Rayner and Fraser.

17236. Regulation of multi-speed electric motors. Burnand.

18622. Method of producing metallic incandescence bodies for electric glow lamps. Justice. (Deutsche Gasglühlicht Akt.-Ges., Auerges.)

18739. Electric motors. Mendelson.

20942. Current collectors for electrically-driven vehicles. Knowles.

21043. Electric batteries. Van Raden and Robinson.

21206. Electrical time-switches. Venner and Griesbach.

22000. Storage batteries. Sokal, Bloomfield, Wolf, and Wolff.

23810. Electric ignition devices for internal-combustion engines. Ayton.

24406. Plates for secondary and storage cells. Gratze.

1907.

2877. Galvanic cells. Rüter. (Date applied for under International Convention, Feb. 6, 1906.)

6809. Starting switches for electric motors. Moy, Bastie, and Ernest F. Moy, Limited.

7791. Electric transformer furnaces. Grönwall, Lindblad, and Stalhane.

7829. Electric power transmission apparatus. Emmet. (Date applied for under International Convention, April 4, 1906.)

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.

Name.	Amount paid.		Last price
	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	—	⅛-⅝
—— Ord., 1 125,000	1	..	¼-½
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	9/16-11/16
British Aluminium Co., Ordinary, 2,001-40,000	5	..	4¾-5¼
—— 7 per cent. Cum. Pref., 1-40,000	5	..	5-5⅛
—— "A" 6 per cent. Cum. Pref., 1-20,000	5	..	5-5¼
—— 4 per cent. Funding Certificates, 1-20,000	5	..	3⅞ 4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	100-103
—— 5½ per cent. Loch Leven Deb (Reg.), Red., 1-3,000	100	..	96-99 xd
British Insulated and Helsby Cables, Ord., 1-100,000	5	—	6¾ 7¼
—— 6 per cent. Cum. Pref., 1-100,000	5	—	5¾-6¼
—— 4½ per cent. Mortgage Debentures	100	—	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	—	87 91
British Westinghouse Elec. and Manuf. 5 per cent. Pref., 275,001-375,000	5	—	1-1¼
—— 4 per cent. Mortgage Debenture Stock	100	—	59 64
Brush Electrical Engineering, Ordinary, Nos. 1-105,751	2	..	⅛-¼
—— Non. Cum., 6 per cent. Pref.	2	..	⅜-½
—— 4½ per cent. 1st Debenture Stock	100	—	88-91
—— 4½ per cent. 2nd Debenture Stock	100	—	7 -74
Callender's Cable, Debentures	100	—	105-107
—— Ordinary	5	—	9½-10¼
—— 5 per cent. Pref.	5	..	5⅜-5⅝
Consolidated Electrical Co., Ordinary, 1-110,000	1	..	⅛-¼ xd
Crompton and Co.	5	..	1¾-2⅛ xd
—— 5 per cent. Debentures	100	—	93½-96½
Dick, Kerr, and Co., Ordinary, 1 260,000	1	..	1⅜-1⅝
—— 6 per cent. Cum. Pref., 1-305,000	1	..	1-1¼
—— 4½ per cent. Debenture Stock, Red.	100	..	101-104
Ellison and Swan United, "A" Shares, 1-89,261	5	—	1⅛ 1⅜
—— "A" Shares, 01-017,139	5	—	2¼-2⅜
—— 5 per cent. Debentures	100	—	89-92
—— 4 per cent. Deb. Stock, Red.	100	—	83 85
Electric Construction, Nos. 1 to 112,100	2	—	5/16-7/16
—— 7 per cent. Cumulative Pref.	2	..	1⅛ 1⅜
—— 4 per cent. Perp. 1st Mort Deb.	100	..	77-81
Electrolytic Alkali Co., Ordinary, 1-202,218	1	..	⅛-⅜
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	—
General Electric Company (1900), 5 per cent. Cum. Pref.	10	—	8-8½
—— 4 per cent. 1st Mort. Deb. Stock	100	—	82 86
W. T. Henley's Telegraph Works, Ordinary	5	—	11½-12½
—— 4½ per cent. Preference	5	—	5-5⅛
—— 4½ per cent. Debentures	100	—	105½ 107½
India Rubber, Gutta Percha, and Telegraph Works	10	..	15 16
—— 4 per cent. Debentures	100	—	97-99
National Electric Construction Co., 1-170,000	1	..	27/32-31/32
Parker, Thos., Limited, Ordinary	10	—	10-10¼
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5	..	3¼-4
Telegraph Construction and Maintenance	15	—	31-33 xd
—— 5 per cent. Bonds	100	—	99 102
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	..	9½-9¾

Electric Lighting and Supply.—

Name.	Amount paid.		Last price
	£		£
Adelaide Electric Supply Co., 6 p. c. Cum. Pref., 1-10,000		..	4¾-5¼
Bournemouth and Poole, Ordinary	10	—	10 11
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	—	10 10½
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	—	10½ 10¾
—— 4½ per cent. Debenture Stock, Red.	100	—	99 102
Bromley (Kent) Electric Light and Power Co.	5	—	4⅜ 4½
—— 4½ per cent. 1st Debenture Stock, Red.	100	—	98 100
Brompton and Kensington, Ordinary	5	—	7⅞ 8⅛
—— 7 per cent. Preference	5	—	7½ 7⅝
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	—	6¾ 7⅛
—— Nos. 80,001-100,000	4	—	6¼ 7¼
Cambridge Electric Supply Company, £10 Ord.	8	—	14¾-15¼
Canadian General Electric Co., Common Shares	$.00	..	119-123
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	—	99-102
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	—	3¼ 4
—— 4½ per cent. Cum. Pref., 1-80,000	5	—	3⅞ 4¼
—— 4 per cent. Debenture Stock, Red.	100	—	95 98
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	—	3¼ 3⅜
—— ditto (1903) 40,001-80,000	5	—	3¼ 4¼
Chelsea Electricity Supply	5	—	3¼ 4¼
—— 4½ per cent. Debentures	100	—	101-104
Chicago Edison Co., 1st Mt. 5 p. c. 30-yr. Gld. Bds., Red., 1-1,200	$1000	..	98-101
City of London, Ordinary	10	—	9-10
—— 6 per cent. Cumulative Pref.	10	—	10⅜-11⅜
—— 5 per cent. Debenture Stock	100	—	121-124
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.).	100	—	96-99
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1,633	50	—	50-53
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100	..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-70,000	5	..	4½-5
—— 5 per cent. Preference, 1-50,000	5	..	4½-5
County of London Electric Supply, Ordinary	10	—	7-8 xd
—— 6 per cent. Cum. Pref.	10	—	10¼ 11¼ xd
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	—	106-109
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	—	£4 97
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5	—	¼-1
—— 6 per cent. Cum. Pref.	5	—	1¼ 2¼
—— 4½ per cent. First Mort. Deb	100	—	76 81
Electrical Development Co. of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, 10,751-15,75[illegible]	—	..	78-80 p.c.
Electric Lt & Traction Co of Aust., 6 p c Cm Pf, 1 30,000	5	—	2¼ 2⅜
—— 5 per cent Debenture Stock Red	100	—	85½ 89½
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red	100	—	91½ 96½
Folkestone Electric Supply, Ord. Nos. 1-10,000	5	—	4¼-4⅜
—— 4½ per cent. First Deb. Stock, Red.	100	—	96 99 xd
Hove Electric Lighting, Ord., 1-13,000	5	—	6¾-7¼
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100	..	103-106
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Deb. Stk. Red.	100	—	94-97
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	—	—
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5	—	8¼ 9¼ xd
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	—	94-97 xd
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9¾-10¼
London Electric, Ordinary	5	—	1⅜-2⅛
—— 6 per cent. Pref.	5	—	4¼-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	93-96

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Name.	Amount paid. £		Last price £
Madras Electric Supply Corporation, 5 per cent. Construction Deb. Stock., Red. (Prov. Certs.), all paid	—	..	94-97
Metropolitan Ordinary, 100,001-300,000	5	—	5½ 6½ xd
—— 4½ per cent. First Mortgage Debenture Stock	100	—	103 107
—— 4½ per cent. Cum. Pref.	5	—	4¾ 5¼
—— 3½ per cent. Mortgage Debenture, Red.	100	—	87 92
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds., 1935, C 1-1,000 ($100), D 1-3,000 ($500), M 1-4,400 ($1,000)	—	..	74½-76 p.c.
Mexican Light and Power Co., Capital Stock	$100	..	43-45
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14,000 ($1,000)	—	..	£2 8 xd
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	—	95-98
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,000	5	—	7¼ 7¾ xd
—— do., 57,001-75,000	5	..	7¼-7¾ xd
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid)	4	—	7-7½ xd
—— 5 per cent. Pref., 1-57,000	5	—	4¾ 5¼ xd
—— do., 75,001-87,500 (issued at 10s. prem., 4s. paid)	4	..	4½-5¼ xd
Notting Hill Electric Lighting	10	—	11½ 12½
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	—	96 99
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	—	5¼ 6¼
—— 4 per cent. Debenture Stock	100	—	95 97
River Plate Electricity Co., Ord., 1-119,687 & 120,501-120,507	1	..	⅞-¾
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	..	⅞-1
—— 4 per cent. Debenture Stock, Red.	100	..	95-98
Rosario Electric Co., 6 per cent. Cum. Pref., 1-20,000	5	..	5-5½
—— 6 per cent. Cum. 2nd Pref., 1-15,000	4	..	5-5½
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	—	96 98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	—	..	99 101 p.c.
Smithfield Markets Electric Supply, Ord. 1-12,000	5	—	½-1½
—— 4 per cent. Debenture Stock	100	—	71-75 xd
South London, Ordinary	5	—	2-2½
South Metropolitan Electric Light and Power, Ord.	1	—	⅝ ¾
—— 7 per cent. Cum. Pref.	1	—	1⅛-1⅜
—— 4½ per cent. 1st Mort. Deb.	100	—	100-103
St. James's and Pall Mall, Ordinary, 101-20,080	5	—	7¼ 8¼ xd
—— 7 per cent. Pref.	5	—	6⅞ 7⅜ xd
—— 3½ per cent. Deb.	100	—	86 91
Urban Electric Supply Co., Ordinary, 8-30-007	5	—	1½ 2½
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	—	2-3
Westminster, Ordinary	5	—	9 10
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	—	5-5½

Electric Tramways.—

Name.	Amount paid. £		Last price. £
Anglo-Argentine, 5½ per cent. Cum. Pref., 1-260,007	5	—	6-6½
—— Ord.	5	—	8⅜-8⅝
—— Permanent 6 per cent. Debenture Stock, 1888	100	—	131-134
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	—	102-106
Barcelona Tramways, Ord., 1-20,000	10	—	—
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	—	—
—— 5 per cent. Deb., Red., 1-600	100	—	—
—— 4½ per cent. Red. Deb. Stock	100	—	—
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1	—	¾ ⅞
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	—	29/32-1 1/32
Birmingham and Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100	..	94-99
Blackpool and Fleetwood Tramroad	10	—	13⅜-13⅝
Bombay Elec. Supply & Trams. Co., 6 per cent. Cum. Pref.	8	..	7⅜-8¼ xd
—— 4½ per cent. Deb. Stock, Red.	100	..	96-97
Brisbane Tramway Invest., Ord., 1-75,000	5	—	3⅛ 3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	—	4¾-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	—	96 100
British Columbia Electric Railway Co., Ord. Def.	100	—	127-132
—— Ord. Pref.	100	—	110-114
—— 5 per cent. Cum. Perpetual Pref. Stock	100	—	103-106
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	—	100-103
—— 4½ per cent. Vancouver Power Deb.	100	—	100-102
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	—	2½ 3
—— 6 per cent. Cm. Pf., 30,001-60,000	10	—	7 7½
—— 5 per cent. Perpetual Debenture Stock	100	—	100-103
—— 4½ per cent. 2nd Deb. Stock	100	—	78-81
Buenos Ayres and Belgrano Trams.	5	—	4¼-4⅜
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	—	4⅜-4½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	4⅜-4½
—— 5 per cent. Deb. Stock, Red.	100	—	105-115
—— Prov. Cert., all paid	100	—	100-103
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100	—	92-97
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb. Bonds, Red., 1-1,500	100	..	99-103
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	..	101-106
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	93-96
Calcutta Tramways, 1-105,000	5	—	7¼ 8
—— 105,001-137,610	5	—	5¼ 5⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	—	102 106
Cape Electric Tramways, Nos. 1-480,000	1	—	5/16 7/16
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	—	4¼ 5
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100	—	98 101
City of Buenos Ayres Trams. Co. (1904). 1-248,000	5	..	5 3/16-5 7/16
—— 4 per cent. Deb. Stock, Red. 1985	100	..	97-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	00	—	94 98
Cork Electric Tramway and Lighting Co., Ordinary	10	—	13½-14¼
—— 6 per cent. Cum. Pref.	10	—	13-14
—— 4 per cent. Debentures	100	—	98-101
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	—	13¼-14¼ xd
—— 6 per cent. Pref., Nos. within 1-60,000	10	—	12⅜-13⅜ xd
—— 3½ per cent. Mort. Debs., 1-3,000 Red.	100	—	93-97
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100	..	98-101
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6,957	$1,000	—	83-88
Imperial Tramways, Ordinary	all	—	18-19
—— 6 per cent. Cum. Pref.	all	—	14-14½
—— 4½ per cent. Deb. Stock	100	—	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5	—	1 1½
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	—	66 71
Kalgoorlie Electric Tramways, 1-250,000	1	..	5/32-5/32
—— 5 per cent. "A" Deb. Stock	100	..	89-93
—— 6 per cent. "B" Deb. Stock	100	..	78-82
Kidderminster and District Lighting and Traction, Pref.	5	—	8-8½
Lancashire United Tramways Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	—	94-97
—— £296,500 2nd Mort. Deb. Stock	—	—	—
—— £83,330 Deferred Deb. Stock (all fully paid)	—	—	—
Lisbon Electric Tramways Limited, Ord., Nos. 1-594,188	1	..	1 1/16-1 5/16
—— 6 per cent. Cum. Pref., Nos. 1-425,553	1	—	1 1/16-1 3/16
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100	..	96 98
London United Trys. (1901), 5 per cent. Cum. Pref.	10	—	7⅜ 8¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	—	84-88
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Rd.	100	—	96-99
Manila Elec. R R. and Lghtg. Corp., 5 p.c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000	..	93-95
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 23,436-25,000	5	..	4⅜-5¼
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	97-100
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	—	3/32 5/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	—	27 32 31 32
—— 4½ per cent. Deb. Stock, Red.	100	—	94 97
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	—	..	83½-85¼ p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	—	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 601-2,000 (1922)	100	—	101-103 xd
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	—	⅜-1⅜
Oldham, Ashton, and Hyde Tramway, Ordinary	10	—	12
—— 5 per cent. Cum. Pref.	10	—	8⅜-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100	—	100 104
Potteries Electric Traction, Ordinary, 1-245,000	1	—	5/16-9/16
—— 5 per cent. Cum. Pref., 300,001-545,000	1	—	9/16-13/16
—— 4½ per cent. Debenture Stock	100	—	96 98
Provincial Tramways Co., Ordinary, 1-24,912	10	..	4½-5
—— 6 per cent Cum. Pref., 1-10,000	10	..	10½-11½
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-30,000	5	..	5¼-5⅜
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	97-99
Sao Paulo Tramway, Light, and Power Co.	$100	..	118-122
—— 5 per cent. 1st Mort. Deb., Red 1929, 1-11,000	$500	..	93-95 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1	..	¼-1 xd
—— 4 per cent. Deb. Stock, Red. 1940	100	..	80-84
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs, Red., 1-1,600	100	..	84-88
Yorkshire (West Riding) Elec. Tram Co., Ord., 70,001-110,000	5	..	1-1¼
—— 6 per cent. Cum. Pref., 1-46,261	5	..	3¼-3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	87-90

Electric Railways.—

Name	Amount paid. £		Last price £
Central London, Ordinary	100	—	73-75
—— 4 per cent. Pref.	100	—	92-94
—— ,, ,, deferred	100	—	53-56
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	—	102-105
City and South London, Consolidated Ordinary	100	...	46-47
—— 4 per cent. Debenture Stock	100		102-105
—— 5 per cent. Pref. Stock '91	100	—	117-121
—— ,, ,, ,, '95	100	—	115-118
—— ,, ,, ,, '01	100	—	110-113
Liverpool Overhead, 5 per cent. Pref.	10	—	10-10½
—— Ordinary, 1-50,000	10	—	3¾-4⅛
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	—	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	...	64-67

Telegraphs and Telephones.—

Name.	Amount paid. £		Last price. £
Amazon Telegraph Co., 1-25,000	10	..	3-3½
—— 5 per cent. Debs., Red., within 1-1,069	100	—	85-88
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-23,000 and 53,001-78,000	$1,000	..	90-92
Anglo-American Telegraph Co., Ordinary	100	..	61-64 xd
—— 6 per cent Preferred Ordinary	100	...	107½-103½ xd
—— Deferred Ordinary	100	...	17⅜-17⅝
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort Deb. Stock, Red.	100	...	101-104
Chili Telephone Co., 1-44,000	5	...	6⅜-7⅛ xd
Commercial Cable Co., Ster. 500-year 4 p.c. Deb Stk., Red.	100	...	92-94
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	...	7¼-8¼
—— 10 per cent. Preference, 1-6,000	10	...	15¾-16¾
Direct Spanish Telegraph Co., Ordinary	5	...	3⅜-3⅝
—— 10 per cent. Cum Preference	5	...	9-9¼
—— 4½ per cent. Debs., 1-600	50	...	99-101
Direct United States Cable Co.	20	...	15¼-15⅝
Direct West India Cable Co., 4½ per cent. Debs., Reg. within 1-1,200, Red.	100	...	99-101
Eastern and South African, 4 per cent. Mort. Debs., within 1,000, 1909	100	...	97½-100½ xd
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8,000, 1913	25	...	98⅛-100⅛
Eastern Extension, Australasia and China, 1-300,000	10	...	12¼-13⅜
—— 4 per cent Mort. Deb. Stock, Perp.	100	...	102-104 xd
Eastern Telegraph Co., Ordinary Stock	100	...	134-139
—— 3½ per cent. Preference Stock	100	...	88-90
—— 4 per cent. Mortgage Debenture Stock	100	...	103-105
Great Northern Telegraph Co. (of Copenhagen)	10	...	34-36
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1,200, Red.	100	...	99-101
Indo-European Telegraph Co.	25	...	56-58
Marconi's Wireless Telegraph Co, 1-256,127	1	...	⅛-¼
—— 256,128-384,190	1	...	⅛-¼
Monte Video Telephone Co., Ordinary, 1-72,680	1	..	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492	...	...	⅛-1
National Telephone, Preferred	100	...	10⅝-10⅜ xd
—— Deferred Stock	100	—	105-107 xd
—— 6 per cent. Cum. First Pref.	10	—	11-13 xd
—— 6 per cent. Cum. Second Pref.	10	—	9½-11½ xd
—— 5 per cent. Non. Cum. Third Pref.	5	..	5 5/16-5 9/16 xd
—— 3½ per cent. Deb. Stock, Red.	100	—	£5½-97½
—— 4 per cent. Deb. Stock, Red.	100	—	100½-102½
Oriental Telephone and Electric Company	1	..	1⅛-1⅜
—— 6 per cent. Cum. Pref.	1	..	1 3/16 1 5/16
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100	...	91-94
United River Plate Tele. Co., Ordinary, 1-100,000	5	...	6¼-7¼ xd
—— 5 per cent. Cum. Pref., 1-40,000	5	...	5-5½
—— 5 per cent. Debenture Stock, Red.	100	...	—
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	...	98-101
West African Telegraph Co.	10	...	10-10½
West Coast of America, 1-39,000 and 53,001-53,003	2½	...	1¼-1⅜
—— 4 p.c. Debs., 1-1,500, Gua. by Western Telegraph	100	...	97-100
West India and Panama Telegraph Co., Ordinary	10	...	7/16 9/16
—— 6 per cent. Cum 1st Preference	10	...	7¼-7⅜
—— 6 per cent. Cum. 2nd Preference	10	...	6¼-7¼
—— 5 per cent. Debs., Red., 1-800	100	...	99-102
Western Telegraph Co., 1-207,930	10	...	13¼-14
—— 4 per cent. Debenture Stock, Red.	100	...	100-103

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.							Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1907.	1906.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	July 31	1,523	1,519	+ 9	— h	25½	25	May 31	64 071	15,530 351	1,379 723	0 93	11·14	2,512	6·45
Ayr Corporation	Aug 3	421	437	- 16	—	8	8	,, 15	14,228	3,316,380	353,945	1	9·71	1,830	5·16
Baker Street and Waterloo Ry.	,, 3	2 270	1,209	+1,061	+ 5,717	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 4	1,129	1,145	- 16	- 522	23 53	3·53	March 31	55,025	11,145,531	1,309 903	1·18	10 08	2,338b	6·03
Birmingham Corporation	,, 3	6 134	—	—	—	56½	—	,, 31	17,133	4,709,758	266 526	·86	14·5	8 866	—
Blackburn Corporation	July 31	1,.05	1,016	+ 9	+ 777	24	24	,, 25	48,875	8,661,720	986 953	1·35	11 29	2,036	7·44
Blackpool Corporation	Aug 1	1,932	2,152	- 160	- 1,765	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	,, 3	1,320	1,419	- 99	- 430	16½	16½	Dec. 31	31,846	2,325,677	573,264	3·28	13 19	—	7·27
Bolton Corporation	,, 4	2,864	2,239	+ 625	+ 2,080	42	40	March 31	95 766	20,205 196	2,161,130	1·13	10 63	2 394	6·14
Bournemouth Corporation	July 31	2,203	1,841	+ 362	+ 536	17·41	16·82	,, 31	55,276	10,058,288	1,121,623	1·32	11 83	3 226	7·19
Bradford Corporation	Aug. 3	4,809	4 889	- 80	+ 2·8	95	95	,, 31	230,085	47,108,000	5,053,392	1·172	10 927	2,395	—
Brighton Corporation	,, 4	1,147	1,381	- 234	- 1,740	9½	9½	,, 31	50,339	11,321 160	1,152,828	1·06	10·48	2,914·8	8·014
Bristol Tramway Company	,, 2	5 321	5,506	- 185	—	51½	51½	Dec. 31	259,799	45,312,373	6 127,135	—	—	—	—
Burnley Corporation	,, 3	1,377	1 239	+ 138	—	40	40	March 31	57,992	11,092,704	1,197,772	1·31	11 61	5,388	8·17
Burton Corporation	,, 5	322	351	- 29	- 281	8½	8½	,, 31	17 950	3,878,269	451,082	1 07	9·21	2,0 8	6·76
Cardiff Corporation	—	—	—	—	—	32 62	† 32·26	,, 31	112,209	24,134,363	2,770,049	1·12	9 72	3,782	9·44
Carlisle Tramways Company	,, 3	200	223	- 23	- 322	8 5	8·5	Dec 31	10 713	2,935 002	359,756	—	7 14	—	5 18
Central London Railway	,, 3	4,8 8	5,184	- 365	- 1,945	6	6	,, 31	347,588	4,875,547	1,281,214	1 86	65·10	57,931	35 80
Charing X, Euston, & Hamp. Ry.	,, 3	2,375	—	—	—	8	—	—	—	—	—	—	—	—	—
City and South London Railway	,, 4	2,904	2,282	+ 622	+ 3,232	6½	6½	,, 31	—	—	—	—	—	—	—
Colchester Corporation	May 8	195	195	—	—	8	8	March 31	10,588	2 457,553	220,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	Aug. 1	516	588	- 22	- 472	15½	15½	Dec 31	24,895	5 814,376	882,256	1 01	6 64	—	4 69
Darwen Corporation	,, 2	241	258	- 17	—	7 23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	,, 3	280	337	- 57	- 612	4½	4½	,, 31	11 250	2 853,200	281,343	·94	9·49	2,500	—
Dublin and Lucan Electric Ry.	,, 2	153	147	+ 6	+ 18h	6½	6½	Dec 31	6 358	402,511	113,738	3·79	13·78	942	7·33
Dublin U.T.	July 25	7,165	5,679	+1,487	+ 6,730	48½	48½	,, 31	267,489	50,050,949	7 077,372	1·28	9·07	691	5 55
Dundee City Tramways	,, 31	1,108	1 191	- 83	+ 3 1	22	22	May 15	60 154	13 086 396	1,005 911	·906	11·96	2,180	7·42
East Ham Corporation	Aug. 3	9.7	918	+ 9	- 392	14	14	March 31	36,652	3,689,658	863,816	·64	10 18	2 9·4	6 79
Glasgow Corporation	,, 3	16,872	16,465	+ 407	+ 1,892h	79½	79½	May 31	756 490	195,767,519	17,945 585	—	10 12	—	—
Gloucester Corporation	July 10	278	304	- 26	—	15	15	March 31	15,465	3,962,077	563,595	·70	6·58	959	5·32
G.N., Piccadilly, and Brompton	Aug. 3	3,880	—	—	—	9	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	37	37	,, 31	74 019	17,849,642	1,540 707	—	11 53	2,085	8·56
Huddersfield Corporation	,, 3	1,664	1,589	+ 75	+ 1,081	35	35	,, 31	69,938	12 838,150	1 665,262	1·24	9 71	1,923	—
Hull Corporation	,, 3	2,461	2,406	+ 57	+ 2,005	26	26	,, 31	112,651	27,104,921	2,910,698	1	9 29	—	—
Ilford Corporation	—	—	—	—	—	10½	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	July 31	146	151	- 5	+ 158	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	11,586	3,626,656	419,800	·737	6 62	1 480	5·22
Lancashire United Tramways	,, 31	1,339	1,106	+ 233	+ 9,801	38½	28	—	—	—	—	—	—	—	—
Leeds Corporation	Aug 3	6,883	6,478	+ 410	+ 4,564	89½	89½	March 25	298,233	64,223,666	7,121,038	1 10	10·02	351	—
Leicester Corporation	July 27	2,389	2 459	- 70	—	42	42	Dec. 31	26,011	12 039,252	1,229,507	1	9·79	—	4 83
Liverpool Corporation	,, 27	11,483	11,486	- 3	+ 4,145	104	104	,, 31	547 625	116,642 663	12 166 419	—	—	—	—
Liverpool Overhead Railway	Aug. 4	1,657	1,560	+ 97	+ 643h	6·65	6 65	June 30	81,302	11,171,865	1,024 275	—	—	—	—
London County Council	July 27	31,507	27,057	+4 450	+80 829	98	98	—	—	—	—	—	—	—	—
Lowestoft Corporation	—	—	—	—	—	6	6	Sept. 30	14,511	3,128,857	359,435	1 08	9 68	2 630	6 48
Maidstone Corporation	—	—	—	—	—	2	2	March 31	4,740	850 121	112,227	1 33	10 13	2,370	—
Manchester Corporation	Aug. 3	14,935	14 221	+ 714	+21,029	149	149	,, 31	631,956	125,500,875	14,123,124	1 19	10·73	4,299	6 99
Metropolitan District Railway	,, 4	7,201	7,086	+ 115	+ 124	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 4	14,3 3	13 977	+ 326	+ 2,779	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 3	154	134	+ 20	+ 38	2¾	2¾	,, 31	6 159	1,992,647	206,358	82	7 14	2,239	—
Newcastle-on-Tyne Corporation	,, 3	4,110	4,084	+ 25	+ 325	50	50	,, 31	197 849	43,061,934	4,326,152	1 07	0 98	3,967	7·0
Newport (Mon.) Corporation	June 29	639	628	+ 11	+ 1,197	15¼	15¼	,, 31	30,356	7,252,535	783 435	—	9 29	—	6·4
Oldham Corporation	—	—	—	—	—	34	34	,, 25	65 553	15,466,245	1,504,740	1 16	10 45	1,883	—
Portsmouth Corporation	May 25	2,330	1 578	+ 752	+ 632	28½	28½	,, 31	95,702	19,625,329	197,499	1·17	11 63	—	—
Reading Corporation	Aug. 1	637	703	- 71	- 526	33½	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	11·23	21·29	,, 31	14,881	2,837,110	386,547	1·24	9·24	1,102	7 92
Rotherham Corporation	—	—	—	—	—	9½	9½	,, 31	23 569	5 251,472	593,054	1 07	9·53	2,612	7·49
Salford Corporation	,, 5	5,027	5,138	- 111	+ 1 517	70¾	70¾	,, 31	214,111	39 213 560	4,894,590	1·28	10 29	—	—
Scarborough Tramways Co.	—	—	—	—	—	4½	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 4	5,634	5,500	+ 134	+ 4,453	35¾	35¾	,, 25	210,515	63 952,283	6,049,899	903	9 543	3,653	6·477
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,365	9 294,771	1,108,369	1·27	11·02	—	7 83
Southend-on-Sea Corporation	July 31	563	571	- 8	- 362	9	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	,, 31	39,550	6,766,031	1,027 730	—	9 23	—	4·75
Sunderland Corporation	Aug. 4	1,560	1,692	- 131	- 272	21	20	,, 31	64,858	15,364 463	1 495 785	1·004	10·36	—	6·37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	4,937	1,315,757	102,751	0·87	11 53	1,371	—
Torquay Tramways	July 25	230	—	—	—	5 16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	Aug 3	976	953	+ 23	+ 300	12 68	12·43	,, 31	43,607	7,935,451	862,123	9·27	12·14	3,132	7·50
Warrington Corporation	—	—	—	—	—	9	9	,, 31	17,017	4,418 225	403 363	—	9 85	—	6·33
West Ham Corporation	July 25	2,422	2,357	+ 65	+ 1.125	14·7	14 7	,, 31	—	15,773 742	1,237,165	—	—	—	—
Wolverhampton Corporation	,, 21	853	841	+ 12	+ 255	20	20	,, 31	41,905	8,847,066	950,338	—	10 583	2,062	6·13

† And 98 miles of interlacing track. a Train mile. b Per mile of single track. h Half-year's figures. k Double track

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NOTES.

The Joule Studentship.—The Joule studentship of the Royal Society has been awarded to Dr. T. H. Laby, of the University of Sydney, now of the Cavendish Laboratory, Cambridge, for the investigation of the conditions of condensation and supersaturation of vapours other than steam.

Weighing Forces of Cutting Tools. — Before Section G of the British Association Mr. John F. Brooks described a machine for weighing the forces of a cutting tool. The object of the machine, he explained, is to measure the three co-ordinate components of the force on a cutting tool while in the act of cutting metals. The tool, fixed in a holder, forms part of a simple lever carried by a thin diaphragm of steel. This device gives a universal frictionless pivot when used for very small displacements. The location of the lever is effected by means of electrical contacts in circuit with telephone receivers. Weights are used to balance the forces. The apparatus is capable of measuring maximum, minimum, as well as mean values. The position of the centre of pressure may be found by two or more experiments. The paper was illustrated by diagrams showing the values of the forces on tools with cutting angles of 65deg and 70deg. when cutting cast iron and mild steel, with small cuts at moderate speeds.

Tramway Rail Corrugation.—The points raised by Mr. C. F. Wike, the city engineer of Sheffield, in his paper before the Association of Municipal and County Engineers—to which reference was made in these columns on the 2nd inst.—has received a great deal of attention from road engineers. Mr. H. T. Wakelam, the county engineer of Middlesex, sends us a communication in connection with that paper which is of interest, inasmuch as it throws further light on the troublesome problem of rail corrugation. After duly appraising the diagrams of rails showing the gradations of wear on the treads and the statistics of cost of repairs and renewals which appeared in Mr. Wike's paper, Mr. Wakelam goes on to state in all his travels over the system carried out in the county of Middlesex he has not noticed a single length of corrugated rail, although parts of the tramway system have been subjected to very heavy wear for four years past. He then adds: "We may be lucky in this respect, and our troubles in this connection may yet be in store for us. The analysis of the steel specified by me for rails must be as follows: carbon, from ·50 to ·60 per cent.; manganese, from ·7 to 1·10 per cent.; silicon (maximum), ·20 per cent.; phosphorus (maximum), ·08 per cent.; sulphur (maximum), ·06 per cent. The high percentage of carbon may account for our immunity from corrugation. All the special work, points, and crossings used in our scheme are wholly made of the best manganese steel."

Deposit from Radium Emanation.—In a communication to Section A of the British Association meeting at Leicester, Mr. Sidney Russ explained the causes of the transmission of the active deposit from radium emanation to the anode. A comparison has been made between the amount of active deposit obtained on a wire charged positively and that obtained on the same wire charged negatively at pressures ranging from ·001cm. to 10cm. Diffusion experiments—*i.e.*, experiments made with the wire and containing vessel maintained at the same potential—have also been made over this range of pressure. Whereas the amount of active deposit obtained on the negative electrode diminishes as the pressure is diminished, as has already been found by Makower, it is found that the amount obtained on a positive electrode increases as the pressure is diminished. A comparison has next been made of the quantity of active deposit obtained on positive and negative electrodes in different gases at pressures between ·1mm. and 1mm. Up to the time of writing experiments have been completed in air and hydrogen, and the work is being continued for sulphur dioxide. It is found that whereas in air the amount of active deposit obtained on a negative wire is appreciably greater than on a positive wire over this range of pressure, in the case of hydrogen just as much active deposit is obtained on a positive wire as on the same wire charged negatively. Thus the quantity of active deposit which is directed by an electric field at these low pressures depends on the nature of the molecules with which the radium emanation is mixed.

London Electric Supply Bill.—As we announced last week, the London Electric Supply Bill was withdrawn from the House of Commons on behalf of the promoters on the night of the 7th inst., thus finally disposing of the last means for dealing with the problem of electricity supply in London, and rendering that problem as far off from solution as it was when the first proposals were mooted several years ago. It seemed altogether likely at the beginning of the present session of Parliament that the Bills promoted by the private companies would have very little chance of success, and when first one and then the other of the Bills were withdrawn, not because of their inherent defects, but because political feeling against them ran too high, it became quite evident that the promoters of the London Electric Supply Bill would have to bow to the inevitable and adopt a similar course to that of the promoters of other Bills. Even if the Bill had gone forward last week, and had been given a second reading, there was not the remotest possibility of it making further headway this session, so that withdrawal was the only course open. But the promoters can justly claim to have been hardly treated in not having been allowed an opportunity to state their case earlier in the session. Notice for second reading was given originally on March 25, but postponements were necessitated, first by suggestions from the Board of Trade, and subsequently by the exigencies of the business of the House. It is a great pity that a purely business matter has got mixed up with politics, and the sooner the question is gone into by a fair and impartial committee of business men, not political faddists, the better it will be for all concerned.

Transatlantic Wireless Telegraphy.—The establishment of Transatlantic wireless telegraphy on a commercial basis is doubted by scientific authorities. But Mr. Marconi speaks confidently of effecting this, and to a Canadian correspondent of the *Times* he explained the other day, prior to his departure for England, that he had been experimenting for two weeks at one of the long-distance stations at Glace Bay, and was delighted with the result. He said he was now able to communicate with the coast of England, and explained that he was returning to England to install the necessary machinery to make the regular transmission of wireless messages an accomplished fact. After finishing this work he proposed to return to Canada to perfect the apparatus at Glace Bay, so that the English and Canadian stations could be tuned up to the proper pitch. He hoped to satisfy the Canadian Government regarding the work of transmitting messages between England and Canada, as he had received £16,000 from the authorities at Ottawa to assist in the erection of a station at Glace Bay. Mr. Marconi goes on to say that, when the long-distance apparatus is perfected, private messages from Canada to England will be accepted at 10 cents a word and Press messages at 5 cents. He can say nothing about

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the trouble between the Canadian Government and the company of which he is "simply an employé," but, personally, he has always received from Sir Wilfrid Laurier and his colleagues the warmest encouragement. He declares that from his first coming to Canada, three years ago, the Federal authorities have never spared their efforts to assist him in establishing wireless telegraphy. The company has now a complete system in the St. Lawrence and on the eastern coast of Canada, including Newfoundland and Labrador, and this has been of great benefit to vessels, also in reporting icebergs and fogs. There are about 30 stations at work day and night. Mr. Marconi also announces that he is working on an instrument which will enable a steamer caught in a fog to locate its exact position and steam ahead at full speed in the Gulf and River St. Lawrence, by keeping in constant communication with the shore stations.

Grants to University Colleges.—The report of the Permanent Advisory Committee of the Treasury on the allocation of the money provided by Parliament in aid of university colleges in Great Britain has now been issued, and it is gratifying to note that various colleges in which technical and engineering training is made a speciality figure prominent in the list of recipients, thus showing official recognition of the value of such colleges. The committee in their report recommend that a new maximum limit of £10,000 for all grants should be set up, such limit to be exclusive of any grants for special purposes that may be made from time to time. The following are among the colleges which figure in the list, the first figures after each name representing the grant for 1906-7 and the second figure representing the proposed grant for a period of years: Victoria University of Manchester, £12,000—£10,000; University of Liverpool, £10,000—£10,000; University College, London, £10,000—£10,000; University of Birmingham, £9,000—£9,000; University of Leeds, £8,000—£8,000; King's College, London, £7,800—£7,800; Armstrong College, Newcastle-on-Tyne, £6,000—£6,000; University College, Nottingham, £5,800—£5,000; University of Sheffield, £4,600—£5,000; University College, Bristol, £4,000—£4,000; University College, Reading, £3,400—£3,400. Upon this proposed allocation the committee make the following comments: "The Victoria University of Manchester is allotted less by £2,000 than it received for the years 1905-06 and 1906-07. While we regret this, we think that the grounds for the establishment of a maximum are so strong that the diminution is justified, and we are confident that the reasons which have led us to advise it will not be misunderstood. We certainly do not mean to imply that we regard the pre-eminence of the Victoria University among the colleges as less marked than it has hitherto been. So far as the provision of every facility for carrying on university work is concerned, the growth of the University of Sheffield has been very marked. Local effort was stimulated on the occasion of the creation of the university in 1905 with most substantial and remarkable results. While, however, the staff and equipment have been liberally provided, there has not been so far a corresponding increase in the entries of new students."

Overhead Wire Dangers.—An interesting case from Montreal was recently heard before the Judicial Committee of the Privy Council affecting the interests of owners of overhead transmission lines. It appears that a building contractor used a derrick in putting up a house at Montreal. His workmen brought the derrick into contact with the overhead wires of the respondents (the Montreal Light, Heat, and Power Company), with the result that a current of electricity was diverted to the street and killed the husband of the appellant. On the face of the case it was manifest that the *causa causans* of the casualty was the action of the persons using the derrick, and the question was whether the *causa sine qua non* in the electric wires was there owing to the fault of the company using the electricity. The main argument of the appellant was that construction overhead instead of underground was of itself negligence, and, strange to say, this contention was maintained by a jury in the Montreal Court of Review. The proposition in law laid down at the trial was that the respondents, having alternative powers to place their wires either overhead or underground, were bound to adopt whichever method afforded the greatest protection to the public, and were guilty of negligence if they failed to do so. The Court of Review adopted that proposition, and gave judgment against the respondents. On an appeal to the Court of King's Bench that judgment was reversed and the appellant's action was dismissed. The result was the present appeal The appeal was unanimously dismissed by the Judicial Committee of the Privy Council, their Lordships considering that appellant's contention could not be supported. Another point upon which the appeal rested was that the respondents made no attempt to insulate the wires or put guard wires round them. Their Lordships held, however, that it was an open question whether the insulating the wires or the provision of guard wires would have done any good at all. The appellant's complaint was that the respondents did not experiment on the efficacy of such arrangements. It was impossible to regard that, in the absence of substantive and affirmative evidence, and in view of the adequate support received by the respondents from their witnesses, as a good ground of liability on negligence.

The Radio-Telegraphic Convention. — Mr. Henniker Heaton continues to carry on with unabated vigour his almost single-handed compaign against the signing of the Berlin Convention. A letter which appeared from his pen in the *Times* on Monday morning reflects the disquietude which the Postmaster-General's reply to a previous communication has caused him. He says: "We are giving up a position of pre-eminent advantage, which nobody pretends we should abuse, at the bidding of a rival whose policy is to destroy our maritime supremacy. We are handing over Marconi, bound hand and foot, to his plagiarists and imitators, and teaching great inventors never to trust to the honour or gratitude of England. You say the evidence is overwhelming. I doubt that, but I say that a mistake would be overwhelming. There are national questions too vital to be decided by experts. Suppose (as may well happen any day) you hear that Germany has bought up the cable companies. Would you call for evidence of prejudice to our interests? Suppose Germany proposed to summon a conference to internationalise our coaling stations. Would you send a couple of brilliant subordinates to sign away our safety? No. Would you agree to cut down the navy in order to be on pleasant terms with the Wilhelmstrasse? No. Then I say be equally firm against this insidious attempt. Your loyalty to your permanent officials should be confined to administration, but not to their political acts. The signing of the convention is not a question of urgency. It will take our foreign rivals five years or more to get on equal terms with us in regard to wireless telegraphy. You will shorten the time to one year by signing the convention. Can your officials deny this? Such a grave matter as signing the convention should not be left to the Post Office, which—forgive me—blundered over the inland telegraphs, the cables, and the telephones, and which is now fighting tooth and nail against universal penny postage." The greater part of the controversy centreing round this

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matter has, we regret to say, been of too political a character. The question that seems to agitate men's minds most is not, "Will the convention tend to advance the science and extend the application of wireless telegraphy?" but "Does this country stand to gain or lose any political advantage out of the convention?"

Metropolitan District Railway.—There has now been reached that period of the year when the directors of English railway companies meet their shareholders and explain to them the results of the first year's working of the undertakings in which they are interested. It is thus possible to focus different results and survey the general position of English railways; causes that have brought about the decline in the values of railway stocks may be traced and their bearing upon national industry discussed. Without attempting such a task, we may refer to results obtained by electric railway companies, more particularly London companies, the majority of whom have already held their half-yearly meetings. Elsewhere in this issue there appears the half-yearly report of the Metropolitan District Railway, which reflects generally the position of electric railways in London. Although the report shows a little improvement in one or two respects, much still remains to be done before the state of affairs can be considered as satisfactory, and the best feature of the report is undoubtedly that one which gives reason to hope that the worst has occurred. The receipts show a decrease of only £427 in total, although the revenue from passengers declined by £4,000. There was a decrease of 3,846,472, or 13·14 per cent., in the total number of passengers carried, including workmen and season-ticket holders, the decline in the number of passengers carried at workmen's fares amounting to 1,970,678, or 29·62 per cent. A very encouraging feature of the report is the handsome reduction in working expenses, which has been mainly effected in train working and traffic. This reached a total of £22,976, or 13·77 per cent.; the saving in train working alone amounting to £17,480. The average receipts per passenger were 1·91d., as against 1·67d., an increase of ·24d. per passenger, or 14·37 per cent.; the average fare received being still below 2d. The reduced number of passengers has been accompanied by a considerable saving in the train and car mileage—namely, 1·74 and 7·73 per cent. respectively. There are signs, however, that the District, as well as other London electric railways, has now turned into a brighter path. The revision of fares and the possibility of a mutual understanding being arrived at between the proprietors of London's light railway and omnibus services should effect some improvement. It now remains for the Government to appoint a Traffic Board—with much fuller powers than that granted to the recently appointed Traffic Commissioner, and which is admitted to be only a temporary expedient—in order to introduce reforms on the lines laid down by the late Traffic Commission.

Latest Publications.—The August issue of the *Journal* of the Institution of Electrical Engineers (vol. 39, No. 185. 5s.), which has just come to hand from the publishers, Messrs. E. and F. N. Spon, Limited, 57, Haymarket, London, S.W., is of unusual interest. It opens with a full report of Mr. Robert Hammond's paper on "Depreciation," and is followed by Mr. C. Wade's paper on "The use of Wooden Poles for Overhead Power Transmission." An abstract of the discussion on "Recent Improvements in Electric Lighting," introduced by Mr. A. H. Bate before the Birmingham Local Section, is accompanied by Mr A. M. Taylor's paper on "Central-Station Economics," which was read before the same section. The Manchester Local Section supplies two papers to the current issue of the *Journal*—one by Mr. A. P. Wood on "Some New Flywheel Storage Systems," and the other by Mr. C. F. Smith on "The Experimental Determination of the Losses in Motors." The paper by Mr. C. P. C. Cummings on "Technical Training of Electrical Artisans," read before the Dublin Local Section, is of especial interest at the present time. Mr. C. O. Bastian's communication to the Glasgow Local Section, in which he described a new leading-in conductor for electric lamps, concludes the August issue.—The July issue of the *Transactions* of the Faraday Society (vol. iii., part 1. Price, 10s. 6d.) opens with a paper by Mr. E. E. Fournier-D'Albe on the "Application of the Electron Theory to Electrolysis." Next there is a report of a general discussion on "Osmotic Pressure," which took place early in the current year. The present position and future prospects of the electrolytic alkali and bleach industry are outlined by Mr. J. B. C. Kershaw, who is followed by Messrs. N. Hutton and H. D. Law on "The Potential of Hydrogen Liberated from Metallic Surfaces." Messrs. F. M. G. Johnson and N. T. M. Wilsmore have made some progress along a very interesting line of research—viz., the measurement of the relative affinity of the elements in liquid ammonia solutions. There is also a paper by Mr. J. G. A. Rhodin on "The Impedance of Solutes in Solvents as Manifested by Osmotic 'Pressure,'" and the second and concluding portion of Dr. T. Slater Price's paper on "The Electrolytic Deposition of Zinc." The results of his investigations seem to indicate that the most satisfactory method for the electrolytic deposition of zinc is that in which a rotating cathode is used, the electrolyte consisting of a solution of 2 grm. of sodium sulphate and 1 grm of sodium acetate to each gramme of zinc sulphate.—The June issue of the *Bulletin* of the Société des Ingénieurs Civils (France) contains a paper on "Wireless Telegraphy" by M. P. Janet.

Australian Affairs.—There is now a tendency among municipalities in Australia to depart from the old practice of calling for tenders for supplies from local tradesmen, and to give firms in different parts of the world the same opportunity of tendering as the local people possess. A recent action of the Melbourne City Council to some extent reflects the prevailing tendency in the colony at the present time. In this case the City Council were in need of supplies of arc lamp carbons. Now the custom all along has been to call for tenders locally, the goods to be delivered at the Council's stores at various periods as stated in the specification, with payment subject to deliveries. The acceptance of a local tender involved the ordering of a full supply from the manufacturers in Europe, and then the delivery in instalments as required. It is now proposed that the Council's buying agents in London should call for tenders, the delivery presumably to be in one shipment f.o.b. Tradespeople in Melbourne, a correspondent informs us, are opposed to this proposed change, and they believe that the Council will be prevented from carrying out their proposed change by the operation of the Traffic Law, but this seems uncertain. The City Council and Government contracts are causing a great deal of dissatisfaction in local trade circles. Our correspondent mentions one instance in which an estimated quantity of 400 insulators were to be required in one year, whereas 2,000 were requisitioned for during one month. Local traders would require very large stocks in order to cope with such demands.—Some of the items in the British preference tariff proposals which have just been submitted to the Federal Parliament are of interest, and are given herewith. The first figure shows the general tariff and the second the tariff on British goods: Electrical stoves, 30 per cent.; 20 per cent. Engines, turbines, winches, boilers, pumps, windmills, *ad valorem*. Electrica.

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generators and motors up to 500 h.p., fans, and starting and regulating rheostats, 30 per cent.; 25 per cent. Others, 17½ per cent.; 12½ per cent. Electrical materials, 5 per cent.; free.—The accounts of the city of Melbourne electric supply undertaking for the year ended Feb. 28, 1907, have just come to hand. The capital expended on the undertaking to date amounts to £415,151. The revenue account for last year shows an income of £81,189 and an expenditure of £35,660, leaving a gross balance of £45,529. After meeting interest on capital, transferring £4,400 to sinking fund and £8,303 to depreciation and renewals account, and making special appropriations amounting to £17,700, there is a net balance of £131, compared with £229 for the previous year. The sinking and depreciation and renewals accounts stand respectively at £50,720 and £59,002.

Governing of Hydraulic Turbines.—A paper presented by Mr. Robert S. Ball to Section G of the British Association dealt with the problems involved in the speed control of hydraulic turbines for the range of head of 2ft. to 3,018ft., under which turbines are at work throughout the world, and was particularly intended to apply to hydro-electric installations. All hydraulic regulators may be divided into two classes as follows: (1) disengagement governors (mechanical), which come into action when an assigned departure from the normal speed is attained, being otherwise out of gear with the gate-controlling mechanism; (2) continuous governors (mechanical and hydraulic), which are always connected to the gate-controlling mechanism, and which begin to operate through the mechanism upon the gate at the moment the speed rises or falls from the normal. Mechanical governors are of many kinds, such as the Hartford, Gilkes, Replogle, and others described in the paper, all of which operate upon the controlling gates through a system of gearing or mechanism actuated by the pendulum governor. The power to drive these governors is taken from the turbine usually, but is also sometimes obtained from an independent source, as in a large hydro-electric installation. Hydraulic governors are so called because water or oil under pressure is employed in closed cylinders to actuate the gates, the valves being controlled by the pendulum governor. These governors take various forms, such as the Bell, Gilkes, and Escher-Wyss, according to the type of wheel they are set to control. Where the hydrostatic pressure is sufficient it is used directly in the hydraulic cylinders, but for turbines working under low falls auxiliary oil-pumps are used to provide the necessary pressure for actuating the water-gates There are three forms of gate to which governing mechanism is applied: (1) movable turbine vanes; (2) a circular gate between the runners and the guide vanes; (3) nozzles such as are used for Pelton wheels and other impulse turbines acting under high heads. The function of the flywheel as distinguished from the governor was discussed, the former being a mode of keeping the angular acceleration low when the balance is upset between the driving torque and the resistances opposed to it, while the latter is intended to readjust the balance. The cyclic variations of angular velocity encountered with some forms of heat engine, especially the internal-combustion engine, are absent in the hydraulic plant, which results in a saving in the flywheel capacity, though for impulse turbines it is sometimes necessary to increase the moment of inertia by the addition of a flywheel. The action of hydraulic governors was described and the paper illustrated by 11 figures and diagrams plotted from the results of tests.

State Encouragement to Industry in Hungary.—About eight years ago a law was promulgated for the purpose of encouraging industrial enterprise in Hungary, and so successful has been the operation of that law that it was considerably extended by the provisions of a new law which came into operation on Jan. 1 last. The British Commercial-General at Budapest, Mr. F. S. Clarke, sends home a translation of the new law, which provides for considerable exemptions from all direct State taxes imposed on manufactories, at well as from all municipal, communal, and chamber of commerce rates. As these exemptions are solely for the purpose of encouraging national industry, only those manufactories will be entitled thereto which produce such articles as are not produced in the country at all, or not produced in a measure to provide for a greater part of the demand, or, generally, articles an increased production of which is required by general economic interests. Previous laws of this type have, curiously enough, failed to include electricity undertakings among the exempted industries. But the law which came into force at the beginning of the year extends its provisions to include electricity undertakings, although we note that the position of stations which give a supply of current for lighting remains unaltered. According to Section 2 (Sub-Section *b*) of the law of 1907, manufactories exempted from taxation include " . . . those branches of electricity-producing establishments which yield electric current for industrial or agricultural purposes, provided they submit themselves to the conditions fixed by the Minister of Commerce with respect to the prices of the rent of localities and of electric currents. An exception will be made in this respect for currents serving for lighting, which shall not be accorded any encouragement." The section then reads: "Electric currents produced, and any other energy which may serve technical purposes, shall enjoy the protection of the criminal laws in the same way as these laws protect movables in general. Consequently any unlawful appropriation, in whatever way it may happen, or any unlawful and wilful damage or destruction of the said currents, will be punished in Hungary in the sense of the dispositions of Act V. of the year 1878 respecting damages caused to other people's movable goods or concerning theft. In Croatia, Slavonia, and Dalmatia they will be punished according to the criminal laws there in force. Those industrial establishments which have submitted themselves to the conditions fixed by the Minister of Commerce with respect to rented localities and production of current will enjoy the said encouragements from the beginning of their work." An important alteration in the law is that which authorises the expropriation of either public or private estates "in favour of the establishment of industrial railways and cable lines, of lighting or transmission, and pipe conduits destined for manufacturing, agricultural, and forestry purposes." The policy of attempting to promote Hungarian industry by State aid has been in vogue since 1881, and from the statistical data furnished by Mr. Clarke it would appear to have met with success. The number of factories receiving benefits in one way or other is 730, and of this number 65 are engaged in the manufacture of machinery and electro-technical appliances—45 in this class receive benefits only in favours, five in loans, 13 in subventions, and two in loans and subventions. Two new factories for the manufacture of machinery and electro-technical appliances are shortly to be put into operation, under favoured conditions, with a capital of £54,166, and giving employment to 515 workmen.

Foreign Trade Returns.—The monthly records relating to our foreign trade which are issued by the Board of Trade have shown a continuous expansion in that trade. The returns for the month of July form no exception, and they seem, at first sight, to merit the pæans of praise which

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issue from a section of the Press, and are re-echoed in divers places where maintenance of a policy of *laissez-faire* is raised to the level of a deity, and reverenced accordingly. We need not give here the figures relating to the volume of trade for the past month, as these are doubtless familiar to our readers by this time. But details as to the movements of electrical commodities should prove of interest. The sum total of imports of telegraph cable and apparatus for July amounted to £107,909, an increase of £20,983, or 24·1 per cent., compared with the same month of the preceding year. The total imports for the seven months (1907) amounted to £740,141, an increase of £72,227, or 10·7 per cent., compared with 1906. Under the heading of articles wholly or mainly manufactured, we find that of wire (including telegraph and telephone wire), 5,707 tons, valued at £58,658, were imported last month, compared with 3,950 tons, valued at £42,075, in July, 1906. The imports for the seven months of 1906 and 1907 amounted to 35,941 tons, valued at £366,275, and 37,624 tons, valued at £395,541, respectively. Electrical machinery (of all kinds) was imported last month to the extent of 625 tons, valued at £44,068, compared with 782 tons, valued at £56,857, during the corresponding period of 1906. The value of the 4,234 tons of electrical machinery imported during the first seven months of the current year totalled £337,526 compared with £329,241, which was the value of the 4,049 tons imported last year. Turning to exports, we find that under the heading of telegraph cables and electrical apparatus there was a decline during the past month of £30,183, or 18·7 per cent., compared with July, 1906, the figures for the past month being £136,819. The export for the seven months of the year has, however, slightly increased to £1,269,785, which is £41,685, or 3·3 per cent., more than for the corresponding period of the preceding year. Both in quantity and value does the export of wire (including telegraph and telephone wire) last month show an increase, the figures, 5,360 tons, valued at £95,999, comparing favourably with 4,029 tons, valued at £70,113, for the same month of 1906. The export of this commodity for seven months has thus been brought up to 30,343 tons, bearing a value of £554,352, compared with 25,205 tons, valued at £438,518, which represented the export for the first seven months of 1906. The export of all kinds of electrical machinery likewise shows a big advance, the figures for last month being 1,081 tons, for which a value of £95,774 is returned, compared with 843 tons and £62,062, while for the seven months the following returns are given: 1907—quantity, 7,488 tons; value, £548,706; 1906—quantity, 7,100 tons; value, £500,323. The export of electrical goods of foreign and Colonial origin last month reached a value of £14,713 compared with £10,907, bringing the total figures for the seven months up to £85,852 against £54,304 last year. The foregoing figures would be more assuring if there not other signs available to show that electrical manufacturing is not so rosy as represented. It would be very interesting if the Board of Trade would furnish us with the destinations of the different classes of electrical goods exported. It would, no doubt, be found then that the only foreign markets open to us are in countries not yet fully developed, and where the risks are greater than elsewhere. The first fruits of the labours of the committee appointed under the Census of Production Act will also shed some fresh light on the subject.

Electrical Joint-Stock Enterprise.—If there is still any doubt in the minds of some that the electrical engineering industry is flourishing in the United Kingdom, the record of company registrations for the first half of 1907 should set this doubt at rest. For, while the latest Somerset House returns show a continuance of the general recovery in joint-stock activity noticed last year, the electrical industry has no share in that recovery, although the engineering and allied groups show healthy activity, without any great developments. Perhaps, under present circumstances, inactivity in electrical joint-stock enterprise will give rise to no regret, for the industry is still feeling the effects of the recent boom, and the keen competition between companies, heavily capitalised, is sending profits down to vanishing point, and reacting upon dividends. Moreover, not a few companies have been compelled to engage in the disagreeable process of writing down capital, and we think it will be generally agreed that an industry in which the companies engaged find it necessary to reduce their capital affords very little scope for the profitable play of fresh capital. From a table of English company registrations which appeared in the *Investor's Guardian*, we find that during the first half of this year the capital sunk in electric enterprises amounted to £1,431,030; this compares with £2,088,055 invested during the corresponding period of the preceding year, and £3,206,425 for the first half of 1905. In the returns no distinction is made between companies formed for the purpose of engaging in the manufacture of electrical plant and appliances, and those who were to engage in generating and distributing electrical energy. But it is quite clear that the remarkable inactivity extended over both branches. In the latter branch the decline in joint-stock enterprise does not necessarily indicate that enterprise in electric supply undertakings is on the wane, for the decline in the direction named is in no small measure due to the expansion of municipal enterprise. Furthermore, provisional orders have already been granted for several districts, and it is more than likely than when the stock markets become more active, and more capital is available for these enterprises, the orders will be put into operation. Unfortunately, such redeeming features cannot be pointed to in extenuation of the decline in the electrical manufacturing industry. But it is surely not unreasonable to suppose that the various factors which create such an unfavourable situation will some day be so modified as to avoid the possibility of electrical manufacturing in this country becoming sterile The home market, already weakened by internal competition, is threatened with destruction by attacks from without; but there should be no insuperable difficulty in removing either or both of these complications. The German electrical manufacturers have recognised that it is to their advantage to combine in order to meet circumstances which threaten their mutual interests, and to be able to regulate selling prices proportionately to fluctuations in the cost of labour and raw materials. It is not necessary for us slavishly to follow the German model, but the latter at least provides us with a partial means by which our object may be achieved. It is highly improbable that any improvement will take place in the state of electrical manufacturing here until English firms realise the value of this defensive weapon. But more is required if the future aspect is to be brightened. It is essential that the policy which permits the free and indiscriminate import into this country of goods manufactured abroad under conditions that are clearly designed to enervate enterprise in the manufacture of similar goods at home, should be abrogated to protect such industries that are susceptible to these attacks. With the great and growing use of electricity for all purposes, and the expansion of supply undertakings, the prospect for electrical manufacturers should, in conjunction with a modification in the circumstances just named, be considerably brightened and the home market placed on a more secure basis.

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GREAT WESTERN RAILWAY.

Electric Power and Lighting and the Electrification of the Hammersmith and City Railway.

In our issue of July 13, 1906, we gave a short description of the new electric supply system of the Great Western Railway which has been installed partly to meet the requirements of the Metropolitan Railway Act, 1902, which provided that, concurrently with the electrification of part of the Metropolitan Company's Inner Circle Railway, the Hammersmith and City line, owned jointly by the Metropolitan Company and Great Western Company, and also the lines of the Great Western Company used in connection with the Hammersmith and City Railway, should be electrified. The portion to be electrified includes the Hammersmith and City line proper with its branch line from Latimer-road to Uxbridge-road, and the Great Western additional lines between Bishop's-road and Westbourne Park. From Uxbridge-road to Addison-road the trains run over the West London line, a portion of which has, in consequence, had to be electrified, together with two bays at Addison-road Station. The system of supply to the trains on these lines had necessarily to be the same as that in use on the trains running over the Metropolitan Company's lines on the Inner Circle Railway between Bishop's-road and Aldgate. The new electric system also provides for the supply of power for arc and incandescent lighting and small motor work throughout the Great Western Company's system in the London district, as well as on the Hammersmith and City Railway. The lighting supply for the Great Western Company's own purposes has, up to the present, been provided from a generating station, near Paddington, containing plant which was laid down in 1884 by Mr. J. H. Gordon. The Great Western Company's new electric system includes a main generating station, three sub-stations, and 11 distributing centres.

The generating station is situated at Park Royal beside the Great Western Company's new line to High Wycombe. The three sub stations are situated as follows: at the junction between the High Wycombe line and the Great Western main line at Old Oak Common, at the south side of the Great Western main line at Royal Oak, and on the west side of the Hammersmith and City Railway at Shepherd's Bush. The distance from Park Royal to Old Oak Common is about one mile, to Royal Oak about $4\frac{1}{8}$ miles, and to Shepherd's Bush about five miles. The distributing centres are situated, one at each of the Royal Oak and Shepherd's Bush sub-stations, two at Old Oak Common adjoining the new locomotive sheds and the new carriage sheds, one at Westbourne Park Station, one at the new train sheds at Hammersmith, and the remaining five in the neighbourhood of Paddington Station.

The electrical power is generated at Park Royal as three-phase alternating current, with a frequency of 50 periods and at a pressure of from 6,300 to 6,600 volts, and is transmitted at this pressure to the three sub-stations. In the sub-stations the greater part of the three-phase current is converted by motor converters from about 6,500 volts alternating to 600 volts direct current, and at this pressure the current is supplied to the conductor rails of the Hammersmith and City Railway and the lines worked in connection with it from the Royal Oak and Shepherd's Bush sub-stations. From Old Oak Common, Shepherd's Bush, and Royal Oak sub-stations direct current at 600 volts is also distributed for sundry power purposes, and also for arc lighting to the Great Western Company's locomotive sheds, carriage sheds, goods yards and offices, and Paddington Station. A certain part of the three-phase supply is distributed from each sub-station at the full pressure of about 6,500 volts to the distributing centres, where it is transformed down by static transformers to either 220 or 110 volts At this pressure the alternating current is used for arc and incandescent lighting and small motor work throughout the Great Western Company's locomotive sheds, carriage sheds, stations, goods yards, offices, and hotel at or near Paddington, and on the Hammersmith and City Railway.

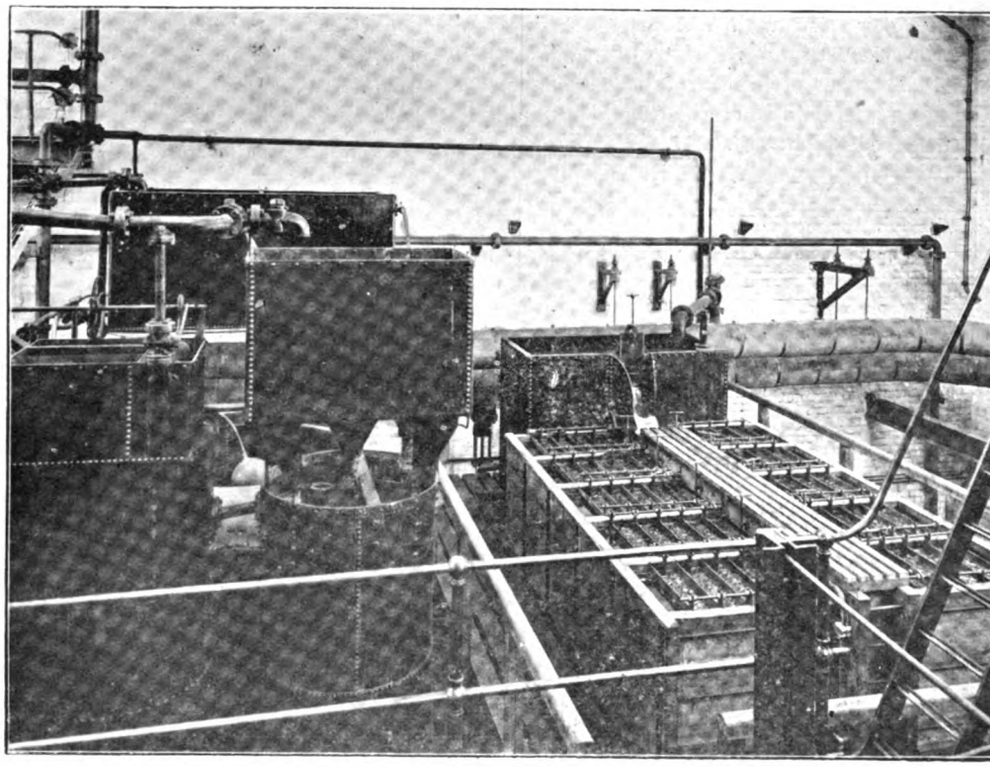

FIG. 1.—View of the Davis-Perrett Water-Softening and Oil-Separating Plants at Park Royal.

MAIN GENERATING STATION AT PARK ROYAL.

The present station only occupies about one-sixth of the ground available, and is so designed and placed on the site as to enable five other similar stations to be built as the demand for power increases. At the extreme east end of the present station are the coal silos, built below ground-level so as to be underneath the railway siding, which connects with the main line. The silos are constructed of ferro-concrete, and have a total storage capacity of about 400 tons of coal. The main building is a steel structure, filled in with brick and roofed with glass and slate, the wooden framework for the latter being lined on the inside

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with fireproof plaster. The boiler-house, at the east end of the main building, is arranged in three bays, and is 115ft. 6in. long by 95ft. wide and 80ft. high to the peak of the roof of the centre bay. The two side bays are for the accommodation of the boilers, leaving the centre bay clear. A set of steel coal bunkers, built between the main stanchions, is provided over the centre bay, with a total storage capacity of about 600 tons. To the west of the boiler-house, and separated from it by a party wall, is the main engine-room, which is also arranged in three bays, the two side bays taking the engine sets and the centre bay the condensing plant, which is also above floor-level. The switchboards are arranged on galleries extending across the whole breadth of the engine-room at the west end. The concrete foundation blocks for the main engines and for the condensing plant leave five passages in the basement, from end to end of the engine-room. The three centre passages and the space at the east end of the foundation blocks accommodate the pipework, and are separately drained, and entirely shut off from the remaining two passages and the switchboard basement at the west end, which accommodates the cables. The engine-room is 121ft. long by 108ft. 6in. wide and 50ft. high from the engine-room floor-level. The depth of the basement is 8ft. The engine-room floor is paved with red tiles, and the walls are faced with white crystopal tiles. The roof is ventilated by hinged casements in the sides of the lanterns. As an annexe to the engine-room, on the north side a building

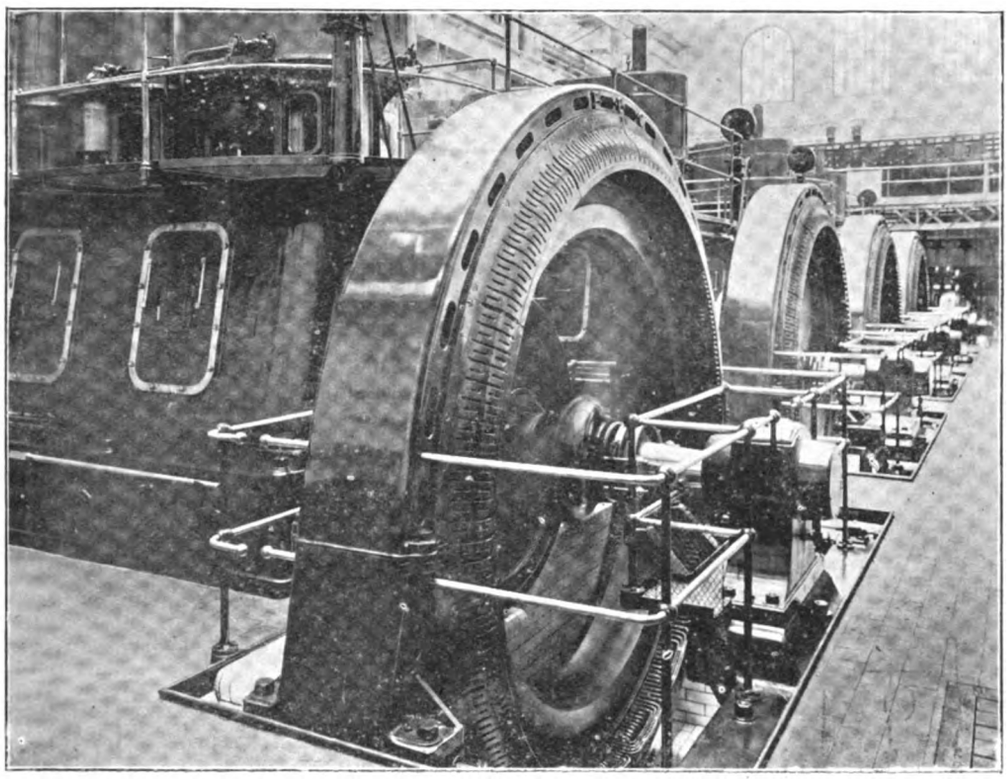

FIG. 2.—Park Royal Main Generators from Floor-Level.

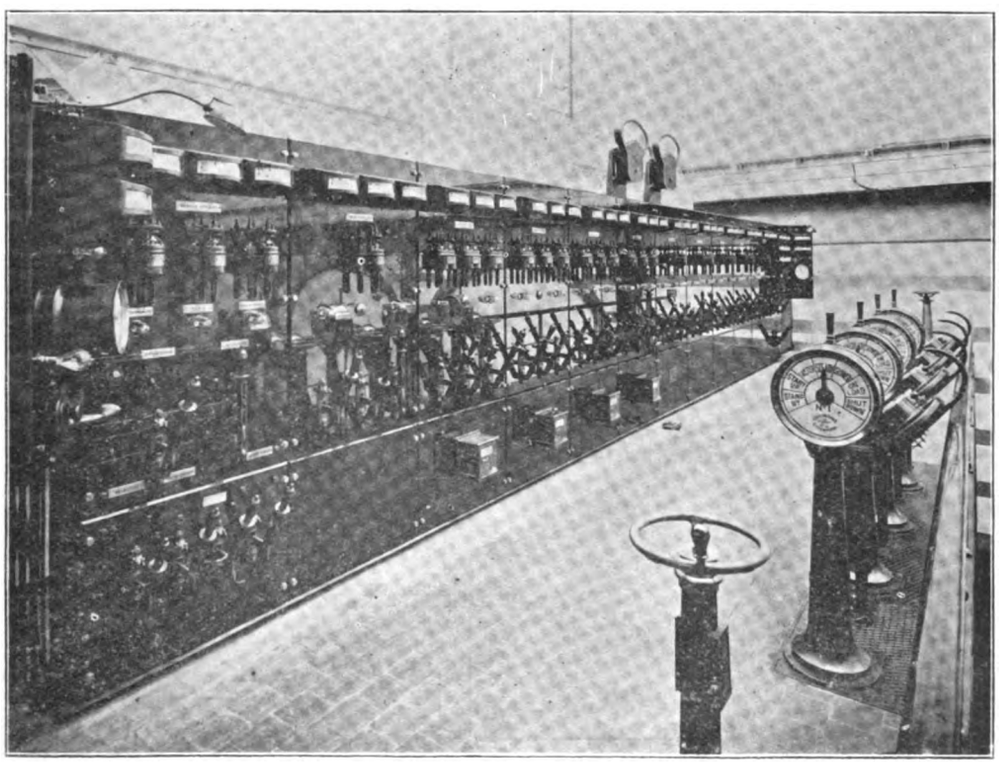

FIG. 3.—North Main Control Board at Park Royal.

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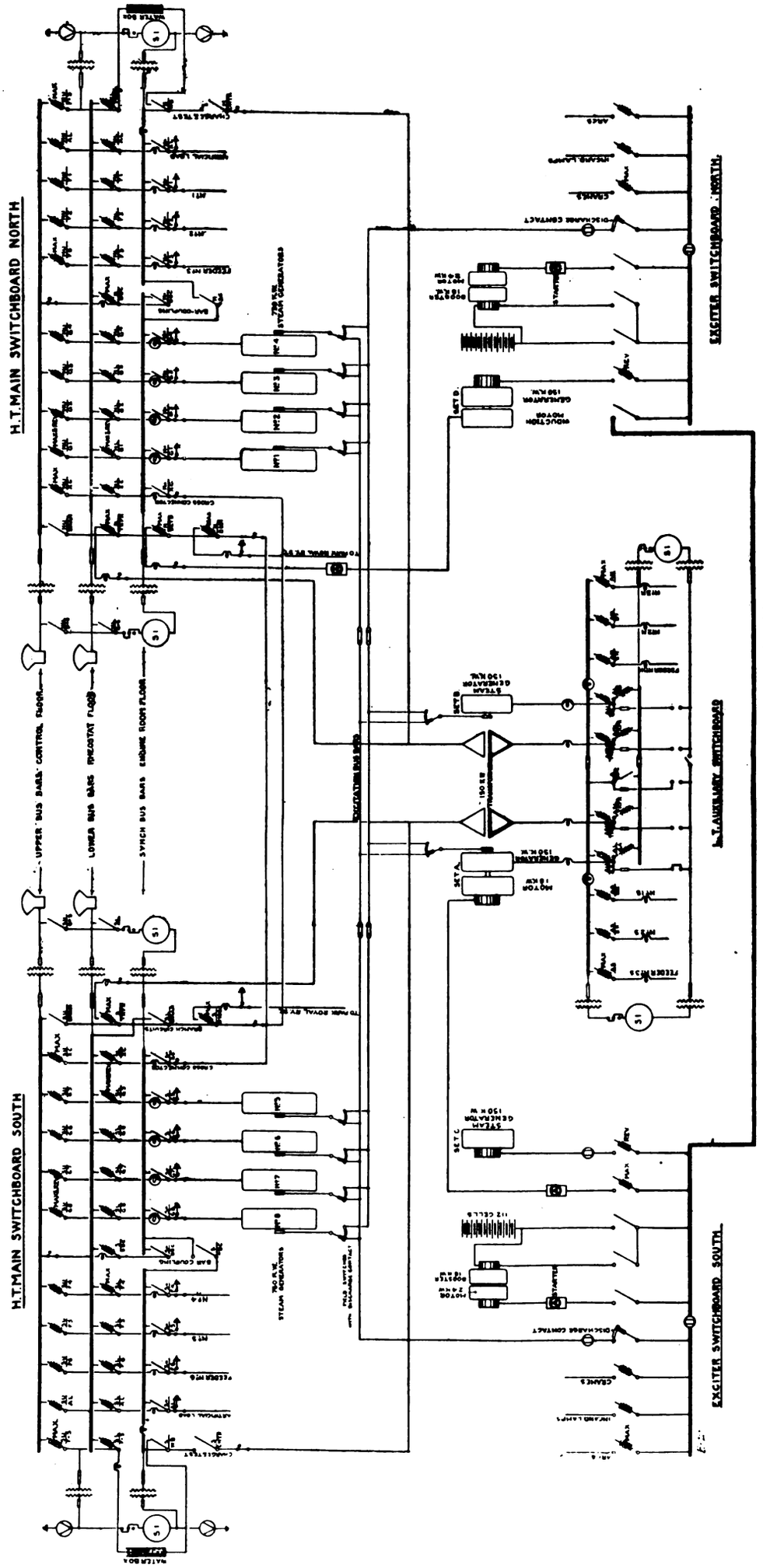
H.T. MAIN SWITCHBOARD NORTH
H.T. MAIN SWITCHBOARD SOUTH
EXCITER SWITCHBOARD NORTH.
EXCITER SWITCHBOARD SOUTH.
H.T. AUXILIARY SWITCHBOARD
UPPER BUS BARS CONTROL FLOOR
LOWER BUS BARS ENGINE ROOM FLOOR
SYNCH BUS BARS ENGINE ROOM FLOOR

Fig. 4.—Single-Line Diagram for Switching and Synchronising.

121ft. long by 25ft. 7in. wide and about 36ft. high is provided, which is divided into two portions, each 60ft. long, to serve as a workshop and as stores respectively. The office buildings, built as an annexe to the engine-room

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at the west end, measure 108ft. 6in. long by 20ft. wide and about 23ft. high, and include two battery-rooms on the ground floor as well as the necessary accommodation for the staff on the first floor. Under the offices, and just outside and throughout the length of the west wall of the engine-room, a cable tunnel is provided, through which the feeder cables are carried after leaving the switchboard basement.

PLANT.

Coal is brought on to the site over a railway siding in connection with the new line to High Wycombe, a special train of steel hopper wagons, each of which has a carrying capacity of 20 tons, and is provided with flap doors, through which the coal is delivered from the bottom of the wagon into the coal silos, being used for the purpose. The whole of the coal conveyor and elevator plant is arranged so as to be in duplicate, and the normal carrying capacity of each set is 50 tons of coal per hour when also dealing with the ashes.

Water is supplied from the canal at Old Oak Common, with an alternative supply from the Water Board, to a water supply tank in the yard outside the west end of the engine-room. From this tank it passes through a pipe to the pump-room basement in the boiler-house. From this point the water is pumped, by means of a centrifugal pump, through two cylindrical drain-water coolers, up into an overhead feed tank in the engine-room. The make-up feed water is supplied from the overhead tank through water-softening plant into the hot-well tanks. The feed pumps draw from the hot-well tanks with an alternative connection to the main water-supply pipe, and deliver through water-meters and pump-exhaust feed heaters to the boiler feed ranges. The steam, after passing through the steam pipes and engines, may be exhausted to atmosphere, but normally passes through mechanical oil separators into surface condensers, from which the condensed water is drawn by air-pumps, and delivered by force pumps to a height of 20ft. at the west end of the boiler-house, to the inlet of an electrical oil separating and filtering plant, and thence to the hot-well tanks.

The boiler-house contains 10 Babcock and Wilcox double-drum water-tube boilers. Each boiler has a heating surface of 5,764 square feet, has a normal evaporative capacity of 19,200lb. of water per hour at a pressure of 200lb. per square inch, and is equipped with a self-contained superheater, proportioned so that steam is delivered at a temperature of 550deg. F. at the boiler stop valve. The boilers are fitted with mechanical stokers of the chain-grate type. The drums which revolve the grates are driven through worm gear, and a ratchet and pawl arrangement with speed adjustment, from eccentrics on an overhead shaft running along the front of each block of boilers. Each stoker shaft can be driven from either end by a 15-b.h.p. three-phase motor, a clutch being provided at each end for connecting or disconnecting either motor. The motors are started up by means of starting switches placed on the stoking floor.

In the pump-room there are four steam-driven feed pumps of the vertical type, each pump having a capacity of 6,000 gallons per hour, delivered against the working pressure of 200lb. per square inch. Each feed pump can deliver into either of two 4in. 'bus pipes which are carried round three sides of the pump-room. The oil separating and filtering plant for the treatment of the condensed steam from the condenser on its way back to the hot-well tank is in duplicate, and is placed on each side of the pump-room outside the water-softening plant (Fig. 1). Each plant is capable of separating oil from and filtering 8,000 gallons of water per hour.

The main steam-pipes between the boilers and the engine sets are arranged on the duplicate system in the boiler-house, and on the ring system in the engine-room. The condensing plant is placed above floor level in the centre bay of the engine-room, and is divided into four sections, one for each pair of engines, each section consisting of a surface condenser, combined air and force pump, and circulating pump. Each surface condenser is designed to deal with 42,000lb. of exhaust steam per hour. The air-pumps are driven direct by a two-crank compound steam-engine, and are of the Edwards's type.

The cooling towers, which are of the Klein natural-draught wood type, are arranged in four towers, each of which can be divided into two sections. The galvanised steel main distributing trough is carried along the east end of the towers, and takes the water discharge from the two main pipes from the engine-room and distributes it to the four towers, a separate distributing valve being provided for each section of each tower. The main distributing trough is provided with a tumbling bay and measuring weir. Each cooling tower is 104ft. long and 21ft. wide at the base, the height from the base to the water inlet being 24ft., and to the top of the tower 74ft.

There are eight main generating sets (Fig. 2), four in each side bay of the engine-room, each set consisting of a Belliss engine driving direct an E.C.C. alternator generating three-phase current with a periodicity of 50 cycles per second, at a voltage of 6,300 to 6,600 volts, the normal output being 750 kw., with an overload capacity of 25 per cent. Each main engine is of the three-crank, triple-expansion, high-speed type, running at 250 r.p.m. The main three-phase generators are of the ordinary rotating field-magnet type, the total weight of the magnet wheel and flywheel being about 11 tons. The stationary armature is wound in open slots, and is star connected, but the centre point is not permanently earthed. Screws are provided for sliding the armature sideways for inspection when required.

The auxiliary plant is divided into eight sections, each of 150 kw. capacity, four of which are normally used for supplying direct current at about 225 volts for excitation purposes and arc and incandescent lighting, and for the overhead crane motors, and the remaining four sets being normally used for supplying three-phase current at about 650 volts for driving the various three-phase motors throughout the generating station, including those for the stokers, the coal conveyors, the condenser circulating pumps, and other pumps. The four direct-current auxiliary sets consist of a generator driven by a Belliss compound engine, a generator driven by a three-phase induction motor designed for the full high-tension pressure of 6,600 volts, and two batteries. The batteries, which form a stand-by for the excitation supply, are worked in parallel with the generators in the usual way, with motor-driven boosters for charging them from the 'bus bars. Each generator with its battery can be worked by itself, and used for exciting any or all of the main generators when required. There is, therefore, a complete stand-by generator and battery for the excitation supply. The four three-phase auxiliary sets consist of a generator driven by a Belliss compound steam-engine, a synchronous generator driven by a direct-current 225-volt motor, and two sets of static transformers. The motor-driven three-phase generator can be run reversed, taking current through the transformers from the high-tension supply, or direct from the auxiliary three-phase supply, and delivering direct current to the exciter switchboard, and it can also be used, when required, for charging feeders. Each set of static transformers is delta connected, and the high-tension winding of each transformer is divided into two sections, which can be connected up either in parallel or in series. The high-tension windings of the transformers are normally connected up in parallel, and can then be connected to the high-tension switchboards The high-tension windings can be connected up in series when it is desired to obtain a pressure up to 13,000 volts for testing purposes.

In each main engine-room bay and in the workshop a 20-ton overhead travelling crane is provided, all three motions of which are worked by series motors supplied with direct current at 220 volts.

The switchgear includes two main high-tension switchboards (Fig. 3) for controlling the 6,500-volt three-phase circuits, which are placed one at the west end of each of the main engine-room bays, an auxiliary switchboard (Fig. 4) for controlling the 650-volt three phase circuits, placed on the same gallery as the main switchboard control panels, and two switchboards for controlling the 220-volt direct-current circuits, placed one at the west end of each of the main engine-room bays on the floor-level immediately under the front of the main switchboard control gallery.

(To be continued.)

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THE PRESENT POSITION OF GAS AND PETROL ENGINES.*

BY DUGALD CLERK, M.I.C.E., F.C.S.

The present position of the internal-combustion motor industry in Great Britain is one of sound commercial prosperity. At no previous time have the gas and oil engine builders had so many orders in hand, and never before have these motors been applied so successfully to so many different purposes. Smooth success, however, is not interesting from the point of view of the scientific investigator or inventor; and, accordingly, I propose to discuss the present position with regard to existing difficulties rather than existing successes.

Engines of small and moderate powers are built in large quantities; their difficulties have been thoroughly overcome and they have attained to an almost fixed type. The larger part of the British gas-engine industry is occupied with such motors, generally under 100 h.p. per cylinder. The turnover in Britain at present of such engines is at the rate of some 300 engines per week. It is generally recognised that these engines are as reliable as the best steam-engines of similar dimensions and much more economical in fuel consumption. The smaller engines mostly use coal gas, and the larger producer gas evolved by means of modern suction producers using anthracite for fuel.

Experience in the constru tion and design of the large gas-engine is accumulating. They are better understood in Britain than they were even three years ago. It is a remarkable fact, however, that engines which attained a reputation for success upon the Continent were not at first successful here. This is shown by the fact that the Koerting, Oechelhauser, and Cockerill engines had all to be modified in their construction by the British engineers who undertook their manufacture here. This is also true of the Diesel oil-engine. Alterations have been made in England to fit it for the conditions of practice here. All these engines have been much improved in the last few years, and they are now, no doubt, better able to compete with the steam-engine with regard to reliability and freedom from breakdown.

Large gas-engines of English design have also been built in greater numbers, principally by the Premier Company, Messrs. Crossley Bros., Limited, and the National Gas-Engine Company. English designers have always felt the desirability of keeping down cylinder dimensions as much as possible, and in this Continental designers have recently shown a strong tendency to follow them. This trend is due to a more general recognition of two facts: practical difficulties with large-diameter cylinders due to unequal expansions, resulting in cracking, and a better appreciation of the fact that increase in cylinder and other dimensions requires an increased expenditure in metal and workmanship in greater proportion than increase of power obtained. The large gas-engine really presents two distinct problems. The first is to build engines of large power which will continue to run effectively and economically for long periods without breaking down, and the second is to build such engines at costs sufficiently moderate to enable the engines to effectively compete with the large steam-engines in the matter of first cost. British engineers recognised for some time that the first part of the problem has been solved to some extent on the Continent, but many of them have felt that this solution has involved weights of material and costs of construction which are almost prohibitive, considering the moderate powers obtained. In fact, English engineers consider the large gas-engine as it at present exists both too heavy and too costly for its power. Personally, I do not believe that sound and continued commercial success can be looked for with really large gas-engines until some better solution be found for their present constructive difficulties. Apart from the questions of the engines themselves there are other difficulties which prevent the equal competition of gas-engines with steam-engines for powers, say, greater than 400 h p. or 500 h p. Coal gas is too expensive a fuel for large engines. Producer gas, evolved by the suction producer from anthracite, air, and steam, effectively meets the wants of medium-sized engines up to 200 h.p., but the cost of anthracite handicaps engines of larger size, and equal competition will not be possible until better bituminous fuel producers are designed than those which at present exist. The work on the Continent has not aided the solution of the bituminous fuel producer problem. Practically all the large Continental gas-engines are operated with blast-furnace gas. Some success has been attained in Britain as the result of strenuous and praiseworthy efforts by Dr. Mond, Messrs. Crossley, and others, but it cannot yet be said that an entirely satisfactory bituminous producer has appeared. In my view no bituminous fuel producer can be considered really satisfactory until it attains simplicity, lightness, and the fewness of parts of the anthracite suction producer which now forms so large a British industry. Returning, however, to the engine difficulties, the large gas-engine may be considered as combining the difficulties of hydraulic engineering work at considerable pressures with those proper to a boiler furnace or flue. The possible pressures to be resisted by such engines cannot be taken as less than 400lb. to 500lb. per square inch, and a heat flow through the cylinder and combustion chamber walls has to be provided for greater than that of most boiler furnaces. It is obvious that here we have contradictory conditions involved, which become rapidly onerous with increase of dimensions. Thick castings are required to stand the high pressures, but to allow free heat flow from the flame within the cylinder to the water in the water-jacket calls for thin castings. Engines of small dimensions do not involve any serious conflict, but where metal is required of about 3in. thickness to resist internal pressures the temperature difference between the flame and water side of the metal becomes serious, and great stresses are set up which ultimately lead to the cracking of the castings. Great attention has been paid to this phenomenon of cracking, and in existing large gas-engines the difficulty has been partly met by skilful design and special quality of metal used. Although much ingenuity and skill has been spent in this direction, yet it is found that a dimension limit is very soon reached. Cylinders, for example, of 51in. diameter have been found to be too large. Nothing but the highest skill in designing and the greatest care in the choice of material and workmanship enables such cylinders and combustion chambers to withstand for any length of time the severe treatment to which they are exposed.

In a paper which I had the honour to read at the Cambridge meeting of the British Association I directed attention to the question of the working fluid of these engines, and described experiments which I had made and engines which I had built with the aim of reducing the mean temperature in order to reduce heat flow. Good results were obtained with these engines, but I came to the conclusion that the methods of reducing temperature then adopted did not go far enough. For the last three years I have been attempting to reduce maximum pressures as well as temperature without reducing mean pressures in order to diminish the weight of the engines for a given power and secure moderate thickness of cylinders and combustion chamber castings. There are several ways of reducing temperatures and maximum pressures without reducing mean pressures, but all require much more accurate knowledge of the properties of the working fluid than we at present possess. One solution of the problem appears to lie in compounding, and I am now at work on this. Many attempts have been made to compound the gas-engine by Dr. Otto, Messrs. Crossley, Mr. Butler, Messrs. Dick, Kerr, and Co., and others, and I myself have also at various times built experimental compound engines. No success, however, has yet been attained. There is no difficulty in getting some work from the low-pressure cylinder, but the additional work obtained was always too small in amount to justify the expense of the separate cylinder. The lack of success was mainly due to ignorance of the rates of cooling of the working fluid at different temperatures and pressures. Experiments made with closed vessels do not give much information on the necessary points. I found it necessary to make experiments of this nature on the engine itself in its working condition

* Paper read before the British Association at Leicester.

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instead of on closed vessels. At the beginning of 1905 I designed a new method and performed a considerable number of experiments on a 50-h.p. gas-engine, by means of which I obtained a cooling curve in the actual engine cylinder, and much other information of a useful nature both from the scientific and the practical points of view. Fig. 1 shows two sections of this engine. Its action was modified by so altering the valve arrangements that at any desired moment both inlet charge valve and exhaust valve could be held closed, and with this device I was enabled to get diagrams from which a cooling curve could be calculated. One of these diagrams is shown at Fig. 2. It will be seen that the usual charging stroke—compression, explosion, and expansion—is performed proper to the four-cycle gas-engine, but when the exhaust period approaches,

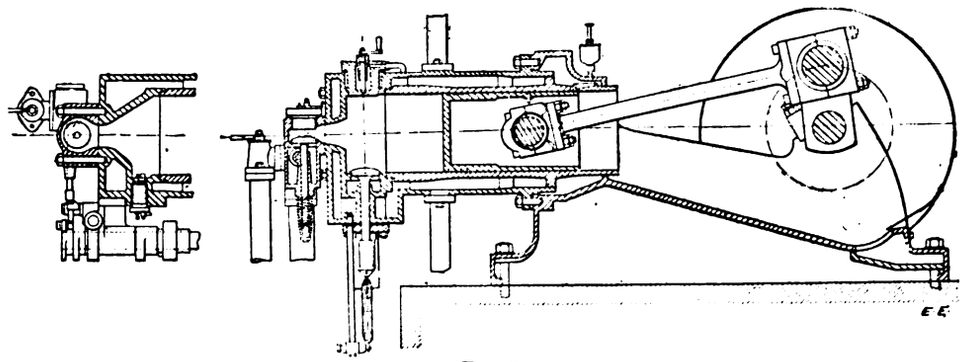

FIG. 1.

instead of opening the exhaust valve and discharging the gases at the proper point, the valves are all kept closed, and no gases are allowed to escape from the cylinder. The energy stored up in the flywheel accordingly causes the piston to compress the whole contents of the cylinder into the compression space, and the temperature which had fallen by expansion rises again by compression. A point is touched by the indicator pencil on a vertical line at the compression end of the card. On expanding, a line below the first compression line is drawn, then the next in-stroke traces another compression line. In this way a series of compression and expansion lines are obtained, each terminating under compression at certain specific points. These points are successively lower in order. In this particular diagram it will be observed that before

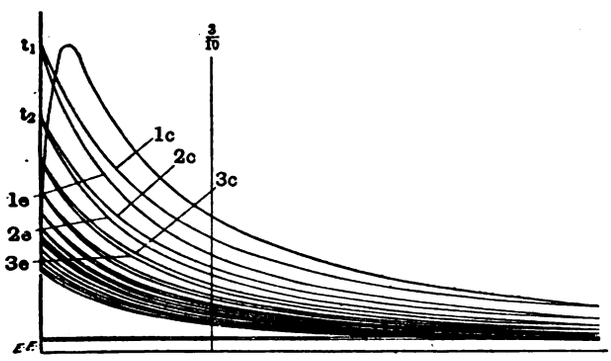

FIG. 2.

the ordinary compression line of the engine is reached six of these points are marked. If no cooling took place in the cylinder, obviously whenever the volume was restored to any particular point—that is, say, to the volume of the compression space—no fall of temperature would be visible between one revolution and another. The compression and expansion lines would coincide. The fall, as you see, is gradually decreasing from revolution to revolution. This gives an idea of the time taken to lose heat to the cylinder walls with all the engine parts in their ordinary state. The temperature fall from point to point, however, is not entirely due to heat loss. Some of the heat disappears as work done. A certain amount of the heat is converted into work at each reciprocation This, however, can be allowed for, and a cooling curve obtained which shows the real temperature drop due to cooling upon the expanding and compressing lines. From this curve, by somewhat troublesome calculations which I need not enter into here, the apparent specific heat of the charge can be obtained for each expansion line. Tables I. and II. have been calculated from the numbers so obtained. These tables clearly show that the apparent specific heat of the working fluid, which consists of the products of combustion in the cylinder of this particular engine, increases considerably with temperature, so that the instantaneous value is about 28 per cent. greater at 1,000deg C. than it is at 100deg. C., while at 1,500deg. C. the increase amounts to 31 per cent. The mean apparent specific heat between 0deg. C. and 1,000deg. C. is 15 per cent. greater than it is at 100deg. C.; between 0deg. C. and 1,500deg. C. it is 20 per cent. greater. These apparent specific heat numbers enable me to obtain a curve of heat loss to the sides of the cylinder either for complete double strokes or for partial double strokes at the inner end of the stroke.

TABLE I.—Apparent Specific Heats (Instantaneous) in Foot-Pounds per Cubic Foot of Working Fluid at 0deg. C. and 760mm.

Temp. Deg. C.	Specific heat at constant volume. Ft.-lb.	Temp. Deg. C.	Specific heat at constant volume. Ft.-lb.
0	19·6	800	26·2
100	20·9	900	26·6
200	22·0	1,000	26·8
300	23·0	1,100	27·0
400	23·9	1,200	27·2
500	24·8	1,300	27·3
600	25·2	1,400	27·35
700	25·7	1,500	27·45

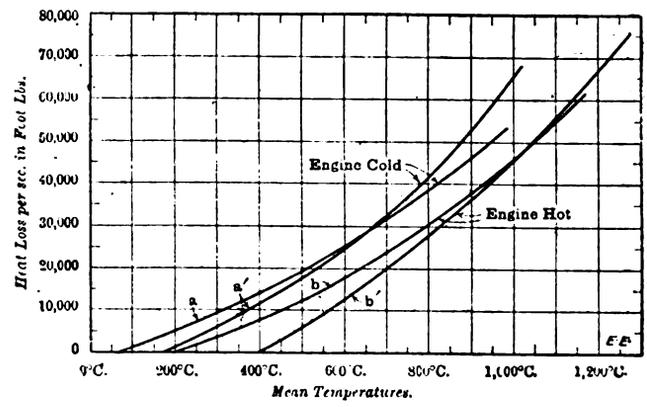

FIG. 3.

TABLE II. — Mean Apparent Specific Heats in Foot-Pounds per Cubic Foot of Working Fluid at 0deg. C. and 760mm.

Temp. Deg. C.	Specific heat at constant volume. Ft.-lb.	Temp. Deg. C.	Specific heat at constant volume. Ft.-lb.
0-100	20·3	0-900	23·9
0-200	20·9	0-1,000	24·1
0-300	21·4	0-1,100	24·4
0-400	21·9	0-1,200	24·6
0-500	22·4	0-1,300	24·8
0-600	22·8	0-1,400	25·0
0 700	23·2	0-1,500	25·2
0-800	23·6	—	—

Fig. 3 shows four such curves. The curves *a*, *b* represent the heat losses incurred in complete revolutions—that is to say, in complete double strokes. Here the surface exposed and covered alternately is that due to the whole sweep of the piston The curves *a'*, *b'* represent losses incurred at the upper three-tenths of the double stroke, while the piston moves from three-tenths stroke to the

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end, compressing into the clearance space, and then moves out again to the point of three-tenths of the outward stroke. The ordinates give heat loss in foot-pounds to the second and the abscissæ mean temperatures per total stroke or double three-tenths stroke. This table gives interesting information enabling approximate calculations to be made dealing with the durability of the working fluid exposed to cylinder surface. It has enabled also important facts to be discovered as to the mean temperature of the cylinder walls and the heat flow with varying density. Curves *a*, *a'* were calculated from experiments made with the engine running without load at 120 r.p.m., jacket water kept at a mean temperature of 13deg. C. Curves *b* and *b'* are calculated from experiments made with the engine running at 160 r.p.m. with a load of 150 b.h.p. and jacket water at 80deg. C. The curves are accordingly marked as "Engine cold," "Engine hot." Where the engine is running cold, the mean temperature for the complete strokes of the walls is shown to be about 65deg. C., notwithstanding that the jacket water is 13deg. For the three-tenths stroke, running cold, wall temperature 165deg. C. With the engine running hot, the whole stroke shows mean temperature of walls 190deg. C.; for the inner three-tenths, 400deg. C. These numbers, giving quantitative values of heat loss for a given cylinder, enable the conditions within the cylinder walls to be realised with some accuracy. In this particular engine the walls of the combustion space are about 1¼in. thick, and calculating the temperature gradient in those walls for the heat flows, given temperature difference, say, 700deg. C. between gas and interior of the wall, gives a temperature difference in the metal between the water side and the gas side of 60deg. C. A temperature difference of 1,000deg. C. between gas and inner wall gives temperature difference in the metal of 104deg. C. These differences are accentuated with greater metal thickness almost in proportion to the thickness: those with the higher temperature to the last calculation a thickness of ⅜in. wall would give a temperature difference in the metal itself of over 300deg. C. These numbers throw an important light upon the problem of the large gas-engine, and enable me with some confidence to experiment upon the variations of indicator diagram and the transfer of hot gases from cylinder to cylinder required for successful compounding. The experiments show also many interesting and unexpected facts in connection with the behaviour of high-temperature working fluid in these engines. Much remains to be done, however, and I am continuing the investigation on three engines with the object of determining the laws of the working fluid within the gas-engine cylinder more completely. Time presses, and I would refer those interested in this matter to a paper read by me before the Royal Society in March, 1906, and a paper read before the Institution of Civil Engineers at the beginning of this year. Prof. Callendar is also working on this problem of the quantitative laws of heat loss and efficiency in engines of different dimensions, and he has contributed an important paper this year upon the subject to the Institution of Automobile Engineers. Prof. Hopkinson, too, of Cambridge, has thrown some light upon the subject by ingenious experiments made upon gaseous explosions within closed vessels, and he is at work upon other experiments which will undoubtedly increase our knowledge on this troublesome and complicated subject.

In modifications of the conditions of the working fluid combined with mechanical modifications of the engine using it, I hope to find in the near future some more satisfactory solution of the large gas-engine problem than at present exists. It appears to me that the problem is one more of working fluid than of pure mechanism. So far, however, the conservative attitude of British engineers towards large gas-engines has been fully justified. We are all much indebted to Mr. Humphrey for a very able paper read before the Institution of Mechanical Engineers about seven years ago advocating the claims of the large gas-engine. Like all pioneers, Mr. Humphrey was a little too sanguine as to the rapid development of these engines, but he was undoubtedly right as to the ultimate success to be expected from them. Progress in solving the large gas-engine problem has been somewhat slow, but it has been steady. There is no occasion whatever for discouragement, notwithstanding recent difficulties with a large gas-engine installation at Johannesburg, of which much has been written in the engineering publications. The difficulties at Johannesburg are, in my opinion, to a large extent due to the daring nature of the experiment undertaken by an eminent firm of engineers whose experience was rather in steam-engines than in gas. They very boldly attempted to solve at one stroke the difficulties both of the large gas-engine in itself and those peculiar to the bituminous producer. I have no doubt that if they be given time they will solve these difficulties, but the experiment was on too large a scale for most experienced gas-engine constructors and designers. I do not attach any importance to this partial failure. It emphasises, what I have always held, the necessity for precaution and much further study in connection with the large gas-engine problem. It appears to me, however, eminently unwise and unsafe to attempt to solve the numerous problems involved in too short a time. Gas-engine builders must be content with the slow growth of experience and the slower solution of these difficult problems.

The increasing interest in larger type of gas-engines has clearly been shown in the last two years by papers read at the Institution of Naval Architects and at the Institution of Civil Engineers. For the first time in the history of the Institution of Civil Engineers a paper has been read this year, that by Mr. Milton, upon the marine gas-engine problem, which is a valuable contribution to the understanding of the subject from the steam-engine designer's point of view. I am in agreement with Mr. Milton in most of the conditions which he lays down as necessary for success in a marine gas-engine, but I regret that I do not coincide with him in considering that the particular type of engine which he proposes will solve the difficulties, although that type is one invented by me in 1878. Mr. Thornycroft read a very important and interesting paper at the Institution of Naval Architects last year upon the marine gas-engine, describing motor vessels built by Messrs. Thornycroft driven by engines and anthracite suction producers of the Capitaine type. To Messrs. Thornycroft belong the honour of being the first to propel a sea-going launch and a canal boat in Britain by means of a gas-engine driven by gas produced on board. Papers read this year before the Manchester Association of Engineers by Mr. Vennell Coster and the Institution of Naval Architects by Mr. McKechnie are also exceedingly interesting, but both writers greatly underrate the difficulties of the marine gas-engine. Mr. McKechnie, indeed, contemplates engines on shipboard of over 16,000 h.p. in the immediate future. I fear it will be some years before we have gas-engines of 16,000 h.p working on land, and considerably later before we have them at work on sea.

As I have already said, part of the large gas-engine problem depends upon the producer. A bituminous fuel producer of a type suitable for use on shipboard has not yet been devised, and until such a producer is designed and thoroughly tested the anthracite suction producers of to-day will not allow any great extension of gas motive power to large sea-going vessels. Mr. Capitaine has, I am informed, applied an engine of 300 h.p. to a towing vessel on the Rhine, but as yet this movement is in its early infancy.

The great success of the suction producer in connection with stationary engines on land has enabled the power of gas-engines in use to be very materially increased. Tests at the Royal Agricultural Society's show last year have proved that even small producer-driven engines only require 1lb. of fuel per brake horse-power per hour, including lighting-up and stand-by losses of the producer at night. Other experiments, some of them by myself, show very clearly that with a good suction producer we can obtain 85 per cent. of the whole heat of the fuel in the form of inflammable gas ready for delivery to the engine. Many tests have shown that the running consumption of many of these engines at full load does not exceed ¾lb. of anthracite per brake horse-power per hour.

So much for the position of the gas-engine at present. I have only a few words to say about petrol engines. A

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complete paper could be profitably devoted to the peculiarities and interesting points of the petrol engine, but I would only say that petrol-engine construction now forms a very large and well-founded British industry. Petrol engines operating on the four cycle by virtue of high speed of revolution are able to give very large power for very small weight, and they give a very fair thermal efficiency considering their small dimensions. This question of efficiency is a fascinating one, but I have no space to deal with it here. Speaking as the owner of a motorcar, I can say that the petrol engine as now developed is exceedingly reliable and very economical. Many of its points, however, are in urgent need of careful scientific study. To one point only will I refer, as experiments will throw important light upon the nature of the combustion occurring in these motors. This year the Royal Automobile Club has made a valuable set of experiments, at which I had the honour to assist, upon the exhaust gases given out by these engines under different conditions of running. The experiments clearly proved that, so far as visible smoke was concerned, many petrol engines now running on the road had attained absolute perfection. Speaking for the six-cylinder "Napier" car, on which I acted as observer during the test, I can truly say that nothing more perfect could be imagined in the way of absence of visible vapour or smoke. During a run of 150 miles on the open road I never once detected the faintest smoke coming from the exhaust pipe of the engines. In these tests, however, exhaust gas analyses were made, and it was found that, although many of the cars burned the petrol given to them in a most complete manner and evolved a minimum of carbonic oxide gas, yet some of them showed percentages of carbonic oxide in the exhaust greater than 2 per cent. It was resolved by the Royal Automobile Club to continue these experiments later in the year; but, meantime, as a matter of interest, I thought it well to examine the exhaust gases of my own car—an 18-h.p. "Siddeley." The following results were obtained under different conditions:

TABLE III.

	Percentages of CO in exhaust gases.		
	April 23.	May 7.	July 3
Engine throttle full open; car climbing hill...	3·6	3·6	2·2
Engine throttle less than half open; car running on level	6·9	4·2	2·4
Engine running without load; car standing...	0·5	0·4	1·8

From this it will be seen that, as at first adjusted, the carburetter of this "Siddeley" car was supplying an excess of petrol at the higher loads, so that no free oxygen was left in the exhaust. Consequently, carbonic oxide appeared when running with light load of 6·9 per cent. and heavy load 3·6 per cent. Successive tests were made as given above. Undoubtedly, as will be seen, by altering the adjustment of the auxiliary air valve, the carbonic oxide was reduced to very nearly 2 per cent. It is highly desirable that the exhaust gases of these cars should contain a minimum of carbonic oxide, in view of the rapid increase of their use in large cities like London. In the open road, a little carbonic oxide rapidly diluted by air would do no harm, but in large cities, when horse traction is replaced almost entirely by petrol motor vehicles, it will be necessary to look into this carbonic oxide question with great care. It is quite certain that the problem can be effectively solved, because in investigating gas-engine exhaust I have found that a good engine properly adjusted will not produce more than $\frac{1}{10}$ per cent. of carbonic oxide in its exhaust under any circumstances of ordinary running. Several of the cars tested by the Royal Automobile Club this year also showed remarkably low percentages of carbonic oxide, notably the Lanchester, Pilgrim, and Albion, and it will be noted that in my own car, with the engine running slowly, waiting at the door of my house to start, the carbonic oxide attained a minimum. The problem is one of the carburetter—a much more difficult problem than appears at first sight. There are many interesting problems to be solved with regard to the petrol engine, but this one of the carburetter appears to me at the moment to be the most pressing.

In this paper I have not dealt with the question of thermal efficiencies at all. The thermal efficiencies of all gas and internal-combustion engines are very high compared with any other form of heat motor. In recent tests by the Thermo-Dynamic Standards Committee of the Institution of Civil Engineers an ordinary "National" gas-engine—the one referred to in this paper and shown at Fig. 1—gave an indicated efficiency of 35 per cent. and a brake efficiency of as nearly as possible 30 per cent. The efficiency obtained from smaller petrol motors is somewhat less, but in tests made by Hopkinson it rises as high as 24·6 per cent. This is a very high efficiency for small-diameter cylinder.

So far as I understand the question, although large increases in thermal efficiency are still probable, efficiencies are quite high enough at present for all practical purposes, and the main efforts of engineers and scientific men interested in the internal-combustion motor should be directed to the solution of the large gas-engine problem in such a way as to reduce weight and increase power of the unit; to improve the bituminous fuel producer; to apply the improved engine and producer to marine purposes, and overcome the various difficulties there presented; in petrol engines to design carburetters capable of proportioning the charge more accurately than at present under all conditions of running, whether with light or with heavy loads.

The scientific problems I have already indicated broadly. I need not further refer to them here.

DISCUSSION.

Mr. W. WORBY BEAUMONT agreed with the author that there were many difficulties yet to be solved in the construction of large gas-engines. The temperature range in the cylinder walls was very great, more than that in the plates of a boiler. When the difference in temperature between the inner and outer surfaces was considered, one wondered that the cylinders held together. He thought the difficulties in the building of large-power engines might be reduced by using higher speeds and more cylinders to develop the power. The paper showed how practical experience helped scientific research and *vice versâ*. As another example of this he mentioned the inquiry of the Automobile Club into the composition of the exhaust gases of petrol engines. This was undertaken with a view of reducing the objectionable smell of the exhaust. The research had, however, shown how the economy of the engines could be improved. Thus, besides reducing the nuisance the facts obtained were valuable.

Colonel R. E. CROMPTON spoke of the difficulties attending the use of large gas-engines. Smaller engines with producers had aided the spread of electrical supply to small towns. He advised caution in the experiments with larger units. The introduction of the suction producer had raised the price of anthracite, and for large-power plants the bituminous coal producer had yet to be perfected. The matter had the serious consideration of the committee of the London electricity supply companies, but at present the experience acquired did not warrant the use of large gas plants. He recalled a suggestion of Prof. Elihu Thomson that fused quartz strengthened with steel might serve as the material for large gas-engine cylinders.

Prof. B. HOPKINSON congratulated the author on the beautiful and simple method he had used for the determination of the specific heat of gases. He described experiments he had made for ascertaining the temperature of the internal parts of a gas-engine by means of thermo-couples. This showed that the surface of a 12in. piston 1¼in. from the outer diameter was 450deg. C. The surface next the cylinder was at 150deg. C., so that there was a temperature fall of 300deg. C. in 1¼in. The temperature of the exhaust valve was 650deg. C.

Prof. HELE-SHAW spoke of the excellent work in the Johannesburg engines. There was no scamping of any kind. The same size engines were working satisfactorily in Germany, but on furnace gas. The cost of such a large experiment was very great, and the failure to get successful working with the bituminous coal producer had certainly set back the industry. It would have been better to make a smaller trial first.

Mr. HUDSON BEARE also spoke of the Johannesburg plant, and Prof. JAMIESON followed with some confidential remarks which were inaudible to those behind him.

Mr. DUGALD CLERK, in reply, said there were many difficulties yet to be fully solved, and the Johannesburg case showed again the pluck of English engineers. Where there were pioneers there were bound to be martyrs, too. The Westinghouse Company were now building 750-h.p. six-cylinder engines. He thought the German large-power engines were too heavy and costly. Producers up to 100 h.p. were now a thorough success, and over 100 per week were being turned out. This had raised the price of anthracite. As regards the

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Johannesburg plant, it showed the effect of a change in conditions. These engines had worked well with blast-furnace gas, but the composition of the gas from the bituminous coal had made all the difference. He considered that for suction producer plants we were well ahead of the Continent, and we obtained more power from a given size cylinder of engine. Here mean pressures of 100lb. per square inch were common, while the Continental engineers used 60lb., and got heavy, expensive engines.

DEVELOPMENTS IN ELECTRIC INCANDESCENT LAMPS.*

BY LEON GASTER.

The fascinating study of the methods for converting electric energy into light has received during the last few years considerable attention at the hands of many investigators, and it is my object in this paper to give a short review of some of the most important improvements which came before my notice during this year, and to exhibit the lamps mentioned in actual operation. Some of the members will probably recollect that, when discussing Sir William Preece's paper last year at York, I had the privilege of showing a few sample 110-volt metallic-filament lamps consuming one watt per candle-power. Those lamps represented at the time exceptional samples, but to-day they are ordinary commercial articles. The theoretical considerations regarding the manufacture of these metal-filament lamps have been adequately dealt with by several writers in this and other countries. It will, therefore, not be necessary to attempt to go over the whole ground. I will, therefore, only briefly refer to what has so far been accomplished. The subject is very wide, and it is impossible to describe in detail any particular process.

I will start with the improvements of the carbon filament, and bring before your notice the metallised, or, as it is also called, the graphitised carbon filament, by the aid of which lamps are made consuming on an average 2·5 watts per candle, with a useful life of about 60 hours. The earlier lamps were made for candle-powers from 50 candles upwards, but the lamps exhibited to-night are of 16 c.p., consuming only 40 watts. The lamps are manufactured for voltages varying between 100 and 130. They are sold under the name of the "Gem" lamp, and are now being manufactured in this country at Rugby. Before leaving the carbon filament I would also like to mention the use of the double carbon-filament lamps, the two filaments being comprised in the same bulb, one large and one smaller filament, by the aid of which either the full candle-power or only a very small candle-power can be used, and the expenditure in lighting thereby reduced.

Having dealt briefly with the carbon filament, I will pass on to the Nernst lamp. A recent improvement consists in fitting the lamps with a newly-designed cut-out coil of high resistance, and it is claimed that by the use of this coil a great reduction of the premature failures of filaments will be secured. I am exhibiting here a few of the lamps using this device. Several improvements remain still to be made in order that the lamp may light up as soon as the switch is turned on. As regards the efficiency of the lamp, no very great further improvement has yet been secured.

Coming now to the metal-filament lamps proper, I will refer first to the osmium lamp as produced by Dr. Auer von Welsbach. Although the introduction of this lamp met with considerable success at the time as representing a great advance over the carbon-filament lamp, owing, however, to the expensive nature of the metal used, and partly to the difficulty in manufacture, and bearing in mind the improvements which have since been made by the same inventor by the use of tungsten, its use is now likely to be restricted to comparatively low voltages.

The use of tantalum is sufficiently well known not to require much explanation. It is certainly the only metal-filament lamp which has met with a very great demand for the time being, and proved to be a successful commercial lamp. There have not been, as far as I know, any particular developments made during this year which require to be recorded, except those in the direction of lengthening the life of the lamps when used on alternating-current circuits. The explanation of the reason why the life of these lamps is considerably shortened when used on alternating current of higher frequencies than 50 is still wanting; although several explanations have been offered, they do not quite meet the case. One particular point may be mentioned in connection with this lamp—namely, the endeavour to make a suitable combination of the lamp with Holophane shades, forming one unit, thereby to secure any desired effect of illumination, either concentration or distribution. I will dwell more fully on this point in the latter part of the paper. The tantalum lamp is as yet only made for voltages up to 125; the high-voltage lamp has not as yet been perfected or brought into the market. The next most important metal used in the manufacture of filaments, and with which much is expected to be accomplished, is certainly tungsten (wolfram). Several methods have been devised for preparing filaments by the use of this metal. One of the first methods was worked out by Dr. H. Kuzel, of Vienna. By his process the metal is obtained in the colloidal state by means of an arc under water. The resulting paste of extremely fine metal is squirted into filaments, and afterwards heated in order to make them better conductors. The lamps are manufactured in Vienna by Kremenetsky. From such tests as have been made it is ascertained that the lamps consume a little over one watt per candle-power, with a useful life of about 1,000 hours, with a loss of only 10 to 15 per cent. of the initial candle-power.

Another method of manufacturing tungsten filament is the joint invention of Dr. Alexander Yust and Franz Hannaman, of Vienna. According to their process the carbon filament is electrically raised to a high temperature in an atmosphere of gaseous tungsten or molybdenum compounds. The carbon then becomes coated with metal, and, after burning out the carbon, the filament appears quite homogeneous even under the microscope. By another method the metallic powder is prepared by chemical means mixed with an agglutinant, and squirted into the form of filaments, which are then freed from carbon as before. Various other processes have been devised for preparing a paste of the oxide of tungsten, which can be squirted in filaments and afterwards reduced. According to the British patent 4,814 of 1907, Messrs. Siemens and Halske have devised a process of stamping tungsten powder, sometimes mixed with another metallic powder, but without an agglutinant, in a tube of some metal which is easily drawn or rolled, such as tantalum or iron. Then, after electrically sealing the ends, they subject the tube to drawing or rolling processes. After the completion of the drawing process the outer skin can, if desired, be removed. This method obviates the necessity for the great care and treatment involved in the ordinary fusing process, but I have not heard whether the method is actually in use. The diameter of some of these metal filaments is very small, lying between 0·05mm. and 0·03mm. A filament yielding 60 c.p. at 110 volts requires to be over 600mm. long. Experiments which attempt the manufacture of filaments of smaller diameters, such as permit the production of lamps of 110 volts and of about 20 c.p., are in progress, and some lamps of such small candle-power and even of high voltages have already been made on a laboratory scale, some of which I am showing here to-night, being made in this country at the Robertson Lamp Works in London. The average life of these tungsten lamps for the present can be reckoned to lie between 600 and 700 hours; some lamps have been burning as long as over 2,000 hours.

The next lamp using tungsten, and which is already used commercially, is the "Osram" lamp, and it is the invention also of Dr. Auer von Welsbach. The lamps are for the present manufactured by the Deutsche Gasglühlicht Gesellschaft, and are imported by the General Electric Company, who, I understand, have decided to begin the manufacture of the same in this country. The lamps are made in various sizes up to 100 c.p., and for varying voltages, but the common type which is expected to be used in the near future will be intended for voltages lying between 100 and 130, and of 35, 50, and 100 candle-power

* Paper read before the British Association at Leicester.

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The lamps burn with an efficiency of 1·2 watts per candle-power, having a useful life, on an average, of over 600 hours. The candle-power is well maintained over the whole useful life of the lamp. The lamps are recommended to be burnt for the present with the filament in a vertical plane, and can be equally well used on direct or alternating current circuits. The Berlin A.E.G. Company are also manufacturing some type of tungsten lamps, the process for the manufacture of which has not been divulged, but I am able, through the kindness of their English branch, to show you some of the lamps in actual operation. The lamps are made for various voltages; the lamp shown yields 50 Hefner candle-power at 100 volts.

Turning now to the zircon-wolfram lamp, to which I have already referred on more than one occasion, I should like to draw attention to some of the improvements which have been made during the last few months, which certainly represents a great advance over the lamps previously exhibited. You will have an opportunity to see, for the first time, I believe, metal-filament lamps of voltages above 100 which burn satisfactorily in any position in the chandelier. The filaments are mounted on spring hooks made out of tungstenised carbon, the hooks having the effect of maintaining the filament rigid and in shape whilst in service, and of preventing the loops from touching, also of allowing of a greater number of filaments in the bulb, and, consequently, of reducing their length and that of the lamp. The lamps can be burned in any position, and the breakage of filaments is considerably reduced. On account of the elasticity of the spring hooks, the breakage of filaments has been reduced in transit and in service.

Another improvement over the old type of lamp is the adoption of electrical soldering of the filament to the leading in wires, thus doing away with the inconveniences caused by the use of graphite paste, which was a partial cause of the blackening, the giving off gases, and the defective contacts met with in the previous lamps. The improvement also avoids much extra labour, and also the danger of oxidation of the filament, if the paste is not very carefully burned away. The electrical soldering process takes place in the open, and an experienced operator can carry out the soldering of about 500 lamps daily. The firm of La Carriere in Paris are the inventors of this spring hook, and I understand that the filaments can now be mechanically mounted in such a manner that the operators do not have to touch them with their fingers, thus reducing thereby the number of breakages in mounting the filaments. One operator can mount about 500 lamps of 110 volts daily. The latest type of 110-volt contain only four filaments of 0·025mm. diameter, giving out 24 Hefner candles, or for 220-volt 48 Hefner candles necessitating only the use of eight filaments. Lamps can also be made of 150 c.p. to 200 c.p. to compete with small arc lamps for shop and street lighting. The progress made in this country with the use of this lamp has not been great, but arrangements have been made for a factory to be established in London for the manufacture of filaments, and the subsequent sale to lampmakers. You will have an opportunity to see some of the latest lamps in actual operation. I may mention that the zircon-wolfram lamp was the first metal-filament lamp of 220 volts which I had the privilege of showing in this country, early this year, when discussing Mr. Swinburne's paper at the Institution of Electrical Engineers. To-night I will show you some 200-volt 46-c.p. 46-watt lamps. There is no doubt that the drawback which was, and still is, common with most of the tungsten lamps of having to burn in a vertical position will gradually be overcome, as you have seen that this has already been accomplished.

Before closing with the series of lamps using tungsten I should like to show you a Helion lamp, of which very little information is as yet available, although unauthorised extraordinary statements were made regarding the efficiency and performance of this lamp. I think I am the first to have the privilege of showing the lamp in this country, having obtained same from the conjoint inventors, Prof Parker, of Columbia University, and Mr. Clark, during my recent visit last April and May to the States. You will notice the lamp looks like an ordinary carbon incandescent lamp mounted in the same-sized bulb, and it is a 100-volt lamp, consuming 35 watts, and gives out 30 c.p. I have had the privilege of seeing, at Prof. Parker's laboratory, the manufacture of the filament for which silicon is reduced from a gaseous form in combination with carbonaceous gases on the surface of a high-resistance carbon core. The inventors claim that this lamp operates at a high temperature without the carbon and silicon uniting to form carborundum, as might be supposed. The silicon shows no tendency to become molten or fluid at the temperature attained. The filament starts with a negative temperature coefficient less than carbon, but at about a red heat the coefficient changes distinctly to positive, and remains so as the temperature is further increased. The efficiency of the lamp is claimed to be 1·2 to 1 watt per candle, or it can run even at less. Although a useful life between 600 and 1,000 hours is claimed, a proper series of life tests could not be made, as there seems to be a difficulty in keeping the joints between the filament and the leading-in wires in good condition. For the proper working of the lamp it is essential that mercury-vapour pumps must be used for obtaining the vacuum, and great care must be taken in selecting the carbon core, so as to obtain homogeneity and purity, otherwise the results are considerably affected. Experiments are now being conducted by the inventors, using as a core the graphitised (metallised) carbon filament, but I have not as yet heard with what results. The inventors are also experimenting with a special cement for the use of making the joints, and I hear that the results are promising. One of the characteristic features of the lamp, as you can see, is that the length of the filament need not be increased over the ordinary carbon lamp. The filament is very pliable, and there will be no difficulty (if the present defects, which are chiefly of a mechanical character, have been overcome) in making lamps of low and high voltages and of reasonable candle-power. The lamp easily stands transport, and will be just as safe to handle as the ordinary carbon-filament lamp of to-day. This is rather an important point, because one of the troubles common to all metal-filament lamps at the present is their liability to breakage in transport and in handling, particularly so at the hands of the unitiated consumer. The advantage to be derived from the use of metal-filament lamps may often more than be counterbalanced by the expenditure for renewals of lamps on account of the breakage of the filament. Iridium has also been used for the manufacture of lamp filaments. According to Gülcher's process, amorphous iridium is made up into a paste by the aid of an organic binding material. The filaments are squeezed from this paste, and are made to glow in the air, and not in a receiver containing air in the diminished pressure or indifferent gases. The lamp is only produced for low voltages up to 24, and consumes between 1 to 1·5 watts per candle. Other metals, like vanadium, niobium, molybdenum, etc., may also be used in the future, but not much has been made public as yet regarding their use for filaments.

During a visit which I paid to Mr. W. J. Hammer, of New York, one of the first assistants of Edison, and the owner of a wonderful collection of about 1,000 original lamps or parts of incandescent lamps, showing, as he says, "the history of an art," I was fortunate enough to see amongst other lamps a few samples of Mr. Heany's invention, some using, I am given to understand, titanium for the filament, and others using a metallic alloy of tungsten and titanium in a dense, shining, coherent state. See United States patents Nos. 839,585 and 842,546. I am given to understand that more will be heard about this lamp shortly. In one of Mr. Hammer's articles ("Electric Lighting by Incandescence," see *Electrical Review*, New York, March 9, 1907) he draws attention to the early work of Lodyguine, some time in 1897, where he suggests the depositing of refractory bodies upon platinum or carbon base or temporary support, which he describes under the word "fillet." This using of the "fillet" bears resemblance to some of the latest developments in incandescent lamps using carbon as a fillet or core.

In speaking of the economies which can be derived by the use of these new metal-filament lamps, one naturally has to bear in mind the fact that the economy to be

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derived depends on the price at which the lamps could be sold, the rate of charge for the current used, and the useful life of the lamp, and this is a matter which requires proper calculation, and which one must not overlook when tempted to adopt these new metal-filament lamps for the sake of economy only. The question of breakage in transport and in handling by dusting or fixing the lamps is a very serious drawback, and to mitigate this evil the lamp-makers will have to work out an arrangement with the consumer so as to reduce this expense to a minimum. The price of the lamp of 100 volts 50 c.p. is 4s., but there is no doubt that this high price, with an increased output and growing demand, will be greatly reduced in the near future.

Although we have seen that the metal-filament lamps can be made of relatively small candle-power at voltages above 100, and of high voltage up to 240, I am given to understand that it is not the intention of most of the manufacturers to sell for the present other lamps than those of high candle-power above 30 c.p., and intended for voltages varying between 100 and 130. This decision has a distinct commercial value, making the change from the carbon filament to the use of metal filaments gradual, so as to be properly appreciated and beneficial to the consumers, manufacturers, and energy suppliers alike. The fact that the high candle-power lamps consume only about one-third or even less energy than generally the present carbon lamps will, to a very large extent, meet the complaints of the consumer, who, in adopting the lamps, will obtain increased illumination at the same or less energy expenditure than hitherto. It is well known that the carbon incandescent lamps are at present in many cases fixed at a low position, often situated in the direct angle of vision, and, therefore, detrimental to sight. The reason may be that, on account of the expense at which energy is supplied to the consumer, he could not well afford to enclose the lamps in properly diffusing globes, or to remove them a good distance away from the objects he wishes to be illuminated. With the advent of the new metal-filament lamps of relatively high candle-power, the lamp could easily be removed to above the level of the eyes, or enclosed in properly diffusing globes. We should thus obtain good illumination without additional increase of expenditure. I believe, personally, that the high-efficiency lamp will prove of inestimable benefit to the consumer, manufacturer, and supplier alike. It will bring the electric light within reach of many who have so far hesitated to adopt it, and render it a cheap and convenient method of lighting. The change from carbon to metal filament must be made gradually. With the extensive use of electricity for lighting purposes, the present suppliers of electric energy will, no doubt, benefit in the long run from the change. For those circuits where high voltage is used, and where it is advisable to introduce the metal filament, resort must be had to series wiring, which, as a whole, is not quite satisfactory, because as soon as one of the lamps breaks all the lamps in the circuit go out, and it is not so easy for the ordinary consumer to detect the broken lamp. Several devices have now been introduced to mitigate this drawback. Mr. Dowsing is showing here two of his devices for this purpose, and which you can see in actual operation. There are also specially devised cut-outs, which act automatically as soon as the lamps break. Where alternating current is used, the voltage can easily be brought down to suit the voltage of the lamps, or auto-transformers similar to those used with arc lamps adopted. In many places on the Continent it has even been found advisable, on account of the charges for current being high, to put down motor-generators to reduce the voltage, instead of rewiring the existing installation. Under certain conditions the expenditure of fixing a motor-generator has proved to be quite satisfactory.

Speaking generally of the impressions which I received during my recent visit to America, I should like to inform the meeting that very great progress has been made in the recognition of illuminating engineering as a distinct branch of specialisation in the engineering profession. I observed an extensive use of successful combinations of shades, lamps, and lampholders, by the aid of which combination the best and most efficient illumination is obtained. The Holophane shades and reflectors seem to be very much used, enabling us to direct the light where it is mostly wanted, and produce any desired effect of illumination. I think that this combination of lamp, lampholder, and reflector, forming one suitable unit, is worthy of the careful consideration of the lampmakers in this country.

Having dealt briefly with the improvements made with incandescent metal filaments for general illumination, I should like to draw attention to the progress made in the use of vacuum tubes, and in particular wish to refer to the Moore vacuum-tube method of illumination. I had an opportunity of seeing several installations, and also of listening to the lecture recently delivered by Mr. Moore before the American Institute of Electrical Engineers. I had hoped to have been able to exhibit some of these tubes at this meeting, as two of Mr. Moore's representatives are now in this country, but unfortunately this was not practicable. Two installations have already been erected in London, one outside the Savoy Hotel and another at Salisbury House. The Savoy installation consists of a tube 176ft in length, consuming 2,950 watts, using nitrogen gas for producing yellow light. Power factor 70 per cent. The Salisbury House installation consists of a tube 85ft. in length, consuming 2,200 watts, with a power factor of 60 per cent. A white colour is obtained by using CO_2. I am quite satisfied that a useful field will be found for the application of this method of illumination. The use of CO_2 has enabled Mr. Moore to obtain with his tube the nearest approach to daylight yet attained, and I am given to understand that colour can be matched in such a light with extreme accuracy. This is certainly a severe test for any method of lighting.

I should also like to draw attention to one fact in connection with illumination, which seems to deserve greater consideration at the hands of manufacturers and large consumers of light, and that is the great value which ought to be attached to the adopting of proper methods of illumination. The advantages to be derived are: firstly, the sight of the workpeople will be improved and prolonged; secondly, the output will be quite appreciably increased; and, thirdly, which is very important, the quality of the work under proper illumination will be of the same high standard as when done in the daytime. The economies derived by not using proper methods of illumination are false economies when one bears in mind the fact that the expense of providing and keeping up proper illumination is in many cases only a small fraction compared with the value and the nature of the work turned out. This question of defining the proper amount of light necessary for different purposes forms a very useful task for the illuminating engineer.

Before closing I should like to refer to an American institution with the work of which I was struck as being of extreme importance for the much-needed improvement in lighting, and that is the work of the engineering department of the National Electric Lamp Association. Fifteen lampmakers in the United States have combined for the purpose, not of forming a trust, but with a determined object of improving the quality of the lamps they are manufacturing, and thereby maintaining a proper and high standard. The best evidence of the value of this association is the fact that lamps have been improved during the past few years considerably, and every advantage to the manufacturer has been proved to be an advantage in which the purchaser has shared. Instead of each factory employing imperfectly trained chemists to analyse the chemicals which enter into the manufacture of lamp filaments, a well-paid and highly-skilled chemist is employed in a thoroughly-equipped laboratory to perform this work, and sufficient resources are put at his disposal to keep on making proper researches and keep abreast with the latest discoveries. No independent company with a capacity less than about 15 or 20 million lamps a year could possibly afford to maintain an engineering organisation which should be in any way compared to the engineering department of the National Electric Lamp Association, and it is only by reason of this association that such an engineering organisation can exist. In passing, I may also mention in connection with the necessity of testing incandescent lamps the beautifully-equipped electric testing laboratory which I

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visited in New York which is so ably conducted by Dr. C. Sharp. This laboratory is munificently equipped for the purpose of testing lamps for life, candle-power, energy, consumption, etc., securing for the consumers lamps according to the standard specification. It is only by such a central organisation and well-equipped laboratory that authoritative and unbiassed tests could be carried out. In view of the fact that in this country a standard specification for carbon lamps has been framed, and has come into force on this July 1, I hope before long that such a testing laboratory will also be established in this country, and will receive the proper support of the municipal authorities and companies supplying current for lighting purposes, enabling the consumers to get lamps of really good quality.

In bringing this paper to a close I should like to venture on indicating the lines upon which further researches might be conducted, and for that purpose I will refer once more to Mr. Hammer and his publications, and say with him that the ultimate solution of the problem of securing a satisfactory and efficient illumination may be obtained by means of the stimulation of phosphorescent and fluorescent substances in various ways, thus producing a cold light, a light, as he calls it, without flame and without heat. We must soon stop producing long and useless heat waves, and also, as far as possible, all radiation outside the visible spectrum, in the utilisation of our illuminants. Let us hope that the time is not very distant when I shall be able to present to you another paper giving the progress made in this inexhaustible field of research for converting electric energy into light, and to show how much more can be saved from the large waste which is now going on. Our aim should always be, if we cannot abolish *waste*, to reduce its importance to a minimum whenever we can.

DISCUSSION.

Sir W. H. PREECE gave his experience with the use of Osram lamps, both at his house at Wimbledon and in Wales. He had used at Wimbledon 20-c.p. 105-volt Osram lamps supplied through a transformer from a 220-volt circuit. The result had been that in the first year the cost of the transformer was paid for by the saving in current. The lamps had not blackened at all, and so far there had been no need for renewals. He again called the attention of the section to the extreme variations in voltage which were sometimes found in supply circuits. This should be improved in the future, as it was bad for all types of lamps.

Colonel R. E. CROMPTON had used a great many Osram lamps, and found that consumers preferred the extra light, so that the supply companies would not suffer from the introduction of these lamps. The high-voltage lamps used in this country had enabled very good regulation to be obtained. He was sure from his practical experience abroad that in no other country was the service so regular as in England. He knew of circuits where the variation never exceeded 1 or 2 per cent. from that declared. He felt sure that the lampmakers would be able to turn out 220-volt lamps in the near future.

THE CONSTITUTION OF THE ATOM.

On Friday, Aug. 2, an interesting discussion took place in Section A of the British Association meeting at Leicester on the above subject, in which both physicists and chemists were well represented. It was opened by Prof. E. RUTHERFORD, who gave a brief but clear *résumé* of our present knowledge of the subject. Starting with the fundamental idea of the atom as defined by Dalton, he explained that it did not follow that because the atom was the smallest quantity of a substance which can enter into chemical combination that it was the smallest that could exist. The more recent work tended to the idea that matter might be discontinuous in structure. Passing on from the periodic law of Mendeléeff, there was the valuable contribution of Faraday, who proved that in electrolytic conduction matter and electricity always went together. Helmholtz followed with the idea that one unit of electricity was carried by the unit of the hydrogen atom. Prof. J. J. Thomson showed in 1897 that the cathode-ray particles travelled at very high speeds, and that these negatively-charged particles had about one-thousandth the mass of the hydrogen atoms. Kaufmann afterwards proved that moving charged masses acted as currents, so that the inertia of the electrons might be accounted for by the electricity carried. It was also shown that the stability of the atom was not affected by the liberation of the electrons. It was remarkable that, while so much was now known of the negative electron, nothing could be found as to the positive. It was supposed by some that positive electricity simply acted as cement to hold the electrons together. One experimenter in Berlin thought that he had found evidence of positive electrons one-third to one-fourth the size of the negatives, but the experiments would have to be repeated and confirmed. Prof. Larmor had long held that there must be positive electrons. Some recent work by Prof. Thomson on the origin of mass pointed to there being only one electron in the hydrogen atom, and not more than 200 in the lead atom. From the work of Prof. Schott, he did not think spectrum analysis was likely to help much in the question. It seemed probable that the light given off came from the loosely-attached electrons, and not from the inner part of the atom.

Sir OLIVER LODGE spoke as a champion of the electrical theory of matter, which as a working hypothesis was a good guide to experiments. Inertia was capable of explaining the electrical effects observed, and electricity could be shown to have the same effects as a moving mass.

Sir WM. RAMSAY said that the atom of hydrogen was still the element on which much of their chemical work depended. He thought that the subject should be considered more on chemical lines, and that combinations between atoms might be affected by electrons. Prof. Rutherford had said that there was no evidence that the removal of electrons affected the composition of atoms. With this he disagreed. He had made experiments lasting over two and a-half years in which radioactive materials were enclosed in different crucibles. For example, with a nickel envelope he had found that the inner skin contained some new element which was radioactive, due to the bombardment by β rays.

Prof. F. SODDY disagreed with Sir Oliver Lodge, and thought that it was a mistake to theorise too much without more experimental data. He thought that the discoveries from radium did not justify the many theories which were based on them.

Lord KELVIN spoke at some length, but, due to the very bad acoustic properties of the hall, we could not follow his argument.

Prof. RUTHERFORD replied to a number of the remarks which had been made, which closed a most interesting discussion.

PERSONAL.

The salary of the assistant manager of the Newcastle-on-Tyne Corporation, Mr. T. P. Easten, has been advanced by £25 per annum.

Mr. J. W. Papworth, assistant electrical engineer to Kilmarnock Corporation, has been appointed electrical engineer at Stirling at a salary of £200.

The Whitby Urban District Council have agreed to increase the salary of the electrical engineer, Mr. L. H. King, to £175 per annum, and to £200 in February next.

Mr. E. W. Dunton, late engineer and manager of the British Accumlator Co., has been appointed assistant London manager to the London office staff of the D.P. Battery Co. His address is now 11, Victoria-street, Westminster.

Mr. W. E. Rogers, of the Warrington Corporation electricity works, having tendered his resignation on his appointment as chief assistant engineer at Dewsbury, the Warrington Electricity Committee recommend the appointment of Mr. H. B. Jackson as mains engineer at a salary of £130 per annum, with a maximum of £150.

We regret to have to record the death of Sir John D. Milburn, Bart., which took place last Saturday at his residence, Guyzance, Acklington, Northumberland. Among the numerous business appointments held by the deceased baronet was that of chairman of the Newcastle and District Electric Lighting Co. and the Northern Counties Electricity Supply Co.

APPOINTMENTS VACANT.

Charge Engineer, Ilford Urban District Council electricity works. Salary, £120 per annum, increasing by annual increments of £10, on satisfactory service, to £150 per annum. Applications to Mr. J. W. Benton, clerk, by Aug. 27. See advertisement.

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PORTSMOUTH TRAMWAY ACCOUNTS.

The issue of the current number of the *Proceedings* of the Institution recalls to mind the paper of Mr. Robert Hammond on depreciation and the excellent discussion thereon. Such papers and discussions are mostly of the academic type, inasmuch as the views expressed are kept for criticism rather than for use. No municipality or company alters its system of keeping accounts or of dealing with revenue because of opinions expressed in these discussions, yet they serve a purpose in supplying a kind of ideal standard by which the systems pursued can be roughly compared. After all, the world is large, and that portion of it wherein roads are of primary importance small. At any rate that is the impression one obtains on reading accounts of the motor ride from Pekin to Paris. Most of the distance was covered, not on made roads, but on casually defective tracks. To bring the waste places of the earth into conformity with the notions ruling as to roads in civilised parts needs a large expenditure of money. So there is hope for the extension of business yet. Rome was not built in a day, but she showed us how early the necessity of roads was felt. According to Mr. Clement Stretton in his contribution on "Stone Roads, etc.," to the Handbook of Leicester for the British Association, the first roads—"stone roads"—consisted of "two continuous lines of blocks of stone, each being from 2ft. to 6ft. in length, 1ft. in width, and about 6in. in depth, the distance between the two lines being 4ft. and the outside width 6ft., and, consequently, the wheel gauge being 5ft. outside." A plate-way made in stone. Many engineers are enamoured of plate-ways even now, and miles of such ways in stone are to be seen, as well as of iron or steel. Stretton goes on to tell us that Outram in 1785 designed a plate-way from Loughborough to Nanpantan; and from the name Outram we get the word "tram." Outram's design was not allowed, but a modification of William Jessop's wherein the flanged wheel was first used was made, and so came about the edge-rail-way. "The Duke of Rutland in 1793 had the Belvoir Castle 'edge-rail-way' constructed to convey coal from the Grantham Canal to the Castle. This line is still in use after 114 years, and is the oldest example of Jessop's flanged wheels to be found in the world." A detailed history of this line would be interesting. What was its first cost, what the weights carried and mileage run, what the repairs, renewals, etc., and what the lessons, if any, to be learned? Thus the tramways of to-day had their origin. There was, however, an interregnum in evolution, and the latest types are only of to-day. From these we are learning our lessons, and it is by the aid of such elaborately detailed accounts as those of the Portsmouth undertaking that we get to know with some degree of certainty exactly what goes on in electrically-worked tramway systems. As is well known, a municipality obtains its capital by means of loans, the security being the rates. These loans have to be repaid within a certain period determined by a Government department. In a new departure the exact life to which the loan might extend is not determinable with any great degree of exactitude, hence the period allowed may or may not be too long or too short. Experience gradually determines with greater exactness the life of the various parts of the undertaking. Not only have the loans to be repaid, but the undertaking has to be kept efficient, thus renewals to quick-wearing parts and in case of accidents commence soon after the opening. A good deal of controversy has gone on as to preparation for renewals, and scores of guesses have been made as to probable demands. Portsmouth has taken the

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most enlightened plan of thoroughly investigating the question of renewals, in order to make the necessary reserve for such purpose. It has 14½ miles of route—with the exception of the half mile—with double track. A hundred cars form that part of the equipment. These make 2,199,823 car miles a year and carry 20,668,825 passengers in that period. The generating station had during the year to provide over three million Board of Trade units, so that, altogether, the experience gained on such a system by ordinary wear and tear is valuable. A committee was formed to report, and has reported. The life of loans as taken for the report is 27 years. The permanent way has cost £209,790, and the report estimates that £244,705 will be the required amount to be spent in keeping the permanent way in working condition during that period. Electrical equipment has cost £59,141, and it is estimated that £16,418 will be required. The cars have cost £58,997, and will require £25,000 during the 27 years for renewal of car equipments. Considering the various items altogether, renewals are estimated to cost about £296,000, or close on £11,000 (£10,971) per annum. The Portsmouth authority has made provision in accord with this report. We cannot enter further into this matter for the moment, merely referring to it as a proof that the municipalities are fully alive to all the necessities of the case.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE TELEPHONE QUESTION.

SIR,—You have been so good in allowing me to comment upon the present aspect of the telephone question that I venture to trouble you once more. I have explained how the expenditure for new switchboards between now and 1911 must be extremely heavy, and how the Post Office have contrived that the British taxpayers' millions shall be spent in Chicago and not in England. If any benefit in the way of improved apparatus that could not be produced in this country were to result, little exception could be taken to such a policy; but such is not the case. The American apparatus which the Telephone Company are obliged to put in by command of the Post Office is, on the contrary, incapable (at least, on a large exchange) of providing even a passably efficient service. This arises from several causes. The first is the violation of natural conditions which occurs when the transmitting apparatus is used as a conductor for heavy signalling currents, a defect inseparable from the common-battery system. The telephone transmitter, a very delicate instrument, yields its best results under certain well-defined and well-understood conditions, which have to be sacrificed in order that the transmitter may serve for signalling as well as for speaking currents. Result: an inefficient transmitter which has to be bawled at closely, and the articulation of which is so defective that mistakes in passing numbers are constantly occurring, while operators demand repetition of the number you want quite as a matter of course, and often several times. The inefficiency varies with the hour of the day and the state of the traffic. In the morning and evening and on Sundays the transmission is much louder than during busy times—sometimes so loud that articulation is lost and it is occasionally difficult to distinguish between "Yes" and "No." During the busy hours, owing to the great strain on the common battery, voices are often so faint as to be inaudible. An experience I had with my office telephone some time since illustrates the matter very well. The operator at Victoria had given three wrong connections consecutively through mistaking the number asked for. This was sufficiently annoying to induce me to make a formal complaint. The next day I was visited by a gentleman with an American accent, who explained that he had been brought over from the United States by the Post Office to supervise their London telephones. He admitted that the common-battery transmitter was defective in articulation especially with regard to certain numerals, and he pointed out that in the number which had been mistaken three times the figure 5 occurred. This he said was a specially bad mouthful for the common-battery transmitter, and he advised me in future to use the French word "cinq" instead, "a practice which is followed in New York with the best results." So the British Postmaster-General sent an American electrician to a British subscriber to advise him to use a French word! The common-battery transmitter is not only rendered inefficient by adapting it for signalling currents, but it is ineffective as a conductor of those currents, because it perforce has to retain some of the characteristics of a transmitter. This renders it necessary to make it a fixture on the wall or on a stand, to the martyrdom of the poor subscriber, because if attached to a long flexible cord, as a good transmitter can be, it is apt to be shaken. A shake alters its conductivity sufficiently to distort the signalling currents, and so mix up their meaning at the exchange that the operator sometimes thinks a conversation is finished before it has begun, and so disconnects and evolves confusion. So the convenient hand combination of transmitter and receiver made familiar by the municipalities must go because it does not fit in with the autocratic requirements of American manufacturers. To the same Moloch is also sacrificed the privacy of the extension line between the clerks' office and the principal's. Then, again, to the passage of perpetually varying currents through the transmitter, and through more or less faulty connections at the exchange, is due the distracting imitation of motor 'bus discords to which I referred in my previous letter. It follows that the American common-battery system—at least, as practised in London—in wrong both in theory and practice, for it is bad engineering to constrain any piece of apparatus to a use for which it is not naturally adapted. Nevertheless, I am prepared to admit that it may be made to work fairly well on a small exchange of a few hundred subscribers where the traffic is not specially heavy. Unfortunately for it, London and the other big British towns do not come under this category. Add to all I have said that the system is extremely costly to construct and maintain, and that it requires an electric installation of dynamos, motors, and accumulators, which cause a Post Office telephone exchange to closely resemble an electric lighting station. It will, no no doubt, be asked "Why, if this is so, do manufacturers produce and the Post Office insist upon such a system?" The manufacturers' reason is satisfactory enough from their point of view. The patents are theirs, and it pays to make and charge for two or three parts instead of one. The Post Office reasons are neither so simple nor so good. Firstly, as already stated, when ordered to telephone London they were unprepared with any scheme, and went to America instead of calling in outside British assistance; secondly, the pettifogging yearning after economy in little things which has ever distinguished the Post Office caused the consideration to be irresistible that this system requires no separate transmitter batteries at the subscribers' offices. One common battery suffices for all, and the Post Office engineers expected to evade the necessity of inspecting subscribers' instruments except at rare intervals, and so to keep down the staff of electricians. Another consideration was that with this system it is possible to crowd a greater number of subscribers in front of one operator, and to keep down operating expenses by compelling a girl to attend to as many as possible. I am far from denying the propriety of the two last reasons, provided they are compatible with efficiency and are really economical. But they are neither one nor the other. Lumping all the batteries into one brings with it the disabilities I have described. Refraining from inspecting the subscribers' instruments (which require care and cleaning apart from all battery considerations) makes neither for efficiency nor for economy in the long run. Loading the operators up to their full limit in ordinary times render them incapable of dealing properly with the extraordinary pressures of traffic which, from one cause or another, arise many times in a year.

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The municipalities approached the problem very differently. They, without exception, determined to place efficiency in the front rank and let economy follow as closely thereto as might be. Some of them may possibly have made mistakes, but in no case have they erred as the Post Office has. The municipalities use a central battery at the exchange for signalling purposes, but they do not pass the signalling currents through the transmitters, and they provide separate cells at the subscribers' for speaking. This plan keeps the line free from noises, and as the transmitters are designed as such exclusively, they provide the highest attainable perfection in articulation, while being much more convenient and comfortable to handle. With them conversation may be carried on in a whisper. There is no nonsense about substituting the word "cinq" for "five" or other rubbish. As a consequence subscribers prefer to use them for speaking over the Post Office trunk lines, for they yield better results than the Post Office transmitters over long as well as short distances; and there are not two opinions as to their superiority. All complications about extension lines vanish. The speaking is the same during the busy times as in the small hours of the morning. Operators are not overloaded. The municipal system is also very much cheaper, and permits of tariffs of from £5 to £6. 6s. per annum, without any restriction as to the number of talks, while still cheaper rates are provided for the smaller subscribers. And all at a profit! Why cannot the Post Office do likewise? That question should form one of the points for investigation by the inquiry I advocate—an inquiry which the municipalities would welcome, and from which the Post Office shrinks. If one of the Post Office exchanges in London, say the Central or Victoria, could be converted to the municipal system, a few days' experience would suffice to prevent the present one ever being reverted to, for the London subscribers, for the first time in their history, would learn what a good telephone is like.—Yours, etc, A. R. BENNETT.

TRANSFORMERS.

SIR,—The answers to Question No. 976, dealing with the theory of the current transformer, which appear in your issues of July 12 and 19 touch upon a very interesting subject, and one which has not been given much prominence in the technical Press On one point in particular, however, most of the writers are not, I think, very clear. The magnetising current is considered to consist of two components at right angles—one a component in phase with the primary current, which takes care of the iron losses, and the other a component at right angles to the primary current. This way of looking at things is quite correct when dealing with ordinary transformers, where the primary circuit is connected to a constant potential, but in the case under consideration the effect of the iron losses is simply to cause a small current to flow in the primary circuit, which is in phase with the supply voltage. In most cases this component will not be in phase with the primary current—only so when the power factor of the circuit is unity.

In other words, given that we have a definite current flowing in a conductor, then if we introduce into the circuit a current transformer for the purpose of measuring this current, the value of the current will be altered by a very small amount due to the iron losses and dependent on the phase relation of the primary current to the supply voltage. The magnetising ampere-turns are now simply the resultant of the primary and secondary ampere-turns. Therefore, we see that the error due to the iron losses is simply that due to the variation effected in the line current, just as in a direct-current circuit the introduction of an ammeter produces a slight alteration in the current to be measured. However, with a well-designed transformer such that the maximum flux density is probably less than 1,000 lines per square centimetre, the iron losses may be neglected entirely.

Most of the writers lay stress on the contention that serious errors are produced by slight variations in secondary resistance and inductance. With a well-designed transformer the introduction of, say, 10 times the secondary winding resistance into the secondary circuit will not produce appreciable errors. This means that varying the capacity of the instruments as necessitated by ordinary circumstances, will not have any serious effect on the accuracy.

As to the question of inductance in the secondary circuit, the popular conception is that this should be kept as small as possible. It can be shown mathematically, however, that when a transformer is used with a wattmeter—*i.e.*, the phase displacement between primary and secondary currents is of great importance, particularly so at low power factors—*a large inductance in the secondary circuit is a distinct advantage*, notwithstanding that it causes a slight increase in the magnetising current. The reason is that for low power factors the limiting factor of accuracy is the displacement between the primary and secondary currents, and increasing the secondary inductance has the effect of bringing the two currents more nearly 180deg. apart, thus materially improving the accuracy of the wattmeter reading.—Yours, etc., A. P. YOUNG.

Lynn, Mass.

AN INTERESTING EXPERIMENT.

The difficulty of obtaining a satisfactory load factor has been most discouraging in the case of some of the power supply stations established in this country. True this difficulty might have been foreseen, since the supply of the relatively small amount of current for lighting by these concerns coincides with the motor load, the supply of energy in bulk to a few local authorities for general purposes not having balanced matters to any great extent. Having regard to these circumstances, we have pleasure in reporting an interesting experiment in connection with the first large carbide of calcium factory to be erected in England by "The British Carbide Factories, Limited." This factory will represent an attempt on a large scale to utilise the surplus load of a large power station (in this case that of the Yorkshire Electric Power Company), or, in other words, to fill up the valleys in the load charts of the station, the only means, it is said, of securing, in this country, current at a low enough price to enable the competition with Continental waterfalls to be met. We understand that the initial factory will be equipped with plant for about 2,500 e.b.p., and will be run on a new system patented by Mr. Charles Bingham, of 11, Queen Victoria-street, E C., which will enable the power station to supply the factory with energy varying in amount, as the exigencies of the general demand may require, between a minimum of 350 kw. and the maximum capacity of the furnaces. Thus during the two hours of peak load the power station will be enabled practically to cut off the supply to the carbide factory entirely, if desired, while the arrangements permit of the load being varied from minute to minute as desired by the power company. The entire plant, machinery, etc., of this factory will be of British manufacture, the undertaking will be under British management, while the raw materials will be drawn from the immediate vicinity of the factory itself. It is expected that the plant will commence working about four months hence, when we hope to obtain further details. Meanwhile much is left to surmise. We know how the load on a traction plant may be maintained at a practically constant value by employing a battery of accumulators in conjunction with a Highfield booster, the battery taking current from or yielding current to the line as required. The carbide factory, too, will absorb the energy not required at the moment elsewhere, but here the analogy ceases, since no return can be made to tide over the peak. With this difference the particulars to hand suggest an arrangement whereby, as the general demand for energy increases, the supply to the carbide factory may be temporarily reduced at any time in corresponding measure to meet it. The possibility thus revealed of obtaining an auxiliary load of the accommodating character described is of considerable importance to the power companies concerned, and we shall watch developments with great interest.

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ON THE PUPIN MODE OF WORKING TRUNK TELEPHONE LINES.*

BY SIR WILLIAM PREECE, K.C.B., F.R.S.

In 1896 I read a paper before Section A at Liverpool on "Electric Disturbances in Submarine Cables," in which I dealt with the subject of long-distance speaking by telephone. I pointed out that disturbances were due to energy being in the wrong place. An alternating-current wave, set up in a telephone transmitter by a complete sonorous vibration impressed on the diaphragm, flowing for the period *a g* (Fig. 1), if its voltage were indicated by *a b* when *positive* and by *d e* when *negative*, it would possess in one received wave an energy proportional to the area bounded by *a b c e f g*, if it were wholly utilised, but would only describe the area *a a' d d' g* if the unshaded portion of the figure were proportional to the energy radiated or leaked away, absorbed as a charge or dissipated as heat. The attenuated current thus indicated shows what radiation, leakage, capacity, hysteresis, and resistance may do to absorb energy and deteriorate the clearness and loudness of speech as well as limit the distance to which ordinary speaking is practical. I had previously,† in 1887, pointed out that the product of the capacity, K, and the resistance, R, gave a law which approximately indicated the distance to which speech was possible on telephone circuits. It accurately indicates the distance on single-wire submarine cables. In 1890 I read a paper giving the calculations on which the London-Paris telephone line, with its cross-channel cable, was designed and constructed in association with the French engineers. In 1892 it was determined to establish trunk telephone wires between the great commercial centres of Great Britain.

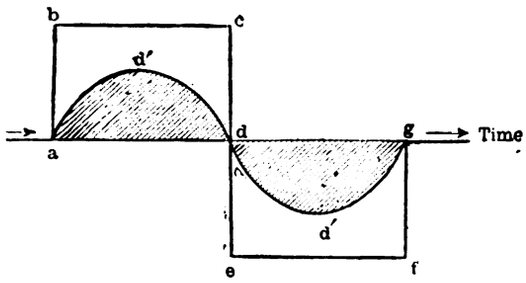

FIG. 1.

All the calculations were based on the K R law. It is quite certain that this law is not absolutely true, for it neglects the factor of self-induction. The K R law is properly of the order K R/L, but experience has shown that inductance on short metallic loops is so small that it may be neglected. Mutual inductance between the two capacity wires compensates to some extent the self-induction in each wire. In long underground cables and long aerial wires, however, the influence of inductance becomes evident as the length of lines increase. On the other hand, capacity also increases owing to the variation of the mutual (wire to wire) capacity and the capacity of each wire to earth, which becomes an important factor with concentric cables or with any departure from symmetry. This is why "Hughes's twist" is so valuable and so superior to the "Cross" system so general in America. It not only completely prevents "cross-talk," but it secures a constant capacity with earth. It is known that the effect of this electromagnetic induction is beneficial in one sense, as I pointed out in 1896, and it has been made more beneficial in another sense by Prof. Pupin (1899), who has shown how we can reduce the weight of copper used on trunk lines and also how we can extend the distance to which ordinary speech is practical.

Pupin's system is not so much the neutralisation of the effects of electrostatic capacity by those of electromagnetic inductance as a system of hastening the discharge of pent-up energy without additional loss by breaking it up into many successive steps. In a long submarine cable discharge is a slow process, and all in one operation. The K R is great and the frequency small. In a "loaded" line it is much more rapid, for it is performed simultaneously in several successive stages of much shorter length and with much less waste or distortion. The factors of energy, E and Q, are pent up by capacity and inductance. Energy is wasted by resistance, leakage, induction, radiation, reflection, and interference. This waste of energy means diminution of amplitude, attenuation of wave volume, and loss of speech; while electromagnetic induction improperly placed means distortion of wave-form, external disturbances, and loss of articulation. The factors that are involved in the problem of long-distance speech are so numerous and so diverse that all attempts to solve them by mathematics, except on very general grounds, have proved fruitless and only approximately true. It has been only by practical experiment that success has been attained. The defect in the mathematical investigation of the problem appears to be the neglect of the prime and principal factor, *energy*, and the assumption that there is in Nature something analogous to *negative* energy. Energy, like matter, is always positive and it cannot be annihilated by a negative sign. But mathematical reasoning undoubtedly guided Prof. Pupin in going as far as he has. Our president, Prof. Silvanus Thompson, took out a patent on Dec. 21, 1891, No. 22,304, where he very carefully considered the subject and very nearly anticipated Pupin.

The establishment of the telephone trunk system in Great Britain in 1896 showed the practical value of the K R law in determining the construction of an aerial system. The weight of copper used in the main trunk lines has been criticised, but the only fault committed was that I did not specify enough. Paris can speak with Liverpool, Manchester, and Hull, but it cannot do so commercially with Glasgow and Edinburgh. London can speak with Aberdeen, Inverness, and Dublin, but not with Cork. Pupin coils have not been applied permanently to the Post Office trunk lines, but careful experiments have been made to feel the way to do so, and thus, perhaps, extend the range of Paris talks in Great Britain.

I designed a new form of cable and described it in my paper read before Section A in Liverpool in 1896, but no one has as yet ventured to test its merits. A cable designed by Mr. Willoughby Smith of four wires symmetrically twisted on the inside of a guttapercha tube so as to leave an air space, failed telephonically from imperfect symmetry. It was laid across the Irish Channel, from Nevin to Newcastle. Concentric underground guttapercha-covered cables were laid in 1895 from the General Post Office to Nine Elms, and failed also from want of symmetry in the capacities between the conductors and earth. A magnificent underground trunk line for telegraphic purposes was commenced between London and Birmingham in 1897, but it was not completed while I was in office (I retired in 1899), and owing to its success it has now been extended, or is being extended, to Manchester, Liverpool, Leeds, and Glasgow in the north, and to Plymouth and Dover in the south.

In 1899 Pupin proposed his coils, and by the enterprise of the American Bell Telephone Company and its allies great progress has been made in the States in developing the system. Many very valuable experiments have been carried out in Great Britain by the Post Office and by the National Telephone Company. It speaks well for the technical spirit of the age that splendidly-equipped experimental laboratories have been established in London at the General Post Office, National Telephone Company's central station, the Eastern Telegraph Company's headquarters, Electra House, and in New York and Boston, in America, by the American Bell Telephone Companies. Very satisfactory advances have been made in Great Britain, and excellent reports of progress have been published by the Institution of Electrical Engineers in London. An admirable paper on "Telephonic Transmission Measurements," by B. S. Cohen and G. M. Shepherd, was read before this institution on May 9 last, which elicited an excellent discussion. I purpose to report the results of a careful inspection I made in New York in April last of the very successful work done in this direction by the New York Telephone Company under the able direction of their chief engineer, Mr. John Carty.

The factors that enter into the problem of trunk-wire

* Paper read before the British Association at Leicester.

† On the "Limiting Distance of Speech by Telephone," *Proc. Royal Society*, vol. xlii., Feb. 17, 1887.

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working are very numerous and complicated. They are *physical*, *commercial*, and *personal*. It is, as I have said, not a question of mathematics, but of experiment. What are the factors in long-distance speaking, in addition to the ordinary elements of electrical energy—viz. E M F., resistance, capacity inductance, current, and time?

1. Eddy-current heat losses in diaphragms.
2. Hysteresis in coils, cores, and circuits.
3. Change of wave shape due to storage and waste of energy in other forms.
4. Attenuation of waves due to dissipation of energy and its absorption.
5. Loss of the higher notes called "harmonics."
6. Reflection of waves from breaks and alterations in circuits.
7. Reduction of efficiency due to leakage, polarisation, radiation, and induction to neighbouring bodies.
8. The reactions and interferences of neighbouring circuits.
9. The constant change of every condition of circuit elements by switching through to different towns and subscribers.
10. The variable formation of the human mouth, tongue, and teeth of different users.
11. Defects of articulation and want of experience in handling the apparatus by the users.
12. The inefficiency of hearing and interpretation of the listener, and the absence of silence about him.
13. The absence of telephonic education in both speaker and listener.

The remedies are self-education, selection of proper apparatus, symmetry of circuits, the proper distribution of the controlling factors, the restoration of stored-up energy, the alliance and mutual forbearance of users and suppliers. It is clear from this incomplete enumeration of the factors involved that the problem of the reproduction of clear speech at a variable distance is a very complicated one. It has been solved by very patient plodding, by incessant experiment, and by judicious compromise. The K R law as applied to submarine cables is very useful for calculating the speed of working, but inasmuch as trunk telephone circuits are aerial and telephonic currents alternating and very variable in form, self and mutual induction must play an important part in their propagation. It was found, however, by experiment that metallic circuits of copper wire suspended in air and constant in character were actually benefited by self-induction. Hence in designing the trunk system of the Post Office in 1891, inductance* was neglected.

Ever since Faraday in 1853, while I was assisting him in his experiments, detected two waves in the underground conductors between London and Liverpool, I have regarded the propagation of intermittent electric currents, whether alternating or direct, in ordinary insulated conductors to be in the form of waves. Cromwell Varley in 1870 made an artificial cable equivalent to one of 12,000 miles long, and showed in evidence 10 distinct currents in it flowing at the same time. I experimented in 1876 at the Silvertown Works on an artificial cable constructed for Mr Stearn to duplex the Atlantic cable, and obtained evidence of several distinct waves present at the same time with beautiful effects of interference in duplex working. These were waves of energy in its electric form propagated with comparatively slow and variable velocity. Hertzian waves, developed in 1887, are disturbances of the æther of very high frequency, of the order of millions per second, having the velocity of light—viz., 186,000 miles per second. Telephonic oscillations in insulated copper conductors are of the order of hundreds per second, having a variable velocity of the order of 1,000 miles per second. The length of a telephonic wave may be from 1 to 100 miles, but that of a Hertzian one may be from 1ft. to 10,000ft. Prof. Pupin in 1900 established the existence of these waves in telephonic circuits, and measured their lengths, their form, and their damping. He has reached a practical stage, and has been the means of creating a very great advance in the economic development of long-distance telephony.

Between the voice of the sender at one end and the sensation of hearing at the other end the energy passes through several forms—acoustic, thermic, electric, magnetic, kinetic, and potential. The relations of these changes are very varied and complicated. The elements of energy in its electric form are coulombs, Q, and volts, E. Currents are coulombs per second. Thus time is an essential element, and the frequency of waves, and, therefore, their length, is a dominant factor in the solution of the question. When electrical energy is transmitted by an insulated metallic circuit like a telephone line we must first consider the capacity, K, resistance, R, and inductance, L, of the circuit. The capacity, K, depends on its form, its length, the dielectric coating, and the surrounding medium. The resistance, R, depends on the metal used, its form and its mass. Copper is universally used for telephonic transmission The influence of inductance, L, depends on the electromagnetic conditions present in the field, on the form of conductor, and on the direction and rate of change of the currents The capacity absorbs energy. It holds up a certain portion of the quantity of the charge, tending to attenuate the current but ready to restore it in reaction. The insulating medium gets warm by hysteresis. The resistance which has to be overcome absorbs a portion of the energy, which takes the form of heat and is lost. The Pupin coil stores up another portion of the energy, which, like a spring under pressure, is ready to react on the release of the forced condition and is restored. The frequency within the region of ordinary speech, which may be said to have from 800 to 1,200 sonorous vibrations per second, is not changed, but as distance increases the fine harmonics which give the individual quality or *timbre* of voice disappear, and only the low fundamental tones remain. Thus the length of a circuit allowing a practical talk is limited by the amount of capacity and resistance present. It is increased by the presence of induction when this induction is put in the right place and is of the right character and amount. It is aided by the human ear, which has a magical gift for interpreting into speech what appear to be the merest phantoms of sonorous vibrations.

(To be continued.)

* Inductance is the coefficient of mutual and self-induction. It is indicated by M or L, and is really a length measured in centimetres.

THE USE OF TRANSFORMERS AS ADJUSTABLE RESISTANCES.*

Voltage regulation in a direct-current circuit may be carried out by means of adjustable resistances, whilst with alternating currents there is the choice of non-inductive resistances or adjustable choking coils. When resistances are used (non-inductive regulation) to reduce the voltage from E to E' with a current J, a loss of (E – E') J watts takes place. With choking coils the regulation theoretically involves no loss, and in practice the loss (due to the winding and the iron core) can be kept very low. In spite of the greater efficiency, however, there are cases for which the use of choking coils is not permissible. For mains charging purposes, for instance, in which a circuit, such as a long cable containing considerable capacity is to be gradually switched on to a high-voltage supply, choking coils are out of place. The use of a choking coil whose inductance is gradually varied from a high value to a low one would be almost certain to produce resonance conditions—*i.e.*, equality of the inductive and capacity equivalent resistances—at some point, and so actually encourage the occurrence of the voltage rises for whose prevention the regulator is introduced. For this purpose, therefore, non-inductive regulation must be employed, and if the handling of apparatus in the high-tension circuit is to be avoided, a transformer connected as in Fig. 1 and whose secondary is gradually short-circuited by a liquid or other resistance may advantageously be employed. For double-pole charging—such as is necessary in the case of concentric mains—the modification shown in Fig. 2 is suitable. The

* Dr. G. Benischke in *E. K. und B.*, July 24, 1907.

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action of such apparatus depends on the fact that the primary of a transformer behaves like a choking coil, with an impedance which falls as the secondary load is increased, so that more current is allowed to pass to the mains and less voltage drop occurs across the primary as the secondary circuit is reduced in resistance.

The maximum choking action occurs when the secondary is on open circuit, and the minimum when the secondary is short-circuited--the voltage across the primary in the latter case being the short-circuited voltage of the transformer, which is only a small fraction of the open-circuit primary voltage. The distinct advantage of this method over choking-coil regulation lies in the fact that whereas with the latter the ohmic resistance remains constant and only the inductive resistance varies, with the transformer both resistances vary simultaneously, and it is possible to alter the amount of variation of each by altering the nature of the secondary load. Further, the ohmic resistance of a choking coil is comparatively small, whilst the corresponding equivalent ohmic resistance of the transformer, both on open circuit and with a non-inductive secondary load, is large compared with its inductive resistance. By never actually opening the secondary circuit, and by closing the maximum secondary resistance correctly, it is, therefore, possible to ensure that the resonance conditions cannot occur.

Consider the case of a five kilovolt-ampere transformer having a no-load loss of 100 watts, and used to charge a cable taking a capacity current of two amperes at 10,000 volts. If the maximum value of the secondary liquid

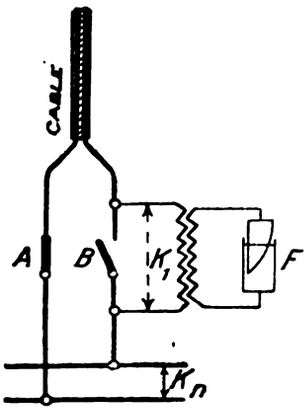

FIG. 1.

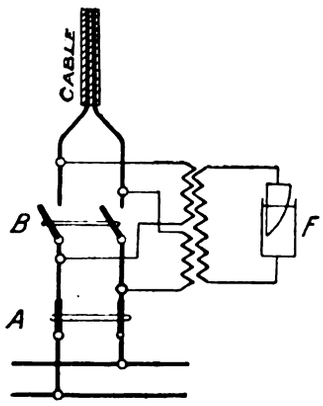

FIG. 2.

resistance is adjusted so as to put a load of 900 watts on the transformer, the current taken by the combination on first switching on will be ·102 ampere. The equivalent ohmic resistance will be $\frac{1,000}{(\cdot 102)^2} = 96,300$ ohms, and the equivalent reactance ($= 2\pi \sim \times$ equivalent inductance) is equal to $\sqrt{\left(\frac{10,000}{\cdot 102}\right)^2 - (96,300)^2} = 19,200$ ohms.

The equivalent ohmic resistance is so large that even with resonance a current of only ·1 to ·2 ampere would enter the cable, and the voltage would remain below the normal. As the liquid resistance is reduced the ratio of ohmic to inductive resistance becomes still greater, and the power factor of the transformer becomes more and more nearly 1. As the short-circuit condition is approached the leakage of the transformer affects the action and the power factor fills again. The equivalent inductance is, however, so small at this point that no fear of resonance exists.

When the liquid resistance has been short-circuited, the switch, B, can be closed without any appreciable increase in the voltage applied to the cable. On the other hand, there is also no danger to the transformer through short-circuiting it, because the primary is in series with the cable capacity across the full voltage.

Only one such transformer is required in a station if suitable change-over switches for the different cables are provided. When disconnecting cables from the 'bus bars the operation is reversed, the secondary being first short-circuited at F, the switch, B, opened, the resistance, F, increased, and, finally, the cable disconnected at A.

NOTE ON AN OSCILLOGRAPHIC STUDY OF LOW-FREQUENCY OSCILLATING ARCS.*

BY J. T. MORRIS, M.I.E.E.

(*Concluded from page 201.*)

DUDDELL ARCS.

Comparative experiments in air and coal gas were attempted of the Duddell arrangement of an arc (shunting a direct-current arc with a capacity in series with an inductance) with copper positive and carbon negative electrodes. Figs. 14, 15, and 16 are typical oscillograms obtained for coal gas. The collected comparative results of the voltage and the various currents are given in Figs 17 and 18, below which are also given the watt curves.

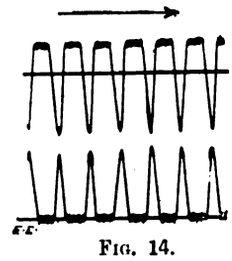

FIG. 14.

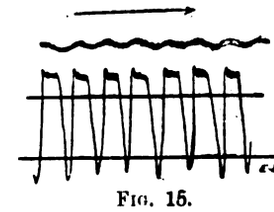

FIG. 15.

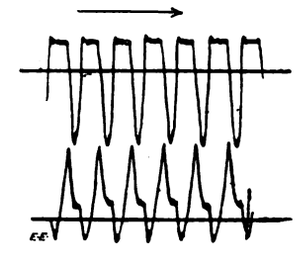

FIG. 16.

A refers to quantities in the capacity inductance circuit, B to quantities in the arc itself, and C to those of the main circuit, D being the voltage on the circuit. The above-mentioned effect will again be noticed (due to the introduction of coal gas), a higher value being attained by the voltage before the current rushes through the arc.

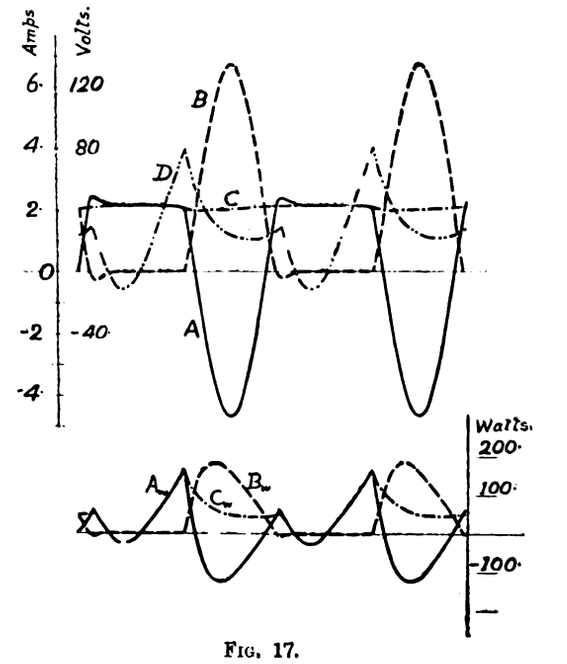

FIG. 17.

Further, it will be seen that the current in the arc itself is practically zero for half a cycle.

PRODUCTION OF REGULAR PULSATIONS IN DIRECT-CURRENT ARC BY MEANS OF A MAGNETIC FIELD.

For a long time past it has been known that when a direct-current arc is suddenly extinguished by the application of a transverse magnetic field, that it goes out with

* Paper read before the British Association at Leicester.

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what may be called an abrupt shriek or wail. This fact suggested to the author that the current through the arc was pulsating, and so, after some preliminary experiments, the following arrangement was devised. The previous

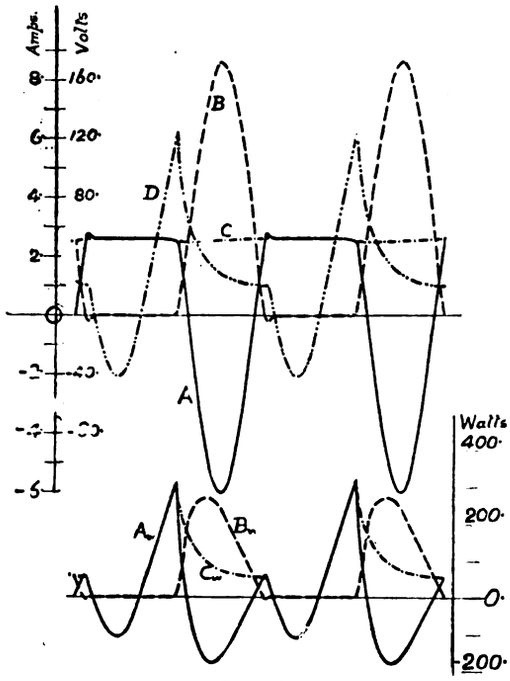

FIG. 18.

horizontal arrangement of carbons was used, but in this case the carbons were bevelled on their upper sides at their extremities, so that the projection of each carbon in a vertical plane formed an angle of 40deg. from the horizontal.

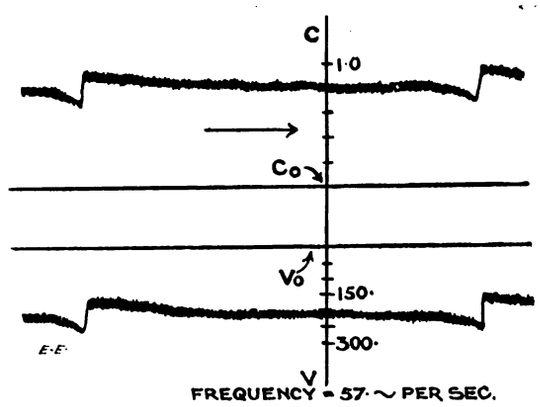

FIG. 19.

When an arc was struck between these at a pressure of 480 volts direct current, having a non-inductive resistance in series, the current through the arc pulsated with a frequency which was higher the stronger the magnetic

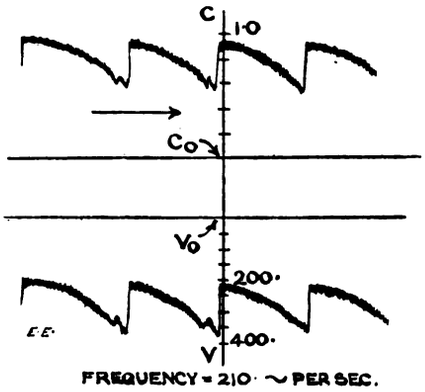

FIG. 20.

field in which it was burning. Oscillograms of the oscillations are given in Figs. 19, 20, 21, and 22 for approximate field strengths of B = 80, 120, 300, and 800 respectively, the frequencies produced being 57, 210, 1,800, and 4,300. These show a rapid rise in frequency with increase of field intensity.

Possibly, by correctly adjusting the field, this action might be made use of to intensify the oscillation produced in an oscillatory circuit connected to it, but these experiments must only be regarded as preliminary. It should be noted that, as far as the evidence in the author's experiments goes, it was not possible to preserve oscillations of constant frequency for more than half a minute at a time.

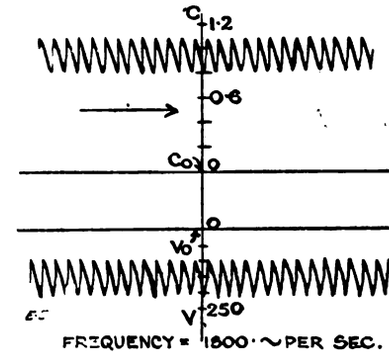

FIG. 21.

An examination of the arc showed that on the positive pole the arc formed a number of separate glowing *spots* in a vertical plane, while the negative electrode had a much shorter but continuously bright *line*. This effect reversed when both poles and field were reversed.

It would appear that the production of these oscillations can be explained simply if one considers the tendency of the arc to shorten, together with the fact that a curved arc in the magnetic field will require a greater voltage for the same current than a straight arc. It is conceivable that in some forms of circuit breakers having magnetic fields which blow out the arc that this oscillatory action might be

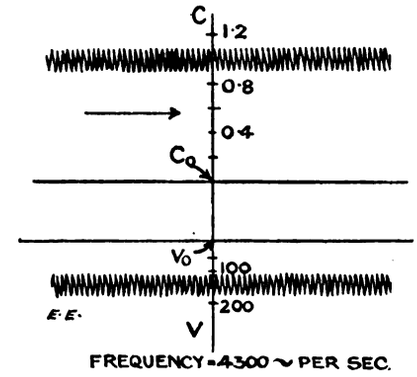

FIG. 22.

distinctly dangerous, should the strength of the magnetic field not be properly proportioned.

The author cannot conclude without expressing his sincere thanks to Mr. A. G. Warren—a senior student of the East London College—for the valuable and painstaking assistance he has rendered in connection with these experiments.

THE DISTRIBUTION OF RADIUM IN THE ROCKS OF THE SIMPLON TUNNEL.*

BY PROF. J. JOLY, SC.D., F.R.S.

The principal classes of material which enter into the composition of the massif of the Simplon are: (*a*) the Jura-Trias sediments, lithologically often much alike and much interfolded; (*b*) the Palæozoic crystalline schists; and (*c*) the gneiss of Monte Leone and the Antigorio gneiss, both stated to be of Archæan age. These rocks throughout contain radium, and for the most part in quantities much above what hitherto has been ascribed to sedimentary or igneous rocks.

Some 36 typical samples, taken from various points in the tunnel, have been examined. The poorest in radium are certain anhydrite rocks. Certain amphibolite schists

* Abstract of paper read before the British Association at Leicester.

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go very high. The Antigorio gneiss rises from $10{\cdot}5 \times 10^{-12}$ and 8×10^{-12} grammes radium per gramme of rock at the Italian entrance to $23{\cdot}7 \times 10^{-12}$ at 4,000m. inwards. Some of the Archæan gneisses yielded very high results.

Such quantities of radium if generally distributed throughout the rocks of the massif would be sufficient to disturb any forecast of the temperature which under normal conditions would be encountered at the level of the tunnel. It is suggested that the radium was, in fact, the source of the discrepancy between the predicted and the observed rock temperatures.

As it is improbable that these results are unique and apply only to this particular sedimentary accumulation and locality, they appear to point to hitherto unsuspected quantities of radium (and its parent elements) in the immediate surface materials of the earth. It seems impossible to avoid the conclusion that these elements were precipitated along with the sediments entering into the composition of the massif. The question then arises whether the accumulation of such quantities of radioactive elements may not enter as a factor in the events attending mountain building. It can be shown that an area of sedimentation whereon has been accumulated some 10,000m. of sediments, having a richness in radium comparable with the Simplon rocks, must necessarily become an area of greatly lessened crust rigidity, and would hence become the probable site of crust flexure under tangential compressive stress.

Further investigation will be required before such views can be generalised and the importance of radium as a source of instability of the earth's crust be determined. Apart from any speculations as to the influence of radium as the cause of an energetic substratum, the shifting of radium and its parent elements by denudation must be regarded as a convection of thermal energy, and this convection, if the quantities involved are sufficient, must, under the conditions referred to above and the unceasing action of denudation, become rhythmic in operation, and at the same time must result in shifting the areas of high temperature and crust weakness from age to age as the site of sedimentary accumulation changes.

NEW TRAMWAYS AND ELECTRIC SUPPLY OFFICES AT LIVERPOOL.

A work which gives an aspect of completeness to the extensive municipal departments at Liverpool which deal with the production and supply of electricity for power and lighting uses and the electrical tramways of the city has just been carried to a satisfactory issue. This has been the completing and opening of a building which has been erected to form the city headquarters for administrative purposes of the electric supply and tramway departments. The building in question, which is spoken of in Liverpool as the new Corporation tramway offices, is situated on the east side of Hatton-garden. The foundation stone was laid in September, 1905, by Sir Charles Petrie, chairman of the Tramways and Electric Power and Lighting Committee, and the work of erection proceeded steadily thereafter, the basement work being done by William Tomkinson and Sons, and that of the superstructure by William Thornton and Sons, Liverpool. The cost of the building will have been in round figures £50,000, and of furnishing about £6,000.

The elevation, which faces Hatton-garden, is 183ft. 10in. long, and the structure extends backwards to a street known as Johnson-street, the depth averaging about 90ft. The building is five storeys in height, and the construction throughout is fireproof. Steel has been largely used to afford support and framing for the building, the upper structure being carried by steel columns fixed in the basement. The roof is supported by steel principals fixed on the Mansard plan, a large area for storage being secured by this means. The elevation is of red pressed bricks as regards the main body of the structure, but light-coloured stone has been used liberally for window dressings, copings, and ornamentation. Inside, the plan of construction adopted was that of having a main central corridor on each floor, the offices and rooms lying on each side and at each end of the corridors. Two electric lifts to carry 15cwt. and a hydraulic lift to carry one ton have been provided, the hydraulic lift being for boxes and heavy goods lowered or raised from a yard at the north end of the building to or from the basement; one of the electric lifts being for the conveyance of goods between the basement and the third floor, and the other serving as the passenger lift between the basement and the fourth floor. The lifts were furnished by the Easton Lift Company, London. The main features of the building internally are the size and lightness of the rooms, the lightness of corridors and passages, and the air of cheerfulness which prevails everywhere. An unusually large provision of windows has been made, and the greater part of the wall areas in the corridors have been faced with white glazed tiles of a size resembling bricks. A dado of ornamental tiles of a light-green colour, or a single line of such tiles suggesting a dado, has been used in the corridors. The ceilings of the corridors are vaulted, the vaulting being faced with fibrous plaster. The rooms on the first floor have been set apart for the use of the electric supply department. The remainder of the building is devoted to the uses of the tramway department, for which, as will be seen hereafter, a large amount of accommodation is now required. To note, briefly, the provision made for the work of this department, it may be stated that the basement of the building contains a large and light room which has been set apart for the accommodation of boys engaged in "point duty"—moving the points at junctions on the tramways. Another large room will be used as a workshop for the fitting and repairing of overhead equipment for the tramways. Other rooms will be available for store or workshop uses, and in one room the heating apparatus for the entire building is located.

The main entrance to the building is in Hatton-garden, and is almost central. On entering, a commodious inquiry office lies on the right hand. On this floor also are situated a number of rooms for special purposes in connection with the daily work of the tramways. Two rooms will be used for interviewing applicants for positions in the service. One room will be used by inspectors. Another room is known as the "record room." Here a record of each employé will be kept, on a plan which will admit of ready reference. A large room at the rear, specially fitted, forms the lost property department, which now fulfils an important service in connection with the tramways, a constant and extensive business being done in receiving, booking, storing, submitting and returning articles of property left in tramcars by passengers. The cash received from the entire system of the tramways will be dealt with in commodious rooms on the ground floor. Twice a day cash will be brought in from the districts, and will be counted, booked, and sent to the bank, or placed in a large safe in the basement. This work, and the very elaborate work of checking the returns of the different conductors on the cars; the receiving, booking, and opening of the punches as brought in by the men; the counting of the small circular pieces of cardboard which are cut out of the tickets when punched, and which remain in the punch; the receiving, classifying, giving out, booking, and re-booking of new supplies of tickets, is done by a large staff of young women.

On the second floor a commodious room has been set apart for the traffic manager, Mr. Charles W. Mallins, A.I.E.E. A feature of this room is a large map of Liverpool—a "skeleton plan showing stopping places for Corporation tramway routes"—which occupies much of the wall area at one end of the room. On the manager's desk are four telephones—one communicating with the Liverpool central telephone exchange, one establishing a private-wire communication between members of the Liverpool City Council and the office of the tramways manager, one communicating with the resident engineer, and one representing the house departmental telephone system, communicating with 15 rooms in the building. A telephone plug-board having 50 lines has been installed in one of the smaller rooms of the building on the ground floor. An operator is continually in charge of this plug-board, and connections are made through it with the central telephone exchange, Liverpool, or with the different departments in the building, as

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stated. Adjoining the manager's room is a spacious "anteroom," the walls of which are largely covered with maps of considerable size relating to the tramways in the city. The offices of the general assistant (Mr. E. A. Smith), the chief clerk (Mr W. R. Meikle), and the general traffic assistant (Mr. E. T Pugh) are adjacent to these rooms, while on the same floor are an extensive drawing-room for the preparation and storing of plans, a stationery storeroom, the depôt box and ticket storerooms, the punching and statistical departments, and other offices.

On the third floor the wages department and typists' rooms are located. On this floor, too, an important branch of the service (the tailoring branch) occupies a range of commodious rooms. In one room a staff of tailors is maintained making and repairing uniform clothing. In another large room coats, after being repaired, are carefully numbered and then stored on shelves. In one room, known as the "master tailor's room," the cloth used in making and repairing top coats and uniforms is subjected to a crucial examination and testing, being tested for strength, warp, and weft by a Goodbrand tester.

With respect to the allocation of the rooms of the electrical department on the first floor, it may be stated that here is to be found the offices of Mr. Alfred Clough, A.M.I.E.E., resident electrical engineer. A large and well-lighted general office adjoins Mr. Clough's room; then come the book-keeping department—general and in connection with the mains—the testing-rooms, and the chief clerk's, estimating, and outside foremen's offices. An extensive drawing office, which is provided with a capacious wall-case in which the plans belonging to the department are conveniently stored, is one of the more important rooms on this floor. The method of storing the plans is especially worthy of note. Each sheet is rolled up and clearly marked, and is set on end in a light rack fixed in the wall-case. If a plan be required, all that is necessary is to ascertain the number of the plan wanted, and then to lift from the rack in the case the plan bearing the number required. On the uppermost floor a room has been set apart for photographing and printing plans and for storing goods used in the electrical supply department. In speaking of this electrical department, it may be mentioned that the building throughout is provided with the electric light, 16-c.p. lamps being chiefly used, all at a pressure of 230 volts. The ordinary plan of office wiring was adopted, grooved casing being used on the straight run and the wires being placed in short lengths of lead pipe where carried through floors or walls. The installation of the electric light was carried out by the staff of the department.

The yard has been provided with a double track, connected with the main tramway track in Hatton-garden, and with a length of overhead trolley wire to admit of special-service cars containing boxes of money, books, or stores being brought into the yard and set by the hydraulic hoist for unloading or for loading under the ordinary working voltage of the tramways. The yard is covered with a roof having a large central skylight, the roof being supported by cross girders and light steel principals. The steelwork for the building was supplied by Richard Moreland and Son, Limited, London. The entire work of construction was done under the supervision of Mr. Thomas Shelmerdine, Corporation surveyor.

The new Liverpool tramway offices above described were formally opened on Friday, Aug. 2, the event being made one of civic importance. Sir Charles Petrie, chairman of the Tramways and Electric Power and Lighting Committee, presided on the occasion. The formal declaration of the opening of the building was made by Alderman F. Smith, deputy-chairman of the committee. In the course of his speech on the event Alderman Smith spoke of the great progress which had been made in the tramways and electrical branches of the municipal service at Liverpool since these undertakings came into the hands of the Corporation. In 1897, he said, when the Corporation took over the tramways, the cars were running about 6,000,000 miles a year; in 1906 they travelled over 12,000,000. They carried in 1897 38,000,000 of people; to-day they carried 122 millions annually. The receipts in 1897 were £290,000; in 1906 they were £563,000. The committee had made contributions to the rates in the last five years amounting to £154,864. About 4,000 cars went over St. George's crossing in a tramway day of 20 hours; more than 4,000 crossed Paradise-street and Lord-street; 3,600 went along the Haymarket and Dale-street; and 3,700 by the town hall. But, said Alderman Smith, it was not for the tramways alone that building was erected. When the Corporation took over the electric lighting the capital expenditure was £468,000; in December last year it was £1,901,000. In 1897 the units of electricity sold were a little over 2,000,000; in 1906, 33,000,000 were sold. At the time of purchase the charge for lighting was 7½d. per unit and 5d. for power; now it was less than half that for lighting and only 1·63d, or a little over 1½d., per unit for power. In 1897 the motors in use were of 130 h.p., while now they were of 7,721 h.p. With regard to the capacity of their plant, at the time of the transfer to the Corporation it was of 4,000 h.p., the largest engine being one of 300 h.p. and running at 350 r.p.m. The plant had been increased to 60,000 h.p., and some of the engines made 1,500 r.p.m. Great had been the saving, not only by the decreased cost of lighting, but by contributions to the rates of £87,412. About 300 people would be housed as the tramway and electric lighting staffs in those new offices, but if the two enterprises went on progressing, as there was no doubt they would, many more employés would be required, and room for them had been provided in a light and airy building, in which the work could be carried on in a way that was desirable.

OPENINGS FOR CONTRACTORS.

ALVESCOT (OXON)—Private residence. Surveyors, Messrs. Smith and Marshall, Chippenham, Wilts.

ANNFIELD PLAIN—Hall at Dipton for the Annfield Plain Industrial Co-operative Society. Architect, Mr. G. T. Wilson, 22, Durham-road, Blackhill.

BURNLEY—Proposed plant extensions at electricity works (£10,000).

CAMBORNE—Residence for Mr. J. W. Lean. Architect, Mr. Sampson Hill, Green-lane, Redruth.

CELEBES (MALAY ARCHIPELAGO)—The Dutch Indies Government, Batavia, propose the construction of an electric tramway from Menado to Tondano.

CHORLEY—The Council have passed plans for a new cotton mill to be erected at Eccleston, near Chorley.

CLONMEL—Lighting district lunatic asylum. Mr. L. J. Lawless, 27, Castlewood-avenue, Rathmines, Dublin.

CROESFAEN—Residence for Dr. E. L. Davies. Architects, Messrs. Cook and Edwards, Masonic-buildings, Bridgend.

EDINBURGH—Industrial hall at Saughton Park for the Scottish Exhibition. Surveyors, Messrs. Alexander Hay and Co., 44, Castle-street, Edinburgh.

GLASGOW—New art school. Messrs. Honeyman, Keppie, and Mackintoch.

HITCHIN—Convalescent home at Benslow Hill (£9,000).

JAPAN—Electric tramway between Chofu and Shimoneseki proposed.

KINGSTON-ON-THAMES—Children's home for the Guardians. Clerk Mr. J. Edgell, Union Offices, Norbiton, Kingston-on-Thames.

LONDON—Chapel and classroom at South Tottenham. Architect, Mr. W. B. Rees, 3, Dumfries-place, Cardiff.

LONDON—Isolation hospital to be extended for the Wimbledon Town Council (£1,522).

MANCHESTER—Church. Architect, Mr. E. D. Lingen Barker, 2, Exchange-street, Manchester.

MANCHESTER—Infants' school and alteration to Southall-street municipal school. Cheetham Education Offices, Deansgate, Manchester.

NEWCASTLE-ON-TYNE—New school in Bolam-street (£17,160).

ORMSKIRK—Extension of infirmary for the Guardians (£5,835).

ROME—The Municipality are about to construct new electric tramways.

ROME—The Italian State Railways propose to install an electric crane at their sheds in Venice.

ROYTON—New spinning mill containing 60,000 ring spindles to be erected at Uppermill.

ST. AGNES—Bungalow. Architect, Mr. Sampson Hill, Redruth.

SCOTLAND—Erection of convalescent home at Edzell. Architect, Mr. J. Sim, Montrose.

SHEFFIELD—Extending Lodge Moor hospital for the City Council (£8,500).

SOUTH SHIELDS—Tramway extensions proposed (£13,000).

WAKEFIELD—For extending the Corporation electricity undertaking (£7,250).

WHITEHAVEN—Secondary school for the Cumberland Education Committee (£10,416). Contractors, Messrs. Hughes and Stirling, Bootle, Liverpool.

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COMPANIES' MEETINGS AND REPORTS.

LIVERPOOL OVERHEAD RAILWAY.

The directors' report states that for the half-year ended June 30, 1907, the gross revenue receipts amount to £38,246. 10s. 4d., and the working expenses to £30,035. 6s. 7d. The number of passengers carried was 5,423,595, compared with 5,533,553 during the previous half-year. The above figures show a decrease in the total number of passengers carried of 21,505, but the total receipts have increased £463, while the expenses have been reduced by £265. The through traffic to Southport and Aintree in connection with the Lancashire and Yorkshire Railway Co. continues to make slow but steady progress. The directors regret to have to report the retirement of Mr. Richard Hobson, who has rendered to the Company most valuable services, and who has acted as deputy-chairman ever since the formation of the Company. The following is a statement of the revenue account: receipts from passenger traffic amount to £37,234. 16s. 5d.; miscellaneous receipts and interest, £1,011. 13s. 11d.—£38,246. 10s. 4d.; less working expenses £30,035. 6s. 7d., £8,211. 3s. 9d.; deduct interest on mortgage debentures, and on calls paid in advance £4,339. 8s. 2d., £3,881. 15s. 7d.; add balance brought forward Dec. 31, 1906, £4,246. 9s. 6d.; leaving available for dividend, £8,128. 5s. 1d. Out of this balance the directors recommend the declaration of a dividend of 5 per cent. per annum on the preference shares (less income tax), leaving a balance of £4,452. 8s. 1d. to be carried forward to next half-year.

The half-yearly meeting was held on Wednesday at Liverpool, Sir William B. Forwood (the chairman) presiding.

The CHAIRMAN, in moving the adoption of the report, said that to meet the serious competition which had been forced upon the Company by the Liverpool Corporation tramways and the electrification of Lancashire and Yorkshire Co.'s Southport line, considerable reductions in the fares had been urged as the only way of maintaining their traffic. The directors were not wholly in sympathy with that policy, because there were peculiar conditions attaching to their railway which would prevent low fares proving an important inducement to additional travel. These views had proved to be in the main correct. They had to realise that the railway was a business line used by business men for business purposes, which would not be materially affected if the average fare were lowered. The 1d. fare had no special charm on their line, and its adoption would mean disaster to the Company. They, therefore, adopted a middle course, and tentatively lowered their fares to competitive points where they thought they might attract passengers. Their experience of low fares had not been unique. In London the underground railways, twopenny tubes, motor 'buses, and tramways had all been forced to the conclusion that the policy of 1d. fares can be carried too far, and the fares for locomotion throughout London were now in process of revision. There was a slight reduction in the working expenses.

The report was adopted.

ANGLO-ARGENTINE TRAMWAYS.

An extraordinary general meeting of the Anglo-Argentine Tramways Co. was held on Monday for the purpose of submitting for confirmation certain resolutions which were passed at a meeting of the Company on July 26 last with the object of carrying into effect a provisional agreement entered into with the Compagnie Général de Tramways de Buenos Ayres, dated July 13, 1907, having reference to the acquisition of the Buenos Ayres and Belgrano Electric Tramways Co.'s undertaking. Mr. J. B. Concanon, the chairman, moved the confirmation of the resolutions, which Mr. J. Heaton seconded. The resolution was carried unanimously.

LANARKSHIRE TRAMS.

The report of the Lanarkshire Tramways Co. for the half-year ended June 30 last states that the receipts amounted to £29,703 and the expenses to £16,051, less £621 payable to local authorities, £608 interest on debentures and £224 interest on loans, add balance brought forward, £882, leaving a balance of £13,081. The directors recommend a dividend at the rate of 5½ per cent. per annum and that £5,182 be carried to revenue new account. No provision for depreciation has been made in these accounts. The directors, as usual, propose to deal with this matter when the final accounts are made up at the end of the year.

CHATHAM AND DISTRICT LIGHT RAILWAYS.

The report of the Chatham and District Light Railways Co. for the half-year ended June 30 last states that the receipts amounted to £18,273 and the expenses to £12,941, less £222 written off as per revenue account and £1,196 interest on debentures, add balance brought forward, £578, leaving a balance of £4,492, which the directors recommend be carried forward. The Rochester Corporation are proceeding with their extension lines to Strood Hill, Frindsbury, and Borstal, and it is anticipated that these will be completed early next year and leased to the Company. No provision for depreciation has been made in these accounts. The directors propose to deal with this matter and the payment of dividends when the final accounts are made up at the end of the year.

METROPOLITAN DISTRICT RAILWAY.

The report of the Metropolitan District Railway Co. for the half-year ended June 30 last states that the expenditure on capital account has been £137 588. The gross receipts amounted to £220,628, being a decrease of £427 on the receipts for the corresponding half of 1906. The working expenses amount to £143,936, being a decrease of £22,976. After providing for rent charges, interest on debenture stock, and other charges, the net revenue account shows a deficit of £18,035. To this deficit must be added £10,156, being the Company's proportion of net revenue arising from the City Lines Joint Undertaking, which, although included in the net revenue account, is not available for payment of debenture interest, being specially appropriated to the payment of dividend on the 4 per cent. guaranteed stock. With the above-mentioned addition, the deficiency for the half-year chargeable to capital under the Company's statutory powers is £28,191. The dividend payable on the 4 per cent. guaranteed stock is at the rate of £1. 12s. 6d. per cent. per annum. The following table shows the working expenditure in comparison with the corresponding period of last year:

	Half-year ended June 30, 1907.		+ Increase or − decrease
Maintenance of way and works	£23,728	...	− £407
Maintenance of rolling-stock	21,190	...	− 2,454
Train working and traffic expenses (including joint stations), after deducting the balance of accounts for work done for and by other companies	66,414	...	− 17,480
Rates and taxes (including joint stations)	20,434	...	+ 434
Other items	12,170	...	− 3,069
Total	£143,936	...	− *£22,976

* Equal to 13·77 per cent.

The following table gives a summary of comparative figures for the first halves of the year 1906 and 1907:

	Half-year ended June 30, 1907.	+ Increase or − decrease	Or per cent.
Number of passengers, including workmen and season-ticket holders' journeys	25,426,825 ...	− 3,846,472 ...	13·14
Number of passengers carried at workmen's fares	4,683,100 ...	1,970,678 ...	29·62
Passengers' receipts	£202,099 ...	− £1,929 ...	·95
Average receipt per passenger	1·91d. ...	+ ·24d ...	14·37
Train mileage on District Railway	1,178,743 ...	− 20,826 ...	1·74
Car mileage on District Railway	5,248,529 ...	− 439,985 ...	7·73

Since the opening of the Whitechapel and Bow Railway in 1902 it has been customary in compiling the number of passengers carried on the District Railway to include passengers carried between stations on the Metropolitan Railway and on the Joint City Lines on the one hand and stations on the Whitechapel and Bow and the London, Tilbury, and Southend Railways on the other hand. Such passengers pass over an isolated piece of line at Whitechapel belonging to the District Railway, three chains in length, intervening between the Joint City Lines and the Whitechapel and Bow Railway. During the past half-year the number of passengers so carried have amounted to 4,873,660, and the District Co.'s share of the gross receipts arising from the same has amounted to £305. As the inclusion of these passengers tends to give a misleading impression as to the real volume of traffic, it has been thought better to exclude the above-mentioned figures in compiling the number of passengers carried during the past half-year, and the figures for the corresponding half of 1906 have been similarly adjusted. The directors regret that in consequence of the pressure of other business Mr. R. W. Perks, M.P., has resigned his seat on the Board.

FRISWELL (1906).

The report and balance sheet of Friswell (1906) for the year ending June 30 last states the balance at the credit of profit and loss account is £10,340. 19s. 7d. after deducting all directors' fees, managing director's salary and commission, manager's salary, income tax, depreciation of plant, machinery, and fixtures, and making provision for bad debts, and writing £909. 19s. 6d. off preliminary expenses. The interim dividends paid for the half-year ending Dec. 31 last absorbed £4,987. 10s., and there now remains a balance of £5,353. 9s. 7d. available for appropriation. The directors recommend the payment of a final dividend at the rate of 6 per cent. per annum, less tax, on the preference shares, and 10 per cent. per annum, less tax, on the ordinary shares (making 10 per cent. for the year), absorbing £4,987. 10s., leaving £365. 19s. 7d. to be carried forward to the next account.

NEW COMPANIES REGISTERED.

Contractors' Plant Association.—Registered Aug. 6. Capital, £1,000 in £1 shares. Objects: to buy, lease, advance on sale or exchange, instruments, plant, machinery, and appliances relating to the building and construction of railways, tramways, waterworks, etc., and to adopt an agreement between F. W. Sterry, C. Walker, and S. Harrison. No initial public issue. Registered office: 28, Bond street, Leeds.

MacTaggart, Scott, and Co., Limited.—Registered July 31 in Edinburgh. Capital, £10,000 in £1 shares. Objects: to acquire the business of MacTaggart, Scott, and Co., engineers, Station Ironworks, Loanhead, and to carry on the business of marine, electrical, hydraulic, mechanical, manufacturing, civil and mining engineers, boilermakers, iron and steel founders, shipbuilders, and iron and steel bridge builders, etc. Registered office: Station Ironworks, Loanhead, near Edinburgh.

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Scottish National Exhibition of Industry, Science, and Art, Edinburgh (1908).—Registered July 25 with 500 members, each liable for £1 in the event of winding up. Objects: to open and carry on in or near Edinburgh in 1908 an exhibition of engineering, inventions, manufactures, products, industries, or material resources of all nations. The word "limited" is omitted from the title by licence of the Board of Trade. Registered office: 45, York-place, Edinburgh.

Spagnoletti.—Registered Aug. 1. Capital, £20,000 in £1 shares. Objects: to acquire the business of an electrical and mechanical engineer and manufacturer carried on by J. E. Spagnoletti at Goldhawk Works, Goldhawk-road, Shepherd's Bush, as J. E. Spagnoletti and Co., and to adopt an agreement between J. E. Spagnoletti, H. M. Bayly, J. Lawrence, G. J. L. Nicholson, and W. E. Harrington, whereby the said J. E. Spagnoletti agrees to sell the said business to W. E. Harrington. No initial public issue. Registered office: Goldhawk Works, Goldhawk-road, Shepherd's Bush, W.

Edmundian Copper Mining Co., Limited.—Registered Aug. 7 by Julius and Thomas, 15, Finsbury-circus, E.C. Capital, £135,000 in £1 shares. Objects: to acquire freehold and other farms, lands, buildings, mines, concessions, leases, mining, water, and other rights, mineral and other properties, in Africa or elsewhere; to adopt an agreement with the Consolidated African Copper Trust, Limited; and to carry on the business of copper and general miners, prospectors, explorers, metallurgists, smelters and refiners of ores, metals, and minerals, etc. No initial public issue. Registered office: 8, Old Jewry, E.C.

Societe Anonyme des Accumulateurs A.C.S. (Systeme de Sedneff), Limited.—Registered Aug. 7 by Jessel and Lippens, 792, Salisbury House, E.C. Capital, £140,000 in £4 shares. Objects: to adopt an agreement between Cesar Trouin and Sigismond de Szepczynski of the one part and this company of the other part to undertake and execute contracts for works involving the use of machinery and supply thereof in connection with the use of electricity, and to carry on the business of manufacturers of electric accumulators, electrical plant and accessories thereto, engineers, etc. Registered office: 790-792, Salisbury House, E.C.

Chisholm Manufacturing Co., Limited.—Registered July 31. Capital, £10,000 in £1 shares. Objects: to acquire the business carried on by C. H. Williams and G. Chisholm at Birmingham, as the Chisholm Manufacturing Co.; to acquire patents granted to G. Chisholm—(1) No. 7,748 of 1904, for improvements in electric switches; (2) No. 16,216 of 1904, for improvement in portiere rods; (3) No. 10,727 of 1905, for improvements in plugs for sink wastes; and (4) No. 17,671 of 1905, for improvements in sanitary socket accessories—to develop and turn to account the same; and to carry on the business of brassfounders, electricians, manufacturers of electrical accessories, appliances, and machinery, etc. No initial public issue. Registered office: Providence Works, Fleet-street, Birmingham.

Liens Registered.

Lowne Electric Clock and Appliances Co., Limited, Catford, S.E.—Lien registered July 30 for a series of £1,000 debentures. Charged on the entire undertaking, present and future.

Hendon Electric Supply Co., Limited.—A trust deed dated July 30, 1907, to secure £25,000 (with power to issue further stock, the present instrument being stamped to cover £25,000) has been registered. Property charged: the company's undertaking and property, present and future, including uncalled capital. Trustees: Beaver Trust, Limited, 1, Queen Victoria-street, E.C.

Herbert Plumpton, Limited (Toolmakers, Warrington).—Issue on July 26 of a £850 5 per cent. debenture, part of series created Sept. 28, 1906, to secure £4,000, charged on the company's undertaking and property, present and future, including uncalled capital, subject to a mortgage on the leasehold property securing £750. No trustees. Total amount previously issued of same series, £2,350.

Birmingham Electrical Case Co., Limited.—A mortgage, dated July 26, 1907, to secure £125, and, as collateral security thereto, a debenture of even date for securing the same sum, charged on the company's undertaking and property, present and future, including uncalled capital, have been registered. Holders: W. O. Field, Downing-street, Smethwick, and W. L. Field, Birch-street, Langley, Worcs. (trustees of the Smethwick Mutual Aid Permanent Money Society).

Huinac Copper Mines, Limited.—A trust deed dated July 18, 1907, to secure £40,000 debentures has been registered. Property charged: specifically—the company's present, real, or immovable property in Peru; as a floating security—the whole of the company's undertaking and other assets, except unissued and uncalled capital, and any other assets acquired by means of such unissued and uncalled capital. Trustees: J. J. Keswick, Mabie, Dumfries, and H. M. Matheson, 22, Abchurch-lane, E.C.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Leghorn.—The Municipality invite tenders for electric lighting. Tenders by Sept. 21.

Vienna.—Tenders are invited for a central electric power station at Czernowitz for the Austrian State Railways. Tenders by Aug. 31.

Alcoy (Spain).—The Municipality invite tenders for lighting the town by electricity or gas. Particulars from the Ayuntamiento Constitucional. Tenders by Aug. 24.

Companario.—Tenders are invited for the electric lighting of the town for a period of 20 years. Particulars from the Ayuntamiento Constitucional. Tenders by Aug. 24.

Oystermouth.—The Urban District Council invite tenders for the installation of public and private electric lighting. Particulars from the District Surveyor, Mumbles, Glam.

Clacton.—The Urban District Council invite tenders for the supply of prepayment and ordinary direct-current ampere-hour meters. Tenders by Aug. 21. See advertisement.

Bexley.—The Urban District Council invite tenders for the supply of one 150-kw. tramway generator. Specification £1. 1s. Particulars from the Tramway Manager, Bexley, Kent.

Saint Gaudens (France).—Tenders are invited for overhead electrical equipment, pump, etc., for the waterworks. Particulars from the Deputy Mayor. Tenders by Aug. 22.

Llandudno.—Tenders are invited for the supply of a battery booster, switchboard, cables, etc., by the Llandudno Pier Co. Particulars from the Secretary. Tenders by Sept. 2.

Paris.—The Post and Telegraph Department invite tenders for the supply of switchboards for telephone exchanges. Particulars from 103, Rue de Grenelle, Paris. Tenders by Aug. 25.

Bourges (N. France).—Tenders are invited for the supply of one dynamo and two electromotors for the artillery depôt. Particulars from the Préfecture du Chéré. Tenders by Aug. 30.

Finchley.—The Urban District Council invite tenders for the supply of feeders, distributing mains, and other cables, network boxes, joint-boxes, etc. Tenders by Sept. 16. See advertisement.

Kettering.—The Urban District Council invite tenders for 315-kw. engine and dynamo set and pipe connections, also switchboard panel. Tenders by Aug. 28. See advertisement in last issue.

Brisbane.—The Postmaster-General invites tenders for the supply and delivery at Brisbane of four sections of a common battery switchboard and 650 subscribers' telephones to specification No. 145. Tenders by Sept. 2.

Dundee.—The Town Council invite tenders for the delivery of six electrical tramway car bodies. Specifications, etc., from Mr. Peter Fisher, general manager, Corporation Tramways, on deposit of 40s. Tenders by Aug. 21.

Grimsby.—Tenders are invited by the Corporation for the supply of one 500-kw. continuous-current dynamo coupled to a triple-expansion engine. Specification and particulars from the Borough Electrical Engineer. Tenders by Aug. 19.

Madrid.—Tenders are invited for the supply of materials to the new General Post Office. Estimate, 6,679,000 pesetas. Deposit, 5 per cent. Particulars from the Direccion-General de Correos y Telegrafos, Carretas 10, Madrid. Tenders by Aug. 31.

Acton.—The Urban District Council invite tenders for the wiring and fixing of fittings under their assisted wiring schemes. Full particulars from the electrical engineer, Mr. J. Martin Blair, 130, Churchfield-road, Acton, W. Tenders by Aug. 20.

London, S.W.—The Crown Agents for the Colonies, acting on behalf of the Central South African Railways, invite tenders for the supply of 27,000lb. hard-drawn copper wire. Tenders to the Crown Agents for the Colonies, Whitehall-gardens, S.W., by Aug. 20.

Victoria.—The Deputy Postmaster-General at Melbourne invite tenders for the supply and delivery of 11 sections of a branching system metallic-circuit switchboard for central exchange, Melbourne, in accordance with Victorian specification No. 146. Tenders by Oct. 8.

Adelaide.—The Deputy Postmaster-General for Queensland invites tenders for a common battery switchboard and 3,000 subscribers' telephones. Specification No. 166. Particulars may be obtained from the Commonwealth Offices, 72, Victoria-street, London, S.W. Tenders by Jan. 8, 1908.

Victoria.—The Deputy Postmaster-General at Melbourne invites tenders for the supply and delivery at Melbourne of 11 sections of a common-battery switchboard and 3,000 subscribers' telephones and other apparatus for telephone exchange, Windsor, in accordance with Victorian specification No. 148. Tenders by Jan. 7.

Maidstone.—The Electricity Committee invite tenders for the supply of coal required at their electricity works for the ensuing 12 months. Specifications and conditions of contract can be obtained on application to the Engineer, Electricity Works, Fairmeadow, Maidstone. Tenders to Mr. S. Lance, Monckton, town clerk, by Aug. 26.

New South Wales.—With reference to an announcement inviting tenders for the supply and construction complete of a pneumatic tube service to the General Post Office, Sydney, from the Pacific Cable Board's Office, Royal and Stock Exchanges, etc., the Postmaster-General for New South Wales give notice that the date for the receipt of such tenders has been extended from July 10 to 2.30 p.m. on Wednesday, Oct. 16 next.

Greenock.—The Parish Council invite tenders for the complete electric light wiring and fittings for Smithston poorhouse and asylum. The work must be carried out and the inscallation ready for connecting to the Corporation supply within eight weeks of acceptance of tender. Specifications from Mr. R. P. Fairlie, inspector, on payment of £1. 1s. (returnable). Particulars from Mr. T. Crichton Fulton, 44, West George-street, Glasgow. Tenders by Aug. 26.

South Australia.—The Postmaster-General, Adelaide, invites tenders for the supply of lead-covered telephone cables as follows: 7½ miles 208 pair, paper-insulated, lead-covered, 12½lb. conductors; 3½ miles 156 pair ditto; 4 miles 104 pair ditto; 2½ miles 78 pair ditto; 7 miles 52 pair ditto; 2½ miles 26 pair ditto; and 700 yards 104 pair light lead-covered, silk and cotton insulated. Particulars may be obtained from the Commonwealth Office, London. Tenders to the Deputy Postmaster-General, Adelaide, by Sept. 25.

Erith (Kent).—The Urban District Council invite tenders for the supply and erection of the following plant at their sewage-disposal

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works, Manor-road, Erith: an electrically-driven air-compressor, including three-phase motor, switchgear, cable connections and pipework. Copies of the specification, etc. (£2. 2s.), from Messrs. Hawtayne and Zeden, consulting engineers, 9, Queen-street-place, London, E.C., or from Mr. Charles H. Fry, clerk, Council Offices, Bexley. Tenders by Sept. 2.

Bristol.—The Electrical Committee invite tenders for the supply, delivery, and erection of one 300-kw. and two 500-kw three-phase to direct-current converters (6,000 to 500 volts) with balancers and starters; extra high-tension, alternating-current, and low-tension direct-current switchgear; 10-ton hand travelling crane. Also the supply, delivery, laying, and jointing of 24 miles (approx.) of 0·05 square inch three-core paper-insulated B.O.T. sheathed lead-covered cable, together with the necessary troughing and filling; and the construction of the necessary converter station, inclusive of foundations. Tenders to Mr. H. Faraday Proctor, City Electrical Engineer's Office, Temple-back, Bristol. See advertisement in last issue.

Gothenburg.—The Commercial Intelligence Branch of the Board of Trade are notified by his Majesty's Consul at Gothenburg that tenders are invited for supply of the electrical equipment for the Government power station at Trollhattan, comprising three electric generators for direct current, each of 350 kw.; one accumulator battery of 4,800 ampere-hours capacity; four three-phase generators, each of a maximum of 11,000 kilovolt-amperes; 12 transmitters, each of a maximum of 3,670 kilovolt-amperes; connections; regulators; and control tables. Sealed tenders, marked "Anbud a elektrisk utrustning for Statens kraftverk," should be sent to the Managing Director of the Royal Trollhattan Canal and Waterworks, Trollhattan, Sweden, by noon on Oct. 1 next. Tenders are binding until Jan. 1, 1908. Delivery is to be completed by Sept. 1, 1909. Further information may be obtained from the Managing Director, from whom a copy of the programme can be had against a deposit of 50 kronor, which will be returned on receipt of a tender in accordance with the programme.

RESULTS OF TENDERS.

Ealing.—The Council have accepted the tender of G. Sinclair and Son, at £3,069, for the new boiler which is required in connection with the electricity supply.

Wednesbury.—The Corporation have accepted the tender of Gough and Sons, Wolverhampton, for the erection of a new building for a generating station, and for certain extensions and alterations to existing buildings at the electricity sub-station, Camp-street, Wednesbury.

Wednesbury.—The Corporation have accepted the tender of the Phœnix Dynamo Manufacturing Co., Bradford, for (Section C) balancer boosters and switchgear; and that of the Tudor Accumulator Co., London, for (Section D) battery of accumulators, in connection with the extensions to the electricity works.

BUSINESS NOTES.

TRACTION.

London Tramways Bill.—The Lords' amendments to the London County Council (Tramways Improvements) Bill were considered and agreed to by the House of Commons on Tuesday.

Lowestoft.—The traffic receipts of the Lowestoft Corporation tramways from Oct 1, 1906, to July 23, 1907, inclusive, were £7,114. 2s. 5d., as compared with £6,153. 13s. 4d. in the previous corresponding period—an increase of £960. 9s. 1d.

Tramway Traffics.—The following returns have been issued: Dublin United (week ended Aug. 9), £8,493; increase, £1,888. Kalgoorlie Electric (for month of July), £1,190. Perth Electric (for week ended Aug. 9), £592; decrease, £32.

Japan.—H.M. consul at Shimonoseki, in his report for 1906, states that the construction of an electric tramway between Chofu and Shimonoseki (about five miles) is under consideration, as well as one between Moji and Kokura. Gasworks and waterworks are also to be started at Moji.

Halifax.—The Tramways Committee have recommended the adoption of reduced fares for workmen on the tramcars before eight o'clock in the morning, but not in the evening, the experiment to be for six months. The Council have, however, referred the recommendation back to the committee.

Ayr.—A proposal will be brought before the Town Council next month that application be made for a provisional order to extend the tramways from the north end of the new bridge, by way of River-street, George-street, and Whitletts-road, to Whitletts, and from Whitletts-road, by way of Craigie-road, to Burns Statue Square.

Newcastle-on-Tyne.—The new tramway extension to Fenham-road, from the Barrack-road, will be opened in the first week in September. Advantage will be taken of this opening to have a survey of the whole system. The Tramways Committee have abandoned the suggested duplication of the line from Barras Bridge to Park-terrace. As it would cost £1,460, the committee concluded that it was not worth while proceeding with the expenditure simply for the traffic in the week the Royal Show is held in Newcastle.

Tramway Accidents.—The President of the Board of Trade, who was interrogated in the House of Commons the other day respecting the recent tramway accidents, said inquiries had been ordered in two cases that occurred recently. Apart from the attention which the Board's inspecting officers were necessarily giving to the subject, the whole question of braking appliances on tramways was being investigated by committees of the Tramways and Light Railways Association and the Municipal Tramways Association, and Mr. Lloyd-George said the Board were prepared to assist these committees in a combined investigation at a later stage.

Municipal Tramways Association.—The annual conference of the Municipal Tramways Association will take place in Manchester from Sept. 25 to 27. Mr. J. McElroy, general manager of the Manchester Corporation tramways, will deliver the presidential address, after which the following, among other papers, will be read and discussed: "Long Wheel Base Trucks," Mr. R. L. Acland, Chesterfield; "Employés' Hours of Labour, Rates of Pay, and Method of Computing Same," Mr. A. Baker, Birmingham; "Staff Organisation," by Mr. J. Dalrymple, Glasgow; "Rail Corrugations," by Mr. A. L. C. Fell, London County Council.

India.—It is stated that a complete scheme of electrification is being considered for the goods yard at Wadi Bundar, Great Indian Peninsular Railway. For the Benares electric tramway sanction has been given for construction and electrical supply for all purposes within the municipal area. The approximate length of the tramway is 7½ miles, which is to be completed within three years. A Calcutta firm is in treaty with the Government of Bengal in the Public Works Department for a licence to supply electric energy for power, lighting, and traction in portions of the Burdwan and Manbhum districts. The Government of India have been addressed.

Holywood.—At the monthly meeting of the Urban District Council it was reported that the town clerk had been in communication with the solicitor of the tramway company on the subject of the company's position with regard to wayleave on the streets, the question of the electric power about to be introduced into the district, the possibilities of the electric lighting of the town, and the company's intentions as to the generating station. The company's solicitor stated that the required information would be forthcoming in a few weeks. Holywood is a rising town on the County Down side of Belfast Lough, and four miles from the latter city.

Tramways and Light Railways Association.—The *Official Circular* for August gives the annual list of members of the association. It deals with the month's work of the association, and gives in full the official application to the Board of Trade, approved by the Postmaster-General, for the appointment of an arbitrator to decide the question as to who shall bear the expense incurred by the Postmaster-General in providing fuses and heat coils for the protection of the Post Office telegraphs; other matters dealing with light railways, etc., are dealt with, and the *Circular* ends with an account of the measures taken by the association for supporting an amendment to the Scotch Water Bill now before Parliament, which would, if unamended, injuriously affect tramway interests.

Medical Examination of Tram-Drivers.—A new order has been framed by the Highways Committee, and sanctioned by the London County Council, with reference to the medical inspection of tram-drivers in the Council's service. The order is in the following terms: "We have considered the question of the desirability of the motormen on the Council's tramways being medically examined before being entrusted to drive electric cars. At the present time the eyesight of these men is tested, but, as the result of our careful consideration of the matter, we are of opinion that it would be in the interests of the Council to arrange also for the men to undergo a general medical examination." The drivers are up in arms against this newly-instituted medical examination, and at meetings of employés on the northern and southern systems resolutions of protest were passed.

Light Railway Commission.—The Commissioners have made inquiries into the following applications for powers to construct light railways during the month of July: Elsenham and Thaxted Light Railway—approved; Barton and Immingham Light Railway—approved; Tickhill Light Railway (Amendment)—approved; Upper Wharfedale Light Railway—rejected; North Shropshire Light Railway—approved; Stottesdon Kinlet and Billingsley Light Railway—approved; London United Tramways Light Railways (Extension of Time)—approved. The following orders have been submitted to the Board of Trade for confirmation: East and West Yorkshire Union Light Railway (Borrowing Powers) Order; Kent and East Sussex Light Railway (Further Borrowing Powers) Order; Headcorn and Maidstone Junction Light Railway (Amendment) Order; Holmfield and Southowram Light Railway (Extension of Time) Order.

London Traffic.—In the House of Commons on Tuesday, Mr. Kearley (for Mr. Lloyd-George), replying to Sir John Dickson-Poynder, said that it was not contemplated that the branch in connection with London traffic, recently established in the Board of Trade, should be of more than a temporary character. It was established without prejudice to any future legislative proposals which might be made. Its principal duties would be the collection of information and statistics with a view to bringing the report of the Royal Commission up to date and the consideration of questions affecting the traffic which departments concerned might refer to it. Lord Ribblesdale had tabulated an inquiry for Wednesday night in the House of Lords asking the Government whether the special branch recently created by the Board of Trade is to be entrusted with any of the functions which the Royal Commission on London Traffic recommended should be vested in a Traffic Board.

South Shields.—In a report presented to the Town Council the Tramways Committee have estimated the cost of the permanent way and track of an extension along Bertram-street to a terminus near Corstorphine Town at £2,590, while a further expenditure of £6,390 would be required if the route was continued from Smith-street along Corstorphine Town, Commercial-road, and Laygate to Green-street. The estimated total outlay for the electrical equipment of the whole route was £2,300, and there would be an additional outlay of £1,875 for engineering and other works. The tramways manager reports that, in his opinion, the extension from Laygate-circus to Corstorphine Town, opposite the Tyne Dock boat landing, would meet all requirements

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of the riverside district, and it would, therefore, be unnecessary to construct a line along Bertram-street. By diverting the Frederick-street traffic to the new route at Laygate-circus 60,000 miles run would be saved per year. The manager suggests that at the same time extensions should be carried out to Mile End-road and Harton. An extension to Trow Rocks on the light railway principle would bring Frenchman's Bay and Marsden within easy reach. The reports have been referred to a committee.

New South Wales.—Railway and tramway construction is, says the *Railway Budget*, in full swing again. It is stated that preliminary work is to be pushed on as much as possible to enable the construction of the Erskineville tramway and other short extensions being proceeded with at an early date. The extension from South Head-road to Clovelly, Watson's Bay, will fill the existing gap between the tramway and the steamer ferry. The Minister for Public Works, replying to a deputation that waited upon him to urge the construction of a tramway from Bomaderry—the present terminus of the South Coast line—to Jervis Bay, stated that a departmental engineer had reported that the Nowra Bridge would carry a tramway, and had estimated the cost of a light line of railway, 17 miles to the bay, at £70,000. He would have a survey made, as he believed a railway could be constructed for less than £70,000. The evidence placed before him would justify him in considering this application as for a light railway – not a tramway—to put before the Cabinet, and if they approved of it he would take steps to submit it to the Public Works Committee, perhaps not this session, but certainly next, if the Government continued in power.

Dundee.—The Electricity Committee have instructed the electrical engineer to call for tenders for the foundations for the new generating station in the Hennebique system of reinforced concrete. It is to be a condition that tenders be only asked from contractors who are licensed and qualified by experience to carry out such work. The engineer was likewise instructed to take in tenders for the high and low tension cable systems. The Dundee city tramways have specified the use of the Thermit joint in connection with the tramway extension they are carrying out at present. The Board of Trade have informed the Tramways Committee, on the subject of the complaint by the Dundee tramway employés that they cannot run in accordance with the time-tables and at the same time observe the Board of Trade regulations, that from the reply of the tramways general manager to the complaints made by the tramway employés steps had been taken to ensure compliance with the Board of Trade regulations, and they desired to know upon what particular point, if any, in the complaints the Corporation desired to have the Board of Trade's observations. The committee have resolved to ask the Board of Trade to state, after making due inquiry, whether the drivers could run in accordance with the official time-tables and at the same time observe the Board of Trade regulations.

Liverpool.—The improved device for sanding electric tramway tracks, which was invented some 12 months ago by Mr. Chas. W. Mallins, A.I.E.E., general traffic manager of the Liverpool Corporation tramways, and fully described in the *Electrical Engineer* for Jan. 4, 1907, p. 17, has proved so satisfactory through its trial period at Liverpool that all cars on the Liverpool tramways are now being fitted with the apparatus in question. The main feature of the invention, it may be remembered, is the provision on tramway cars of an additional supply of sand, which, by the use of special levers, can be discharged on either rail when the wheels fail to grip the metal, so as to increase the friction between wheels and rails. The apparatus was fitted on 50 cars at Liverpool. The results of the trials point to the much-dreaded difficulty of tramway working—the skidding of wheels on greasy rails—being largely overcome by the use of an increased quantity of sand, as by the apparatus in question. The improved tramway ticket punch which was invented by Mr. Mallins, and described in the *Electrical Engineer* for Dec. 28, 1906, pp. 921-922, is likewise being adopted generally on the Liverpool tramways. An alteration has, however, been made in the form of the box or case of the punch, one side of the case being made as a raised, circular, upper case. The punch as modified is stated to be 4oz. lighter than any other punch in the market. The chief feature of this punch is its security, as the case can only be opened by the use of magneto-electrical contact pieces of a special form and with a current of a particular strength. An order for a full supply of the punches for the Liverpool cars has been placed with the St. Helens and Helsby Cable Co.

Darwen.—The revenue account of Darwen section of tramways shows a gross profit for the past year of £4,169, and after making provision for interest and sinking fund charges, and for repayment of principal to Public Works Loan Commissioners, also £900 for depreciation, a net profit of £477, as compared with a gross profit of £3,931 and a net profit of £375 for the previous year, showing an increased profit of £102. Five thousand pounds has been transferred from depreciation account towards the cost of relaying a portion of the track with new rail and welding the joints on both the up and down lines, leaving, after carrying £900 to the credit of the fund during the year, the sum of £400 to the credit of depreciation account. The revenue account for the Hoddlesden section, after debiting £150 for depreciation, shows a gross profit of £170, but after debiting interest and sinking fund charges a net loss of £594 is the result, as compared with a gross profit of £108 for the previous year and a net loss of £640, being a reduction on the loss of last year of £45. The net loss standing to the debit of profit and loss account for the Darwen section at March 31, 1907, is reduced by the net profit of £477 from £1,916 to £1,439. The net loss standing to debit of the Hoddlesden section is £1,717. The latter sum will be reduced during the year by the sum of £1,600 to be transferred from gas profits, as per resolution of Gas Committee. The total number of miles run and the average receipts per car mile are as below: Darwen section—209,936 miles; receipts per car mile, 14·0327d. Hoddlesden section—30,957 miles; receipts per car mile, 13·1980d. As compared with previous year: Darwen section—209,159 miles; receipts per car mile, 13·5382d. Hoddlesden section—30,525 miles; receipts per car mile, 13·262d.

Salford.—The annual report of the general manager of the Salford Corporation tramways (Mr. G. W. Holford) for the year ended Mareh 31 last, states that the total length of tramways worked by the Corporation is as follows: Salford, 36½ miles, owned by the Corporation; Manchester, 9½ miles, running powers by agreement; Eccles, 8 miles, leased to Corporation; Swinton and Pendlebury, 6¾ miles, leased to Corporation; Prestwich, 7 miles, leased to Corporation; Whitefield, 4½ miles, leased to Corporation; Trafford Park, 2½ miles, worked jointly with the Manchester Corporation—total length, 74¾ miles. He reports that not a single fatality has happened in connection with the running of the cars during the past 12 months. The financial statement shows that the year's working has resulted in a gross profit of £90,709, to which must be added the sum of £4,540 for interest on investments, etc., making a total available balance of £95,249, and this has been dealt with as follows: payments to local authorities for running powers, etc., £25,410; interest and sinking fund charges, £40,795; purchase of property, Church-street, £1,154; contribution in relief of rates, £13,000; depreciation and renewals fund, £14,889—total, £95,250. The following particulars are given relating to the tramways undertaking at March 31: Total borrowing powers, £1,192,246; borrowing powers exercised, £669,583; unexhausted borrowing powers, £522,663; gross capital expenditure, £671,363; population served by tramways, 350,000; traffic revenue, £221,908; total revenue (including interest on investments, etc.), £237,443; working expenses. £142,193; interest on capital (including income tax), £22,772; sinking fund, £18,022; rents to outside authorities, £25,410; purchase of property, £1,154; net balance, £27,889; disposal of net balance—in relief of rates £13,000, to depreciation and renewals fund £14,889; car miles run, 5,268,933; passengers carried, 43,614,123; total number of units used, 7,983,603; number of units used per car mile, 1 53; average number of cars in use per day, 125; percentage of working expenses to receipts, 59 per cent.; average traffic revenue per car mile, 10·56d.; average traffic revenue per mile of single track, £3,102; average total revenue per car mile, 10·81d.; average car miles per day, 115·5; average speed per hour, 7·75 miles; average car hours per day, 17; average working expenses per car mile, excluding power cost, 4·42d.; average working expenses per car mile, including total power cost, 6·47d.; scale of fares—1d. average distance 1½ miles, 1½d. 2½ miles, 2d. 3¼ miles, 2½d. 4½ miles, 3d. 5¼ miles, 3½d. 6 miles; average fare paid, ·59d.; average fare paid per passenger, 1·27d.; average number of passengers per car mile, 8·27; average journeys per head of population per annum, 124·6; number of cars in stock. 177; total amount of sinking fund in hand and unapplied, £87,205; amount of sinking fund applied in reduction of debt, £38,495; amount of depreciation and renewals fund, £46,145.

Sunderland Tramway Accidents.—A Board of Trade inquiry into the two tramway accidents on the Sunderland and District Tramway Co.'s service on Mill Hill Bank, near Silksworth, on July 29, was held last week by Lieutenant-Colonel von Donop. The driver of the car which met with the first accident in his evidence said he was employed at the sheds as a fitter, and also acted as spare motorman. The car was to run between Grangetown and Houghton. He first went to Grangetown and then made two complete journeys to Houghton and back. It was on the third journey to Houghton in going down Mill Hill, or Botcherby Bank, that the accident happened. Previously in going down the bank he had had no trouble in controlling the car. On the top of the Mill Hill he brought his car to a stop as required by the Board of Trade, making use of the magnetic brake. The controller handle was in the neutral position. On receiving the signal from the conductor to start he released the hand-brake and the car moved about a yard. He then put the controller handle to the third notch of the magnetic brake. He allowed the car to reach a speed suitable for that notch, but found that the car was not taking the brake, and he put the controller back in the off position. He applied sand and found that the wheels were revolving, and on this he applied the magnetic brake at the first notch, but there was no brake whatever. The car was then gaining speed, so he reversed the motors, and soon afterwards the switch "blew." Witness then turned to the hand brake as a last resource, but the car was travelling too fast for the hand brake to stop it. He could do nothing more. The car ran off the line just after taking the curve, and went into a wall. The speed at the time would be about 30 miles an hour. The inspector remarked that it looked very much as if the car had gathered too much speed from the magnetic brake handle not being in the right position. The driver of the car in the second accident said he was returning from Grangetown when he lost control of the car on Mill Hill Bank, and it collided with the car derailed by a previous accident. He brought the car to a stop at the top of the bank by using the magnetic brake and steadying the car with the hand brake. On receiving the signal from the conductor to start he released the hand brake. At this time the controller handle hung on the seventh notch of the magnetic brake. He moved the latter to the sixth notch, and finding the car moving at a speed suitable for that notch he moved the handle to the fifth notch, and then to the fourth and the third, to give the speed required for running down the hill. The car did not run at more than three or four miles an hour. The car took the bank nicely until about 50 yards from the curve at the bottom. The rails were very greasy, and in order to prepare for the stop at the bottom he moved the magnetic brake handle to the fourth notch, and then the car skidded. In order to make the wheels revolve he released the brake to the third notch and then to the second and first notch. The car by this time had reached the curve. The wheels revolved, and he returned the handle to the second and third notch, but the wheels began to skid again. He was now on top of the derailed car, and could not prevent

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a collision. He did not apply the hand brake at all. At the time of the accident the car was not running more than five or six miles an hour. There was a conflict of evidence at the inquiry as to the stopping of the first car at the Board of Trade stop. After several passengers had given their evidence, the inquiry concluded.

LIGHTING AND GENERAL

Keighley.—Electricity cables are to be laid by the Town Council in several additional streets at an estimated cost of £419.

Wakefield.—A Local Government Board inquiry is to be held on Aug. 20 into the Council's application for sanction to borrow £7,250 for the electricity undertaking.

Worksop.—The Council have decided to reduce the amount asked for electric lighting purposes from £2,000 to £1,700, as the purchase of an economiser has been deferred.

Dublin.—The Lighting Committee have intimated that they are prepared to consider proposals for the supply of motors to their consumers on the hire-purchase system.

Notice of Dividend.—According to the *London Gazette*, a first and final dividend of 3d. in the £ has been declared in the estate of F. Williams, electrician, 17, Orchard-road, Bemerton, Salisbury, Wilts.

Guatemala.—A consular report from Quezaltenango states that telegraphs have been freely constructed, and the system is in excellent condition and maintained a very good service throughout the year.

Notice of Intended Dividend.—The *London Gazette* announces that the last day for receiving proofs in the estate of D. Roberts, electrical and motor engineer, and lately trading at 3 and 5, Whiston-street, Derby, is Aug. 28.

Oulton Broad.—The Urban District Council have adopted the following resolution: "That this Council do consent to a provisional order being granted by the Board of Trade to the Council under the Electric Lighting Acts, 1882 to 1899."

Tunis.—The last annual report of the Tunis Gas, Electricity, and Water Co. shows that while there was no increase in the consumption of gas last year, that of electric current was much higher, as shown by the fact that the number of consumers rose from 383 to 519.

Electric Clocks.—An inquiry has been received by the London Chamber of Commerce for the names of makers of electric clocks. Firms may obtain fuller particulars from the Statistical and Information Department, Oxford-court, Cannon-street, London, E.C.

Charing Cross, West End, and City Electricity Supply Co.—The directors of the Charing Cross, West End, and City Electricity Supply Co. announce an interim dividend of 5 per cent. per annum (2s. 6d. per share) on the ordinary shares for the past half-year, less income tax.

Swansea.—On Saturday the municipal telephone system was taken over by the National Telephone Co., and the latter paid to the Swansea Corporation bankers the amount agreed upon—namely, £26,936. According to agreement the whole of the municipal telephone staff has been taken over.

Whitby.—The waterworks company have decided to obtain a new balancer from the Lancashire Dynamo Co. at an estimated cost of £75 to replace the balancer at the electric light works, which has given out and found not to be of sufficient capacity for the nature of the business at present being done.

Copper and Leather Belting.—A firm in Durazzo (Albania) ask for the names of British importers of old copper and of exporters of new copper. A Bulgarian inquirer desires to get into touch with British exporters of leather belting. Particulars may be obtained from the London Chamber of Commerce.

W. T. Henley's Co.—The directors of W. T. Henley's Telegraph Works Co. have to-day declared an interim dividend on the preference shares of 4½ per cent. per annum, less income tax, and on the ordinary shares of 10 per cent. per annum, less income tax, for the half-year ending June 30 last, both payable Sept. 2.

Treport and Eu (France).—A British consular report states that works have recently been built here for the treatment of copper ore by the application of electricity to the minerals with which the copper is ordinarily combined in nature, and with the object of separating the metal less expensively than by the usual method.

Haddington.—At a meeting of the Western District Committee of the County Council intimation was made by Messrs. Guild and Guild, W.S., Edinburgh, on behalf of the Electric Works and Development Co. of their intention to apply in November for a Board of Trade electric lighting provisional order for the burgh of Cockenzie, parish of Tranent, and county of Haddington.

Colchester.—The electricity supply department submitted the engineer's report, as under: Output of electricity in units during June—lighting, 1907, 43,258 (1906, 25,112); ditto, traction, 43,371 (43,641); used in generating station, 15,312 (12,580)—total, 101,941 (81,333). Number of consumers at end of June, 1,166 (924); total number of 8-c.p. lamps connected, 43,746 (37,127).

Wireless Telegraphy.—A wireless telegraph station has been established on the high ground to the west of Dieppe adjoining the golf links. It is simply for experiments with the Artom system, which will take place between Dieppe, Havre, and Barfleur. Communication and experiments are proceding with Havre, and the necessary masts and material are preparing for the Barfleur station.

Milan.—The Société Anonyme Westinghouse of Le Havre have secured a contract from the city of Milan for the supply of a 3,500-kw. turbo-generator set, running at 1,250 r.p.m., to yield three-phase current at 8,650 volts, 42 periods. The turbine will operate in conjunction with a Westinghouse-Leblanc surface condenser and air-pump. The set will be installed in the Via Adige central station, Milan.

Bromley.—The finishing touches are being put on the new town hall, and it will eventually be the most imposing building in the borough. In the police court electric light has been installed, there being eight chains of three lights each suspended from the ceiling. A few defects have been remedied on the suggestion of the magistrates. Altogether the accommodation is far superior to that in the old building, and consequently the business is greatly expedited.

Aspull.—At the monthly meeting of the District Council the clerk read a letter from Messrs. Peace and Ellis, in which they stated that as one of the clauses submitted by the Lancashire Electric Power Co. for advertisement was not in accordance with the terms of the deed of transfer of the Aspull electric lighting order, they had written to the company pointing it out, and saying that they proposed to amend the same before the publication of the advertisement in the newspapers.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to Kepitigalla Rubber Estates' further issue of 5,500 vendors' shares of £1 each, fully paid, Nos. 219,501 to 225,000, and United River Plate Telephone Co.'s £300,000 4½ per cent. mortgage debenture stock. The committee has also been asked to appoint a special settling day in Dunlop Rubber Co.'s 220,000 shares of £1 each, fully paid, Nos. 1 to 220,000. The committee has further been asked to allow Kepitigalla Rubber Estates' 219,500 shares of £1 each, fully paid, Nos. 1 to 219,500, to be quoted in the official list.

Rhyl.—At the monthly meeting of the Rhyl District Council it was stated that a committee had gone into the question of the electricity undertaking, and had received an expert report containing several recommendations from Messrs. Preece and Cardew, and had recommended the Council to defer the report for a year, and in the meantime to engage an expert canvasser to try to increase the number of electricity consumers. Attention was drawn to a number of streets through which it was obligatory on the Council's part to lay mains under the order, which should have been cabled within two years of the date of the order, and some streets existed in which it had not done. The Council decided to defer the work for a time.

Darwen.—The revenue account of the electricity department shows a gross profit of £3,323. 3s. 1d., and after providing for interest, sinking-fund charges, and repayment to Public Works Loan Commissioners, a net profit of £65. 13s. 1d., reducing the amount standing to debit of revenue account from £1,435. 16s. 11d. to £1,370. 3s. 10d. The number of units sold has been 660,812. as compared with 655,918 for the previous year, an increase of 4,894, or ·74 per cent. The number of units sold for the past two years for the different purposes are as follows: lighting, 1907, 148,955 (1906, 141,428); power, motors, and radiators, 61,419 (51,180); public lamps, 58,570 (61,448); tramway traction, 391,868 (401,862—total, 660,812 (655,918), or a net increase of 4,894 units.

New Patent Law.—The current quarterly issue of the *Law Magazine* contains an article by Mr. Scott Duckers on proposed amendments of the patent law. At present there are three Bills before Parliament — the Government Patents and Designs Bill, another Government measure entitled the Patents and Designs (Consolidation Bill, and also a private Bill called the Patents and Designs (No. 2) Bill, introduced by Mr. Dundas White. As far as can be judged at the present time, the first measure will pass into law this session, while little or no progress will be made with either of the other two. The Consolidation Bill, as its name implies, is intended to make a sort of code of patent legislation, and provides for the repeal of all the Patents Acts from 1883 to 1902.

Kirkheaton.—A very interesting example of the ready adaptability of electricity may just now be seen at Battye Lock, Kirkheaton. The Calder and Hebble Navigation Co. have recently found it necessary to carry out some repairs at this lock, requiring the water to be temporarily drawn away from that portion of the canal. At a little distance from each end of the lock a dam has been erected, and at the east end a platform has been constructed over the canal. At this platform a centrifugal pump has been placed, together with a 25-h.p. motor driven by electrical energy supplied from the mains of the Yorkshire Electric Power Co. The motor has been lent by the power company, and, although only occupying a space measuring about 2ft. by 2½ft., is pumping at the rate of 145,000 gallons of water per hour, and considerable local interest has been shown in the work going on.

Aberdeen.—The new telephone exchange to be erected in Bon Accord-street, Aberdeen, will be three storeys above the street, and will consist generally of a front block with a back wing. The front block on the ground floor will be almost absolutely occupied by the district office, while the wing behind will contain the private office of Mr. Stockens, the district manager, with apartments adjoining for his chief assistants. The first floor will contain the apparatus and battery rooms, with accommodation for the male staff. The second floor will be devoted to the "central" proper, containing the storage-room, the school of instruction, etc., in the main building, with dining and sitting rooms for the staff in the wing behind. The building, which will have a frontage of about 84ft., will face directly towards the entrance to Bon Accord-square, and will form an outstanding addition to the street architecture of the city.

Burnley.—The Burnley Electricity Committee have had under consideration the question of proposed extensions at the boiler-house at the electricity works. Mr. Starkie, the electrical engineer, submitted five alternative schemes for the proposed extension. It appears the site available for this is a difficult one to contend with, and in order to best overcome this Mr. Starkie recommended the adoption of a particular scheme, and his advice was acted upon accordingly. The following is a rough estimate of the capital required to meet the

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present requirements: two Lancashire boilers, including seatings, mountings, and stokers, £2,050; piping and valves, £300; economisers, £800; feed pump, £150; coal-handling plant, £1,800; chimney, £1,500; buildings, including excavating, etc., £2,500; and contingencies, 10 per cent., £900—total, £10,000. The above estimate is exclusive of a cooling tower on the boiler-house roof, which would entail a further outlay of £500.

Bergamo.—The Société Anonyme d'Electricite Rag. Carlo Zanchi et Cie., of Bergamo, have placed with the Société Anonyme Westinghouse of Le Havre an order for the complete installation of a generating station. The equipment will include a Westinghouse turbo-alternating set of 1,250 kw. at 1,500 r.p.m., yielding three-phase current at 7,500 volts 50 periods. The turbine of this set will be provided with a We tinghouse-Leblanc condenser having a capacity of 11,000 kg. steam per hour. A second generating set will consist of a Belliss and Morcom steam-engine of 250 r.p.m., direct-coupled to a Westinghouse three-phase alternator of 600 kw., 7,500 volts, 50 periods. This steam-engine will also operate in conjunction with a Westinghouse-Leblanc condenser of 5,000 kg. capacity. The switchboard for both sets will be supplied by the Société Anonyme Westinghouse The boilers, by Babcock and Wilcox, will be four in number, each of 150 square metres heating surface.

Tonbridge.—At the last Council meeting the Electricity Committee reported that two new applications had been received from new consumers, connections to date totalling 8,617. The engineer reported that with regard to the meter testing it was necessary to obtain a testing set and a stop watch, costing £16 and £4 respectively, and it was recommended that the same be purchased. The engineer reported that he had had a prepayment meter on trial from the Mordey-Flicker Electricity Meter Co., and that it had worked satisfactorily. The committee instructed him to retain the meter, the price being 45s. They also decided to retain the Oliver flame arc lamp situated near the junction of High-street and East-street. Mr. Race, in moving the adoption of the report, said the charges to consumers for the June quarter amounted to £367, as against £206 in 1905 and £253 in 1906, thus showing an increase of £114 on the year. The paragraph with reference to the retention of the Oliver flame arc lamp near High-street and East-street was deleted, and the remainder of the report then adopted.

Bull Point Magazines.—The success which has attended the installation of the electric light in the Naval Ordnance depôts and magazines at Bull Point, Devonport, has resulted in the War Department having approved of estimates for completing similar work in connection with the property there under military control. The buildings consist of a range of magazines for the storage of cordite and powder, cartridges, shell, and miscellaneous stores. The contract for completing the electric light installation has been given to Messrs. Foote and Milne, electrical engineers, of Westminster, and the work of excavating the trenches for the electric cables has commenced. The installation will embody all the improvements which experience has suggested, including "lighting pillars" and chambers at intervals to feed the watertight incandescent lamps to be used for illuminating the passages of the magazines, and the arc lights which are to be fixed on steel standards near the entrances and at positions along the line of transporting rails and landing jetties. It is expected that the work will be completed during the current financial year.

Whitefield.—At a meeting of the Electricity Committee, held July 30, the following letter was read from the surveyor of taxes, Manchester: "From the tramway accounts of the Salford Corporation it appears that the said Corporation paid to your Council a sum of £662 in the year ended March, 1905, and £450 in the year ended March, 1906, out of the tramway revenue. I am informed that this payment is not in respect of the rent of the tramlines, the lease in respect of which has not yet been signed, but is a payment agreed to be made by the Corporation to the Council in lieu of a grant the Council formerly received from the county authorities out of the rates. As these two sums represent part of the profits received by the Council in full, the tax thereon is payable by them without reference to the application of the profits. The grant payable by the county authorities being paid out of the rate was not chargeable. Application for payment of the tax on the two sums of £662 and £456 will be made in due course." It was resolved that the chairman of this committee and the law clerk attend the surveyor of taxes with a view to obtaining exemption from payment of the tax on the ground that the Council are not liable in respect of the amounts named in his letter.

Gillingham.—At the last meeting of the Council the borough electrical engineer reported that the equivalent of 356 8-c.p. lamps had been connected and the equivalent of 11 8-c.p. lamps had been reconnected since the last meeting of the committee, making a total of 26,789 equivalent in 8 c.p. lamps with 294 consumers connected, and that applications had been received for the equivalent of 324 8-c.p. lamps. The engineer also reported that a fixed rate per hour is made for outside lighting at Sheerness, and that the system is worked by means of an hour meter fixed by the department, which registers the number of hours during which the lamps have been on, and the account is rendered on the basis of the fixed charge multiplied by the number of hours. Recommended that a fixed charge of 1s. 5½d. per hour be made for 10 arc lamps burning half unit per hour each lamp. The engineer reported that offers of assistance had been received from only three firms, and it was recommended that the idea of an electrical exhibition be abandoned for the present. Recommended that the engineer inquire at the collieries as to the price of small coal and report to the committee, and that in the meantime he purchase small coal as required and report to the committee at each meeting as to quantities purchased, price paid, and firms who supply.

Glasgow.—The Electricity Committee of the Glasgow Corporation, in their fifteenth annual report, state that for the year ended May 31 last the gross revenue amounted to £224,844. 13s. 6d., and the working expenditure to £106,235. 10s. 8d. Out of the balance of £118,609. 2s. 10d. the committee had to meet statutory requirements amounting to £73,784. 18s. 3d., leaving a balance on the year's working of £44,824. 4s. 7d. The depreciation written off the capital account was £41,754. 18s. 7d., leaving a surplus on the year's operations of £3,069. 6s. This had been transferred to the credit of reserve fund account, which now amounted to £20,536. 6s. 2d. The revenue account continued to show favourable results. The increase of income from all sources amounted to £29,003, while the working expenditure had increased £14,819, principally due, apart from the larger output, to the higher price paid for coal, and also to an increase in respect of rates, taxes, and assessments. The capital expenditure for the year amounted to £261,056. 11s. 4d., and the total capital expenditure as at May 31, less depreciation written off, stood at £1,587,436. 1s. 10d. Notwithstanding that contracts have been entered into for the supply of coal at prices considerably in advance of those of last year, and, having further in view the increased amounts payable for interest and sinking fund during the coming year, the committee, looking to the favourable result of the year's operations, and to the increased demand from large consumers, recommend that the charges current for the year from June 1, 1907, to May 31, 1908, be the same as formerly. The quantity of consumed units supplied to private customers during the past year totalled 24,677,993.

Erdington.—Major J. Stewart has held a Local Government Board inquiry at Aston concerning the application of the Aston Corporation for power to borrow £17,519 for the purposes of a scheme to supply electricity within the urban district of Erdington. Mr. J. Ansell, town clerk, said they were also asking the inspector to inquire into an additional loan of £1,650 required by reason of the necessity to substitute the cables from Aston Cross to Salford Bridge, in order to supply the demand created in Witton by certain large manufacturers, and also by the Tame and Rea Drainage Board. Mr. Ansell went on to speak of the indebtedness of Aston, mentioning that loans sanctioned for sanitary purposes amounted to £110,563, and loans sanctioned but not raised to £3,989, making a total of £114,552. The balance unpaid on tramways and electricity loans was £308,747, and the loans sanctioned but not raisd £52,020, making a grand total of £475.319. Continuing, Mr. Ansell said that in 1898 the Erdington Urban District Council applied for and obtained an order by which they were to supply electrical energy for their district. There were no generation works executed under that order, nor was there any supply of electrical energy for the district. Subsequently Erdington arranged that the Corporation of Aston, under an agreement dated Oct. 3, 1906 should promote a provisional order for the supply of the electrical requirements within the district of Erdington. Aston agreed to promote this order, and within the last few days the Royal assent had been received. Mr. Ansell further mentioned that in 1902 Erdington applied for and obtained parliamentary powers enabling them to construct tramways within the district. These tramways were now worked under an agreement between Erdington and the city of Birmingham, and Aston had effected an arrangement for the supply of the energy needed for the working of the tramways. The inhabitants of Erdington had been canvassed, and 104 residents had expressed their willingness to take a supply of electricity as soon as it was available, and probably this number would be increased to 163. Three sub-stations would be erected at Erdington. Major Stewart intimated that he would report favourably upon the matter.

Turkey.—Attention is called by the American consul at Smyrna to the several concessions granted recently by the Sultan for electric light and traction, and to the prohibitive attitude of the Turkish Government toward the importation of any kind of electrical apparatus. This opposition to the various electrical appliances which have of late years so transformed modern life elsewhere places the Ottoman Empire in the strange position of a country at the very door of European refinement and progress, but lacking almost entirely in the conveniences of modern civilisation. Turkey is practically a virgin soil for electrical enterprise. Up to a year ago there was not a single city or town in the 800,000 square miles of Turkish possessions which could boast of a telephone system or of a central station for electric light or power purposes. Now Damascus and Beirut have their electric central stations, however queer it may seem that the former ancient city should lead in progress the important and quasi-European cities of Constantinople, Smyrna, and Salonica. Quite recently concessions were granted for electrical light and traction in Constantinople, Salonica, and Brussa. Smyrna, the second city in the empire, and perhaps the first in commerce and future prospects, seems to have no immediate future for electrical appliances, although, perhaps, no city feels more the need of them. It is rumoured, however, that permission has been granted for the electrification of the two-mile tramway line between Smyrna and the suburbs on the southern shore of the gulf. Aside from a few isolated plants in mines and private residences, the concessions referred to represent the sum of electrical work in Turkey. Belgium has so far taken the lead in securing large contracts, while Germany, with the exception of the Constantinople concession, nearly monopolises the smaller business, the material for which has to be imported by special permission from Constantinople. The prohibition now covers everything relating to electricity, even the serviceable electric bell, which cannot be imported except with the approval of the direction of customs in Constantinople. It is peristently rumoured that the unaccountable prohibition of electrical apparatus will be raised within the near future, and although in Turkey the near future happens generally to be much more remote than elsewhere, the concessions lately granted without too great reluctance and in rapid succession tend to confirm these rumours and establish the hope that the change is coming soon. It would, therefore, be wise for manufacturers of electrical appliances to turn their attention to this unexplored field with a view to securing a fair share of the coming trade.

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PROVISIONAL PATENTS, 1907.

JULY 30.

17409. Improved electric storage battery. Ernest George Frederick Medley, 2, Calais-street, Camberwell, London.

17410. Improvement in electric switches. Siemens-Schuckertwerke, G. m. b. H., York Mansion, York-street, Westminster, London. (Date applied for under Patents Act, 1901, Sept. 24, 1906, being date of application in Germany.) (Complete specification.)

17455. Improvements in electric signalling apparatus. Deutsche Telephonwerke, G. m. b. H., 322, High Holborn, London. (Date applied for under Patents Act, 1901, Aug. 24, 1906, being date of application in Germany.) (Complete specification.)

17456. Improved parallel-break change-over switch. Edward Dewhurst, 6, Lord-street, Liverpool.

17457. Improvements in and relating to electrolytic alternating-current rectifiers. Arthur Samuel Hickley, 6, Lord-street, Liverpool. (Complete specification.)

17458. Improvements in or connected with electrolytic cells. Arthur Samuel Hickley, 6, Lord-street, Liverpool. (Complete specification.)

17463. Improvements in or relating to electrical ignition devices for internal-combustion engines or the like. Arthur James Postans, Birkbeck Bank-chambers, Chancery-lane, London.

17472. New or improved attachment for the mouthpieces of telephone instruments. Thomas Joseph Haslam, Horace James Rand, and James Walton Smith, trading as the Properties Exploitation Syndicate, 38, Chancery-lane, London.

17474. Improvements in and relating to alternating-current motors of the commutator type and methods of operating the same. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

17475. Improvements in and relating to electric circuit breakers. The British Thomson-Houston Company, Limited, Edmund Basil Wedmore, and William Pancras Hamlyn, 83, Cannon-street, London.

JULY 31.

17489. Improvements in electrodes for storage batteries. William Fennell and William Pagden Perry, 68, Dudley-road, Tipton, Staffs.

17490. Improvement in thermo-electric generators. William Fennell and William Pagden Perry, 68, Dudley-road, Tipton, Staffs.

17526. Improvements in or relating to electrically-propelled vehicles, boats, and the like. Patrick Edward Trainor, 31, Bedford-street, Strand, London.

17515. Improvements in electrical apparatus such as storage batteries. Thomas Terrell, New-court, Temple, London.

17532. Improvements in or relating to surface-contact electric traction systems. Edward Albert Mitchell, 46, Lincoln's-inn-fields, London.

17539. Elevated electric railways. James Monroe Gilstrap, Fife House, Kingston-on-Thames, Surrey. (Date applied for under Patents Act, 1901, July 31, 1906, being date of application in United States.) (Complete specification.)

17548. Improvements in and relating to inductor generators for ignition and like purposes. John Lewis Milton, 18, Southampton-buildings, London. (Complete specification.)

AUG. 1.

17554. Improvements in or connected with winches for electric arc lamps and other purposes. Norman Russell Nichols and John Brache Le Maitre, Carlton-buildings, Paradise-street, Birmingham.

17557. Improvements relating to electrical cut-outs for arc lamp and other circuits. Verity's, Limited, and Frederic Stanhope Worsley, 11, Burlington-chambers, New-street, Birmingham.

17565. Improvements in switches combined with fuses. James Henry Ward, Meyer Hart Goldstone, and Albert Goldstone, Simpson Works, Springfield-lane, Salford, Manchester.

17584. Improvements in switches for electric bells. Graham Harding, 19, Holborn-viaduct, London.

17617. Improvements in a coin-controlled pay station for telephones. Charles Hickling Carter, 40, Chancery-lane, London. (Complete specification.)

17635. Improvements in and relating to inductor generators. John Lewis Milton, 18, Southampton-buildings, London. (Complete specification.)

AUG. 2.

17655. Improvements in arc lamps. William George Heys, 51, Deansgate-arcade, Manchester. (The Scott Electrical Company, United States.) (Complete specification.)

17658. Improvements in prepayment electric meters. William Collier Bexon and Joseph Donald Bexon, 128, Colmore-row, Birmingham.

17659. Improved adaptor for incandescent electric lamps. Arthur Thomas Thompson and George Henry Davis, 128, Colmore-row, Birmingham.

17661. Electric switch for series lighting. Herbert John Dowsing, 24, Budge-row, London.

17686. Improvements in space telegraphy. John Stone Stone, 7, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Aug. 3, 1906, being date of application in United States.) (Complete specification.)

17690. Improvements in space telegraphy. John Stone Stone, 7, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Aug. 31, 1906, being date of application in United States.) (Complete specification.)

17695. Improvements in space telegraphy. John Stone Stone, 7, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Aug. 3, 1906, being date of application in United States.) (Complete specification.)

17698. Improvements relating to commutators and brush carriers of electric machines. Louis Kriéger and Compagnie Parisienne des Voitures Electriques (Procédés Kriéger), 24, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Jan. 29, 1907, being date of application in France.) (Complete specification.)

17704. Improvements in loud-speaking telephone apparatus. Domenico Marzi, 6, Lord-street, Liverpool. (Date applied for under Patents Act, 1901, April 25, 1907, being date of application in Italy.) (Complete specification.)

17707. Improvements in electric switches. Charles Ernest Hunter and William Hodges Warren, Birkbeck Bank-chambers, Southampton-buildings, London. (Complete specification.)

17718. General arrangement of a lifting magnet for electric arc lamps which have their juxtaposed electrodes brought into contact by the action of a weight. Deutsche Beck-Bogenlampen, G. m. b. H., 27, Chancery-lane, London. (Date applied for under Patents Act, 1901, Aug. 2, 1906, being date of application in Germany.) (Complete specification.)

17719. Improvements in and relating to the distribution of electromotive power. Henry Chitty Frederick Montague Lange and George William Mascord, 27, Chancery-lane, London. (Complete specification.)

17722. Improvements in and relating to electric controllers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.) (Complete specification.)

AUG. 3.

17743. Improvements in or relating to the metallisation of vitreous, porcelain, earthenware, and the like surfaces so that metal or metallic alloy may be electrolytically deposited upon such surfaces. Quentin Marino, 1, Imperial-buidings, East Croydon, Surrey. (Complete specification.

17768. Improvements relating to filaments for electric incandescence lamps. Romolo de Fazi, Frederick Grill Claussen, and George Talbot Burrows Cobbett, 37, Essex-street, Strand, London.

17769. Improvements connected with lightning conductors. Valentine Gordon Morris, 173, Fleet-street, London.

17781. Improvements in electric arc lamps. Adrian Denman Jones, 18, Southampton-buildings, London.

17783. Electromagnetic reversing coupling. Frans Marinus Meyer, 72, Cannon-street, London. (Complete specification.)

17796. Improvements in or relating to electric sign or display apparatus suitable for advertising and like purposes. Guy Carey Fricker, 46, Lincoln's-inn-fields, London. (Complete specification.)

AUG. 6.

17817. Improvements in making electrically-conducting joints in metallic-filament incandescent electric lamps. Augustus Charles Hyde, 7, Crown Office-row, Temple.

17830. Electrical attachment for racking off casks. Charles Arthur Allison, 52, Chancery-lane, London. (Vinzenz Spietschka, United States.)

17834. Improvements in electric incandescent filaments for lighting or heating. Albert Gray, 30, Cressy-road, Hampstead, London.

17855. Improvements in or relating to mountings or fittings for tubular incandescent electric lamps. David Assersohn, 7, Southampton-buildings, London. (Complete specification.)

17860. Construction of a lifting magnet having a magnet core which is to serve as a dropping weight for use with electric arc lamps provided with juxtaposed electrodes. Deutsche Beck-Bogenlampen G. m. b. H., 27, Chancery-lane, London. (Date applied for under Patents Act, 1901, Aug. 3, 1906, being date of application in Germany.) (Complete specification.)

17894. Improvements in electricity meters. Compagnie de Construction Electrique, 70, Chancery-lane, London. (Date applied for under Patents Act, 1901, Nov. 10, 1906, being date of application in France.) (Complete specification.)

AUG. 7.

17947. Automatic electrical gong-ringing device for electrical street railway cars. Nathan Fallek, 52, Chancery-lane, London. (Complete specification.)

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17961. Improvements in printing and sight-reading telegraph apparatus. Ernest William Beech, 173, Fleet-street, London.

17968. Process for electrolytic production of lustrous metallic coatings upon other metals. Alexander Classen, Birkbeck Bank-chambers, Chancery-lane, London. (Complete specification.)

17972. Improved manufacture of electric incandescent lamps having filaments made from a plastic mass. Siemens und Halske Akt.-Ges., Birkbeck Bank-chambers, High Holborn, London. (Date applied for under Patents Act, 1901, Aug. 28, 1906, being date of application in Germany.) (Complete specification.)

17973. Improved manufacture of electric incandescent lamp filaments consisting of difficultly fusible metals. Arthur George Bloxam, Birkbeck Bank-chambers, Southampton-buildings, London. (Siemens und Halske Akt.-Ges., Germany.) (Complete specification.)

17993. Polarised or unpolarised buzzer for telegraphic, telephonic, or bell purposes to obviate the use of relays. Benjamin Herbert Thorogood, 36, Knightland-road, Clapton, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Aug. 29.)

1906.

10327. Electro-capillary apparatus. Orling.

17668. Holders and connections for electrical incandescence lamps. Lambert.

17800. Electric cut-out and distribution boxes. Scoccimarro.

18168. Apparatus for transmitting synchronous and other movements to a distance. Siemens Bros. and Co. and Turner.

18278. Electric railway systems. British Thomson-Houston Company. (Kintner.)

18304. Means for preventing the breaking of the conducting wires of electric lamps and electric fittings. Berry.

19951A. Connectors for electric batteries. Sefton-Jones. (Decker Electrical Manufacturing Company.) (Date applied for under Rule 5, Patents Rules, 1905, Sept. 7, 1906.)

20380. Electrolytes for the electro-deposition of copper. Cowper-Coles.

20542. Signal systems for railways and the like. British Thomson-Houston Company. (General Electric Company.)

21243. Pressure regulators for incandescent lamps. Meissner and Danischevski.

21468. Clamps for attaching anchor wires or strain wires to electric trolley wires and in the construction of anchor cars for trolley wires. Mittelhausen and Brecknell, Munro and Rogers, Limited.

21597. Electrical leakage detector and alarm. Marlor and West.

22177. Electromagnetic motors. Fairweather. (Finnigan.)

22691. Electric cables. Paterson and Bass.

22946. Electric order or signalling apparatus. Mechan and Sons, Limited, Smith and Anning.

23755. Railway train electric lighting apparatus. Martin and Martin.

24733. Brushes and brush-holders for dynamo-electric machines. Loring.

24847. Converter for alternating electric currents. Pinot. (Date applied for under International Convention, Dec. 6, 1905.)

27049. Telegraphic transmitting device. Kitsee. (Date applied for under International Convention, June 21, 1906.)

27120. Electrometallurgical process for extracting copper from its ores. Jumau. (Date applied for under International Convention, Nov. 29, 1905.)

27215. Agglutinant for consolidating the active material of electric accumulators. Marino and Barton-Wright.

29420. Telegraphic automatic transmitters. Jones.

1907.

1034. Terminals for electric accumulators, batteries, and other electrical apparatus. Smith.

1280. Means applicable for use in attaching electrical measuring instruments to a switchboard. Hartmann und Braun Akt.-Ges. (Date applied for under International Convention, July 5, 1906.)

2516. Insulating coverings or sheathing for contact rail conductors of electric railways and the like. Baker.

4240. Commutators for dynamo-electric machines. Siemens-Schuckertwerke Ges. (Date applied for under International Convention, Feb. 21, 1906.)

5331. Line tappers for electric wires. Williams. (Date applied for under International Convention, March 8, 1906.)

6699. Electric lampholders for rapid attachment to conductors. Magunna. (Date applied for under International Convention, March 20, 1906.)

6899. Electrical switches. Lundberg, Lundberg, and Lundberg.

13618. Electrode for searchlights. Geb. Siemens und Co. (Date applied for under International Convention, July 13, 1906.)

COMPANIES' STOCK AND SHARE LIST.

Name	Amount paid.		Last price
Commercial and Industrial.	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	—	½-⅝
—— Ord., 1 125,000	1	..	⅛-¼
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	9/16-11/16
British Aluminium Co., Ordinary, 2,001-40,000	5	..	4½-5½
—— 7 per cent. Cum. Pref., 1-40,000	5	..	5-5½
—— "A" 6 per cent. Cum. Pref., 1-20,000	5	..	5-5½
—— 4 per cent. Funding Certificates, 1-20,000	5	..	3¾ 4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	100-103
—— 5½ per cent. Loch Leven Deb (Reg.), Red., 1-3,000	100	..	98-99 xd
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6¾ 7¼
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5¾ 6¼
—— 4½ per cent. Mortgage Debentures	100	..	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	87 91
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	5	..	1-1½
—— 4 per cent. Mortgage Debenture Stock	100	..	59 64
Brush Electrical Engineering, Ordinary, Nos. 1-105,751	2	..	1-2
—— Non. Cum., 6 per cent. Pref.	2	..	1¾ 1¾
—— 4½ per cent. 1st Debenture Stock	100	..	88-91
—— 4½ per cent. 2nd Debenture Stock	100	..	7 -74
Callender's Cable, Debentures	100	..	105-107
—— Ordinary	5	..	9½-10¼
—— 5 per cent. Pref.	5	..	5⅜-5⅝
Consolidated Electrical Co., Ordinary, 1-110,000	1	..	1-1 xd
Crompton and Co.	5	..	1⅞-2⅛ xd
—— 5 per cent. Debentures	100	..	93½-96½
Dick, Kerr, and Co., Ordinary, 1 250,000	1	..	1⅜-1⅝
—— 6 per cent. Cum. Pref., 1-305,000	1	..	1-1¼
—— 4½ per cent. Debenture Stock, Red.	100	..	101-104
Edison and Swan United, "A" Shares, 1-99,261	5	—	1¾ 1⅞
—— "A" Shares, 01-017,139	5	—	2¼-2⅜
—— 5 per cent. Debentures	100	—	81-92
—— 4 per cent. Deb. Stock, Red.	100	..	83 85
Electric Construction, Nos. 1 to 112,100	2	..	3/16-7/16
—— 7 per cent. Cumulative Pref.	2	..	1⅛ 1⅛
—— 4 per cent. Perp. 1st Mort Deb.	100	..	77 81
Electrolytic Alkali Co., Ordinary, 1-202,218	1	..	1-1⅛
Ferranti Limited, 6 per cent. 1st Mort. Deb. Stock, Red.	100	..	—
General Electric Company (1900), 5 per cent. Cum. Pref.	10	—	8-8½
—— 4 per cent. 1st Mort. Deb. Stock	100	..	92 96
W. T. Henley's Telegraph Works, Ordinary	5	—	11½-12½
—— 4½ per cent. Preference	5	—	3-3½
—— 4½ per cent. Debentures	100	..	105½ 107½
India Rubber, Gutta Percha, and Telegraph Works	10	..	15 16
—— 4 per cent. Debentures	100	..	97-99
National Electric Construction Co., 1-170,000	1	..	27/32-31/32
Parker, Thos., Limited, Ordinary	10	—	10-10½
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5	..	3¾-4
Telegraph Construction and Maintenance	15	—	31-33 xd
—— 5 per cent. Bonds	100	—	99 102
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	..	9¼-9¾

Electric Lighting and Supply.—

Name.	Amount paid.		Last price
	£		£
Adelaide Electric Supply Co., 6 p. c. Cum. Pref., 1-10,000		..	4¾-5¼
Bournemouth and Poole, Ordinary	10	—	10 11
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	—	10 10½
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	10¼ 10¾
—— 4½ per cent. Debenture Stock, Red.	100	..	99 101 2
Bromley (Kent) Electric Light and Power Co.	5	—	4¾ 5¼
—— 4½ per cent. 1st Debenture Stock, Red.	100	—	98 100
Brompton and Kensington, Ordinary	5	—	7¾ 8¼
—— 7 per cent. Preference	5	—	7¾ 8¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	—	6¾ 7¼
—— Nos. 80,001-100,000	4	—	6¼ 7¼
Cambridge Electric Supply Company, £10 Ord.	8	—	12⅝-13⅛
Canadian General Electric Co., Common Shares	$.00	..	113-123
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	—	99 101 2
Charing Cross, West End, and City Electric Supply, Ord., 1-8,000	5	—	3¾ 4
—— 4½ per cent. Cum. Pref., 1-80,000	5	—	3¾ 4¼
—— 4 per cent. Debenture Stock, Red.	100	—	95 98
—— "City Undertaking," 4½ p.c. Cum Pref., 1-40,000	5	—	3¼ 3¾
—— ditto (1905) 40,001-80,000	5	—	3¼ 4¼
Chelsea Electricity Supply	5	—	3¼ 4¼
—— 4½ per cent Debentures	100	—	101-104
Chicago Edison Co, 1st Mt. 5 p c. 30-yr. Gld. Bds, Red., 1-1,200	$1000	..	98-101
City of London, Ordinary	10	—	9-10
—— 6 per cent. Cumulative Pref.	10	—	10¾-11¾
—— 5 per cent. Debenture Stock	100	—	121-124
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	—	96 99
City of Wellington Electric Light and Power Co, 5 per cent. Registered 1st Debs., Red., 1-1,650	50	..	50-53
Cordoba Light and Power Co., 1st Mt Stl. 5 per cent. Bds., Red., 1-1,000	100	..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-20,000	5	..	4¼-5
—— 5 per cent. Preference, 1-50,000	5	..	4½-5
County of London Electric Supply, Ordinary	10	—	7-8 xd
—— 6 per cent. Cum. Pref.	10	—	10¼ 11¼ xd
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	—	106-109
—— 4½ per cent 2nd Debentures Prov. Certs.	100	—	94 97
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5	—	½-1
—— 6 per cent. Cum. Pref.	5	—	1¼ 2¼
—— 4½ per cent First Mort. Deb	100	—	70 80
Electrical Development Co of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, 0,751-15,750	—	..	78-80 p.c.
Electric Ltg & Traction Co of Aust., 6 p c Cm Pf, 1 30,000	5	—	2¼ 2¾
—— 5 per cent Debenture Stock Red	100	—	85½ 89½
Electric Supply Co of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red	100	—	93½ 96½
Folkestone Electric Supply, Ord. Nos. 1-10,000	5	—	4¼-5⅜
—— 4½ per cent. First Deb. Stock, Red.	100	—	96-99 xd
Hove Electric Lighting, Ord., 1-13,000	5	—	6¾-7¼
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100	..	103-106
Isle of Wight Elec. Lt. and Pwr., 4½ p c. Deb. Stk. Red.	100	—	94-97
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	—	—
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5	—	8¼ 8¾ xd
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	—	94-97 xd
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9¾-10¼
London Electric, Ordinary	5	—	1⅛-2⅛
—— 6 per cent. Pref.	5	—	4¾ 5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	93-96

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Name.	Amount paid.		Last price
	£		£
Madras Electric Supply Corporation, 5 per cent. Construction Deb. Stock., Red. (Prov. Certs.), all paid	—	..	94-97
Metropolitan Ordinary, 100,001-300,000	5	—	5¼ 6¼ xd
—— 4½ per cent. First Mortgage Debenture Stock	100	—	103 107
—— 4½ per cent. Cum. Pref.	5	—	4⅜ 5¼
—— 3½ per cent. Mortgage Debenture, Red.	100	—	87 92
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds., 1935, C 1-1,000 ($100), D 1-3,000 ($500), M 1-4,400 ($1,000)	—	..	74½-76 p. c.
Mexican Light and Power Co., Capital Stock	$100	..	43-45
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14,000 ($1,000)	—	..	82 84 xd
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	—	95-98
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009	5	—	7¼ 7⅜ xd
—— do., 57,010-75,000	5	..	7¼-7⅜ xd
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid)	4	—	7-7½ xd
—— 5 per cent. Pref., 1-57,009	5	—	4⅜ 5⅛ xd
—— do., 75,001-87,500 (issued at 10s. prem., 4s. paid)	4	..	4½-5⅛ xd
Notting Hill Electric Lighting	10	—	11½ 12½
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	—	96 99
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	—	5⅞ 6⅜
—— 4 per cent. Debenture Stock	100	—	95 97
River Plate Electricity Co., Ord., 1-119,687 & 120,501-120,507	1	..	⅜-½
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	..	⅜-½
—— 4 per cent. Debenture Stock, Red.	100	..	95-98
Rosario Electric Co., 6 per cent. Cum Pref., 1-20,000	5	..	5-5½
—— 6 per cent. Cum. 2nd Pref., 1-15,000	4	.	5-5½
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	—	96 98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	—	..	99 101 p. c.
Smithfield Markets Electric Supply, Ord. 1-12,000	5	—	½-1½
—— 4 per cent. Debenture Stock	100	—	71-75 xd
South London, Ordinary	5	—	2 2½
South Metropolitan Electric Light and Power, Ord.	1	—	⅜ ⅜
—— 7 per cent. Cum. Pref.	1	—	1⅛-1⅜
—— 4½ per cent. 1st Mort. Deb.	100	—	100-103
St. James's and Pall Mall, Ordinary, 101-20,080	5	—	7¼ 8⅛ xd
—— 7 per cent. Pref.	5	—	6⅜ 7⅛ xd
—— 5½ per cent. Deb.	100	—	86 91
Urban Electric Supply Co., Ordinary, 8-30-007	5	—	1½ 2½
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	—	2-3
Westminster, Ordinary	5	—	9 10
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	—	5-5½

Electric Tramways.—

Name.	Amount paid.		Last price.
	£		£
Anglo-Argentine, 5½ per cent. Cum. Pref., 1-260,007	5	—	6-6½
—— Ord.	5	—	8⅜-8⅝
—— Permanent 6 per cent. Debenture Stock, 1888	100	—	131-134
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	—	102-105
Barcelona Tramways, Ord., 1-20,000	10	—	—
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	—	—
—— 5 per cent. Deb., Red., 1-600	100	—	—
—— 4½ per cent. Red. Deb. Stock	100	—	—
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1	—	⅜ ⅜
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	—	29/32-1 1/32
Birmingham and Midland Trams., 4½ p c. 1st Db. Stk., Red.	100	—	94-99
Blackpool and Fleetwood Tramroad	10	—	13⅜-13⅝
Bombay Elec. Supply & Trams. Co., 6 per cent. Cum. Pref.	8	..	7⅜-8⅛ xd
—— 4½ per cent. Deb Stock, Red.	100	..	96-97
Brisbane Tramway Invest., Ord., 1-75,000	5	—	3⅛ 3½
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	—	4⅜-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	—	96 100
British Columbia Electric Railway Co., Ord. Def.	100	—	127-132
—— Ord. Pref.	100	—	110-114
—— 5 per cent. Cum. Perpetual Pref. Stock	100	—	103-106
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	—	100-103
—— 4½ per cent. Vancouver Power Deb.	100	—	100-102
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	—	2½ 3
—— 6 per cent. Cm. Pf., 30,001-60,000	10	—	7 7⅛
—— 5 per cent. Perpetual Debenture Stock	100	—	100-103
—— 4½ per cent. 2nd Deb. Stock	100	—	78-81
Buenos Ayres and Belgrano Trams.	5	—	4⅛-4⅜
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	—	4⅜-5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	4⅜ ⅛
—— 5 per cent. Deb. Stock, Red.	100	—	105-115
—— Prov. Cert., all paid	100	—	100-103
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100	—	92-97
Buenos Ayres Gl. Nat. Trams Co., 5½ per cent. Pref. Deb. Bonds, Red., 1-1,500	100	..	99-103
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	..	101-106
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	93-96
Calcutta Tramways, 1-105,000	5	..	7¼ 8
—— 105,001-137,610	5	..	7⅛ 7⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	—	102 106
Cape Electric Tramways, Nos. 1-480,000	1	—	5/16 7/16
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	—	4⅜ 5
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100	—	98 101
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	..	5 3/16-5 7/16
—— 4 per cent. Deb. Stock, Red. 1985	100	..	97-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	00	—	94 98
Cork Electric Tramway and Lighting Co., Ordinary	10	—	13½-13⅝
—— 6 per cent. Cum. Pref.	10	—	13-14
—— 4 per cent. Debentures	100	—	98-101
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	—	13¼-13⅜ xd
—— 6 per cent. Pref., Nos. within 1-60,000	10	—	12⅜ 13⅜ xd
—— 5½ per cent. Mort. Debs., 1-3,000 Red.	100	—	93-97
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100	..	98-101
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6,957	$1,000	—	83-88
Imperial Tramways, Ordinary	all	—	18-19
—— 6 per cent. Cum. Pref.	all	—	14-14½
—— 4½ per cent. Deb. Stock	100	—	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5	—	1 1⅛
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	—	66-71
Kalgoorlie Electric Tramways, 1-250,000	1	..	5/32-5/32
—— 5 per cent. "A" Deb. Stock	100	..	89-93
—— 6 per cent. "B" Deb. Stock	100	..	78-82
Kidderminster and District Lighting and Traction, Pref.	5	—	8-8½
Lancashire United Tramways Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	—	94-97
—— £296,500 2nd Mort. Deb Stock	—	—	—
—— £83,330 Deferred Deb. Stock (all fully paid)	—	—	—
Lisbon Electric Tramways Limited, Ord., Nos. 1-594,188	1	..	1 1/16-1 5/16
—— 6 per cent. Cum. Pref., Nos. 1-425,563	1	..	1 1/16-1 3/16
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100	..	95 98
London United Trys. (1901), 5 per cent. Cum. Pref.	10	—	7⅜ 8⅛
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	—	84-88
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Rd.	100	—	96-99
Manila Elec. R.R. and Lghtg. Corp., 5 p.c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000	..	93-95
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 23,436-25,000	5	..	4⅜-5⅛
—— 4½ per cent. 1st Mort Deb. Stock, Red.	100	..	97-100
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	—	3/32 5/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	—	27/32-31/32
—— 4½ per cent. Deb. Stock, Red.	100	—	94-97
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	—	..	83½-85½ p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	—	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 601-2,000 (1922)	100	—	101-103 xd
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	—	⅜-1⅜
Oldham, Ashton, and Hyde Tramway. Ordinary	10	—	1⅜
—— 6 per cent. Cum. Pref.	10	—	8⅜-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100	—	100-104
Potteries Electric Traction, Ordinary, 1-245,000	1	—	5/16-9/16
—— 5 per cent. Cum. Pref., 300,001-545,000	1	—	9/16-13/16
—— 4½ per cent. Debenture Stock	100	—	95 98
Provincial Tramways Co., Ordinary, 1-24,912	10	..	4⅛-5
—— 6 per cent Cum. Pref., 1-10,000	10	..	10½-11½
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-30,000	5	..	5⅛-5⅜
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	97-99
Sao Paulo Tramway, Light, and Power Co.	$100	..	118-122
—— 5 per cent. 1st Mort. Deb., Red. 1929, 1-11,000	$500	..	93-95 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1	..	⅛-1 xd
—— 4 per cent. Deb. Stock, Red. 1940	100	..	80-84
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs, Red., 1-1,600	100	..	84-88
Yorkshire (West Riding) Elec. Tram Co., Ord., 70,001-110,000	5	..	1-1⅛
—— 6 per cent. Cum. Pref., 1-46,261	5	..	3⅛-3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	87-90

Electric Railways.—

Name	Amount paid.		Last price
	£		£
Central London, Ordinary	100	—	73-75
—— 4 per cent. Pref.	100	—	92-94
—— " " deferred	100	—	53-56
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	—	102-105
City and South London, Consolidated Ordinary	100	...	46-47
—— 4 per cent. Debenture Stock	100		102-105
—— 5 per cent. Pref. Stock '91	100	—	117-121
—— " " " '95	100	—	115-118
—— " " " '01	100	—	110-113
Liverpool Overhead, 5 per cent. Pref.	10	—	10-10½
—— Ordinary, 1-50,000	10	—	3⅜-4⅛
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	—	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	...	64-67

Telegraphs and Telephones.—

Name.	Amount paid.		Last price.
	£		£
Amazon Telegraph Co., 1-25,000	10	..	3-3½
—— 5 per cent. Debs., Red., within 1-1,069	100	..	85-88
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000	$1,000	..	90-92
Anglo-American Telegraph Co., Ordinary	100	..	61-64 xd
—— 6 per cent Preferred Ordinary	100	...	107½-108½ xd
—— Deferred Ordinary	100	...	17⅜-17⅝
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort Deb. Stock, Red.	100	...	101-104
Chili Telephone Co., 1-44,000	5	...	6⅜-7¼ xd
Commercial Cable Co., Ster. 500-year 4 p.c. Deb Stk., Red.	100	...	92-94
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	...	7½-8½
—— 10 per cent. Preference, 1-6,000	10	...	15⅜-16⅜
Direct Spanish Telegraph Co., Ordinary	5	...	3⅜-3⅝
—— 10 per cent. Cum Preference	5	...	9-9½
—— 4½ per cent. Debs., 1-600	50	...	99-101
Direct United States Cable Co.	20	...	15½-15⅝
Direct West India Cable Co., 4½ per cent. Debs., Reg. within 1-1,200, Red.	100	...	99-101
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 19 9	100	...	97½-100½ xd
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8,000, 1913	25	...	98½-100
Eastern Extension, Australasia and China, 1-300,000	10	...	12⅛-13⅜
—— 4 per cent. Mort. Deb. Stock, Perp.	100	...	102-104
Eastern Telegraph Co., Ordinary Stock	100	...	134-139
—— 3½ per cent. Preference Stock	100	...	88-90
—— 4 per cent. Mortgage Debenture Stock	100	...	103-105
Great Northern Telegraph Co. (of Copenhagen)	10	...	34-36
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1,200, Red.	100	...	99-101
Indo-European Telegraph Co.	25	...	56-58
Marconi's Wireless Telegraph Co., 1-256,127	1	...	⅛-¼
—— 256,128-384,190	1	...	⅛-¼
Monte Video Telephone Co., Ordinary, 1-72,680	1	..	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492		...	⅞-1
National Telephone, Preferred	100	...	106½-108½ xd
—— Deferred Stock	100	—	105-107 xd
—— 6 per cent. Cum. First Pref.	10	—	11-13 xd
—— 6 per cent. Cum. Second Pref.	10	—	9½-11½ xd
—— 5 per cent. Non. Cum. Third Pref.	5	..	5 5/16-5 9/16 xd
—— 3½ per cent. Deb. Stock, Red.	100	—	95½-97½
—— 4 per cent Deb. Stock, Red.	100	—	100½-102½
Oriental Telephone and Electric Company	1	..	1⅛-1⅜
—— 6 per cent. Cum. Pref.	1	..	1 3/16 1 5/16
Pacific and European Tel., 4 p c. Guar. Debs., Red., 1-1,000	100	...	91-94
United River Plate Tele. Co., Ordinary, 1-100,000	5	...	6½-7¼ xd
—— 5 per cent. Cum. Pref., 1-40,000	5	...	5-5½
—— 5 per cent. Debenture Stock, Red.	100	...	—
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	...	98-101
West African Telegraph Co.	10	...	10-10½
West Coast of America, 1-30,000 and 53,001-53,003	2½	...	1⅜-1⅝
—— 4 p c. Debs., 1-1,500, Gua. by Western Telegraph	100	...	97-100
West India and Panama Telegraph Co., Ordinary	10	...	7/16 9/16
—— 6 per cent. Cum 1st Preference	10	...	7⅛-7⅜
—— 6 per cent. Cum. 2nd Preference	10	...	6½-7½
—— 5 per cent. Debs., Red., 1-800	100	...	99-102
Western Telegraph Co., 1-207,930	10	...	13½-14
—— 4 per cent. Debenture Stock, Red.	100	...	100-103

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.							Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1907.	1906.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Aug 7	1,531	1,612	− 31	— h	25½	25	May 31	64,071	15,530,351	1,379,723	0 98	11·14	2,512	6·45
Ayr Corporation	,, 10	447	495	− 48	—	8	8	,, 15	14,328	3,316,380	353,945	1	9·71	1,850	5·16
Baker Street and Waterloo Ry.	,, 10	2,115	1,231	+ 884	+ 6,641	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 11	1,375	1,209	+ 167	− 871	23 53	3·53	March 31	55,025	11,145,531	1,309,903	1·18	10·08	2,338b	6·03
Birmingham Corporation	,, 10	6,844	—	—	—	56½	—	,, 31	17,133	4,709,788	266,526	·86	14·5	8 866	—
Blackburn Corporation	July 21	1,105	1,036	+ 9	+ 777	24	24	,, 25	48,875	8,661,720	986 953	1·35	11·29	2,036	7·44
Blackpool Corporation	Aug. 8	3 359	3,454	− 95	− 1,714	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	,, 10	2,478	2,728	− 250	− 680	16½	16½	Dec. 31	31,846	2,325,677	579,264	3·28	13 19	—	7·27
Bolton Corporation	,, 11	2 660	2, 45	+ 517	+ 2,597	42	40	March 31	95 766	20,205 196	2,161,130	1·13	10 63	2 394	6·14
Bournemouth Corporation	,, 7	2,758	2,743	+ 15	+ 551	17·41	16·82	,, 31	55,276	10,058,288	1,121,623	1·32	11·83	3 226	7·19
Bradford Corporation	,, 10	5,385	5 421	− 44	+ 234	95	95	,, 31	230,085	47,1?8,000	5,053,392	1·172	10·927	2,395	—
Brighton Corporation	,, 11	1,814	2,135	− 319	− 2,059	9½	9½	,, 31	50,339	11,321,160	1,152,828	1·06	10·48	2,914·8	8·0·4
Bristol Tramway Company	,, 9	6 875	6,959	− 84	—	51½	51½	Dec. 31	259,799	45,312,373	6 127,135	—	—	—	—
Burnley Corporation	,, 10	1,355	1 317	+ 38	—	40	40	March 31	57,9?2	11,092,704	1,197,772	1·31	11 61	5,388	8·17
Burton Corporation	,, 11	366	387	− 21	− 303	8½	8½	,, 31	17,950	3,878,269	454,082	1·07	9·21	2,0·8	6·76
Cardiff Corporation	—	—	—	—	—	32 62	†32·26	,, 31	112,209	24,134,363	2,770,049	1·12	9·72	3,782	9·44
Carlisle Tramways Company	,, 10	213	233	− 20	− 4·2	8 5	8·5	Dec. 31	10 713	2,935 002	359,756	—	7·14	—	5 18
Central London Railway	,, 10	4,267	4,877	− 610	− 2,555	6	6	,, 31	347,588	4,875,547	1,281,214	1 86	65·10	57,931	35 80
Charing X, Euston, & Hamp. Ry.	,, 10	2,955	—	—	—	8	—	—	—	—	—	—	—	—	—
City and South London Railway.	,, 11	2,106	2,266	+ 840	+ 4,072	6½	6½	,, 31	—	—	—	—	—	—	—
Colchester Corporation	May 8	195	195	—	—	8	8	March 31	10,588	2,457,553	220,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	Aug. 8	535	615	− 77	− 549	15½	15½	Dec 31	24,895	5,814,376	882,256	1·01	6·64	—	4 69
Darwen Corporation	,, 9	260	276	− 16	− 18	7 23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	,, 10	353	439	− 86	− 698	4½	4½	,, 31	11 250	2,853,200	284,343	·94	9·49	2,100	—
Dublin and Lucan Electric Ry.	,, 9	2 6	186	+ 20	+ 37h	6½	6½	Dec 31	6 358	402,511	110,738	3·79	13·78	942	7·33
Dublin U.T.	,, 9	8,493	6,604	+1,888	+10,136	48½	48½	,, 31	267,489	50,050,949	7,077,372	1·18	9·07	691	5 55
Dundee City Tramways	,, 7	1,094	1,116	− 22	+ 283	22	22	May 15	60,154	13 086 396	1,005 911	·906	11·96	2,180	7·42
East Ham Corporation	,, 10	1,164	1,188	− 24	− 416	14	14	March 31	36,652	3,689,658	863,816	·64	10 18	2,9·4	6 79
Glasgow Corporation	,, 10	17,218	17,176	+ 122	+ 2,014h	79½	79½	May 31	756 480	195,767,519	17,945 595	—	10 12	—	—
Gloucester Corporation	July 10	278	304	− 26	—	15	15	March 31	15,465	3,902,077	563,595	·60	6·68	939	5·32
G.N., Piccadilly, and Brompton.	Aug. 10	3,590	—	—	—	9	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	37	37	,, 31	74 019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 10	1,842	1,717	+ 125	+ 1,279	35	35	,, 31	69,938	12 838,150	1 661,262	1·24	9 71	1,923	—
Hull Corporation	,, 10	2,685	2,552	+ 133	+ 2,138	26	26	,, 31	112,651	27,10?,921	2,910,698	1	9 29	—	—
Ilford Corporation	—	—	—	—	—	10½	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 7	197	197	—	+ 158	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	11,586	3,626,656	419,800	·737	6 62	1 480	5·22
Lancashire United Tramways	,, 7	1,811	1,394	+ 417	+10,229	38½	28	—	—	—	—	—	—	—	—
Leeds Corporation	,, 10	8,119	7 491	+ 654	+ 4,982	89½	89½	March 25	298,233	64,223,666	7,121,038	1 10	10·02	351	—
Leicester Corporation	,, 10	2,805	2 830	− 84	—	42	42	Dec. 31	26,011	12 039,252	1,229,507	1	9·79	—	4 82
Liverpool Corporation	,, 3	11,771	11,266	+ 505	+ 4 650	104	104	,, 31	547,625	116,642 663	12 166 419	—	—	—	—
Liverpool Overhead Railway	,, 11	2,168	1,808	+ 360	+ 1,039h	6·65	6 65	June 30	81,302	11,171,865	1,024,275	—	—	—	—
London County Council	July 27	31,507	27,057	+4,450	+ 80,829	98	98	—	—	—	—	—	—	—	—
Lowestoft Corporation	—	—	—	—	—	6	6	Sept. 30	14,511	3,128 857	359,435	1 08	9 68	2,630	6·48
Maidstone Corporation	—	—	—	—	—	2	2	March 31	4,740	850 121	112,227	1 33	10 13	2,370	—
Manchester Corporation	Aug. 10	16,287	15,713	+ 574	+ 21,411	149	149	,, 31	631,956	125,900,875	14,123,124	1·19	10·73	4,299	6 99
Metropolitan District Railway	,, 4	7,201	7,085	+ 115	+ 124	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 11	13,956	13,645	+ 311	+ 3,090	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 10	158	154	+ 4	+ 42	2¾	2¾	,, 31	6 159	1,992,647	206,358	82	7 14	2,239	—
Newcastle-on-Tyne Corporation	,, 10	4,260	4,137	+ 123	+ 448	50	50	,, 31	197,849	43,06 ,934	4,326,152	1 07	10·98	3,957	7·0
Newport (Mon) Corporation	June 29	639	628	+ 11	+ 1,397	15½	15½	,, 31	30,356	7,252,535	783 435	—	9 29	—	6·4
Oldham Corporation	—	—	—	—	—	34	34	,, 25	65 553	13,466,245	1,504,740	1 16	10·45	1,885	—
Portsmouth Corporation	May 25	2,330	1 578	+ 752	+ 632	28½	28½	,, 31	95,702	19,625,329	197,499	1·17	11 63	—	—
Reading Corporation	Aug. 8	894	898	− 44	− 571	33½	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	11·29	21·29	,, 31	14,881	2,837,110	386,547	1·24	9·24	1,102	7 82
Rotherham Corporation	—	—	—	—	—	9½	9½	,, 31	23,569	5 251,472	593,054	1 07	9·53	2,612	7·49
Salford Corporation	,, 12	4,688	4,393	+ 295	+ 1 812	70¾	70¾	,, 31	214,111	39,213,560	4,894,590	1·28	10 29	—	—
Scarborough Tramways Co.	—	—	—	—	—	4½	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 11	6,050	5,710	+ 340	+ 4,793	35¾	35¾	,, 25	210,5·5	63 952,283	6,049,899	903	9 543	3,653	6·477
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,365	9 294,771	1,108,269	1·27	11·02	—	7·83
Southend-on-Sea Corporation	,, 7	898	899	− 1	− 363	9	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	,, 31	39,550	6,766,031	1,027,730	—	9 23	—	4·75
Sunderland Corporation	,, 4	1,560	1,692	− 131	− 272	20	20	,, 31	64,858	15,364 463	1,495,?85	1·004	10·36	—	6·37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	4,937	1,315,757	102,751	0·87	11 53	1,371	—
Torquay Tramways	Aug 8	382	—	—	—	5·16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 10	1,315	1,231	+ 81	+ 384	12 68	12·43	,, 31	43,607	7,995,451	862,123	9·27	12·14	3,132	7 50
Warrington Corporation	—	—	—	—	—	9	9	,, 31	17,0·7	4,418 225	403 363	—	9 85	—	6·33
West Ham Corporation	,, 8	2,795	2,709	+ 86	+ 1.246	14·7	14 7	,, 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	,, 7	1,122	1,104	+ 18	+ 265	20	20	,, 31	41,905	8,847,066	960,338	—	10 583	2,062	6·13

† And 98 miles of interlacing track. a Train mile. b Per mile of single track. h Half-year's figures. k Double track

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NOTES.

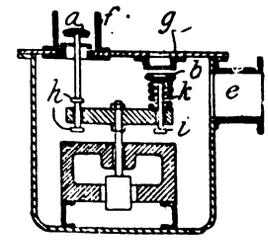
South Africa.—It is just possible that anti-municipalists in England would be rabid municipalists in South Africa. In new townships were the municipality to interest itself in such things as lighting it would be years before private enterprise struck in to carry out the work. Take the action of the little community of Stutterheim, about 50 miles from East London, at the base of the Amatola Mountains, situated in the middle of a rich pastoral district. These people want the township electrically lighted, and for the purpose require a loan of £3,000, the interest on which is to be obtained by renting commonage land. The necessary notice of application to the Governor for permission to lease this land for 21 years has been given, and we trust that very soon this go-ahead township may be blessed with its small but useful installation.

London Traffic.—This question has again been to the fore in Parliament, Lord Ribblesdale having referred to it in the House of Lords on Monday night, when he asked his Majesty's Government what duties were to be attached to the special branch of the Board of Trade recently constituted for the purpose of dealing with matters relating to London traffic, and whether it was intended that this branch of the Board of Trade was to be entrusted with any, and if so which, of the functions which the report of the Royal Commisssion on London Traffic recommended should be vested in a Traffic Board. The reply given by Lord Granard was of a not less shadowy character than that given in the House of Commons last week. It was explained that the action of the Government was only a first step to a "larger policy," and that the new would very rapidly bring the question to a practical issue, and show where legislation is needed by the reports which it would present to Parliament, and by the conferences which it would hold between the various parties promoting schemes of locomotion. Nevertheless, Lord Montague had good reason to say that he thought this appointment of a subordinate department of the Board of Trade was an attempt by the Goverment to shelve all the great questions relating to London traffic.

Steam-Heating Tests.—Mr. Stromeyer, chief engineer of the Manchester Steam Users' Association, has just issued in the form of a memorandum some preliminary results of his investigations into the specific heat of steam. It deals almost exclusively with a report, which is published for the first time, on an investigation by the National Physical Laboratory into pressure gauges. Ten pressure gauges by two of the best known English makers were subjected to a series of severe tests with highly satisfactory results, and give an indication of what may be attained by first-class material and workmanship. The only criticism which the director of the National Physical Laboratory makes is that no attempts have been made to reduce the effect of the influence of changes of temperature. Mr. Stromeyer adds a brief sketch of the development of the pressure gauge, as well as an inquiry into the working not only of pressure gauges but also of numerous barometric and plunger devices for measuring pressures. These instruments seem now to have attained a high degree of perfection. In a previous memorandum it was mentioned that the Manchester Steam Users' Association was giving pecuniary support to the National Physical Laboratory in its researches into the specific heat of steam. The work seems to have been far more difficult and tedious than was anticipated, but some results have at last been obtained, and have been copied from the annual report into the memorandum. They should prove of interest to all who may contemplate using superheated steam.

Accidents caused by Lighting Systems in Germany.—Some curious statistics have been prepared by an engineer well known in Germany showing in tabular form the number and nature of accidents that occurred in the German Empire during the year 1906, due to the employment of various illuminants. Gas lighting caused slight injury to 112 persons; 149 were seriously injured, and 41 fatally injured. In the case of electric lighting 42 persons were slightly injured, 46 seriously injured, and 35 fatally injured. Lamps burning petroleum caused slight injury to 199 persons and serious injury to 218 persons, the number of fatalities with this class of illuminant being 127. Two hundred and fifty-nine persons suffered injury (more or less severe) and 58 were killed from the use of alcohol for lighting. Petrol caused 115 accidents and 13 deaths, while acetylene caused slight injury to 24 persons, serious injury to 34, and 10 deaths From the sparse abstract of the statistics which appeared in a German contemporary, it is seen that 44·4 per cent. of the number of fatal accidents are attributed to petroleum, 20·3 per cent. to alcohol, 14·3 to gas, and no more than 12·2 per cent. to electricity. The majority of the fatal accidents which took place were due to inattention, rashness, and drunkenness, two only being caused by short-circuits. It is obvious that the danger to persons where electricity is employed is very slight compared with the danger where other illuminants are used. It would be interesting to have exactly similar statistics for England and other countries.

Electrically - Operated Valves. — Messrs. W. Lahmeyer and Co. have recently patented an electrically-operated valve mechanism suitable either for direct or for alternating currents, the armature in which is connected to the valve so as to allow a certain amount of play, so that the vibrations of the armature are not communicated to the valve proper. The figure shows a distributing valve mechanism in which the passage *e* can be put into communication through the valve *a*, and passage *f* with the compressed air, gas, or liquid reservoir, or through the valve *b* with the exhaust, *g*. The stem of the valve *a* is fitted with adjustable stops, *h*, to limit the free play of the valve. The stem of the valve *b* has a stop, *i*. In operation one of the valves is always closed. If the valve *a* is closed the admission of fluid is cut off, and the magnet presses the valve *b* towards its seat, acting through the spring, *k*. Before the valve has reached its closing position it is energetically closed by the pressure of the fluid.



Breakdowns of Electrical Machinery. — An interesting table is given in last year's report of the chief engineer of the British Engine, Boiler, and Electrical Insurance Company, Limited, showing the causes of breakdowns in electrical machinery during 1906. It is notable that breakdowns increased in a somewhat lower ratio compared with preceding years. The rate of breakdowns during 1906 among dynamos was 1 in 16, and among motors 1 in 8·2. The rate among continuous-current machines, both dynamos and motors, was twice as high as among alternators. A large number of starting switches have recently been insured, and this shows evidence of the fact that owners have begun to see the advantage of insuring

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these. The breakdowns which were brought to the notice of the company's inspectors during the past year were attributable to the following causes:

	Per cent.		
	Dynamos.	Motors.	Starters.
Accidental	15	9	22
Dirt and neglect	14	19	11
Age and deterioration	21	25	23
Bad workmanship and design	23	18	9
Overloading	0	2	7
Unascertained	27	27	28

In the case of dynamos and motors about 50 per cent. of the breakdowns were thought to be due to failure of armatures and rotors, 20 per cent. of the dynamo breakdowns and 28 per cent. motor breakdowns occurred at the commutators and brush gear, and 11 and 14 per cent. respectively at the magnet coils and stators. Of starting switch and controller breakdowns, 48 per cent. originated at the resistance coils, 10 per cent. at contacts and switch arms, and 17 per cent. at the automatic apparatus, while 25 per cent. were attributed to miscellaneous causes.

Purification of Water by Electricity.—It has long been known that electricity will decompose water into its elements—hydrogen and oxygen. Only during a comparatively recent period has it been found that not only does this decomposition occur, but at the same time the animal and vegetable impurities present are rendered inert. This action is due to the fact that when oxygen is set free from water by a current of electricity it is liberated in its nascent and, to a certain extent, in its ozonised form, and will then energetically destroy all lower forms of animal and vegetable life, so that when a current of electricity is passed through water, the gases produced effectually kill and coagulate the dangerous organic impurities, which may be removed by filtration. Many attempts have been made to utilise means of water purification based on this principle. A method which is said to have met with a large amount of success is that known as the Hinkson electric liquid purifier, to which the *Canadian Engineer* in a recent issue calls attention. This apparatus was devised by Mr. F. B. Hinkson, and it carries out the principle of oxidation, coagulation, and filtration of water by electricity in such a manner as to furnish an absolutely organically pure water in any quantity required, at a cost not exceeding ½d. per 1,000 gallons. It can easily be attached to any water supply, as it does the work under 100lb. pressure, and does not retard the flow but 1½ per cent. The electricity may either be direct or alternating current, or may be furnished by dry cells or batteries. The apparatus is designed so that it is only using current while water flows through, and shuts off immediately the water is turned off at the spigot. It is claimed for this system that it is a means for effectively purifying water for domestic uses at an exceedingly low cost, and results attained where it has been installed are said to bear out this claim.

Effect of Stress upon Corrosion of Iron.—An account of an elaborate research on this subject was given by Prof. W. H. Walker and Mr. Colby Dill at the recent convention of the American Electro-chemical Society. The authors explain that their investigation was undertaken with the hope of throwing some light upon the question of the sign and magnitude of the potential changes caused by straining a piece of iron, particularly below the elastic limit. Some very pure commercial iron (Swedish charcoal iron) was tested in the usual manner to determine the modulus of elasticity and the elastic limit. From these data the maximum amount of work which it is possible to do upon the cubic inch of soft iron by stretching it to its elastic limit was calculated to be 5·16 inch-pounds, which is equal to 5·83 joules. One cubic inch of soft iron varies approximately 126 grains, the specific gravity being about 1·7. The work done in joules per equivalent is, therefore, 1·30, and the change in E.M.F. which would be expected is 1·30 joules divided by 96,540 coulombs, or 0·000134 volt. The magnitude of this charge is thus very small; its direction should be positive, but it is the manifestation of energy stored up in the metal. The maximum charge was 0·0004 volt. The charge, when great enough to be measured, was negative—*i.e.*, the strained metal had a slightly lower potential than the same metal unstrained. Other experiments are described, from which it is evident that somewhere above the elastic limit the potential rises suddenly several hundredths of a volt. The magnitude of the increase depends upon the rate of straining, and ceases abruptly when the straining ceases. Measurements upon specimens under torsional stress give results similar to those obtained from tension tests. Out of a considerable number of specimens strained to breaking, the potential of six reached a constant value shortly after fracture. The difference between the initial and the final potentials varied from − 0·0019 volt to + 0·0077 volt, and the single potential of unstrained iron was found to be 0·156 volt.

Telephone Transformer Apparatus.—A patent recently granted to Messrs. Siemens Bros. and Co. is described as follows: In transformer apparatus employed, as in telephone systems, at the points of connection of alternating-current circuits of different electrical properties, arrangements are made to allow the passage of continuous current between the circuits while preventing its passage from one side to the other of the same circuit, one side of each circuit being in metallic connection through a part of the transformer or auto-transformer coils with the corresponding side of the other circuit, while the condensers, polarisation cells, or the like are inserted between the parts of the transformer windings. As shown in

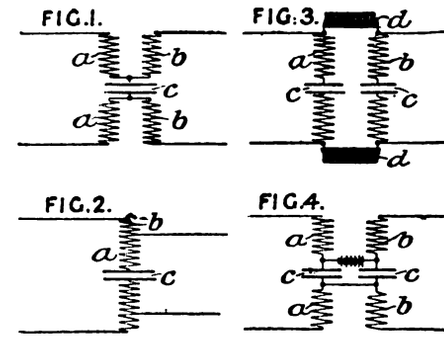

Fig. 1, each half, *a*, of the divided transformer in one circuit is connected by a wire to each respective half, *b*, of the transformer in the other circuit, and a condenser separates the halves. Fig. 2 shows an analogous arrangement with an auto-transformer. In the arrangement shown in Fig. 3, separate condensers are employed and the connections are made through choking coils, *d*. In that shown in Fig. 4, applicable to a central-battery telephone installation, the connections are made through the battery on one side and a plain wire on the other. The transformers may have separate or common cores forming open or closed magnetic circuits, or they may be coreless.

Electrical Openings in India.—In a United States consular report some interesting data are given with regard to Indian electrical developments, which deserve the careful attention of an English audience. Though some of the matters reported upon have already been dealt with in these columns, interest in them is still sufficiently fresh to warrant further attention. Mention is made first in the report of the little city of Poona, near Bombay, in which an extensive electric car system has just been inaugurated.

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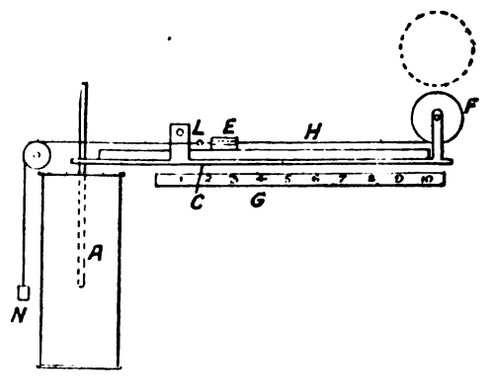
A Bombay firm has made a start with a scheme to provide Poona with electric energy for lamps, motors, and cars. The supply at first is to be confined to the municipal limits of Poona, and this area enlarged as the demand requires. It is proposed to supply the energy from a central station, and to lay underground mains or to erect overhead wires as may be approved by the local government. All the streets to be supplied are under control of the municipal government, but it is already understood that there will be no opposition by Government to the proposed scheme. We come next to a paragraph in the report in which the consul states that "no country stands as well in India as America in regard to all kinds of electrical machinery and supplies, as well as to methods in the use of them. American electrical engineers are considered the best in the world, and it is suggested that they pay some attention to the Poona proposition." The extensive electrical works in Kashmir, under the direction of American elec trical engineers, are said to be making rapid progress towards completion. The power is derived from the Jhelum River, below Baramulla. The big flume capable of carrying 20,000 h.p. is completed, and the turbines to furnish 5,000 h.p. are being installed. Electrical energy for mills and other purposes will be conveyed to Serinagur, many miles away. The scheme is a large one, and great commercial results are confidently expected. The comfort and convenience that will necessarily follow to a large territory occupied by millions of people would be hard to describe. The items of lighting and operating electric fans alone are worth the expenditure on this great enterprise.

High-Efficiency Lamps and the Central Station. Some questions relating to the introduction of the new electric lamps were discussed from the central station point of view by Mr. R. S. Hale at the recent convention of the Illuminating Engineering Society, Boston. Mr. Hale believes that while too great an improvement in illuminants may cut down the sales of electricity, there is an intermediate point where the improvements may actually increase sales, and the improvements that are now apparently coming on in the opinion of the author are about this point. Touching on the question of free lamp renewals, he states that the immediate result to a central station that supplies free lamp renewals is a very important one. With the new illuminants the effect will be to give the customer more light in proportion to the money paid, which may result in a decrease in income, followed possibly by an increase. He shows that the falling off in income due to a sudden introduction of the tungsten lamp might be very much greater than the falling off in expense, since the latter is not affected by the immediate use of energy. The cost of renewals is also important, since if this is large in proportion to the cost of electricity, it is difficult to handle the question of free renewals. Therefore, from a central-station point of view, the new illuminants should be developed along the line of lamps whose renewal cost will be small in proportion to the cost of electricity, or otherwise the central stations will be forced to give up the policy of free lamp renewals. This situation, he adds, has actually arisen to-day in the case of very large wholesale customers using electricity for very long hours. On the other hand, small consumers object to paying for tantalum lamps, even though the combined cost of the lamp and the energy used is less for a 22-c.p. lamp than for the cost of energy alone used by the ordinary 16-c.p. lamp. The same is true of the flame arc lamp, the customer rather paying a greater amount for energy used than to pay two charges even if the total of the two were less than the charge for ordinary arc lamps. When central stations supply lamps they must handle the question so as to give as small a temporary loss of income as possible, and so as to get the final result from the new illuminant as quickly as possible.

Current Meters.—Mr. W. W. Lackie, electrical engineer to the city of Glasgow, has patented a device for measuring electrical currents. A maximum-current indicator comprises a pivoted lever, C, connected to the core of a fixed solenoid, A, so as to be tilted when a certain current passes. The tilting connects a wheel, F, carried by the lever, with a wheel of the counting train of a watt-hour or other meter, so as to move a weight along the lever till the latter is tilted back. The position of the weight indicates the current strength. The time taken to tilt the lever back is approximately the same for all currents, and depends on which wheel is used as driving wheel. According to the provisional specification the lever is trough-shaped, and the driving wheel may belong to clockwork, driven



electrically or by a spring so as to make the apparatus complete in itself. In the arrangement shown the wheel, F, winds in a cord, H, which passes through the weight, E, and moves it by a stop, L. When the lever tilts back, the cord is unwound by a weight, N, leaving the weight, E, for its position to be read from a scale, G, on or separate from the lever. The cord may be fixed to the weight, E, the part to the left being omitted, but in that case a further increase of current would be recorded in a shorter time than the original current. In a modification the driving wheel or bevel gearing, or a cord therefrom, rotates a long screw so as to move a nut along the lever. A pulley with a weighted cord or a spring may be provided to rotate the screw back when the wheels are out of gear, returning the nut, but leaving an indicator piece which the nut pushes. In a third form a rack is moved along the lever by a pinion which engages with the driving wheel. In modified forms the lever is hung from hooks, and the solenoid is above the lever, its plunger being connected between the pivot and the weight.

Transformer Connections.—The relative advantages of delta and star transformer connections frequently occur in the selection of three-phase power-house and sub-station equipment, both with and without a grounded neutral connection. No hard-and-fast line can be drawn between the sizes best adapted to each style of connection, and a proper decision can only be made with local conditions in mind, influenced by the characteristics of delta and Y windings as modifying the price, weight, and reliability of the capacities demanded. The question is discussed in our contemporary the *Street Railway Journal*, and the considerations bearing upon the respective systems clearly set forth. With the delta connection the pressure across the terminals of one phase is the same as that of a circuit to which they are connected, but in the case of a Y connection each winding furnishes only 57·7 per cent. of the line or 'bus potential. The current in one leg of a delta winding is 57·7 per cent. of the line current, while in a star system each leg carries

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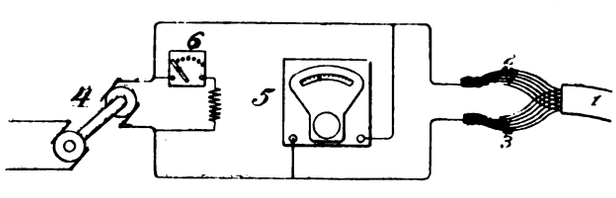
100 per cent. line current. For a given transmission voltage the star connection theoretically allows the use of smaller transformers, although the actual saving is not large, and the installation is not subjected to over 58 per cent. of the voltage normally. The size of the wire must be increased, but in small transformers, where the insulation takes up a considerable portion of the volume of the coil, and where the wire is of small cross-section, the star connection probably gives a better mechanical construction. Less insulation is required when the neutral is grounded than when the delta connection is employed. With the grounded neutral there is less strain on the apparatus in the case of the line grounds. As the sizes of transformers increase the insulation advantages of the star connection become of less moment, and the flexibility of the operating arrangement tends to become important. If the transformers are connected in delta and one coil breaks down, the voltage relations are not seriously disturbed, and the transformers will keep in service. The faulty one can then be disconnected, and three-phase current at full line potential obtained from the other two. In a three-transformer Y system, in case of the failure of one unit, the tendency is for the entire system to break down, though with a grounded neutral operation will be possible in many cases. A general summary of the observations made by our contemporary leads to the conclusion that the reliability desirable in heavy power work seems better served by the use of the delta winding, though in very high potential practice the Y should be considered seriously on its merits as applicable to the conditions so far as known.

Drying Cables.—The *Western Electrician* describes a new electrical process of drying cables. As shown in the accompanying drawing, the method is to fan out the conductors into two groups, each comprising a wire from every pair in the cable. The two groups are connected to a generator capable of giving the required range of voltage, one group being connected to each terminal, and an E.M.F. is established between the members of each pair of conductors of the cable sufficient to cause a flow of current through the moisture remaining in the insulation, electrolytically decomposing the moisture. As decomposition



progresses the insulation resistance gradually increases, and in order to maintain a flow of current strong enough—that is, above the critical value required for electrolysis—the impressed E.M.F. may be gradually raised, but not, of course, beyond the dielectric strength of the cable. Regulating the voltage by means of a field regulator, 6, or otherwise, so that the voltmeter, 5, connected across the terminals indicates an E.M.F. of, say, 100 volts, the voltage may be gradually increased at intervals of half an hour or so, as the insulation resistance rises, due to the decomposition of moisture, until the resistance is increased to the required value. This may take, say, from two to six hours. The increase in voltage is, of course, limited by the dielectric strength or breaking-down point of the cable being dried; and if the insulation resistance is still below the desired value when this limit is approached, the intensity of current required for electrolysis may then be further maintained by temporarily increasing the conductivity of the moisture remaining in the insulating medium by means of heat. This may be produced by applying an alternating E.M.F. from a suitable generator to the two groups of wires, 2, 3, to develop the heat in the dielectric itself by molecular action set up therein; or strong current may be passed through some or all of the conductors of the cable to heat the conductors by the $I^2 R$ effect. To facilitate the drying out of the cable any or all of the foregoing means may be employed, but ordinarily a cable would have sufficient dielectric strength to withstand the voltage required to produce the necessary electrolysing current without resorting to the heating process. The above arrangement is not the only application of the principle that may be employed. For example, the electrolysing current may be passed from all the wires to the metallic sheath of the cable, from one layer of wires to another, from one wire to another, or from any group of wires to a single wire or to another group.

Central Stations and Isolated Plant.—A great many industrial establishments still possess private plant for the generation of the electrical energy required in the works, and the problem which, therefore, faces the industrial manager is whether an isolated plant service or service by a central station is the more economical. There is a general tendency in all classes of industry towards greater centralisation, and the power supply industry forms no exception to this tendency, for on every hand there is to be seen an extension of the areas over which a public supply is available. It is obvious, therefore, that there must be no little competition between each class of service, as well as needless duplication, which central stations, on whose side there are definite favourable conditions, are endeavouring to remove. It is essential that a power user should thoroughly understand and weigh the considerations governing the selection of each class of service, and should appreciate the limitations of isolated plant. The question is discussed in the current issue of *Cassier's Magazine* by Mr. H. S. Knowlton, who indicates the various conditions bearing upon the selection of a power supply, and insists that these conditions should be given some sort of financial value. Obviously, the first task to attempt is to determine as closely as possible the immediate power needs and maximum and minimum loads at different periods. Having obtained the probable load curve of the plant, the capacity guarantees of manufacturers, and first cost proportions for equipment, it should not be difficult to determine the necessary investment to handle the business. We may turn to an example of the cost of energy obtained from a private plant, as worked out by Mr. Knowlton. He assumes a 300-kw. isolated plant; the net cost of generating power on a 30 per cent. load factor 300 days in the year may, he says, by good management, be brought as low as 1¼d., but adding fixed charges, consisting of 5 per cent. interest, 8 per cent. depreciation, and 2 per cent. insurance, taxes and space valuation for renting and storage, the actual power cost works out to a fraction above 1¾d. per kilowatt-hour. This figure comes close to the average central-station rate, but it will certainly not appear so favourable unless, as in the case of a colliery, where the cost of fuel is a comparatively unimportant item, or where exhaust steam is employed. Nor must we overlook the advantages of a central-station supply to the consumer, who is relieved of the worry incidental to the erection of the plant, piping, etc., who can immensely increase his motive power within a short time at little or no trouble, and is thus free to concentrate his energies upon the details of his own business. Mr. Knowlton asserts that while everything favours the central station in most cases, the business of electrical supply will have to be greatly improved before the isolated plant will be needed no more, and he foresees that there will be room for many isolated plants for a long time to come.

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Nevertheless, he admits that the tendency of the time is in the opposite direction.

British Commercial Attaches.—The intrusion of business men and business matters into the foreign legations of His Britannic Majesty must seriously disturb the serene atmosphere of those homes of effete dignity and etiquette, and we can imagine those pampered sons of luxury who have been wont to embellish the places by their presence looking a little askance at the prospect of having to descend from the ranks of diplomatic gossip into the arena of commerce. There is, happily for these functionaries (and for British commerce), hope that commercial matters will be dealt with by a separate branch, according to a new system suggested by Sir Eldon Gorst and Mr. Llewellyn Smith in a parliamentary paper just issued on the present system of British commercial attachés and commercial agents abroad. The duties of commercial agents have never been strictly defined. They consist in watching and reporting on the commerce, industries, and products of special districts, and in answering inquiries on commercial subjects. But, so far as we can gather, the expectation that British firms would utilise their services for the purposes of conducting special inquiries at a distance has not been realised. The present arrangements for commercial agents are, apparently, entirely temporary and provisional, and both Sir E. Gorst and Mr. Smith see no reason why their functions should not be equally well discharged by the consular staff, strengthened where necessary for the purpose. Two principal defects are pointed out in the existing system of commercial attachés. In the first place, long residence in a foreign country is not favourable to an up-to-date knowledge of industrial developments at home; and, in the second place, there is a tendency to devolve upon the attaché all the current commercial work of the diplomatic mission to which he is attached, with the result that it is difficult for him to visit the commercial and industrial centres within his district. With a view of providing a foundation for a more efficient system, Sir Eldon Gorst and Mr. Llewellyn Smith make tke following among other recommendations: (1) the existing commercial attachés residing in European capitals, including the present commercial agent in Russia, who should be made a commercial attaché, to have their headquarters in London, and to divide their time between special investigations abroad, particularly in districts of interest to British manufacturers, work in the Board of Trade, or the commercial department of the Foreign Office, and visits to manufacturing districts in the United Kingdom; (2) the commercial attachés at the more distant posts and in the countries where special qualifications other than commercial are the chief requirements—such as Turkey, China, etc.—to continue to have their headquarters in those countries, but to be relieved so far as possible of the current commercial work at the embassies and legations, to be required to move about freely within their districts, and to pay periodical visits on duty to the principal centres of industry in this country, and to the departments charged with commercial matters; (3) the present temporary arrangements for commercial agents to be discontinued, and the functions now performed by these agents to be assigned to the members of the consular service.

Registration of Electrical Contractors.—It has always been the desire of the members of any profession to limit their ranks as far as possible to those only who, by the efficient conduct of the duties appertaining to their respective spheres, show themselves adequately qualified for honourably upholding the traditions of their profession. This peculiar trait in English industrial character has its origin in the dim and distant past, when the various trades' guilds bound together those who were already engaged in the arts and crafts, and prepared others for entry therein. That same spirit has filtered through the different ages down to the present era, and we have it with us even to-day, though in a different form. The technical, medical, and learned societies, which have arisen from the desire of men labouring in the same field to bring into prominence the results of individual effort, and to give to these the widest application; those societies and institutes which, while encircling the different professions and promoting the common interests of their members, yet fix a standard of knowledge or experience, or both combined, to which an applicant must attain before gaining entry, are really a survival of the ancient guilds. Concurrently with this growth of voluntary association there has developed another form of "protected" industry—*i e*, that which is allowed to be carried on only under licence from the State or other authority. Though, on the surface, the connection between these two branches is not altogether obvious, it nevertheless exists in an indirect way, as is shown by the achievement of a like end, for licensing in many cases amounts to no more than the State enforcement of regulations which have not been established, or looked upon as binding, by the custom of a particular trade. In the electrical industry membership of the Institution is regarded as a sufficient passport. But it is by no means a guarantee that the member is fully qualified to engage in every branch of the industry, just as, on the other hand, a person may be a fully qualified engineer without becoming a member or associate of the Institution. This is one of the results of the exceptional specialisation which is rife in these days, an instance of which is furnished by the case of electrical contracting work, which requires a careful preliminary training and a great deal of skill on the part of the workman engaged in wiring, for careless and inefficient work is liable to give rise to much danger both to life and property. The proposal to license electrical contractors has often been mooted, and it is not unlikely that more will yet be heard of it. We do not think that licensing is looked upon with favour by many contractors, though there is, no doubt, a large consensus of opinion in its favour. It raises the problem as to who should be the licensing authority—the State, the municipality, the Institution of Electrical Engineers, or an association of contractors. It also leaves open for decision whether the contractor only or his workmen also should be licensed, and a host of other questions. If licensing is the only means of retaining public confidence in electrical work, there is nothing that can prevent its ultimate adoption. But have electrical contractors exhausted every other means of ensuring this? By fixing a standard of education for wiremen, and awarding a diploma for practical efficiency, they will do much towards raising the status of the trade and inspiring the public with confidence in their work. In this way the charlatan, the adventurer, and the untrained and inexperienced workman will be kept out. There is plenty of scope here for the operations of the Electrical Contractors' Association, and by working actively in this field they will greatly enhance their useful record. At the same time, the association deserves wider recognition among contractors than apparently it receives. With adequate support it should attain a position of some power and authority, so that, in addition to safeguarding the interests of contractors in purely business matters, its membership would be looked upon as a hall-mark of efficiency and reliability. Moreover, there is no reason why the association should not further extend its sphere of usefulness in interesting itself in the training and equipment of electrical artisans.

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GREAT WESTERN RAILWAY.

Electric Power and Lighting and the Electrification of the Hammersmith and City Railway.

(Continued from page 225.)

SUB-STATIONS.

The Royal Oak sub-station is equipped with four 400-kw. traction motor converter sets, worked in parallel with a battery having a one-hour discharge rate of 1,680 amperes, in conjunction with reversible boosters. The sub-station also contains two 200-kw. motor converters for direct-current lighting and power purposes. The Shepherd's Bush sub-station (Fig. 5) is equipped with seven 400-kw. traction motor converters, worked in parallel with a battery having a one-hour discharge rate of 840 amperes, in conjunction with reversible boosters. The Old Oak Common sub-station is equipped with one 400-kw. and two 200-kw. motor converter sets for direct-current lighting and power purposes. From each of the three sub-stations high-tension distributor feeders are run from the high-tension 'bus bars to the various distributing centres (Figs. 6 and 7). All three sub-stations are designed so that they may be developed on the same lines, and Royal Oak, being the most representative sub-station, is most suitable for a detailed description.

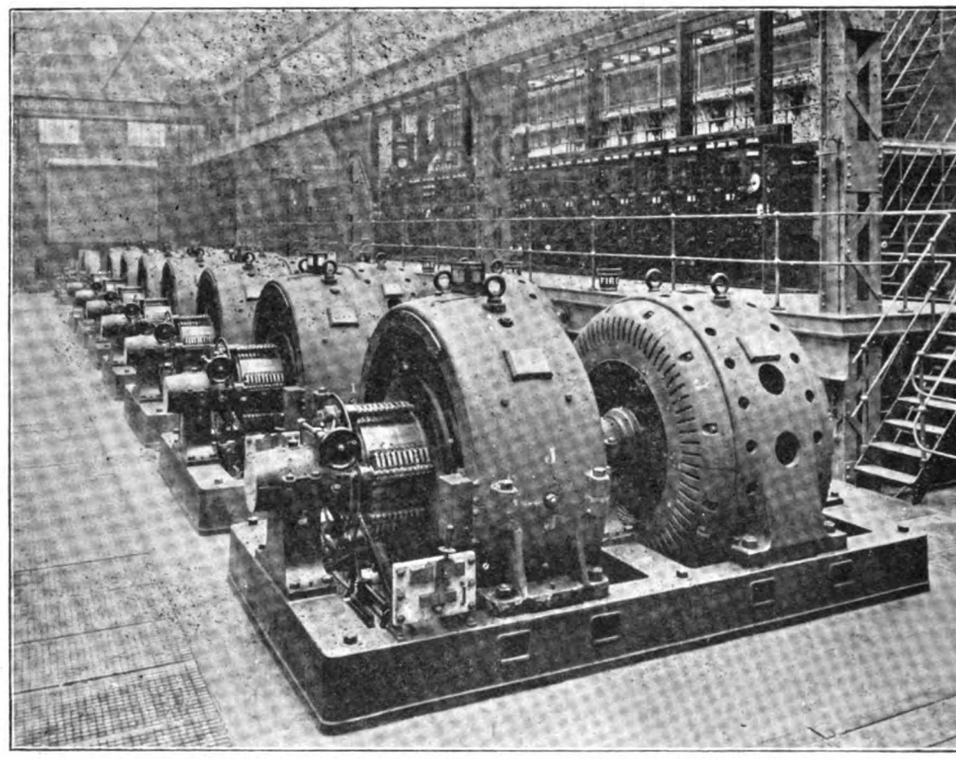

FIG 5.—Motor Converters and H.T. Switchboards at Shepherd's Bush Sub-station.

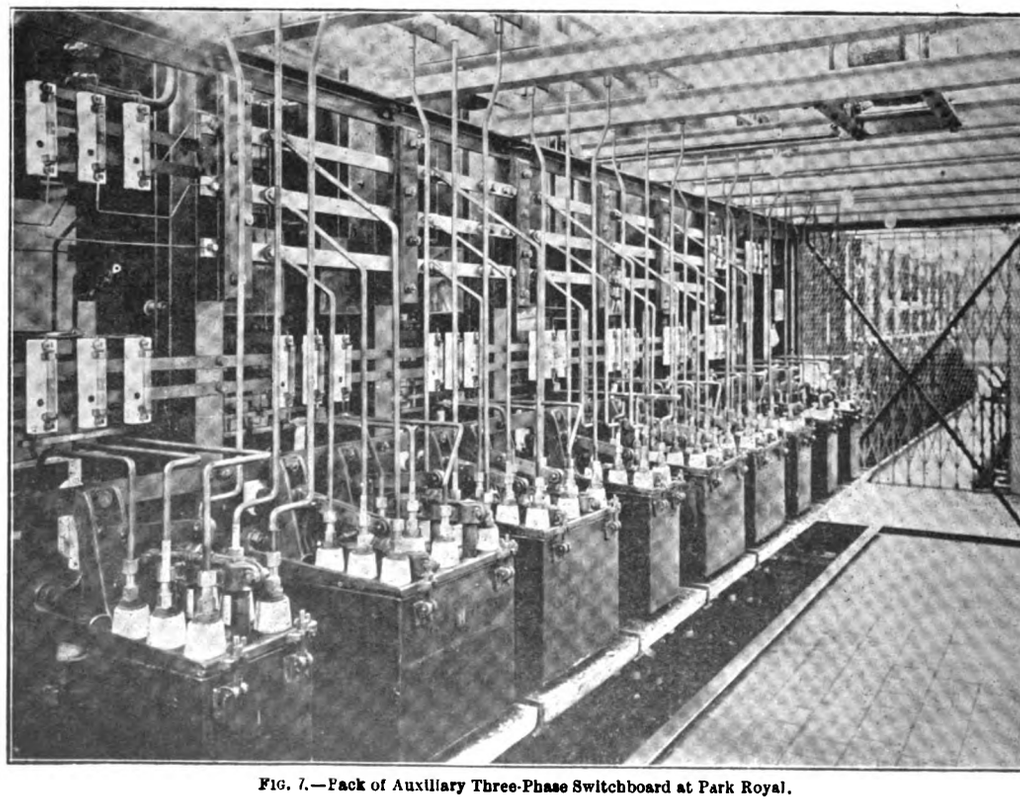

FIG. 7.—Back of Auxiliary Three-Phase Switchboard at Park Royal.

DISTRIBUTING CENTRES.

There are 11 distributing centres, in which the 6,500-volt three-phase current from the sub-stations is stepped

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down to either 220 or 110 volt three-phase current for the lighting and power circuits. Each centre consists of a brick chamber, the usual dimensions being about 20ft. by 12ft by 9ft. high, five of these buildings being placed above ground, four in the neighbourhood of Paddington Station being in the form of underground chambers, and the remaining two forming the transformer rooms at Shepherd's Bush and Royal Oak sub-stations. Two high-tension distributors are carried from one or other of the sub-stations to each distributing centre, being connected at the sub-station end by a maximum current automatic cut-out. One of these high-tension distributors is connected to the left-hand section, and one to the right-hand section of the extended sub-station 'bus bars which have been described above. Where more than one distributing centre is fed by one pair of feeders leaving the sub-station the distributing

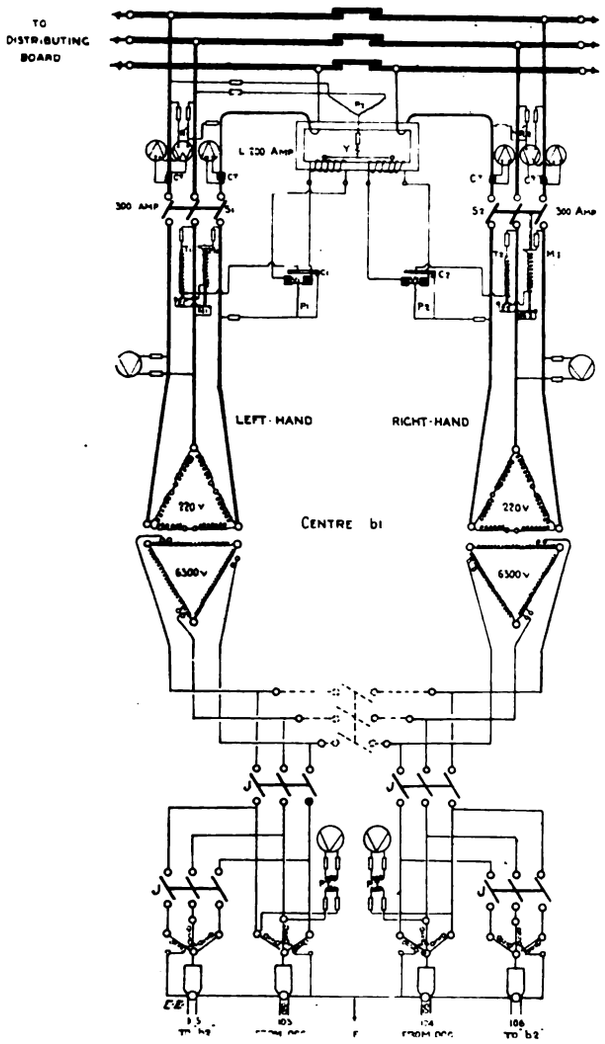

FIG. 6.—Typical Sub-station Connections. S_1 and S_2, Main L.T. Three-Pole Oil Switches; M_1 and M_2, Closing Solenoids for S_1 and S_2; T_1 and T_2, Tripping Solenoids for S_1 and S_2; N_1 and N_2, Switch operated by Closing Solenoids for cutting out same when Main Switch is in "On" position; R_1 and R_2, Wattmeter Star Resistance for Neutral Point; P_1, P_2, and P_3, Relay Resistances; V_1 and V_2, Reverse-Current Relays; C_1 and C_2, Contacts actuated by Relays V_1 and V_2 breaking circuit of Tripping Solenoids T_1 and T_2; Y, Switch for Disconnecting Relays; Z_1 and Z_2, Switches operated by Tripping Solenoids T_1 and T_2 to close Closing Solenoid Circuits; J, H.T. Oil-Break Three-Pole Switch; CT, Current Transformer; P T, Potential Transformer; L, Discriminating Transformer.

centres are worked in parallel, the left-hand and right-hand feeder at every distributing centre being connected to the left-hand and right-hand section respectively at the sub-station.

CABLES.

Between the generating station, the sub-stations, and the distributing centres about 37 miles of high-tension three-core cable and about 14 miles of low-tension concentric cable have been laid, in addition to between three and four miles of single low-tension cable used in the form of jumper cables in connection with the conductor rails. Each high-tension feeder between the generating station and the sub-stations has three cores of ·15 square inch sectional area, insulated with paper, lead-sheathed, and armoured with galvanised wire. The high-tension distributors are similar cables of ·05 and ·0125 square inch sectional area. The low-tension direct-current and alternating-current cables are concentric paper-insulated, lead-covered cables, no armouring being provided on these cables, as was done on the high-tension feeders in order to meet the requirements of the Board of Trade. The trunk multi-core and the branch telephone cables are also paper-insulated and lead-covered.

All the high-tension three-core, low-tension concentric, and telephone cables are laid in Howard asphalt troughing, a separate trough being used for each cable. These troughs are filled in with bitumen and covered with a layer of asphaltic concrete, ironed over all the troughs, which are placed side by side so as to form a waterproof covering The trenches in which the troughing is placed are excavated about 2ft. deep, and have a 4in. layer of concrete laid on the bottom to form a bed for the troughing. Where the cables have to cross under any railway lines, a trench is excavated which is floored with concrete, and brick walls

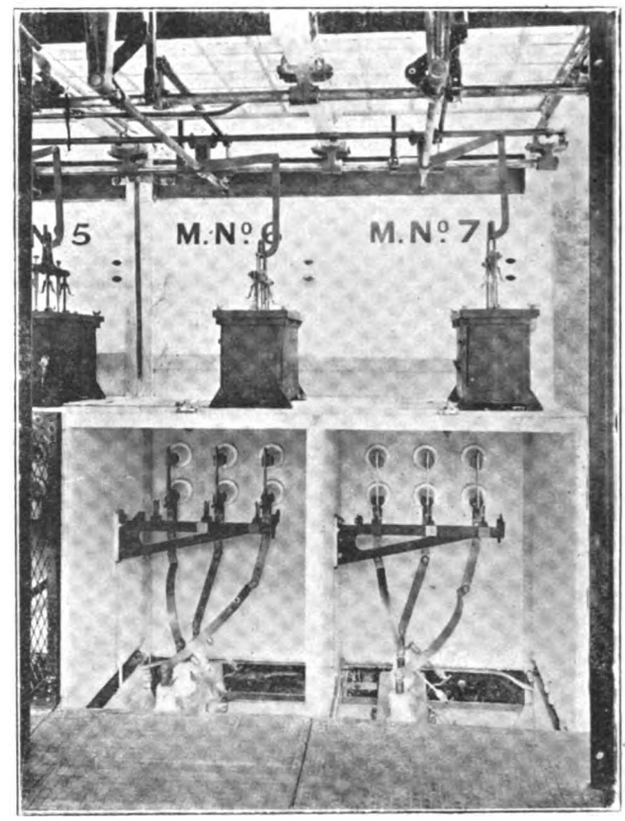

FIG. 8.—Cell in Basement under H.T. Switchboard showing Phase-Changing Links.

are built up on the side, on the top of which are laid old rails covered with concrete and a damp-proof course to form a floor for the sleepers and rails. In this way all weight and pounding from the passing trains is kept off the cables. The culverts so formed are provided with ventilating inlets and outlets and inspection manholes at convenient points. The number of culverts in which the cables pass under the rails is 29. The route chosen for the feeders has, as far as possible, been at the side of the line, so that any repairs, examination, or jointing can be done with greater ease. In certain places, however, more particularly between Westbourne Park, Royal Oak, and Shepherd's Bush, it has been necessary to lay the feeders in the 6ft. way. At one point where the route of the cables crosses the proposed new line between Acton and Shepherd's Bush a bridge, formed of old girders, has been provided to support the cables in such a way that when the cutting for the new railway is made it will be unnecessary to disturb them. At points where the cables are laid across railway bridges the cables have been laid on steel plates fixed to the bridge girders, the ends of the plate being built into the concrete bed of the cable trench at each end of the bridge, but left free for a few feet between the bridge structure and the anchoring point,

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so as to minimise as far as possible the effect of vibration. All the laying and jointing had to be done without interfering with the traffic, and great care had to be taken to avoid accidents. It is satisfactory to be able to state that not a single life was lost in carrying out this part of the work.

There is one point of special interest in connection with the way in which the cables are jointed The usual method of jointing the cables after they are laid was departed from, as it was considered that a much better joint would be made if more space was given to the jointer than is possible after the cables are laid and where there are a number placed side by side. The method adopted in the present instance was to leave the last 20ft. or 30ft. of each length of cable unlaid until the end had been jointed to the next length of cable to be laid in the same trough. The ends of the two cables to be jointed were laid on a temporary platform placed over the trench and protected by a jointer's tent or by a special arrangement of tarpaulins where the clearance was limited, and all jointing was done where there was ample room and things could be kept clean. Where the cables were laid through the subway

Fig. 9.—View of Hydraulic Bond Press.

underneath the main lines between Westbourne Park and Royal Oak, the lengths of cable were so arranged that the joints came opposite the refuges provided in the walls of the subway, where the jointing could be done with safety.

Track Work.

The system adopted for supplying current to the train collecting shoes is the same as that already in use on the Metropolitan and District Railways. There are two insulated conductor rails, the positive being 3in. above rail level and 16in. outside the running rail, and the negative conductor being 1½in. above rail level and in the centre of the track. The two conductor rails are of an inverted channel section, resting at intervals not exceeding 10ft. on iron-capped porcelain insulators, as shown on the drawings published in our issue of July 13, 1906. The insulator is fixed to the sleeper by small clamps and coach screws. This design leaves the conductor rail and insulator free to move up and down relatively to each other when trains are passing, owing to the spring in the sleepers and in the road bed. The rails, which are 44ft. 6in. long, weigh 102·8lb. per yard, and have a cross-sectional area of 10 square inches. They are made of a special quality of steel having a conductivity equal to 15 per cent. of that of copper. The conductor rails are fished by a joint plate bolted on the underside, and are bonded by four laminated copper strip bonds which are practically protected by the sides of the conductor rails and the joint plate. At intervals of about 130ft. the conductor rails are anchored by means of special insulators having a groove in the iron cap, in which a bolt engages which passes through the flanges of the conductor rail, the anchor insulator being secured to the sleeper by semi-circular clips. The bond terminals were expanded into the conductor rails by means of hydraulic presses, which were of two types. One type consisted of a combined press and pump, shown in the accompanying view (Fig. 9), which was used when the trains were not running, and which could be readily moved by means of runners along the surface of the rail, and have the centres of the rams quickly adjusted to the bond terminals. The other type consisted of a specially-designed press worked by a separate pump, and so arranged that it could be used on the positive conductor rail without removing it when trains passed. Steel ramps 13ft. long (1 in 50), made from a bent section of the ordinary conductor rail, are normally used at facing ends, and steel ramps 4ft. 6in. long (1 in 9) at trailing ends. At sidings and points where the collecting shoes may pass over the rails in either direction at a medium speed, steel ramps 8ft. long (1 in 25) are fitted to each end of all rails. At cross-overs where the speed is less, cast-iron ramps (1 in 8) are fitted.

Both positive and negative conductor rails are insulated from earth throughout their whole length, but at each substation the negative is connected to earth through a resistance. On the occurrence of an earth on the positive the potential of the negative conductor rail may drop to about 600 volts below earth when a current of about 100 amperes passes through the earthing resistance. The conductor rails on the "up" line can be connected electrically on one end of the line to the other, and those on the "down" line can be similarly connected from one end to the other. Section insulators are placed at certain points in the conductor rails on each line for the purpose of disconnecting any section of the conductor rails when a fault occurs or repairs are necessary. The cross bond and section pillars are of cast iron with locked doors. The switches in the section pillars are worked by hand. Interlocking tablets are provided in the signal cabin in the case of a cross bond pillar and in the pillar in the case of a section pillar, so arranged that when a key is withdrawn the switch is left locked in the open position and cannot be again closed until the key is inserted. When the switches are in close position the keys cannot be withdrawn.

(To be continued.)

ON THE PUPIN MODE OF WORKING TRUNK TELEPHONE LINES.*

BY SIR WILLIAM PREECE, K.C.B., F.R.S.

(*Concluded from page 238.*)

The diagram Fig. 2 illustrates a complete telephone circuit with its Pupin coils. It is one of a pair of twin copper lines of No. 14 B. & S. gauge, weighing 65lb. per mile, twisted about each other and insulated with dry paper, having a resistance of 13·7 ohms and a capacity of 0·065 microfarad per mile. Each coil has a pure soft-iron ring core 3in. in diameter, made of fine varnished wires to reduce hysteresis to the lowest possible point, and is wound with two wires, which are connected as shown in Fig. 3. Mutual induction is thus eliminated and self-induction alone is active. It has an inductance of 0·252 henry. Such an underground cable with 112 pairs of wires (loaded) has been laid between New York and Philadelphia, 90 miles long. Nineteen of these pairs are of No. 16 B. & S. gauge for a short distance. The Pupin coils have been fixed at every 1¼ miles, and it works with a commercial efficiency which Mr. Carty calls a "14 mile

* Paper read before the British Association at Leicester.

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talk." The standard of comparison is a mean circuit of 10 miles of No. 19 (1mm) copper wire in the city of New York, which is called the "10-mile talk standard." Each individual section can be shown diagrammatically, as in Figs. 4 and 5. The straight lines indicate the two wires of the loop, the wavy lines the inserted coil. The capacity of the loop is shown as a condenser, and the E.M.F. of the coil as a battery cell. In the diagram they are shown

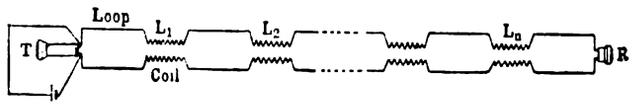

FIG. 2.

separate at one instant, but in activity they act together to maintain the flow of energy and retain the form of wave. A, B, C represents *time*. It does not represent length of space or distance. In Fig. 5 (1) is the rise of the wave when energy is absorbed and held up; (2) is the decay of the wave when energy is restored. Thus in each section energy is held up as the wave is rising and given out again slightly impaired by hysteresis when the wave is falling

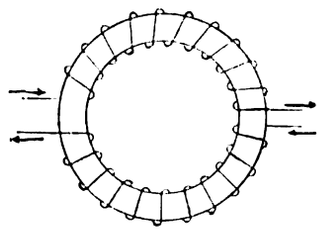

FIG. 3.

It is evident, from the clearness of speech, that the sum of all these actions results in a continuous flow of alternations without change of frequency when the limiting distance is not exceeded. When this limit is reached the waves are so attenuated that speech becomes impossible.

On the other hand, it must be pointed out that although capacity is greater than inductance in its influence on the current waves, they neither absorb energy permanently.

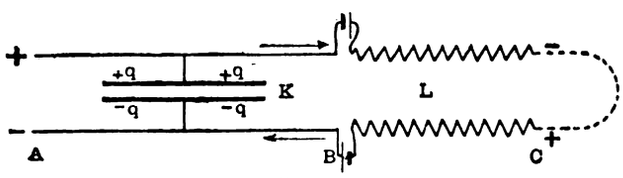

FIG. 4.

They only hold it up for a time. Energy can be absorbed or it can change its form, but it cannot be destroyed. This is the doctrine of the conservation of energy. Resistance, radiation, and leakage do absorb energy and dissipate it wastefully. Our first object is to prevent waste of energy, and our second object to direct the pent-up energy into a proper channel to maintain the amplitude and form of the waves. This is what Pupin has done. If we represent

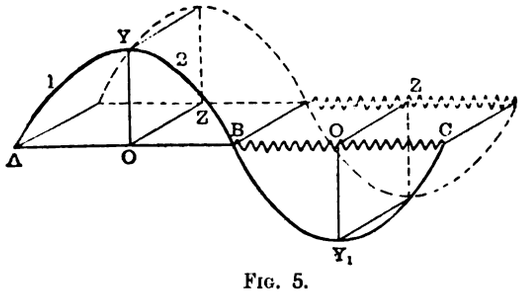

FIG. 5.

the action in a Pupin section in another way by Fig. 5, where A B represents the metallic loop and B C the double coil, A C being equal to one complete period of one short fundamental wave, then O Y will represent the maximum E M.F. acting during the period A B, and O Y_1 that acting in the coil during the same period. O Z represents the quantity of electricity, Q, flowing during the same period; Q is assumed constant. The sections A B, B C are in tune with each other. A solid figure described by Q and E (the variable E.M.F.) would represent the energy propagated, except the minute losses in the section, which are inherent to the conditions of the circuit. These losses multiplied eventually absorb all the energy and the limit of speech is reached. The influence of the coils is clearly a time influence. It is a case of tuning. They break up a circuit into a series of sections in which the energy flows in virtually simultaneous steps instead of being prolonged and damped down as it would be in a long submarine cable. The frequency remains unaffected. It is clear that in each wave-length there are four distinctly marked points, *a*, *a'*, *d*, *d'*, where changes of phase affect the distribution of energy and its factors. It is as though Q remained for an instant in A B and E in B C. They then change partners with an action that continues the forward movement, but with a slight loss due to waste. I regard the action as somewhat analogous to the transmission of mechanical impulses through a line of billiard balls in touch with each other.

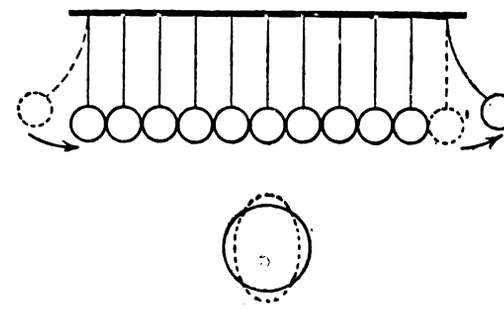

FIG. 6.

An impulse (Fig. 6) is imparted by a driven ball striking the first ball, which is compressed, as shown in the figure, by the lower ball; its elasticity by its expansion transmits the impulse to the next ball, with a slight loss of energy, and so on successively through the series until the last ball is impelled away as though no energy had been absorbed. The impulse corresponds to the current, the elasticity to the E.M.F., and the ball to the Pupin section with its capacity (mass), its resistance to change of form and its resilience. This is not unlike the action of air particles against the tympanum of the ear when carrying sonorous vibrations.

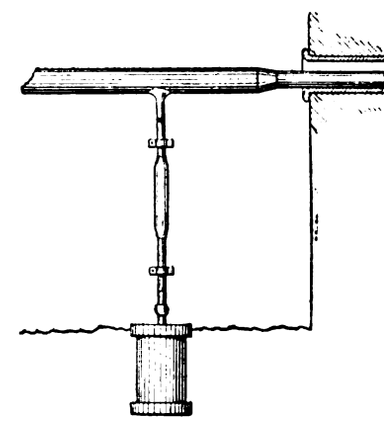

FIG. 7.

The size of coils and the distance apart is mainly a question of experiment. It varies with every circuit; in fact, the solution of the problem is a case of experience and compromise. Sir John Gavey has obtained the best results with coils on long lines at 1⅛ miles and at every two miles on shorter lines, Mr. Carty at every 1¼ mile on long lines, but at every ¾ mile on short lines. The former gets better results with no iron core, the latter prefers fine iron wire as a core. Mr. Gill, engineer-in-chief of the National Telephone Company, places them at every mile, and uses iron cores. These coils are buried in iron cylinders filled with resin oil, and buried as shown in Fig. 7. It certainly appears to me that iron must experience some hysteresis, though very minute, and, therefore, causes loss of energy, and though it must enhance the strength of the currents by

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intensifying the lines of magnetic force, it is of more consequence to reduce the loss of energy and retard the attenuation of the waves. If the coils are improperly placed or imperfectly designed, they do more harm than good. Thus coils which are quite effective at every mile destroy speech altogether if placed at every four miles.

Among the numerous disturbing influences are those of the instruments at each end. Not only does the receiving apparatus act as a reflector and inductor, but it is a source of secondary radiation, and it causes interference and attenuation. This is very much aggravated by the constant changes of local lines at each end. Hayes has diminished this disturbance by *tapering*, or the gradual reduction of the inductance of the loading coils as the terminal stations are approached. Tapering is distinctly beneficial. Virtually, as all oscillograms show, it becomes a series of small waves of one frequency, probably, according to Kennelly, of about 800—upper G in the treble—which remains constant. There must be a slight loss of energy in each section of precisely similar percentage. The result is the curve of attenuation must be a logarithmic one, and its logarithmic decrement or attenuation constant is obtainable. The smaller this decrement is made the greater the length of the curve and the further speech can be carried. This is the function of the Pupin cell. The relative and continued attenuation of currents is shown by Fig. 8, where (1) is an

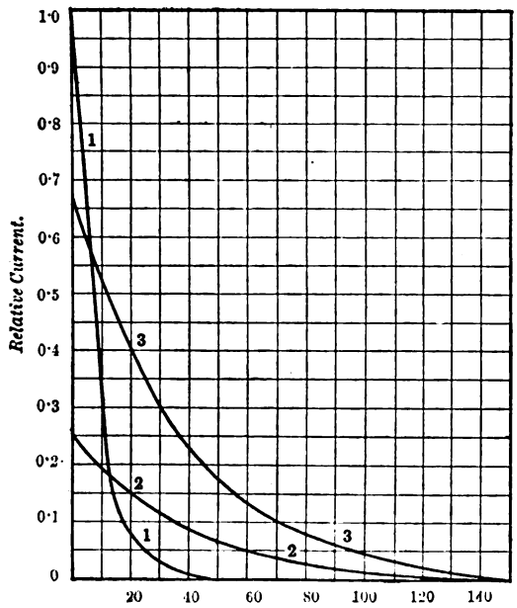

FIG. 8.

unloaded line, (2) a loaded line without tapering, and (3) the same line loaded and tapered. This is due to Mr. Hayes, of the American Bell Telephone Company, who read an admirable paper at the St. Louis Congress in September, 1904.

Through the courtesy of Mr. Gill I am able to exhibit some admirable models which show the behaviour of the voltage and currents throughout the whole circuit, with their changes of phase and their variation of amplitude. They are based on calculation, and not on experiment. The white-coloured line is the voltage (P.D.) and the red line the currents. They convey an admirable impression of the complicated character of the problem. The wavelength of the fundamental note, by loading, is reduced to one-third, and, of course, the velocity is reduced in the same proportion, but the strength of the received currents is increased from 2·7 to 3·30 milliamperes All disturbances are filtered out. Speech becomes clearer and louder. The inductance coils are usually of three classes :

Heavy, having	0·252 henry.
Medium ,,	0·176 ,,
Light ,,	0·133 ,,

Loading is not so efficient at present on aerial loops, because it has not been so thoroughly thrashed out as on underground cables, but it is distinctly beneficial, and the solution of the more complicated problem is well in hand. At present the dimensions of the Pupin coils for aerial loops, as well as the spacing, has to be determined experimentally for each circuit. The United States Conference standard cable is, in terms of 10-mile talk :

Weight of copper (pounds)	20
Diameter (mils)	36
Resistance per mile (ohms)	44
Capacity wire to wire (microfarads)	0·06
Capacity wire to earth (microfarads)	0·088
Insulation (megohms)	500
Effective limit (miles)	41·6

N.B.—Effective limit does not mean effective commercial conversation. This would approach 60 miles. Our English standard cable is now nearly the same—viz, No. 20 copper wire, of 20lb weight per mile, having a diameter of 36 mils, a resistance of 44 ohms per mile, a capacity of 0·056 microfarad, an inductance of 0·001 henry, and an insulation of 200 megohms. It would be a great advantage if this cable were made an international telephone standard.

Sir John Gavey experimented on the underground cable which was commenced under my guidance when I was in office in 1897. The cable consists of 76 wires laid up in pairs. Each wire weighs 150lb. per mile, having a resistance of 5·5 ohms at normal temperature (60deg. F.). Each conductor is insulated with paper twisted in pairs, each pair being insulated. There are 38 pairs arranged symmetrically and insulated in layers. The only insulation is dry paper and air, and the covering is lead. The diameter of the cable is 2½in. The capacity is 0·063 microfarad per mile and the insulation about 30 megohms per mile. It is drawn into 3in. cast-iron pipes. It was designed and laid for telegraphic purposes, but with the idea that for long distances metallic circuits might be commercially valuable without mutual interference. In the extension of the system to Glasgow each insulated conductor was lapped with copper foil to act as a screen, a practice that had proved very successful in a submarine cable from Bacton (Norfolk) to Germany. The length of cable from London to Birmingham is 115 miles, and, although unloaded, it was found possible to speak through it commercially. The use of loaded lines is growing rapidly. The equivalent range of speech has been increased in one case from 66 to 176 miles. This is an instance of an underground cable. Although in Germany they have found the ratio to be 1/4, in America it is thought that 1/3 is the outside commercial limit, and in Great Britain we find the range of a loaded line is 2·4 times that of an unloaded one. I have been able to test (July 25, 1907) the relative efficiency of unloaded and loaded cables of what should be called the international standard pattern. I found that 8·3 miles on the former was equivalent to 20 miles on the other. This was not 2·4 to 1. It was not a test of possible distance, but of relative efficiency.

The result is not equally beneficial in aerial wires, for the conditions are more variable, especially in insulation and in atmospheric electrical troubles in countries like South Africa. Anyway, loaded lines will enable us to use less copper for long trunk wires—something of considerable advantage in these days of inflated prices in copper, and in countries like South Africa, where one long stretch of 1,010 miles has to bring, say, Johannesburg to Cape Town. The application of this principle to submarine cables has not yet reached a practical stage Our president will have something to say on this. Prof. Pupin has the matter in hand on the other side of the Atlantic. The reaction coils must, however, be placed at such small distances apart that the manufacture of such a cable seems difficult and its maintenance problematic.

It is important to observe that in telephone circuits the frequency is not affected. If it were, speech would be impossible. It is attenuation that limits the distance. It is well known that in practice the higher notes (harmonics) superimposed on the fundamental notes (*which give the quality of sound*) are the first to disappear, and that the last to remain are the low fundamental notes decreased in volume. The ear is so marvellously constructed that it adapts itself to all the perplexities of existence, and it can interpret speech amid the turmoil of considerable external disturbances. We know little of its internal structure, and less of the physical actions that render it such an exquisite analyser of sonorous vibrations. It has been assumed that the velocity of propagation of the current waves through

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the circuit is such that the action in each Pupin section is virtually simultaneous, and the action continues along the line. If we admitted geometrical length, the physical explanation would be more complicated. A slower velocity in loaded cables means an increase to the limiting distance of speech. Hence the reason why the limit is reached so rapidly in cables and underground wires. On overground lines the distance to which it is possible to speak is limited only by the weight of copper. Two thousand miles is easily attained without coils. The question of loaded underground cables against open unloaded aerial circuits is purely a financial question. The dominant factor is the price of copper. But the cost of maintenance, the reliability of working, and the freedom from troubles must weigh considerably in the balance. Every case must be decided on its own merits.

I cannot too often repeat the warning that telephone troubles arise principally from ignorance of the system of working, and that the principal source of trouble arises with the subscriber himself. The American knows this, and does all he can to support the company which supplies him. The Englishman growls and writes to the Press and thinks he has done a clever thing. Some wiseacre has even proposed to establish a Users' Mutual Protection Society to maintain the present unfortunate antagonistic system between supplier and user. The best protectors are personal self-reliance and self-education.

DISCUSSION.

Sir OLIVER LODGE opened the discussion, and said that the advantage of having self-induction in such lines was very great. This was first predicted by Oliver Heaviside, and it was remarkable that his first paper was rejected by the Society of Telegraph Engineers and Electricians. He had clearly shown in his writings that self-induction actually helped by strengthening the higher harmonics which tended to be damped out in transmission. In fact, the high-frequency tones were preserved. In connection with cables inductance was also advantageous, although there might be a certain amount of reflection from the receiving station. Even if the inductance was lumped together in the centre of the cable, they would get improved transmission. In spite of what the author had stated, they should make the waves in a telephone or telegraph line as like true Hertzian waves as possible—that was to say, the electrical and magnetic energy should be equally transmitted. The tendency was to damp down the magnetic energy, and hence by reducing the electric energy they caused it to keep pace with the magnetic energy. For this reason artificial leakage was of service. It was remarkable that Mr. Oliver Heaviside had shown all this in his theoretical writings; thus there was coincidence between scientific prevision and practical accomplishment.

Mr. S. G. BROWN also referred to a publication of Mr. Oliver Heaviside's in 1890, which showed the advantage of self-induction placed in lines as isolated blocks. The self-induction should be as equally distributed as possible in order to avoid reflection. The practical solution by Prof. Pupin had been sold to a company in the States for £100,000, together with an annual charge of £10,000. In submarine cables the insertion of blocks of induction seriously interfered with cablelaying, and also increased the reflection. He had endeavoured to design a cable with continuous compensation, and the great difficulty was the low permeability of iron. If this could be increased from 150 to 1,000, the problem could be solved by D-shaped copper and iron conductors twisted together.

Prof. S. P. THOMPSON said that in 1891 he had gone into the subject after reading Oliver Heaviside's work. He found that perfect compensation could not be obtained by anything added to the ends of the cable, although inductive shunts helped transmission. He proposed then to introduce these shunts at intervals along the cable, but found that the cable companies were strongly opposed to the use of self-induction in any form whatever. The fact that the original Atlantic cable was destroyed by the use of a large induction coil, perhaps, was the reason of this. There was also a strong objection to any device which involved a change of cross-section of the cable. The fact remained that inductive shunts had been used with success on telegraph lines, and a telephone cable with compensating inductances at intervals had been laid in Lake Constance. There was still a great deal to do in the perfecting of submarine cables, on which the speed of signalling was only one-tenth that on land lines. Even if the improvements raised the cost three times, it would be worth doing, as the total cost of the cable included the heavy charges for laying.

Sir W. H. PREECE, in reply, said it was advisable to tune each mile of cable, and if the four transformers were placed in the middle of a four-mile length the messages were stopped. He did not agree with the other speakers as to the services rendered to telegraphy by Oliver Heaviside.

Sir OLIVER LODGE interposed a remark to the effect that he referred rather to what was disclosed in Oliver Heaviside's writings than to what telegraph engineers had learned from the same.

THE DENSITY OF THE ETHER.*

BY SIR OLIVER LODGE, F.R.S.

1. The theory that an electric charge must possess the equivalent of inertia was clearly established by J. J. Thomson in the *Philosophical Magazine* for April, 1881.

2. The discovery of masses smaller than atoms was made experimentally by J. J. Thomson, and communicated to Section A at Dover in 1889.

3. The thesis that the corpuscles so discovered consisted wholly of electric charges was sustained by many people, and was clinched by the experiments of Kaufmann in 1902.

4. The concentration of the ionic charge, required to give the observed corpuscular inertia, can be easily calculated; and consequently the size of the electric nucleus, or electron, is known.

5. The old perception that a magnetic field is kinetic has been developed by Kelvin, Heaviside, FitzGerald, Hicks, and Larmor, most of whom have treated it as a flow along magnetic lines; though it may also, perhaps equally well, be regarded as a flow perpendicular to them and along the Poynting vector. The former doctrine is sustained by Larmor, as in accordance with the principle of least action, and with the absolutely stationary character of the ether as a whole; the latter view appears to be more consistent with the theories of J. J. Thomson.

6. A charge in motion is well known to be surrounded by a magnetic field; and the energy of the motion can be expressed in terms of the energy of this concomitant field—which, again, must be accounted as the kinetic energy of ethereous flow.

7. Putting these things together, and considering the ether as essentially incompressible—on the strength of the Cavendish electric experiment, the facts of gravitation, and the general idea of a connecting continuous medium—the author reckons that to deal with the ether dynamically it must be treated as having a density of the order 10^{12} grm. per cubic centimetre.

8. The existence of transverse waves in the interior of a fluid can only be explained on gyrostatic principles—*i.e.*, by the kinetic or rotational elasticity of Lord Kelvin. And the internal circulatory speed of the intrinsic motion of such a fluid must be comparable with the velocity with which such waves are transmitted.

9 Putting these things together, it follows that the intrinsic or constitutional vortex energy of the ether must be of the order 10^{33} ergs per cubic centimetre.

Conclusion.—Thus every cubic millimetre of the universal ether of space must possess the equivalent of 1,000 tons, and every part of it must be squirming internally with the velocity of light.

TABULATED ANSWERS RECEIVED TO INQUIRY RE PUBLIC LIGHTING.

By collecting and tabulating the information given on the following pages *re* public arc lighting, Mr. Francis Teague, the city electrical engineer of Bath, has rendered a helpful service to municipal electrical engineers generally. The table enables some interesting and instructive comparisons to be made with regard to the different methods of trimming, etc, in vogue, but these we may well leave to the reader.

FORTHCOMING EVENTS.

Association of Engineers-in-Charge.—Saturday, Aug. 24, visit to cement works at Northfleet.

Iron and Steel Institute.—Sept. 23, 24, and 25, Vienna meeting.

Royal Meteorological Society.—Nov. 20, annual meeting.

* Abstract of paper read before the British Association at Leicester.

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—	1. Number of lamps.		2. Type						3. Method of trimming			4.	5
			Open.		Enclosed.		Flame.						
	Arcs.	Incandescents (groups).	Number, and burning hours.		Number, and burning hours.		Number, and burning hours.		Raising and lowering gear.	Ladders.	Other special facilities.	Have you a superintendent responsible for the public lighting?	Number of men employed in lamp shop on repairs, adjustments, and testing.
Ayr (N.B.) ...	111	201	60 16 49 32		— —		1 16 1 40		63 See remarks column.	48 See remarks column.	—	Police employ a superintendent who looks after the whole of public lighting, except arc lamps.	1
Bath	194	5	75	18	102 60 14 36		3	18	175	19	—	No; this is part of main supt.'s duties.	2, foreman and mate.
Battersea ...	460	3	431	30	29	80	—	—	221	239 (towers)	—	A foreman who also attends to repairs outside.	1 and 1 boy.
Bermondsey...	168	202	167	48	1	70	—	—	All fitted.	—	Telescopic ladders are kept.	Arc lamp repairer responsible for all repairs, etc., under supervision of mains supt.	
Blackburn ...	207	470	—	—	—	—	—	—	—	Ladders used.	Tower lorry used for all tramway routes.	Assistant responsible for this, who is also responsible for drawing office.	2 during winter months, also help with trimming.
Blackpool ...	275	695 includes Nernst.	255	15-16	—	—	20	17-18	—	Ladders used.	—	Yes; under chief engineer.	3
Bootle	182	200 (about).	121 2,000 45 3,700 per lamp per annum		16 3,700 per lamp per annum		—	—	A few lamps fitted.	Ladders used.	—	A foreman.	1
Brighton	372	1,745 standards.	372	32	—	—	—	—	All fitted except the canopy tops.	—	With canopy-topped lamps, stepping keys are put into the posts.	Yes.	12
Bristol	693	7 experimental.	676	24	—	—	17	40	17	Heathman ladders used.	—	Arc lamp inspector responsible to distribution supt.	2
Cardiff.....	615	About 12 experimental.	—	—	600	50 & 70	15	—	—	Ladders used, 20-rung.	—	No; men work under mains supt.; only a head trimmer.	1 Trimmers do small repairs
Cheltenham ..	388	2 groups (19 lamps).	383	16	4	70	1	16	—	Ladders used. See remarks column.	—	No; under mains supt. A foreman is employed to look after testing, repairs, etc.	1
Chester.....	196	728 (not grouped)	73 3,857 45 1,780 per lamp per annum		54 3,857 24 1,780 per lamp per annum		—	—	One sample.	Ladders used.	—	Yes (assistant mains supt.).	1
Derby	190	800 (about).	166 30 — 50		7	80	17	18	—	Ordinary tower ladders used.	—	No; under mains supt.	1
Dublin	500	—	500	32	—	—	—	—	500. See remarks column.	—	—	Yes.	3

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6. Number of trimmers.	7. Number of arc lamps trimmed and cleaned per day per man.	8. Do trimmers inspect lamps during hours of lighting?	9. Wages — Superintendent.	Mechanics.	Trimmers.	10. Do trimmers receive a bonus in respect of good reports concerning lamps on their rounds?	11. Trimmers' holidays.	12. Remarks.
3 (2 whole time, 1 part time). See remarks column.	55 35 21	Only during winter, when the arc lamp adjuster cycles round	37s. 6d.	35s.	25s. to 30s.	No; when tried was not a great success.	8 days in summer; no public holidays.	Columns Nos. 3 and 6: Remaining arc lamps being fitted with lowering gear; when completed the number of trimmers will be reduced to 2.
4	35 to 40	Yes. See remarks column.	30s. (foreman. 75 per cent. of these wages are chargeable against public lighting and 25 per cent. against private lighting (arcs).	24s.	24s.	Yes, if during any 14 days the police do not report any arc lamp out when it ought to be lit, a bonus of 1s. is paid to each trimmer.	5 days.	A lamp of each type used on public lighting is kept ready to replace a faulty lamp found on either report; the trimmer changes this at once. Column No. 8: There are 2 trimmers scouting each week. First inspection after the arcs are switched on; this takes about one hour. Second inspection finished about 11 p.m., if everything is correct. Two trimmers come in early and switch off independent lamps that are fed from distributors, and they take this duty on alternate weeks.
6 and 6 mates. See remarks column.	50 to 65, according to distance apart.	Two switchmen, who also scout during evening and attend to any small defects	44s. per week of 48 hours.	42s. per week of 48 hours.	35s., mates 30s. per week of 48 hours.	No.	6 working days and 1 for every public holidays.	Column No. 6: Mates employed as trimmers receiving trimmer's rate of pay, when not assisting with tower ladders. Trimmers work 6 days per week, with day off to compensate for Sunday duty.
3 and 3 mates.	40	No; a night man engaged	Repairer, 9d. per hour.		32s. per week of 53 hours, 30s. mates do.	No.	1 week.	—
2	—	Yes, in turn.	30s., portion of assistant's salary, Column 4.	—	6½d. to 6¾d. per hour.	No.	3 days with pay.	Switching on and off of lamps carried out by two of the trimmers alternate weeks, with two ordinary labourers at 6d. per hour to help.
6	90 to 100 in all.	Each trimmer takes watch duty in rotation every 7 days (5 trimming and 1 watching).	37s. 6d., with two weeks' holiday.	17s. 6d. to 25s. (youths).	28s. to 30s.	No.	1 week.	Cost: Electricity, £3,500; repairs, carbon, etc., £1,162; capital charges, £1,088—total cost, £5,750. Gas, approx., £5,700.
2 groups of 2 each.	46 (about). 30	No.	40s.	—	30s., mates 15s.	No.	1 week.	Gas and electric worked from one department, and some of the maintenance is done by men who work on both, so it is difficult to separate the staff.
15 trimmers, 17 lamplighters.	These men have also to light and extinguish a district on arcs and incandescents each day.	No; one watchman on duty from lighting to extinguishing time.	70s.	28s. to 34s.	22s. to 26s., lamplighters, 16s. to 20s.	No.	2 weeks with pay.	—
8 with 8 mates.	Average 85 lamps on their daily round. See remarks column.	Yes.	50s.	30s.	23s. and 27s.	No.	10 days.	Incandescent lighting purely experimental. Tender for 120 flame arcs (to replace open-type arcs) now before committee. Column No. 7: The lamps are not all of necessity trimmed every day.
5 with 5 mates.	29 on a yearly average.	Yes; two hours in evening.	38s. Head trimmer.	35s.	30s. to 36s., improver 18s., mates 10s.	No.	1 week with pay.	—
5 with 5 mates.	217 to 388 in all according to season.	Yes.	45s. Head trimmer.	—	25s. to 28s., mates 19s. to 21s.	No.	1 week.	Column No. 3: Two men to each ladder — *i.e.*, trimmer and mate. Five ladders in use and one spare.
5 with 5 mates.	34 in 5 hours.	Yes.	38s. 6d. to 50s.	26s.	21s. to 25s., mates 18s. to 21s.	No.	1 day for every 2 months employed per annum.	
4	50 (about).	Yes.	—	6½d. per hour	23s. to 26s.	No.	8 days.	—
6 and 1 foreman to inspect above and repair switches, etc., on site.	42 (about).	No; two special inspectors.	60s. See remarks column.	50s. to 55s.	32s. 6d. for 7 days.	No.	1 week.	Column No. 9: Superintendent's salary proposed to be increased to 80s., owing to extension of lighting. Arrangements generally satisfactory. Column 3: Find lowering gear much cheaper than ladders formerly used.

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—	1. Number of lamps. Arcs.	1. Number of lamps. Incandescents (groups).	2. Type. Open. Number, and burning hours.	2. Type. Enclosed. Number, and burning hours.	2. Type. Flame. Number, and burning hours.	3. Method of trimming. Raising and lowering gear.	3. Method of trimming. Ladders.	3. Method of trimming. Other special facilities.	4. Have you a superintendent responsible for the public lighting?	5. Number of men employed in lamp shop on repairs, adjustments, and testing.
EAST HAM	202	111 (222 lamps).	— —	196 60	6 16	—	—	Light tower wagon drawn by horse.	Yes; an inspector.	Inspector and assistant.
EDINBURGH ...	1,176	Only a few.	201 60 78 40 897 20	— —	— —	—	A ladder worked by 1 man.	—	No; under mains supt.	6 and 1 foreman.
FOLKESTONE ...	84	2 on each lamp.	82 Dusk to midnight.	2 All night.	— —	—	Ladders used.	—	No; under mains supt.	None regularly.
FULHAM	276	483 includes Nernst.	276 32	— —	— —	—	Some ladders used.	Others by means of step-irons.	Under mains supt., with working foreman.	Foreman does this.
GLASGOW	837	—	817 40	2 80	18 40	—	Ladders used.	—	Yes.	10
GOVAN.....	215	—	215 3,950 per lamp per annum.	— —	— —	90	125	—	No; under mains supt.	1 and 1 labourer.
HACKNEY	393	49 separate Nernst lamps.	392 Average 2,952 per lamp per annum	1 3,940 per lamp per annum	105 now being erected	All, except 9 centre carriers which are climbed	—	Automatic switching, also feed wires from works for switching original main roads.	No; a working foreman.	The foreman, lamps' assembler, and 1 boy
HAMMERSMITH.	264	65	202 All night.	61 All night.	1 All night.	—	Ladders used.	—	No; chief assistant combines this with other duties.	1
HAMPSTEAD ...	122	—	114 36	8 70	— —	28 See remarks column.	28	Remainder with short ladders and climbing irons.	No; chief indoors assistant combines this with other duties.	Trimmers do their own repairs, etc.
HASTINGS	105	—	— —	— —	105 All night.	All fitted	—	—	No; under mains supt.	—
ISLINGTON	612	—	458 16	— —	154 16	—	—	Trimmers climb columns by step-irons which fit into holes in columns.	No; under station supt.	2 mechanics 1 assistant 1 labourer } 4
LEEDS	626	—	— —	625 60	1 40	—	—	Special very light telescopic tower used.	Yes	2
LIVERPOOL.....	188	188 - 376 lamps and 32 groups.	188 2,105 per lamp per annum	— —	— —	—	Ladders used.	—	Yes	6 men

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6. Number of trimmers.	7. Number of arc lamps trimmed and cleaned per day per man.	8. Do trimmers inspect lamps during hours of lighting?	9. Wages — Superintendent.	Mechanics.	Trimmers.	10. Do trimmers receive a bonus in respect of good reports concerning lamps on their rounds?	11. Trimmers' holidays.	12. Remarks.
2	100	Yes.	50s.	35s.	37s. 6d.	No.	1 week.	—
14 and 1 foreman.	55 to 60 in winter.	Each trimmer switches on his own lamps and reports if any do not light up.	—	27s. to 35s., foreman 42s.	27s. to 30s., foreman 40s.	No.	7 days.	—
2	—	Yes.		—	28s. and 38s.	Trimmer 3s. 6d. weekly	10 days.	—
5 and 1 boy.	30 (about).	Two men on scout duty 2 hours per night in turn	80s.	35s.	30s., boy 21s.	No.	1 week.	During the year about 135 gas lamps will be converted to Nernst lighting.
11 with 11 mates.	40 per trimmer and mate.	No.	60s.	7d. per hour, foreman 8½d.	27s., mates 21s. 5d.	No.	14 days with pay.	Now starting a system of switching on and off by starting switches controlled from central stations, by which the number of trimmers will be reduced by one-half, and all men will then be paid at a rate per hour.
3 with 2 mates.	30	No.	40s.	32s., labourer 5d. per hour.	28s. to 30s., mates 24s.	No.	14 days with pay.	—
7	65 to 75, according to route.	Each trimmer scouts his own lamps after they are switched on, and reports faults, "outs," etc.	45s.	Boy 12s. to 15s.	27s. 6d., rising to 30s.	No, not practical.	1 week after 12 months' service.	Column No. 6: Five trimmers nominally do the trimming work, the two spare men are employed in overhauling, cleaning lamps, top gear, etc. Every man takes turn at this work, so as to become familiar with the whole of our apparatus. Column No. 2: One extra trimmer only will be required when flame arcs are completed, because of the better lamp routes that can be arranged, and because these lamps are magazines. The 49 Nernst shown will be superseded by some of these. 303 lamps are arranged alternately in the main roads, and half are switched off at 12 midnight, so that hours given (2,952) is the average. All-night lamps burn 3,940 hours per annum.
4	—	Yes.	—	38s.	28s. to 32s.	No.	1 week.	—
2 with 2 mates.	30 (about).	Yes.	—	—	35s., mates 25s. to 30s.	No.	4 to 6 days, according to length of service, and all bank holidays.	Lowering gear found to be a great advantage. Lamps, globes, etc., receive better attention, also great saving in time.
2 lads.	—	—	—	—	—	—	—	The 105 flame arcs have just been fixed, replacing ordinary arcs. They are magazine lamps, long burning, holding 9 pairs carbons, and are controlled by time switches, and are giving complete satisfaction, none having been out during the 3 months of use. The lads employed are utilised during their spare time on the mains work.
12	50	Trimmers take it in turn. Oct. to March 4 men per week. April to Sept., 2 men	—	8d. and 9d. per hour, 54 hour week.	31s. 6d.	Yes, 2s. 6d. per week.	14 days.	—
6	Each trimmer attends to 106 lamps for which he is responsible.	The 2 lamp repairers and the storekeeper inspect lamps 2 nights each per week. On Monday night no lamps inspected.	60s.	33s	27s.	No.	1 week with pay, also Christmas Day and Good Friday	—
in all.	38	Periodical visits by foreman.	—	5½d. to 7½d.	per hour.	No.	1 week.	Electrical public lighting very small, confined to centre of city. Only 5 miles in length. Remaining 446 lit by gas. Arcs go off at midnight, when two incandescents on each pillar light up.

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—	1. Number of lamps.		2. Type						3. Method of trimming			4.	5.
			Open.		Enclosed.		Flame.						
	Arcs.	Incandescents (groups).	Number, and burning hours.		Number, and burning hours.		Number, and burning hours.		Raising and lowering gear.	Ladders.	Other special facilities.	Have you a superintendent responsible for the public lighting?	Number of men employed in lamp shop on repairs, adjustments, and testing.
LEITH	297	—	287	20 to 26 (See remarks column.)	10	80	—	—	Tried, but abandoned.	Ladders used.	—	A foreman under mains supt.	—
LONDONDERRY	185	56-112 lamps.	185	32	—	—	—	—	—	Ladders used.	—	No; lamp switchman responsible as far as possible, and report any failings. See remarks column.	1 man, who also acts as station engineer and performs many other duties.
MORECAMBE	104	276	104	16	—	—	—	—	—	Heathman ladders used.	—	No; attended to by staff.	—
MOTHERWELL	60	701	60.	All night.	—	—	—	—	—	Tower ladder used.	—	No.	1
NEWPORT	168	120, in parallel.	—	—	160	60	8	17	—	—	Towers.	Yes.	2
NOTTINGHAM	164	—	150	—	6	—	8	—	—	Ladders used.	—	No; for gas lighting only.	—
PAISLEY	91	—	91	20	—	—	—	—	—	Ladders used.	—	No; under mains supt.	1
PARTICK	297	156 (Nernst).	297	36	—	—	—	—	—	Ladders used.	—	No; under mains supt.	2
PEMBROKE	69	121	66	16	3	40	—	—	47	22	—	Yes.	Done by superintendent.
PERTH	80	2 on each lamp.	5	32	75	75	—	—	—	Ladders used.	—	Yes. See remarks column.	—
PETERBOROUGH	113	113 - 226 lamps, 8 doubles and 3 singles in side streets.	109	1,754 per lamp per annum	4	1,754 per lamp per annum	—	—	—	Ladders used.	—	No; under mains supt.	—
PLYMOUTH	80	—	80	32	—	—	—	—	—	Ladders used.	—	For gas lighting only.	4 (gas).
POPLAR	344	80 groups 555 posts	341	28-30	3	30	—	—	—	Ladders used.	Step-irons for isolated crutch lamps	A foreman under mains supt.	3 including foreman.
PORTSMOUTH	265	442	264	Dusk to 11.30	—	—	1	Dusk to 11.30	—	Men mount with small ladders, then hook on to column with strong leather belt while standing on cross bar.	—	No; under mains supt.	2

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6. Number of trimmers.	7. Number of arc lamps trimmed and cleaned per day per man.	8. Do trimmers inspect lamps during hours of lighting?	9. Wages — Superintendent.	Mechanics.	Trimmers.	10. Do trimmers receive a bonus in respect of good reports concerning lamps on their rounds?	11. Trimmers' holidays.	12. Remarks.
8 in winter. 4 in summer.	—	2 men stand by each evening. Reports are made by police.	30s., with house, light and taxes.	—	24s. to 27s. mates 20s. to 22s.	No	7 days.	Column No. 2: Lamps burn all night, about 4,000 hours per annum. Column No. 3: A trimmer and a mate go with each ladder.
2 with 2 mates	45	No.	Chief switchman, 20s.	38s., with house, etc.	18s. to 24s. mates 13s.	No.	14 days.	Column No. 4: In winter time, 2 switchmen switch on circuits at dusk and half off at midnight. One switchboard attendant switches on one section; trimmers switch off lamps in mornings before commencing trimming. In summer time, switchmen switch off in mornings. Each switchman reports and logs any irregularities on his own section, and in case of failures takes out ladder and lights when possible.
1 with 1 mate	50 occasionally 104 trimmed in one day	No.	—	—	15s., mate 5s.	No.	7 days.	
2	30	Yes.		8d. per hour	26s. 6d.	No.	1 day with pay for each two months' service from May to May.	—
2 with 2 mates	—	Yes.	32s.	—	24s.	No.	1 week.	Trimmers also trim about 70 flame arcs for private lighting.
See remarks column.	—	Yes.		(See remarks column.)			—	Column No. 2: Lamps burn from 1 hour after sunset till 11.30. Trimming and repairing let by contract to local contractor. This is found to be cheaper.
1 in summer, 2 in winter, with 1 mate each.	45	Yes	—		30s.	No.	14 days.	—
4	38	No.	—	26s. and 35s.	26s., rising to 28s.	No.	1 week.	
1 and 1 youth. Latter trims lamps fitted with lowering gear.	All, except enclosed lamps trimmed each day. Short ends of carbon used up during summer.	Yes.	30s.	—	25s., youth 5s.	No.	1 week with pay.	Column No. 1: Nine additional flame arcs about to be put up are not included in the number given. Column No. 2: The hours of burning given is not the limit of the lamps, but it is not considered advisable to let them go longer without being seen to.
2	—	Yes. Also light lamps.	22s. See remarks column.		21s., also members of fire brigade receiving 5s. per week in addition.	No.	1 week.	Columns Nos. 4 and 9: Superintendent also acts as fire-master. Amount given is proportion of salary paid as superintendent of lighting.
2		No.	40s.	—	21s. and 26s.	No	None.	Two incandescents on each lamp pillar.
3	40	Yes.	60s. (gas).	32s. 6d. and 35s.	22s. 6d. to 28s.	No	All weekly wage men have 1 week.	The whole of the street-lighting (gas and electric) is under one department.
4 with 4 mates, one extra Nov. to Feb.	40-45	After switching on, they return over their district ensure all lamps are in lighting before reporting off.	40s.	—	35s., mates 30s.	No.	10 calendar days, plus extra days for public holidays.	Three men attend to incandescents. Cycles are provided, and their wages are 30s. per week. One of these men stays on for two hours each night in case of lights out. Foreman is on duty every night whilst trimmers are reporting off, and attends to any trouble. Overtime is paid at single rate to public lighting men, in the event of lamps out, unless the cause is their neglect, when they get nothing.
5	Each trimmer has to trim and clean 50 arcs, and 2 incandescents on each column.	No, but they are employed in turn scouting after lighting-up time.	Mains engineer £150 per ann., rising to £200.	Foreman 40s. and 1s. 6d. for cycle, assistant 21s	28s.	No.	No recognised holidays.	Four switchmen at from 18s. to 20s. per week, and 1s. 6d. for cycle, employed in lighting, extinguishing, cleaning, and changing incandescents in side streets.

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EXPLOSIONS IN ELECTRICITY CULVERTS.

Much has been learned during the past twenty-five years, but perfection is not yet. One reason why greater advantage is not taken of knowledge gained is that progress depends very much upon a majority, and more often than not the majority is interested in things that be, and hates better things to be. Thus it has been in electrical matters. The majority interested in gas or rushlight or steam or wind has done its best to hide the truth, otherwise we should not be now reading with some interest about the cause of explosions in electricity culverts. The admirable report of Mr. J. A Bell to his committee at Aberdeen will, no doubt, be welcomed by the eulogists of gas, inasmuch as it admits an alternative cause for such explosions in which gas plays no part. Fortunately, Aberdeen owns both gas and electricity undertakings, so that a real attempt was made to get at the truth. Enlightened people, the minority have long known that (1) the worst and the really dangerous explosions are those in which gas always plays an important part; also that (2) it was possible to have a mild explosion by the sudden heating of air; further, (3) that electricity in some way or other was the immediate cause of the gas exploding, or of the air being suddenly heated. We are tempted to say that there is no record of a dangerous explosion where suddenly heated air was the agent of destruction, and that wherever any really destructively dangerous effects have been produced they have been produced through the presence of gas in fairly large quantities. The experiments carried out at Aberdeen by Mr. Bell not only corroborated the above views, but have led to modifications of installation or, rather, of distribution details which have lessened, if not entirely prevented, the troublesome explosions, and other alterations are suggested so as to get rid of the causes which have been determined. There may, of course, be other and as yet unknown causes, though it is difficult to see in what direction they can occur. Other points in connection with this report are interesting, and should be thought over by sanitarians especially as regards gas leakage. We are told that, putting aside danger from explosions, a small quantity of gas in the air is very deleterious to health, and these experiments tend to show gas leakage is far too common an occurrence. That this statement is correct is shown by the number of leakages found out, and we may infer that some leakages are not very quickly detected. The gas from these leakages goes somewhere, and if it can percolate to junction boxes or culverts and a spark occurs where there is a collection of gas we get the inevitable explosion. Otherwise the gaseous emanations may be more or less absorbed in the moist soil, and evidence of this is obtainable in almost every case where a gas-main is uncovered. These facts are known, the dangers arising from gas leakage and an electric spark are also known; hence the simple moral. The work of supervision and constant examination ought to weigh equally upon the shoulders of each party. But does it? The party providing the powder generally gets off scot-free; the party providing the match is most frequently blamed, and has to pay. Agree that modifications in electrical distributing systems will tend to minimise accidents, is it possible that any conceivable method of distribution can be so perfect as never to get an accidental spark? We doubt it, and fain would suggest that the gas interests should do as much to prevent escape as the electric interest does to avoid explosion when that escape occurs. Dr. Hay's statement is not generally known or accepted, that gas percolating through soil of sufficient length may lose its odour and retain its explosive property, but from our point of view this matters little. We again assert that the electrical

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undertaking is usually expected to do everything and the gas undertaking nothing. There ought to be some good from this report, even the suggestion to expend a large sum out of revenue to prevent future trouble. No doubt we shall be told this is really a question of obsolescence and nothing more, and the expenditure is just one of those things which ought to be provided for, but is not. What a nice point for further controversy!

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE TELEPHONE QUESTION.

SIR,—Since my last letter of Aug. 8 the third reading of the Telegraph (Money) Bill, which gives the Post Office the uncontrolled expenditure of £6,000,000, has been carried by 107 to 20 in an attenuated House, in spite of spirited protests from the few who have studied the question and realise the impolicy of such a vote. The fact, however, does not in the least justify any cessation in the demand for an inquiry into the telephone administration of the Post Office either as regards inflated tariffs or inefficient service.

The justice of the criticisms of the Post Office telephone instruments which you have so kindly permitted me to voice in your journal has just received an unexpected confirmation from an official source. One of your contemporaries (London *Daily Mail*, Aug. 13) has interviewed the telephone authorities on the subject of indistinct transmission of speech, with comical results in more senses than one—comical because of the ludicrous suggestions that are made for improving the efficiency of the official transmitter, which ought to need no improvement, and comical because our worthy Postmaster-General (Mr. Sydney Buxton) lives in the full and certain belief that the Post Office instruments are perfect, and, therefore, incapable of improvement. In this belief he had, I was sorry to observe, the bad taste the other day to make fun of the Paris telephone system, and contrast it unfavourably with his own. The Paris system is, indeed, not perfect, but it is, on the whole, no worse than the London one.

It seems, according to this new light, that the common-battery transmitter, although selected by the Post Office as the most perfect of its kind, has an evil habit of mixing up numerals. If it were possible to eliminate four of our ten numerals, then all would be well, but that cure, although simple, does not commend itself to the telephone authorities as very practicable, since "three," "five," "six," and "eight" turn up pretty constantly in everyday work. So, as a result of "many hundred of errors" (fancy that in a perfect system!), operators and subscribers are to be asked to help that poor transmitter which is so imperfectly perfect by mispronouncing certain words. Thus the official pronunciation of "four" is to become "fo," and of "nine," "nin"! By the help of still other banalities and rules it is hoped that "the enormous accumulation of mistakes" (!) will be reduced—not abolished. This almost makes me yearn again for my Yankee electrician and his "cinq." So the language of Shakespeare and Milton has definitely broken down before the American common-battery transmitter; but hope need not be abandoned. Let the Post Office and National Telephone Company refuse to make any connections unless they are asked for in Esperanto, and all may yet be well. For the municipal transmitters English, and that unmutilated, will still suffice.

The rather pathetic story of this interview concludes with advice as how best to speak to a common-battery transmitter. "Put the lips close to the mouthpiece and speak right in" is the advice. The American "right in" comes very appropriately. Everyday experience shows that it is, indeed, necessary to do this in order to get anything through at all. Frequently, even when this is done, it is necessary to speak so loudly that your clerks in the next room can hear what is said without the aid of any telephone. One result is that the breath condenses on the mouthpiece and leaves it covered with moisture, to the disgust, if not danger, of the next user, who has to put his lips "right in," too. Now, this faulty, nasty, insanitary, and behind-the-age transmitter has been adopted by the Post Office as its standard, and the National Telephone Company are not allowed to use any other, on pain of having its apparatus rejected and not paid for in 1911. Query: What proportion of the £6,000,000 voted the other day is going to America in payment for these transmitters?—Yours, etc, A. R. BENNETT.

Westminster, S.W., Aug. 19, 1907.

SIR,—I wonder if Mr. Bennett ever read the fable of the fox who lost his tail, and then tried to persuade his brother and sister foxes that tails were very unfashionable. Municipal telephony failed mainly because its technical methods were all wrong. Now Mr. Bennett suggests that the Post Office and the National Company should give up modern methods and go back to the hybrid and antiquated systems with which the municipalities experimented.

Mr. Bennett is never funnier than when he discusses technical points. To those who know that more telephones are worked by the common-battery system than by all other methods together, his letters have a certain air of unreality. But there are still people prepared to argue that the earth is flat, and doubtless Mr. Bennett could get up a column letter on that point which would be most impressive to the provincial newspaper reader. That the common-battery transmitter carries less current when signalling than when talking is a minor point, of course. It is, nevertheless, "bad engineering practice" to make any piece of apparatus serve two purposes. No doubt this pronouncement also impresses the provincial newspaper reader. But what a *dictum* to come from a M.I.E.E.! I wonder what Robinson Crusoe would have said to it. And how about the kitchen range? Would Mr. Bennett have two—one to cook the joint and another to heat the water? Is it bad engineering practice to "constrain" the receiver to hold down the switch-hook, or does Mr. Bennett advocate a separate weight? It is fortunate that inventors know little about "good" engineering practice, or we should still be back in the "good old days."

The story about the use of "cinq" instead of "five" in New York is fiction. If Mr. Bennett had stopped to think before putting his "Romance of No. 5" into print, he would, perhaps, have seen the absurdity of advising one individual subscriber to say "cinq" instead of "five." The difficulty which Mr. Bennett is labouring over is not confined to the telephone. Did not the Cheshire cat repeatedly ask Alice, "Did you say 'pig' or 'fig'?" And it is not confined to English. In French you have *deux* and *neuf*, *six* and *dix*; and even *sept* and *huit* are sometimes taken for each other on French telephones—which are not yet worked by common battery. In German you have *zwei* and *drei*; in Spanish *tres* and *seis*—in fact, a similar difficulty occurs with every language and over every telephone, but clear speaking and careful checking of numbers will work wonders.

Mr. Bennett had much better stick to telephone politics—so much more favourable a field for romantic essays than the technicalities of telephone circuits and telephone operating.—Yours, etc., HERBERT LAWS WEBB.

[It does not seem quite clear to us that Mr. Webb replies to Mr. Bennett. "You're another" is not an answer. Mr. Bennett inferentially says that "five" is clearly heard if spoken by one system and not by another. Mr. Webb says they are all alike, and phonetics, as indicated by Grimm's law, are troublesome all the world over. But is one system better or worse than another? To abuse Mr. Bennett for ignorance of technical engineering telephonic knowledge is nonsense. He certainly knows what he is writing about.—ED., *E. E.*]

COSTS OF A SUPPLY STATION.

Mr. A. M. TAYLOR writes to us on a subject which interested many electrical engineers at the recent I.M.E.A.

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convention, and which, in fact, interests them always. He says:

"I would be glad to say, through your paper, that I have for a long time past recognised that Wright's method for finding the law of costs, though extremely useful in those early days and very ingenious, is now not an adequate guide to what I have termed the true running cost.

"At the Sheffield convention I was almost tempted to enter the field in discussing Mr. Burnett's paper, and am again now; but this is a large question, and cannot be dealt with in a single letter. One thing is clear to me—that the divergence between the true running cost for a station of the size of Barrow, as estimated by Mr. Burnett and by myself,* is too considerable for *both* of these methods to be right.

"As regards the maximum demand system, the clauses in my recent paper headed 'Combined Diversity Factor' and 'Diversity Improvement Factor' were a first attempt to attach a definite numerical value to the preference which should be given to the load which best adjusted itself to the peaks that already existed when this load was introduced to the station. Such a statement of the case takes account of the possible shifting of existing peaks by the over-development of some particular class of load, and would meet the difficulty caused by the application of 'restricted-hour' charges *as at present understood*, tending to create a new peak. In abandoning the maximum demand *method*, I would not like to go so far as to say I abandoned the maximum demand *principle*, for Mr. Wright very early took account of diversity factor. It is in the form of statement of the charge *to the consumer* that the maximum demand system seems so wanting.

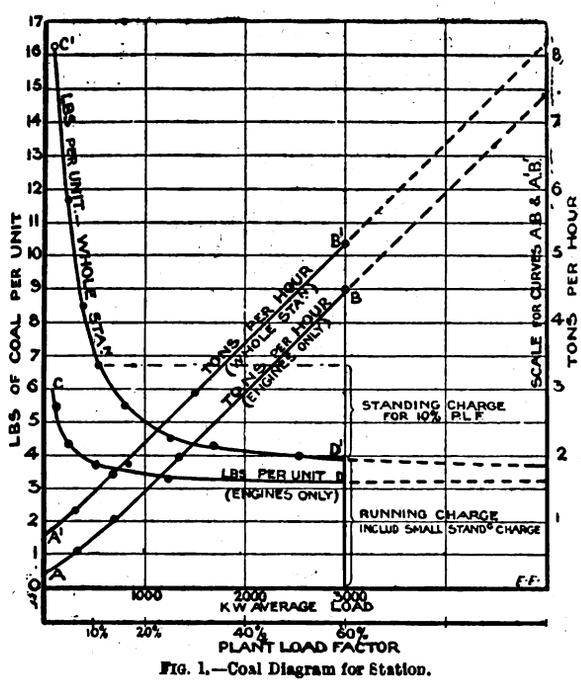

FIG. 1.—Coal Diagram for Station.

"I beg to differ from the statement in a contemporary that 'the stand-by losses of modern power supply are not materially greater during the period of lighter sales.' Presumably the writer means losses *per unit*, and not total losses. If, however, Fig. 1 of my recent paper is correct, these losses *are* in most stations materially greater, and will be for some years to come.

"I also urge that stand-by losses be *not* included under running charges.

"With regard to another criticism, my recent paper was an attempt 'to establish (the outworks of) a definite system for accurately separating running and standing charges,' but the more one goes into this question the more difficult it becomes to deal with it comprehensively. If, however, we could all agree about *coal* costs it would be something gained, and I cannot see why the steam consumption tests of a representative engine, taken at its most economical load, and translated into pounds of coal in terms of the boiler full load evaporation test—*i.e.*, ignoring losses in the direct steam-pipe to engine, which can easily be estimated separately—cannot be safely taken as a first approximation to the running charge for coal for the station, including as it does the full stand-by loss of both engine and boiler, which is *not* strictly a 'running charge,' and which will quite compensate for the neglected loss in the straight-through pipe joining engine and boiler. To this result is added a percentage for auxiliaries (full-load tests), and, finally, any correction desired may be made for non-compliance with test conditions in everyday working, *not* as regards loading of the set, but as regards *conditions* only. The 'running charge' for coal thus deduced corresponds with the ordinate of my curve C D, herewith, for 5,000 kw., which represents the consumption with every engine and boiler in the station fully loaded, including auxilaries, and includes losses in straight-through steam connections.

"The difference between curves C D' and C D represents standing losses in steam ranges (per unit generated), and increment of loss *per unit* in engines, straight-through pipes, boilers, and auxiliaries over and above that for full-load conditions, the standing losses at *full* load for these latter being included in the ordinates of the curve C D, as already explained.

"It may be added that the early part of curve CD, covering the range of the output of the first 1,000-kw. engine and boiler, is calculated from the engine performance at various loads, while the earlier part of C D' can be obtained experimentally. I assume that the boiler has a performance curve connecting total coal with total steam, not very dissimilar to that connecting total steam with horse-power hours in the engine—*i.e.*, that there is a standing loss, which is sensibly constant at all loads—as I endeavoured to show in my 1904 paper. I also assume that most engineers agree that the steam consumption of the engine debitable to the running charge is *less* than the observed results of tests made at the most economical load, paradoxical as this may seem. Similarly with the boiler evaporation.

* See my recent paper, *Electrical Engineer*, Feb. 22, *et seq.*

THE "WILKINSON" FEED-WATER HEATER.

Having regard to the large experience in central-station work which Mr. Geo. Wilkinson, M.I.E.E., M.I.M.E., has had both at Harrogate and elsewhere, whereby he has learnt to appreciate the importance of economies effected in the boiler-house, it is not surprising that the feed-water heater invented by him should have met with unqualified success. Experience had shown him exactly what was wanted, and his inventive genius, combined with mechanical knowledge, did the rest. A paper, entitled "Live Steam-Heated Feed Water; Its Effects on the Efficiency and Output of Steam-Boilers," read by Mr. Wilkinson at the annual convention of the Municipal Electrical Association in London in June, 1906, and reprinted in our columns at the time, reflected the close attention given by the author to the subject.

The apparatus, which may be regarded as the fruit of this attention, consists of the following parts: A de-aerating chamber fixed at the highest position within the boiler into which the feed water is delivered; a number of dishes and plates, fixed alternately, over which the feed water gravitates to a receiving chamber below. These are built round a vertical hydraulic tube passing through the shell of the boiler. This tube is open at its upper and closed at its lower end. A little mercury is poured down the tube to facilitate the transmission of heat to a thermometer which is inserted therein. This thermometer gives the temperature of the feed water at the point where it flows into the water-space of the boiler. A tank and dip pipe are fixed below the receiving chamber, and serve to convey the feed water at steam temperature to the bottom of the boiler, near the "blow-off" valve. A small pipe connecting the de-aerating chamber to an air-valve outside the boiler completes the equipment. The heater has been designed for and applied to many types of steam-boilers, being easily and cheaply fixed. It is cleaned in a few minutes, and when installed incurs no upkeep expenses.

The chief characteristics of the apparatus are its simplicity and cheapness, and an accurate registering of

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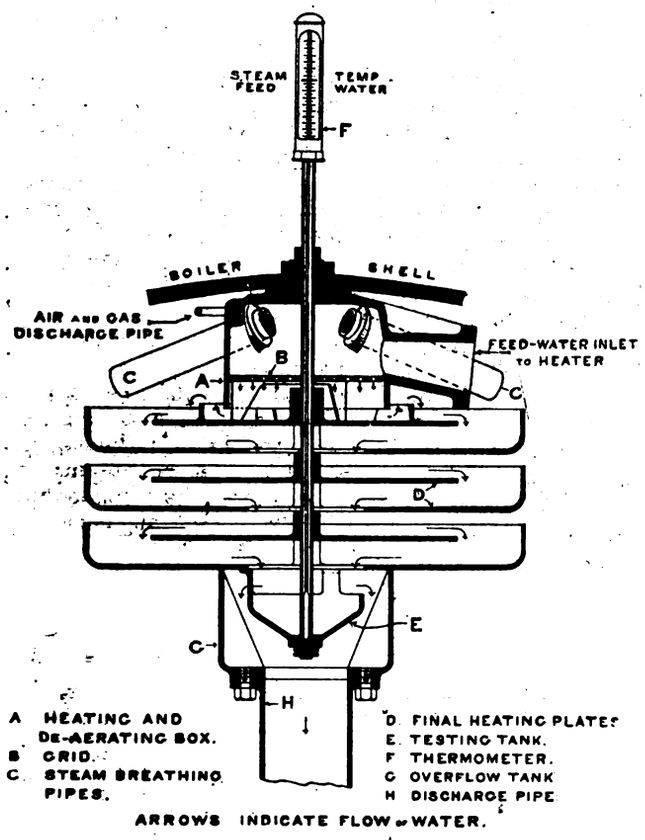
the temperature of the feed to the bottom of the boiler. It is also claimed to be the only apparatus on the market

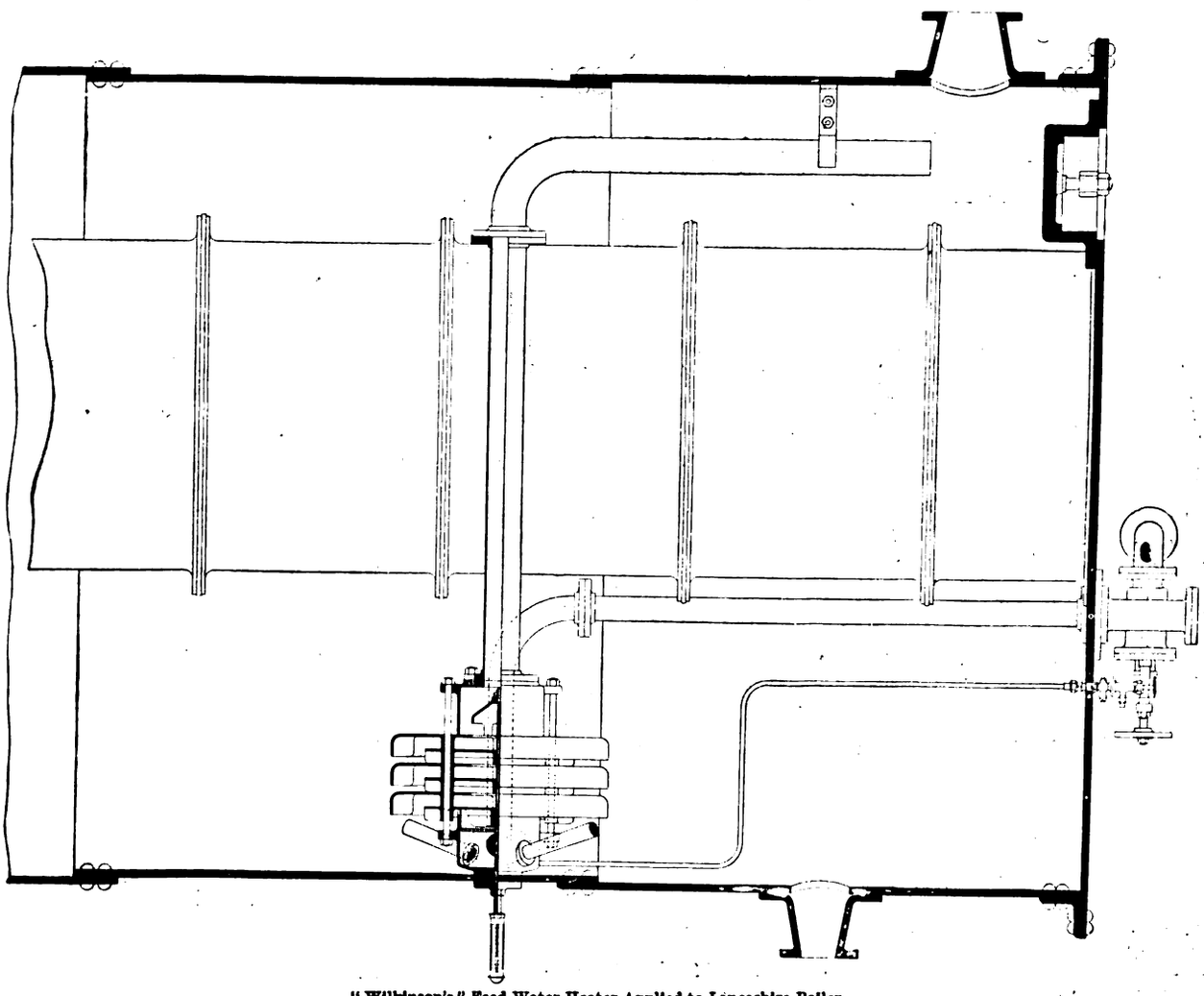


"Wilkinson's" Feed-Water Heater.

the water above the temperature of the steam, which heats it; hence the extremely high efficiency obtained by its use. On this point the following quotation from a report by a user of the heaters, who discovered the effect in common with other users while making independent tests, will be read with interest: "There is no doubt whatever that on more than one occasion, when testing your feed-water heater with water from the economisers, the temperature of the water exceeded the temperature of the steam in the boiler under test by as much as 5deg. F. In order to make sure that there was no mistake on this point, the position of the two thermometers upon which the readings were being taken was reversed, but the readings still remained as above mentioned."

The working pressure of this boiler is 150lb. per square inch. The higher the boiler pressure the greater the superheat in the water leaving the heater. Careful tests have shown that the last 10deg. F., bringing the water up to steam temperature, are worth more than 50deg. F. at any other part of the temperature scale, as the curve of efficiency rises rapidly when steam temperature is approached. In some cases, since the heaters have been introduced, the evaporation with low-grade fuel has been improved from 6½lb. to 8lb. of water evaporated per pound of coal.

Following are the results of careful tests to determine the saving effected by this heater. The boiler upon which these tests were made had been continuously under steam for four months; the fires were lit on Dec. 16, 1906, and the tests made on April 24, 1907. This is sound evidence of the heater in keeping the boiler clean and free from scale. Counters were fixed upon the automatic stoker and feed pump to secure uniformity of feed of fuel and of water. The fuel was weighed and the water gauged in large standardised tanks. To secure regularity of steam pressure, the supply valves on the boiler were kept "blowing off." The work done by the boiler in each test was taken up



"Wilkinson's" Feed-Water Heater Applied to Lancashire Boiler.

that raises the water to the full temperature of the steam. As a matter of fact, with heaters of adequate size it raises

electrically and metered. By varying the loads at the switchboard, the "blowing off" was kept fairly regular.

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	Economiser with heater.	Economiser without heater.	Difference in favour of heater.
Duration of test	3 hours.	3 hours.	—
Coal burnt per hour	888lb.	844lb.	—
Coal burnt per hour per square foot of grate area	26·1lb.	24·82lb.	—
Water evaporated per hour	8,824lb.	7,425lb.	—
Water evaporated per hour per square foot of heating surface	8·02lb.	6·75lb.	1·27lb.
Water evaporated per pound of coal	9·93lb.	8·79lb.	1·14lb.
Equivalent evaporation from and at 212deg. F.	12lb.	10·64lb.	1·36lb.
Absolute steam pressure (average)	155·9lb.	155·3lb.	—
Temperature of steam at above pressure by thermometer	363° F.	364° F.	—
Feed temperature from economiser	256° F.	246° F.	—
Feed temperature due to steam feed heater	363° F.	—	—
Combined efficiency of plant, including superheater	84·68 %	74·73 %	10·4 %
Calorific value of coal (B.Th.U.)	14,200	14,200	—

Summarised, the substantial gains are as follows: Increased evaporation per pound of coal, 12·9 per cent.; saving in coal, making no extra allowance for a continuously clean and efficient boiler, 11·4 per cent.

We understand that ample facilities are provided for the manufacture and quick delivery of the apparatus, while a dozen agents have been established in this country and abroad. Already the list of users is a long one. It includes one of the Government departments, and a number of electricity works, where, to judge from the excellent testimonials obtained, the heater is doing capital service in reducing coal consumption, scale formation, etc. But when all is said and done, the numerous repeat orders secured undoubtedly afford the most convincing testimony of the value of the "Wilkinson" feed-water heater.

ELECTRIC CABLEWAYS USED ON SHIPBUILDING BERTHS.

In 1906, at the spring meeting of the Institution of Naval Architects in London, a paper dealing with the system of cableways adopted by Palmer's Shipbuilding and Iron Company, of Jarrow-on-Tyne, was read by Mr. J. L. Twaddell, of that firm. We gave an illustrated description of the installation in our issue for June 8, 1906, since when two larger berths have been similarly equipped in the same yard by Messrs. J. M. Henderson and Co., of Aberdeen, the patentees. In a paper read at the recent Aberdeen meeting of the Institution of Mechanical Engineers, Mr. John M. Henderson gave some further interesting details of the system, as follow:

The conditions at Jarrow are generally similar to those in other large shipbuilding yards, and the suggestion that a system of overhead cables and trolleys might be applied to shipbuilding berths was made in the form of an inquiry from Messrs. Palmer's Company. Broadly, the problem was (1) to suspend the steel cables 100ft. or more above the ground in such a way that a useful load of several tons could be handled; (2) to provide for moving the load transversely, in addition to raising and lowering and running it from end to end of the berth; (3) to place the operator where he would have the best view, and, therefore, the most efficient command of his work. It was also stipulated that electricity should be the motive power. The first berth to be covered is a rectangle 500ft. long and 100ft. wide; the second and third berths are 700ft. long and are each 75ft. wide. Fig. 1 shows the latest form of the gear, which is the larger, and has four load-handling units instead of three. The pillars at both ends of the berths rest on strong concrete seats. The pillars are made of steel, lattice construction, and are rectangular in cross-

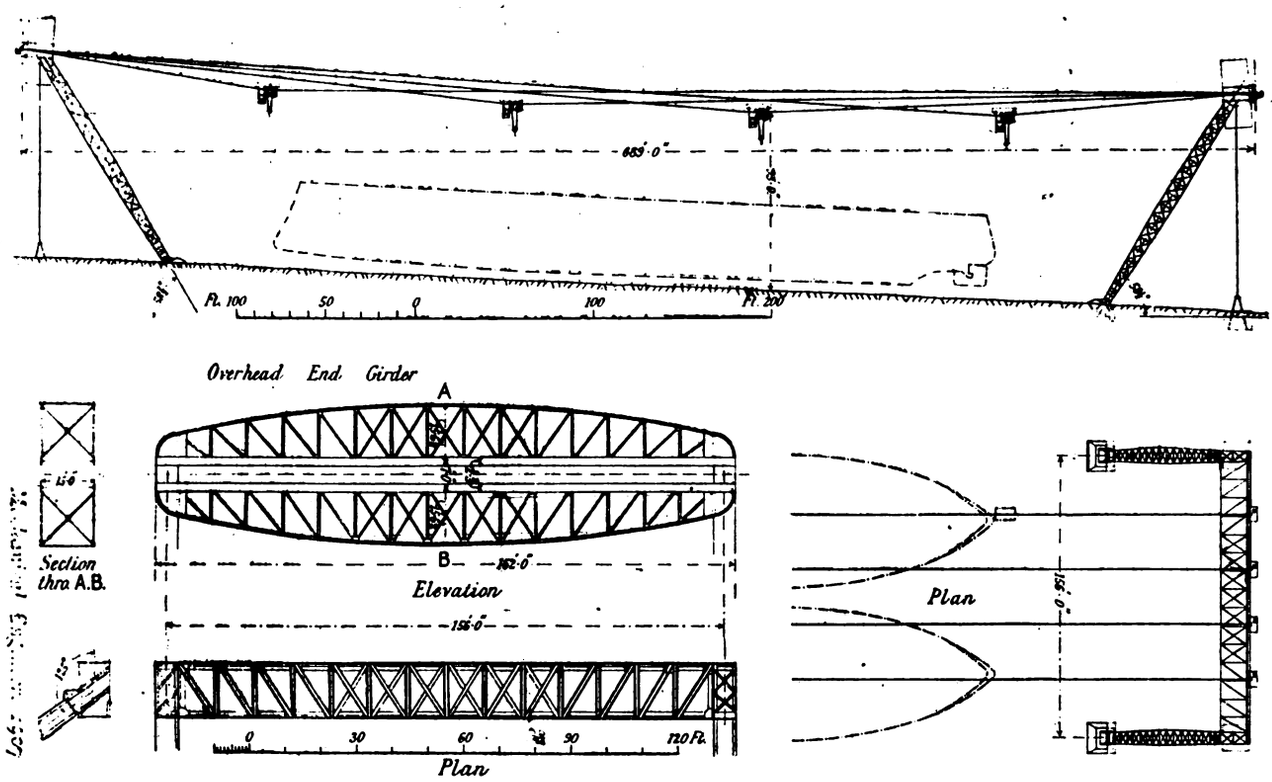

FIG. 1.—Overhead Wire Cableway at Jarrow Yard of Palmer's Shipbuilding and Iron Co.

section. The corners are of stout angles and plates with angle and flat bar bracing on all four sides. There is a short length of plating all round at both extremities. Means of access to the girders are provided by an iron ladder, which is carried up the inside of one leg at each end. As will be seen, the pillars are inclined outwards—that is, from their base away from the berth. Vertical supporting pillars were not practicable; guys could not be fixed in the fairway of the River Tyne nor in the High-street of Jarrow, which properly leads to the gate of the firm whose founder, the late Sir Charles Mark Palmer, made the town. Neither were vertical pillars with buttresses considered to be satisfactory, both on account of excessive cost and the ground space which would be occupied by the props and their foundations.

The cross girders of the larger installation are as shown in Fig. 1. For convenience in erection the end girders were, in the case of both gears, made in two parts—an upper and a lower. They are built of steel sections, plates, and bars, and are of suitable strength to resist the strain due to the weight and tension of the four cables and of that due to the weight of the load carriages with their load. The upper and lower halves of the girders are securely bolted to the head of each pair of supports, and to prevent

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them deflecting horizontally vertical bow stiffening is provided. There is a clear space between the upper and lower portions of the girder to allow of the transverse movement and vertical play of the cables and attachments. Fig. 2 is from a photograph showing the lower portion, weighing 58 tons, of the girder for No. 2 gear at upper end of berth being hoisted into position. While the outward inclination

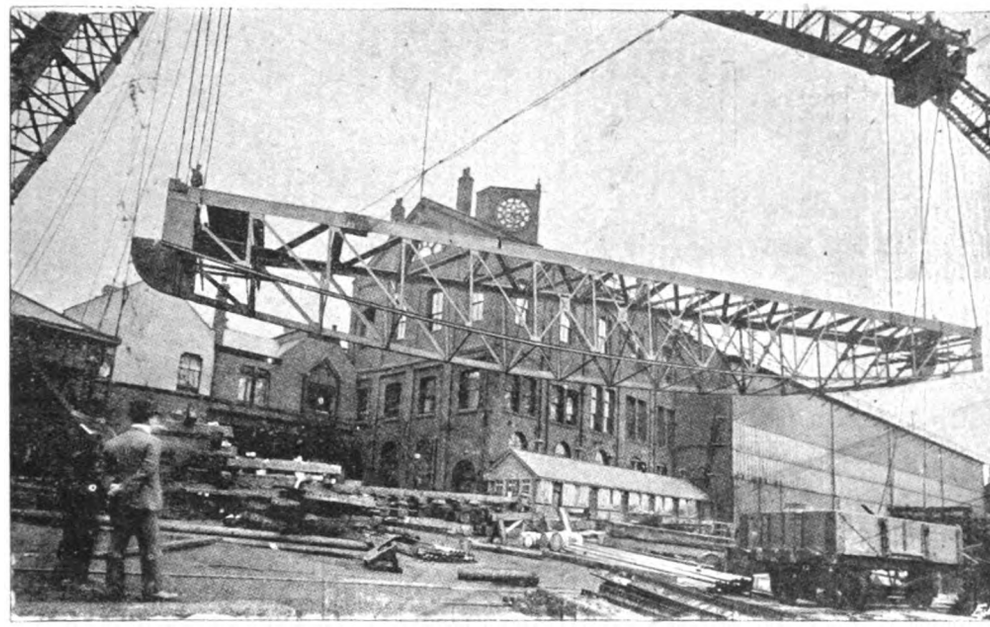

FIG. 2.—Lower Portion of End-Girder being Hoisted into Position.

of the pillars, with the weight of cross girders and end carriages, go towards balancing the weight and tension on cables and the weight of load carriages, the structures are firmly guyed at each corner to a solid concrete block. The four steel-rope guys drop vertically from the head of the column to which they are attached to the anchorage, suitable means for adjustment being provided in each. The anchorages at the river end are well out on the foreshore, and at the upper end are put below ground, leaving only the vertical wires as an obstruction. There are also

The load carriages or trolleys on the second gear are shown in Figs. 4 and 5 They are also of steel framing with a suitable cage for accommodating the operator, and covered in with an awning carried on wrought-iron stanchions. Each of the carriages carries a 35-b.h.p. enclosed reversible motor, from which power for both the hoisting and travelling motions is derived. The longitudinal movement of the carriage is obtained through friction and spur gearing from the electric motor to a travelling motion shaft on which two rope drums are keyed, one at each

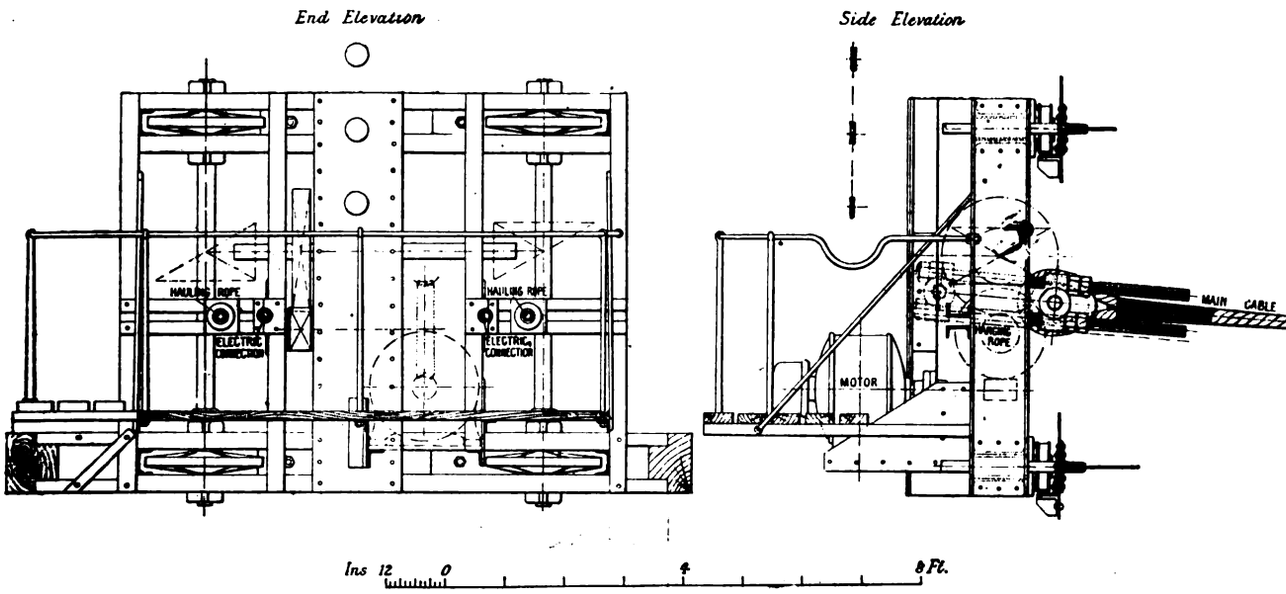

FIG. 3.—End-Carriage for Electric Cableway.

two steel-rope stays, one at each side, connecting the heads of the upper and lower pillars on the port and starboard sides of the berth, so that, although practically in equilibrium, the structures of the cableways are secured by those stays and guys so as to be free of any movement. Both ends of each main cable are attached to a carriage which travels on rails fixed on the outer side of the upper and lower girders. The end carriages are as shown in Fig 3. They are made of a steel framing and are carried on four rail wheels. The four wheels are driven

end. Two wire ropes are stretched from end to end of each cableway, each of the ropes being wound on its drum a sufficient number of times to prevent slip in the opposite direction to that in which the carriage is travelling. The hoisting motion is obtained through friction and spur gearing to a drum running loose on a hollow steel shaft. The load is lifted through four parts of wire rope and hoisting block, the purchase being doubled by the block Mechanical friction foot brakes are fitted to both longitudinal travelling and lowering motions, the operating

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levers being conveniently arranged in the cage. The speeds are: of longitudinal travel, about 500ft. per minute; hoisting three tons, 100ft. per minute, and lighter loads at somewhat higher speeds. The speed of cross travelling is 25ft. per minute or thereby. The gradient of the main cables, irrespective of sag, is the same as that of the ground. In a length of 700ft. the sag is about 22ft., and in cases like that at Jarrow, where all materials are brought to the end of the berth, the load descends by its own weight after being hoisted to the required position over the structure of the vessel. The return journey of the carriage is made when it is light, thus minimising the power required. In such an outfit the importance of the main cables makes it imperative that great consideration should be given to them. The wire of which they are composed was specially drawn, and has a tensile breaking strain of 75 to 80 tons per square inch, with an elongation of 20 per cent. in a length of 8in.

Special collecting gear and connections are provided on each load carriage for the purpose of contact, and the chief point of difference between the first and second installations lies in the arrangement of the bare conductors for supplying energy to the load-carriage motor and control of the end carriages. On the first cableway they are arranged in a vertical plane, and six wires are used in two sets of three on each side of the load carriage, these being stretched as tightly as possible between the two end carriages. The collectors on the load carriage are of the sliding contact type, and rigidly attached to each side of it. It was thought that this method could be improved upon, as there is a certain amount of trouble in keeping the sag of copper wires to correspond with that of the others. In the second installation the wires have accordingly been arranged in a horizontal plane and their number reduced to five. There are, in addition, two supporting steel ropes at each side. The supporting cables are spaced

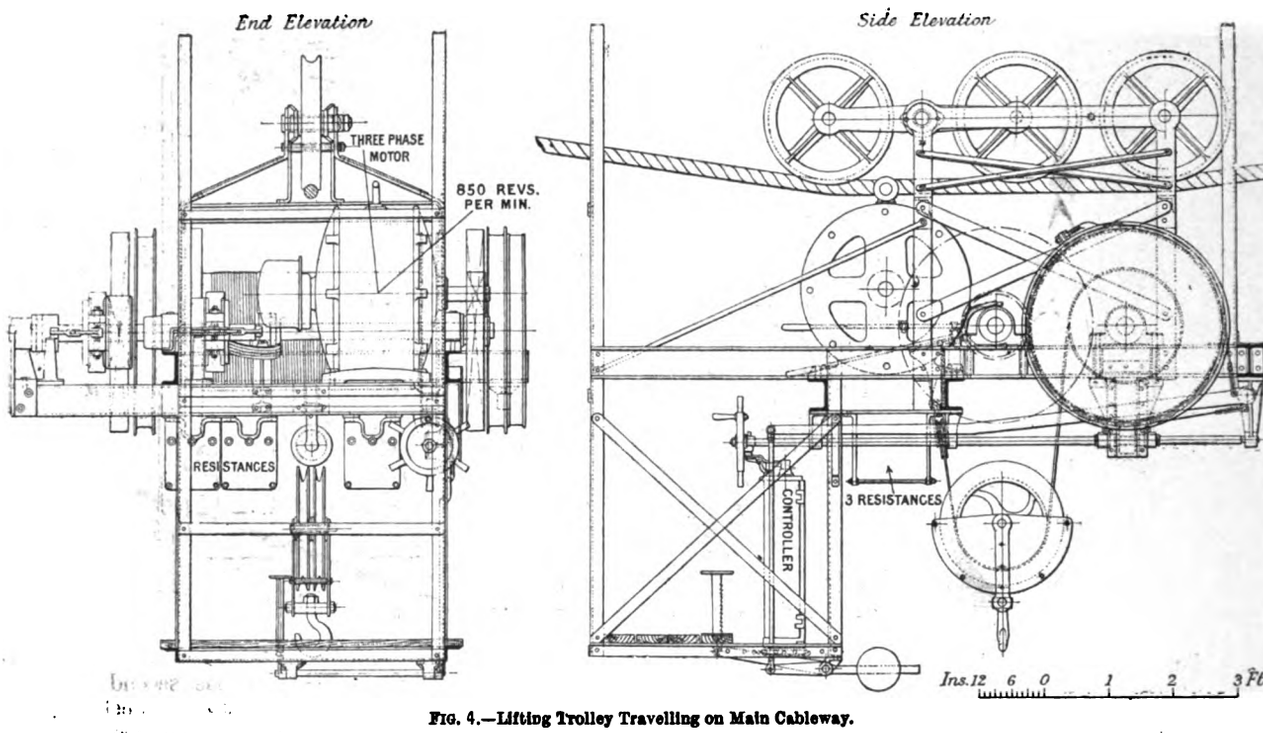

FIG. 4.—Lifting Trolley Travelling on Main Cableway.

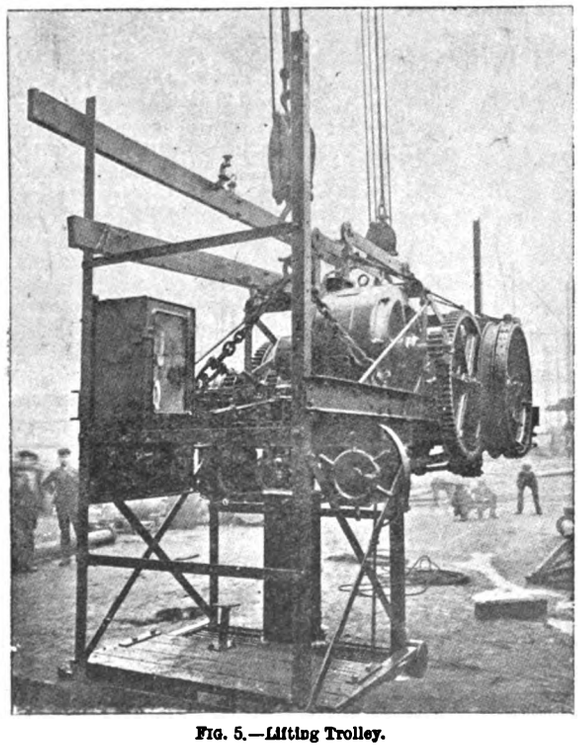

FIG. 5.—Lifting Trolley.

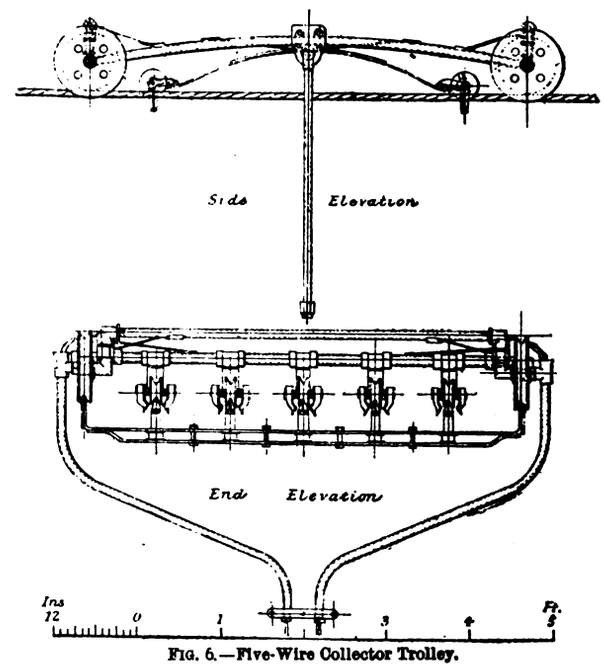

FIG. 6.—Five-Wire Collector Trolley.

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apart by steel distance pieces, into the upper side of which insulator bolts of tramway pattern are fixed to carry the ears for holding the trolley wires. The distance pieces are spaced at 85ft. centres, and give a particularly rigid construction to the conducting wires. The arrangement is illustrated by Fig. 6. On the upper surface of the wires a bogie is placed which is provided with wheels for running on the supporting cables, and also for making contact with the trolley wires. Separate flexible cables are brought down from this bogie to the load carriage, but the pull on the bogie is taken up by separate steel cable connections between it and the load carriage. This arrangement, suggested by Messrs. Palmers and carried out by the author's firm, has been found to answer admirably in all conditions of weather. The bogie and control wires can be reached from the roof of the load carriage, a special platform being provided for this purpose. In the No. 2 cableway the wires are fed from a four-way distribution board on one of the bridges, four three-core flexible cables connecting the board with the trolley wires. The distribution board is fitted with four three-phase overload circuit breakers, one for each load cable, and the board itself is supplied with energy by a three-core cable leading up one of the legs. The reduction in the number of trolley wires from six to five has been possible because the reversing of the end-carriage motors is effected by reversing two of the phases, the remaining phase being supplied by a conductor common to all the motors. The motors are all of the enclosed type, designed to suit the generating plant of the yard, which is three-phase alternating current, voltage 440, with a periodicity of 30 per second. With regard to the working and upkeep of cableways, no special expenditure has been necessary so far, certainly not more than would have been required for an outfit of jib derricks. The main cables, as well as the running and hoisting wire ropes, are kept saturated with oil; and in regard to wear and tear, it is estimated that the main cables, if kept in fairly constant use, will have a life of about six years. The cost of renewal per cable for the smaller gear would be about £95, and for the larger gear about £150. The steel structures were coated, after being built, with linseed oil, and painted at the time of erection. The cost of repainting both is estimated at £95 to £100, and it is intended to do this about every second year.

As to the general utility of the system, experience has proved its excellence; indeed, some features, which before the first gear was put into operation gave some anxiety, have since been found of benefit. For instance, it was thought that a load suspended on a wire of 500ft. in length would have a tendency to surge vertically, and might make it difficult to place plates in the exact position required. In actual practice this fear was soon dispelled; as a matter of fact, it is found to be a distinct advantage to have the plate or piece of material, while being lowered into position, suspended in a more or less elastic fashion, as is the case in a cableway. Take, for instance, a shell plate; it is only necessary to bring the plate to within an inch or two of its position, and the end of a spanner passed through a hole in the plate and the corresponding hole in the frame pinches it into place; whereas, in the case of a rigid crane, the plate would have to be manœuvred into its exact position by the crane man. Another point which gave some concern before the gear was operated was whether, when a load was suspended, say, towards one end of a cableway, and it was found necessary to move it transversely, the two end carriages would move in unison. This, after adjustment of the motor resistances in the end carriages, has been quite satisfactory, no trouble in this direction ever arising.

With regard to the cost of such an installation compared with that of other systems, without going into figures, the author has good grounds for stating that the cheapest arrangement of a fixed structure with cranes overhead would cost double that of the cableway, and in many instances four times as much is nearer the mark, besides which, where the trolleys cannot be moved sidewise, but must travel always in the same line as in fixed structures, more trolleys are required, and hence increase the cost of working and upkeep. Any comparison with cantilever cranes as to cost would be enormously in favour of the cableway, while as to utility there is no comparison possible, the cantilever crane being, in the author's opinion, the most unsuitable of any device for ship construction. Time for erection (another important matter) is again greatly in favour of the cableway, as a berth can be dealt with in from three to four months with a minimum of interference with the progress of work on vessels under construction; indeed, if so arranged, several berths might quite well be installed in the same time.

During the last few years Mr. Twaddell, the author of the paper already mentioned, has taken occasion to obtain some expression of opinion from other shipbuilders as to how far, in elaborateness and expenditure, they would be justified in going in the direction of providing better means of dealing with the material, after all the skilled labour required to be done on it has been completed in the shops and sheds. From their views, together with his own experience, Mr. Twaddell concludes that cantilever cranes and steel structures the whole length of the berth, with cranes overhead, involve a much higher capital expenditure than the benefits accruing therefrom would seem to justify, in addition to which their elaborateness necessitates a very considerable and constant outlay in upkeep, which to some extent modifies their advantages, at least from a financial point of view. The opinion has been advanced by some shipbuilders that jib derricks, if sufficient in number on each side of the berth, meet the requirements very well; nevertheless, some builders have apparently found this insufficient, as, in addition, they have light railways on the deck at as early stages as possible, in order to transport the material in the fore and aft direction after it has been dropped on board by the derrick, thus showing

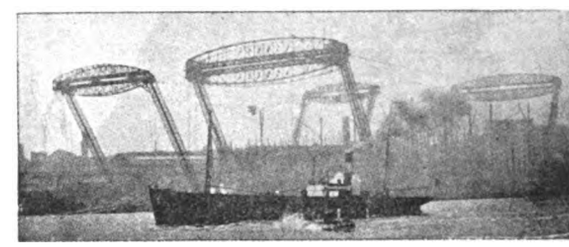

FIG. 7.—Overhead Wire Cableways.

that something more than can be accomplished with a derrick outfit is desirable, and that alone derricks do not meet the case. Amongst the objections to the use of ordinary derricks is to be placed first in importance the fact that, no matter how numerous these are along the building berth, it is impracticable with their aid alone to place every piece of material exactly in the position it must occupy as a part of the vessel's structure, consequently a squad of men must follow the piece of material to the ship, and after it has been (as in the case of a deck-plate, for example) deposited on the deck by the derrick, proceed to haul it into position in the most primitive manner by means of tackle, which has to be fleeted, it may be several times, according to the distance the plate has to be dragged. Particulars of both equipments of cableways are contained in the following table:

—	Dimensions of berths.		Clearance under hook at centre of span.	No. of hoisting units.	Motors.	
	Length.	Breadth.			On end carriages.	On load carriages.
	Feet.	Feet.	Feet.		B.H.P.	B.H.P.
1st gear	500	100	80	3	12	35
2nd gear	700	150	85	4	12	35

—	Circumference of main cables.	Breaking strain of main cables.	Quantity of material used in structures.	Circumference of steel-rope sidestays.	Circumference of anchor ropes.
	Inches.	Tons.	Tons.	Inches.	Inches.
1st gear	7¾	175	278	5½	6¼
2nd gear	8¼	200	456	8½	7

Fig. 7 shows the general appearance of these overhead wire cableways.

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EXPLOSIONS IN ELECTRICITY CULVERTS.

The following report on explosions in electricity culverts has been presented by Mr. J. Alex. Bell, city electrical engineer, to the members of the Gas and Electric Lighting Committee of the Aberdeen Corporation:

Gentlemen,—I beg to report that on Tuesday, 21st ult., at 2.30 p.m., an explosion occurred in the copper strip culverts in the east end of Union-street. Two manhole lids were blown up, and eight yards of pavement between the two manholes were lifted, the flagstones being raised from 5in. to 6in. on one side; the two manhole covers were thrown up into the air and both broken, and a section of one, falling on the copper strip, caused four or five short-circuits, resulting in minor explosions of flame and smoke. The explosion, in my opinion, was due to a service cable failing in an end box and igniting the coal gas in the culvert. There was the presence of gas in the culverts up till Thursday after the explosion, when the gas department found a leak at the top of the Shiprow, and since then there has been no smell of gas in this section of the culverts. A faulty gas service between the section of culvert affected and the Shiprow was also renewed on Wednesday, the day following the explosion. The department keep four men constantly at work examining culverts and manholes, and this section was inspected on April 20, and the culvert opposite on May 2. No traces of gas were found on either of these dates. I may mention that since Jan. 1, 1905, 51 cases of gas leaks have been reported by us to the gas department. The section damaged had pipes leading in at either end, it being an isolated section of culvert, and on carrying out repairs I took the opportunity of laying cable and filling in the culvert solid.

As requested by the convener, I herewith give a brief history of what has been done from time to time in connection with the explosions which have occurred in our culverts and manholes. As far back as 1895, in view of some explosions which occurred in other towns in connection with their electric lighting installations, the Town Council communicated with Prof. Kennedy as to the probable cause, and what steps should be taken to prevent such occurrences in Aberdeen. At that time Prof. Kennedy replied that efficient provision to prevent escape of gas from the gas-mains was the only remedy he could suggest. The first explosion in culverts in Aberdeen of which we have any record was Feb. 15, 1897, which was admitted to be caused by gas. Explosions occurred at various intervals up to the autumn of 1903. In many cases after these explosions there were distinct traces of coal gas in the culverts, and this was most marked when the effects of the explosion were of a severe nature, such as the lifting of several manhole covers and, in some cases, a portion of the foot pavement. The remedies taken at this time were to advise the gas department where gas was traceable, and the periodical examination of the culverts. In short, up to this period the opinion was held that a fault in the cable or the blowing of a fuse was the cause of a spark, and that, due to the presence of coal or sewer gas in the culverts, explosions resulted. In the autumn of 1903 explosions occurred at much shorter intervals, and, in fact, were of such a nature as to necessitate immediate investigation with a view to their prevention. With these latter explosions it was found that a portion of the electric mains or service cable in the manhole concerned was burned out at the time of the explosion, and the presence of coal gas was not traceable in every case. To investigate the matter thoroughly, a culvert with boxes similar to those used in the streets was built in the electricity works yard, and a series of tests carried out. The convener and the gas engineer were present at most of these tests, and Dr. Matthew Hay kindly interested himself in the matter.

In carrying out these tests in the first place, a service cable was built into the manhole and intentionally short-circuited—that is to say, a fault was put on it similar to what might occur in practice, and then the full-pressure current applied, the result being that the cable was immediately burned out and the manhole cover lifted. This at once showed that it was possible for an explosion to occur without the presence of coal or other explosive gas. The next step taken was to prove whether any explosive gas was generated from the insulating material by the intense heat of the fault, and it was found on experiment that a piece of bare copper wire—if short-circuited in the culvert—would create the same explosion, provided electrical energy sufficiently powerful were applied. These experiments tended to show that the explosions were in many cases brought about by the sudden heating and consequent expansion of the air in the manhole or culvert. Experiments were next carried out with ventilated covers, but it was found that a 6in. square hole cut in manhole cover 26in. by 24in. was not sufficient to make any appreciable difference in the height to which the cover was lifted. Culverts similar to those in use in Aberdeen have in some towns been ventilated by means of fans, and where a continuous line of culvert is available this method is in some respects satisfactory. Union-street culverts, however, are divided up into 24 different sections, having pipes, more or less filled with cables, connecting same. This method of ventilation is, therefore, impracticable. Experiments were made also with covers bolted down, but this was not found to be satisfactory. As most of the explosions in 1903 were caused by the failure of a certain type of end connection on service cables—the failure being found to be due to moisture in the culverts attacking the insulation of the cables—a new form of end box was designed to minimise this trouble as far as possible, and some 500 service cables laid into consumers' premises from culverts were altered at considerable expense. There can be no doubt that this alteration had the desired effect, as for well over 12 months after this improvement was made there was not a single case of a manhole explosion brought about by a cable fault.

To sum up the results of the experiments made and the experience gained by the explosions investigated, it was demonstrated, first, that if a cable failure occurred in a manhole, and sufficiently heavy current were available behind it, the box lid would be lifted by the sudden heating and expansion of the air; secondly, if there were any sewer or coal gas present in the box the explosion would be very much more serious. The system of laying electricity supply mains in the city from 1894 to 1896 is that known as bare copper strip drawn into concrete culverts. We have at present these culverts laid in Union-street, Castle-street, St. Nicholas-street, George-street, Castle-terrace, School-hill, Union-terrace, Rosemount-viaduct, Broad-street, King-street, Market-street, Guild-street, and Bridge-street. The four first named have culverts under both foot pavements. In all there are 3½ miles of culverts. Radical alterations in the supporting and insulating of the copper strip and cables in these culverts have been made three times in the last eight years at very considerable expense, and I am unable to suggest anything that will remove the chances of explosion short of doing away entirely with this type of distribution. It does not at present appear practicable to prevent coal gas leaking into the culverts from time to time. As already stated, a staff of men is employed examining manholes and culverts, and any smell of gas detected is at once reported to the gas department. An interesting fact Dr. Hay advised us of was that coal gas may, by filtering through a sufficient thickness of earth, lose its odorous constituents and become quite odourless, but will continue to retain its explosive elements. Even if it were possible to exclude gas from the culverts, there is still the danger of a box lid being lifted by the sudden expansion of air by the heat caused by a cable fault.

I, therefore, beg to recommend that the committee authorise me to replace the existing copper strip culverts by cables laid on the solid system, and that all important manholes on cable-work be replaced by section boxes placed above ground. I further recommend that the Union-street section be commenced as soon as arrangements can be made. Due to the light season of the year being so far advanced, it will not be possible to complete more than from Holburn-street to Bridge-street before the winter, as this work cannot be carried on to any extent after September. In carrying out the work I propose laying a distributing cable on the inside of the existing culverts, tapping on consumers as the work proceeds, then lift the pavement over the culverts and remove road boxes and lay the feeder cables on the solid system inside the concrete culverts, filling in solid with earth before replacing the foot pavement. In estimating the cost of this work I have allowed for increasing the capacity of distributors and feeders to meet future requirements, and this is shown as a capital item below.

Estimate of Cost of Converting Copper Strip Culverts to Solid System on both sides of Union-street from Holborn Junction to Bridge-street.

Feeder and distributing cable	£3,070
Services	142
Section boxes, fusing boxes, etc.	151
Roadwork and supervision	1,016
	£4,379
Add 10 per cent. for contingencies	438
	£4,817
Less amount of copper and gunmetal recoverable	1,421
	£3,396

Of this amount £510 represents increase of capacity of cable, and is, therefore, a capital item.

Estimate of Cost of Converting Copper Strip Culverts to Solid System on both sides of Union-street from Bridge-street to Castle-street.

Feeder and distributing cable	£6,171
Services	107
Section boxes, fusing boxes, etc.	232
Roadwork and supervision	1,084
	£7,594
Add 10 per cent. for contingencies	759
	£8,353
Less amount of copper and gunmetal recoverable	2,838
	£5,515

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Of this amount £483 represents increase of capacity of cables, and is, therefore, a capital item.

Total cost of converting all Union-street culverts	£13,169
Copper and gunmetal recoverable	4,259
Grand total	£8,910

of which amount £993 represents capital expenditure and £7,917 remains to be found out of revenue.

(Signed) J. ALEX. BELL.

COMPANIES' MEETINGS AND REPORTS.

METROPOLITAN DISTRICT RAILWAY.

The half-yearly ordinary general meeting of the Metropolitan District Railway Co. was held on Aug. 14, Sir George S. Gibb (the chairman of the Company) presiding.

In moving the adoption of the report of accounts (*Electrical Engineer*, Aug. 16), the CHAIRMAN said that, although the financial position of the Company was still not at all what they would wish it to be, the results of the half-year's working and the prospects at present were better than they had been for some time past. A year ago he had to present accounts which showed a deficit on the net revenue account of practically £40,000. This half-year, although the gross revenue had slightly decreased, the deficit had been reduced to £18,000, so that the position had been improved by 55 per cent., and this had been done entirely by a saving in working expenses. The capital expenditure during the half-year had been £137,588. This contained an item of £47,860, representing the deficiency of net revenue after payment of debenture interest and the dividend to the guaranteed stockholders at Dec. 31 last, that deficiency being included in capital expenditure by virtue of Act of Parliament. The balance, £89,728, represented money spent during the half-year on capital account. About £48,000 of this had been spent on improvements at stations and various works, and £28,234 was on account of electric rolling stock previously provided less a credit for rolling stock sold of £4,798. At the end of the half-year they had spent £313,000, more than the proceeds of the capital raised, and that excess had been provided by means of temporary loans. Fortunately, they possessed surplus lands of considerable value, and by utilising this security they had been able to provide ways and means. The passengers carried during the half-year numbered 25,426,825, but an alteration had been made in the mode of compiling the number of passengers by excluding those carried over the Whitechapel and Bow Railway. The decrease in revenue from passenger traffic was more than accounted for by the decrease in first-class. The actual decrease was £2,929, but they had lost 360,741 first-class passengers, representing £4,338. Although there had been that decrease, they had carried nearly 1,500,000 first-class passengers, and the first-class was rapidly disappearing. He did not think they ought to abolish it immediately, because if they were to do so they would offend 1,500,000 people each half-year. They carried in the half-year 4,683,000 workmen, showing a decrease of 1,970,678, representing £2,596. The workmen carried yielded an average of 1d. per passenger, and inasmuch as the average cost of carrying them was 1·36d. the proprietors need not distress themselves very much at this reduction. Ordinary third-class passengers showed a decrease of 1,521,000, but an increase in money of £2,075. The net result was that apart from workmen they had had a decrease of 1,876,794 passengers, or 9 per cent., and under the circumstances they might fairly regard this as quite a good result. In miscellaneous receipts there had been an increase of £1,915, the biggest item there being advertising receipts. The decrease in traffic receipts was due to new competition. The Piccadilly Tube was opened on Dec. 15 last, and that directly competed with the District the whole of the distance from Hammersmith to Holborn. He had gone very carefully into the matter, and had come to the conclusion that during the half-year they lost 2,250,000 passengers by diversion to the Piccadilly Tube, which carried 12,000,000 passengers altogether. Their loss in money due to the same cause had been £22,000, and in his judgment the only reason why they had been able to maintain practically their gross revenue had been that by means of the increase of fares they had received a farthing more per passenger than they did on the old fares, representing altogether some £24,000. Thus, had it not been for the increase of fares, their receipts would have been £22,000 less than they had been for the half-year. After referring to the London traffic problem generally and to the conference which was recently held between the different carrying companies, he moved the adoption of the report, which recommended a dividend at the rate of £1. 12s. 6d. per cent. per annum on the 4 per cent. guaranteed stock.

Sir CHARLES DALRYMPLE seconded the motion, which was carried unanimously.

TYNESIDE TRAMWAYS AND TRAMROADS.

The report of the directors of the Tyneside Tramways and Tramroads Co. for the half-year ended June 30 shows a surplus of receipts over expenses of £4,476, making, with £449 brought forward, a total credit to profit and loss of £4,925. The directors recommend a dividend at the rate of 2 per cent. per annum, carrying forward £600.

GUEST, KEEN, AND NETTLEFOLDS.

The report of Guest, Keen, and Nettlefolds for the year ended June 30 last states that, after making provision for bad and doubtful debts, the accounts show a profit of £470,511, to which must be added £167,145 brought forward, making an available balance of £637,657. Deducting from this the amount paid for debenture interest for the 12 months and interim dividend on the preference and ordinary shares, amounting altogether to £161,569, there remains £476,088. The directors recommend a dividend on the ordinary shares at the rate of 10 per cent. per annum, free of income tax, for the six months ended June 30, 1907 (making 10 per cent. for the year), and a bonus on the ordinary shares of 1s. per share, free of income tax; that £50,000 be placed to an accident and fire insurance fund, £100,000 to reserve, and that £186,588 be carried forward.

HARDY PATENT PICK.

The balance-sheet of the Hardy Patent Pick Co. for the year ended June 30 last shows a net profit of £16,258, making, with £6,206 brought forward, a total of £22,464. The directors propose to deal with the profits as follows: interest on debentures, £1,263; dividend on the 7 per cent. preference shares, £1,736; dividend of 10 per cent. on the ordinary shares, £6,890; depreciate tools and patterns, £500; provide for extensions, £5,000; carry forward to next year, £7,075. The buildings and machinery have been kept in an efficient state of repair out of the year's revenue.

NEW COMPANIES REGISTERED.

S. H. Heywood and Co., Limited.—Registered Aug. 13. Capital, £12,000 in £1 shares. Objects: to acquire the business of mechanical, electrical, and hydraulic engineers carried on by S. H. Heywood and H. W. Heywood at 37A, Fountain-street, Manchester, and at the Standard Works, Reddish, Lancs., as S. H. Heywood, and to carry on the same and the business of electricians, suppliers of electricity for light, heat, motive power, or otherwise, manufacturers of electrical apparatus, etc. No initial public issue. Registered office: Standard Works, Reddish, Lancs.

Contractors' Plant Association, Limited.—Registered Aug. 6. Capital, £1,000 in £1 shares. Objects: to buy, lease, hire, advance on sale or let on hire, sell, supply, or exchange instruments, plant, machinery, materials, and appliances relating to building, contracting, construction, equipment, maintenance, and working of railways, tramways, reservoirs, waterworks, etc., and to adopt an agreement between F. W. Sterry, C. Walker, and S. Harrison. No initial public issue. Registered office; 28, Bond-street, Leeds.

Rotary Illuminating Addressing Co.—Registered with a capital of £5,000 in £1 shares. Objects: to acquire and carry on the business of James Pollock, electrical engineer, 95, Douglas-street, Glasgow, of general bill-posters and newspaper and general advertising agents and contractors. No initial public.

Liens Registered.

Holman James and Co., Limited (Electricians, Maidenhead). £1,200 5 per cent. debentures, created 29th and dated July 31, 1907, charged on the company's undertaking and property present and future, including uncalled capital, have been registered. No trustees.

James and Browne, Limited (Electricians, London).—Issue on July 20 of £100 5 per cent. debentures, part of series created June 29, 1906, to secure £6,000. Charged on the company's undertaking and property, present and future, including uncalled capital. Trustees: J. W. Ellis, Portland House, Basinghall-street, E.C., and E. Hughes, 106, Holland-road, Kensington. Total amount previously issued of same series, £4,850.

Ligno-Carbon Co., Limited (Newton Abbot).—A debenture, dated July 30, 1907, to secure £200, charged on the company's property, present and future, including uncalled capital, has been registered. Holders: S. G. Chamberlain, Broadway-buildings, and J. Hill, Greyfriars-chambers, Reading.

Andrews' Governor Patents, Limited (London).—An agreement dated Aug. 2, 1907, to secure £500, charged on patent No. 5,385 of 1903, and the company's undertaking and property, present and future, including uncalled capital (if any), has been registered. Holder: A. Ramsay, Chesham, Folkestone.

Phœnix Engineering Co., Limited (Chard).—A debenture, dated July 31, 1907, to secure £400, charged on the company's undertaking and property, present and future, has been registered. Holder: Mary Anne Pownall, Queensbury House, 88, Regency-square, Brighton.

Jetley, Limited (Electrical Engineers, London).—A trust deed dated Aug. 2, 1907, to secure £4,000 debentures, created by resolution of even date, has been registered. Property charged: by debentures—the company's undertaking and property, present and future, including uncalled and unpaid capital; by trust deed—the leasehold hereditaments, 8, North Audley-street, W. Trustee: J. M. Henderson, Moorgate-street-buildings, E.C.

PERSONAL.

We regret to announce that Mr. Joseph Kincaid, senior partner in the firm of Messrs. Kincaid, Waller, Manville, and Dawson, civil engineers and contractors, died somewhat suddenly on Tuesday from heart failure at his residence, Whitehall Court, S.W. Mr. Kincaid, who was over 70 years of age, was the chairman of the City of York Tramways Co., and a director of the Primitiva Gas and Electric Lighting Co. of Buenos Ayres.

We are informed that the business of Messrs. J. S. Cunnington and Co. has been removed to 7, Great Newport-street, St. Martin's-

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lane, London, W C., where they are also carrying on the business of the late "Improved Electric Supplies."

The partnership existing between Messrs. Thos. L. Miller and Adrian Collins, practising in London at 61, Old Broad-street under the style of Miller and Collins, has been terminated by mutual consent as and from July 31, 1907.

Messrs. T. L. Miller and Wilson, consulting engineers, of 18, Westminster-chambers, 1, Crosshall-street, Liverpool, and 19, Brazennose-street, Manchester, have taken into partnership Mr. Henry Villiers Pegg, A.M.I.C.E., and have opened an office at 47-8, Scottish Temperance Insurance Buildings, Donegal-square, Belfast, and will in future practise under the style of T. L. Miller, Wilson, and Pegg.

The late Mr. William Page, of Morningside, Park-avenue, Watford, Herts, a director of the Brompton and Kensington Electricity Supply Co., the Chelsea Electricity Supply Co., Page, Arnold, and Co., and the Urban Electric Supply Co., and chairman of the Consolidated London Properties and the Metropolitan Properties Co., who died on April 2, left property valued at £59,506 gross and £56,351 net.

Major W. Montgomery, Royal Engineers, who has charge of the submarine mining establishment at Broughty Ferry Castle, has been appointed officer in charge of the Forth defence electric lights. Major Montgomery has been 10 years at Broughty Ferry, and, altogether, 36 years in the service. He entered the Royal Engineers as a bugler boy in 1871.

Mr. W. Wallace, of the Lancashire Electric Power Co., has been appointed assistant engineer in the Birmingham office of the Lancashire Dynamo and Motor Co.

Mr. R. L. Johnston, assistant station superintendent of the Yorkshire Electric Power Co., has been presented by the staff with a case of cutlery on the occasion of his marriage.

We note with deep regret the death of Mr. Alderman R. V. Potter, of Taunton, who for many years acted as chairman of the Taunton Electricity Committee.

Sir David Evans, ex-Lord Mayor of London, whose death was recorded last week, was one of the directors of Callender's Cable and Construction Co.

OPENINGS FOR CONTRACTORS.

AUCKLAND—Proposed alteration of workhouse. Architect, Mr. F. H. Livesay.

CARDIFF—Telephone installation at Ely Workhouse. Clerk to the Guardians, Union Offices, Queen's-chambers, Cardiff.

CARDIFF—Three-storey warehouse at Eli Paper Works for Messrs. Thomas Owen and Co. Architect, Mr. J. W. Rodger, 14, High-street, Cardiff.

CHIPPING—House for the Manchester Unity of Oddfellows. Architect, Mr. J. A. Seward, Church-street, Preston.

EDINBURGH—Industrial hall at Saughton Park for the Scottish Exhibition. Surveyors, Messrs. Alexander Hay and Co., 44, Castle-street, Edinburgh.

LONDON—Police station at Wapping (£14,000). Mr. J. D. Butler, surveyor to Metropolitan Police.

LONDON, S.W.—County Court buildings at Brompton, S.W. H.M. Commissioners of Works and Public Buildings.

LONDON, W.—Extensions to Langham Hotel, in Cavendish-place. Architect, Mr. J. Macvicar.

LONDONDERRY—Boot factory and warehouse and shops for Mr. H. M'Keown. Architect, Mr. P. H. Elliott, Exchange-buildings, Castle-street, Londonderry.

MAESTEG (WALES)—Offices for North's Navigation Collieries (1899), Limited. Mr. J. P. Gibbon, Mining Offices, Maesteg.

PLYMOUTH—Repairs at the workhouse. Messrs. Thornley and Rooke, 11, The Crescent, Plymouth.

PONTYPRIDD—Business premises in Market-street. Architect, Mr. A. L. Thomas, Church-street-chambers, Pontypridd.

SHIPLEY (YORKS)—Warehouse for Woolcombers, Limited. Architects, Messrs. J. Young and Co., 62, Market-street, Bradford.

THORNHILL (YORKS)—Carbide factory (electrical equipment, 2,500 h.p.) for the British Carbide Factories, Limited.

UXBRIDGE—Hospital buildings for the Uxbridge Joint Hospital Board.

WARRINGTON—Alterations to premises in Sankey-street, formerly known as the Queen's Hotel. Borough Surveyor, Town Hall, Warrington.

APPOINTMENTS VACANT.

Agents for the sale of meters. Applications to Chairman, Bastian Meter Co., Bartholomew Works, Kentish Town, London, N.W. See advertisement.

Cable-Jointer for electricity works, Swindon. Wages, 8d. per hour. Apply to Borough Engineer. See advertisement.

Test-room Assistant for Stepney electricity works. Apply to Manager, 27, Osborn-street, Whitechapel, London, E. See advertisement.

Assistant Lecturer in Engineering for Swindon Education Committee. Salary, £150 per annum. Applications to Mr. W. Seaton, secretary, by Aug. 31. See advertisement in last week's issue.

Charge Engineer, Ilford Urban District Council electricity works. Salary, £120 per annum, increasing by annual increments of £10, on satisfactory service, to £150 per annum. Applications to Mr. J. W. Benton, clerk, by Aug. 27.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Leghorn.—The Municipality invite tenders for electric lighting. Tenders by Sept. 21.

Ovar.—The Municipality invite tenders for electric lighting of the town, to reach them by Sept. 4.

Warrington.—The Corporation invite tenders for coal bunkers for the electricity department by Aug. 27.

Stockport.—Installation of automatic point controllers for the Corporation tramways. Tenders by Aug. 26.

Prague.—Five and 12 h.p. motors to drive tools are required for the Austrian State Railways. Tenders by Sept. 1.

Swinton and Pendlebury.—Wiring public buildings for electric lighting. Tenders by Sept. 5. See advertisement.

Dublin.—High and low pressure cables. Particulars from City Electrical Engineer. Tenders by Sept. 9. See advertisement.

Beaufays.—The Mayor calls for tenders for an electrically-driven pump in connection with cement reservoir. Tenders by Sept. 14.

Vienna.—Tenders are invited for a central electric power station at Czernowltz for the Austrian State Railways. Tenders by Aug. 31.

Melbourne.—One 500-kw. turbo-alternator, boilers, and other appliances are required for the State Railway of Victoria. Tenders by Sept. 23.

Brisbane.—The Postmaster-General invites tenders for telephones, cells, resistance coils, battery pole changers, operators' sets, etc. Tenders by Sept. 30.

Dunkirk (France).—Tenders are invited for lighting the docks, etc., by electricity, and these must reach the Ingenieur-en-Chef du Service Maritime by Aug. 31.

Finchley.—The Urban District Council invite tenders for the supply of feeders, distributing mains, and other cables, network boxes, joint-boxes, etc. Tenders by Sept. 16.

Oystermouth.—The Urban District Council invite tenders for the installation of public and private electric lighting. Particulars from the District Surveyor, Mumbles, Glam.

Bexley.—The Urban District Council invite tenders for the supply of one 150-kw. tramway generator. Specification £1. 1s. Particulars from the Tramway Manager, Bexley, Kent.

Llandudno.—Tenders are invited for the supply of a battery booster, switchboard, cables, etc., by the Llandudno Pier Co. Particulars from the Secretary. Tenders by Sept. 2.

Bourges (N. France).—Tenders are invited for the supply of one dynamo and two electromotors for the artillery depôt. Particulars from the Préfecture du Chéré. Tenders by Aug. 30.

Melbourne.—The Postmaster-General's Department invite tenders for 11 sets and a common-battery switchboard, and 3,000 subscribers' telephones, etc., for the Windsor exchange. Tenders by Jan. 7.

Brisbane.—The Postmaster-General invites tenders for the supply and delivery at Brisbane of four sections of a common battery switchboard and 650 subscribers' telephones to specification No. 145. Tenders by Sept. 2.

Perth (Western Australia).—The Deputy Postmaster-General invites tenders for two desiccating apparatus, with motor-driven air pump, for telephone cable work, and two ringing dynamometers, etc., to reach him by Sept. 6.

Madrid.—Tenders are invited for the supply of materials to the new General Post Office. Estimate, 6,679,000 pesetas. Deposit, 5 per cent. Particulars from the Direccion-General de Correos y Telegrafos, Carretas 10, Madrid. Tenders by Aug. 31.

Clonmel.—The District Lunatic Asylum Committee require suction gas plant and electric generators, accumulators, wiring, mains, switchboard, etc., for the new power-house which it is proposed to erect in connection with the asylum. Tenders by Sept. 7.

Victoria.—The Deputy Postmaster-General at Melbourne invites tenders for the supply and delivery of 11 sections of a branching system metallic-circuit switchboard for central exchange, Melbourne, in accordance with Victorian specification No. 146. Tenders by Oct. 8.

Adelaide.—The Deputy Postmaster-General for Queensland invites tenders for a common battery switchboard and 3,000 subscribers' telephones. Specification No. 166. Particulars may be obtained from the Commonwealth Offices, 72, Victoria-street, London, S.W. Tenders by Jan. 8, 1908.

Victoria.—The Deputy Postmaster-General at Melbourne invites tenders for the supply and delivery at Melbourne of 11 sections of a common-battery switchboard and 3,000 subscribers' telephones and other apparatus for telephone exchange, Windsor, in accordance with Victorian specification No. 148. Tenders by Jan. 7.

Cardiff.—The Guardians invite tenders for provision of telephones, necessary wiring, switchboard, etc., and alteration of present telephone service, at their Cardiff and Ely Workhouses. Particulars, etc. of Mr. Arthur J. Harris, clerk, Union Offices, Queen's-chambers, Cardiff, to be returned with specification attached by Sept. 14.

Maidstone.—The Electricity Committee invite tenders for the supply of coal required at their electricity works for the ensuing 12 months. Specifications and conditions of contract can be obtained on application to the Engineer, Electricity Works, Fairmeadow, Maidstone. Tenders to Mr. S. Lance, Monckton, town clerk, Maidstone, by Aug. 26.

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Kettering.—The Urban District Council invite tenders for the supply, delivery, and erection of the following plant at their electricity generating station, Rockingham-road, Kettering: (Contract No. 11) extension engine and dynamo (315-kw. set), with pipework connections; (12) extension switchboard panel. Specifications, etc., from Mr. John Bond, clerk, Council Offices, Kettering. Tenders by Aug. 28.

New South Wales.—With reference to an announcement inviting tenders for the supply and construction complete of a pneumatic tube service to the General Post Office, Sydney, from the Pacific Cable Board's Office, Royal and Stock Exchanges, etc., the Postmaster-General for New South Wales give notice that the date for the receipt of such tenders has been extended from July 10 to 2.30 p.m. on Wednesday, Oct. 16 next.

Greenock.—The Parish Council invite tenders for the complete electric light wiring and fittings for Smithston poorhouse and asylum. The work must be carried out and the installation ready for connecting to the Corporation supply within eight weeks of acceptance of tender. Specifications from Mr. R. P. Fairlie, inspector, on payment of £1. 1s. (returnable). Particulars from Mr. T. Crichton Fulton, 44, West George-street, Glasgow. Tenders by Aug. 26.

South Australia.—The Postmaster-General, Adelaide, invit s tenders for the supply of lead-covered telephone cables as follows: 7½ miles 208 pair, paper-insulated, lead-covered, 12½lb. conductors; 3½ miles 156 pair ditto; 4 miles 104 pair ditto; 2½ miles 78 pair ditto; 7 miles 52 pair ditto; 2½ miles 26 pair ditto; and 700 yards 104 pair light lead-covered, silk and cotton insulated. Particulars may be obtained from the Commonwealth Office, London. Tenders to the Deputy Postmaster-General, Adelaide, by Sept. 25.

Erith (Kent).—The Urban District Council invite tenders for the supply and erection of the following plant at their sewage-disposal works, Manor-road, Erith: an electrically-driven air-compressor, including three-phase motor, switchgear, cable connections and pipework. Copies of the specification, etc. (£2. 2s.), from Messrs. Hawtayne and Zeden, consulting engineers, 9, Queen-street-place, London, E.C., or from Mr. Charles H. Fry, clerk, Council Offices, Bexley. Tenders by Sept. 2.

Dundee.—The Electricity Committee invite tenders for the supplying and laying of (*a*) extra high-tension armoured feeder cables, laid direct in the ground; (*b*) low-tension armoured and low-tension, paper-insulated, lead-covered feeder cables and distribution cables, laid direct in the ground, and on the solid system in wood troughing. Conditions, specification, forms of tender, etc., may be had of Mr. H. Richardson, engineer-in-chief, Corporation Electricity Supply Department, Dudhope-crescent-road, Dundee. Tenders to Mr. W. H. Blyth Martin, clerk to the Corporation, City Chambers, Dundee, by Sept. 2.

Bristol.—The Electrical Committee invite tenders for the supply, delivery, and erection of one 300-kw. and two 500-kw three-phase to direct-current converters (6,000 to 500 volts) with balancers and starters; extra high-tension, alternating-current, and low-tension direct-current switchgear; 10-ton hand travelling crane. Also the supply, delivery, laying, and jointing of 24 miles (approx.) of ·05 square inch three-core paper-insulated B.O.T. sheathed lead-covered cable, together with the necessary troughing and filling; and the construction of the necessary converter station, inclusive of foundations. Tenders to Mr. H. Faraday Proctor, City Electrical Engineer's Office, Temple-back, Bristol. See advertisement in last issue.

Gothenburg.—The Commercial Intelligence Branch of the Board of Trade are notified by his Majesty's Consul at Gothenburg that tenders are invited for supply of the electrical equipment for the Government power station at Trollhattan, comprising three electric generators for direct current, each of 350 kw.; one accumulator battery of 4,800 ampere-hours capacity; four three-phase generators, each of a maximum of 11,000 kilovolt-amperes; 12 transmitters, each of a maximum of 3,670 kilovolt-amperes; connections; regulators; and control tables. Sealed tenders, marked "Anbud a elektrisk utrustning for Statens kraftverk," should be sent to the Managing Director of the Royal Trollhattan Canal and Waterworks, Trollhattan, Sweden, by noon on Oct. 1 next. Tenders are binding until Jan. 1, 1908. Delivery is to be completed by Sept. 1, 1909. Further information may be obtained from the Managing Director, from whom a copy of the programme can be had against a deposit of 50 kronor, which will be returned on receipt of a tender in accordance with the programme.

RESULTS OF TENDERS.

Leatherhead.—The Leatherhead and District Electricity Co. have placed an order for a 100-kw. Diesel-E.C.C. set.

Southend.—The Corporation have placed a contract for a "Simplex" water softener to deal with feed water for the boilers at the power station with W. Boby, Salisbury House, London-wall, London, E.C.

Bombay.—The whole of the electrical work at St. George's Hospital, Bombay, has been placed in the hands of F. and C. Osler and Co. for the sum of Rs.61,306, plus Rs.18,856 for four Waygood electric lifts.

Gainsborough.—The Gainsborough Council have accepted the tender of Messrs. Meldrum, of Manchester, for a refuse destructor at a cost of £2,196. 11s., this including £210 for engine and dynamo supplied by Messrs. Marshall, of Gainsborough.

Manchester.—The tenders of Higginbottom and Mannoch, West Gorton, Manchester, have been accepted for the provision and erection of eight electric passenger lifts, six electric goods lifts, and four hand hoists for the new Manchester Royal Infirmary.

Victoria.—The Postmaster-General for the Commonwealth of Australia announces that the tender of the International Electric Co., 55, Redcross-street, London, E.C., has been accepted for the supply and delivery of two telephone switchboards for the sum of £400.

Japan.—The Amorduct Manufacturing Co. have just received advice from an important customer in Japan that the new palace for the Crown Prince and Baron Iwasaki's new house are two of the important installations in hand at present where the Amorduct conduit is used.

Portsmouth.—The Electric Lighting Committee of the Town Council have accepted the following tenders: For steam exhaust and water pipes, Aiton and Co., £3,004; for high-tension switchboard, British Thomson-Houston Co., £850. 8s.; for six transformers, British Electrical Transformer Co., £66 each.

Lowestoft.—The Lowestoft Electricity Committee have recommended the Council to accept the following tenders for the supply of coal for the year ending June 30, 1908: Cory and Son (2,000 tons approx.), steam, 15s. per ton; Bessey and Palmer (1,000 tons approx.), steam, 15s. 11d.; T. Moy, Limited (1,000 tons approx.), steam, 15s. 11d.

Air-Compressors.—Amongst the orders recently received by W. H. Bailey and Co., Albion Works, Salford, Manchester, for their Koster patent air-compressors is one for the South-Eastern and Chatham Railways capable of dealing with 60,000 cubic feet of free air per hour, and another for the Daimler Motor Co., Coventry, to deal with 14,000 cubic feet per hour.

Stevenston.—The Mirrlees-Watson Co. have just secured an order from Nobel's Explosives Co., Stevenston, for a complete installation for the utilisation of exhaust steam from high-speed reciprocating engines. The installation will consist of a Rateau-Brown-Boveri turbo-generator, with a barometric counter-current jet condensing plant and cooling tower, together with the various accessories.

Condensing Plant.—Among the contracts just secured by the Mirrlees-Watson Co., of Glasgow, is one from the Lancashire Dynamo and Motor Co. (for Huelva, Spain) for one low-level counter-current jet condensing plant with duty 10,000lb. steam per hour; Fraser and Chalmers, one surface condenser with 6,000lb. steam per hour: and the Coatbridge and Airdrie Electric Supply Co., air and circulating pumps.

Sunderland.—The Corporation have accepted the following tenders: motor and switch to drive pneumatic equipment at Hylton-road power station, Electric Construction Co., Wolverhampton; switchgear and three power factor indicators, British Westinghouse Electric and Manufacturing Co.; wiring for motors and lighting at Hylton-road, White Bros., Sunderland; indiarubber cables, India Rubber, Gutta Percha, and Telegraph Works Co., London.

South Australia.—The following tenders have been accepted by the Postmaster-General's Department: J. Slater and Co., 500 Meidinger line cells, 500 Meidinger line cups, 500 Meidinger line inverts, for a total sum of £32. 16s. 3d.; India Rubber, Gutta Percha, and Telegraph Works Co., 5,000 Meidinger line corks and tubes at £3. 2s. per 1,000, 6,000 Meidinger line zincs at £33. 6s. per 1,000, two tons crushed salammoniac at £39 per ton; British Insulated and Helsby Cables, 3,000 Meidinger line leads at £10. 13s. 10d. per 1,000; G. Wills and Co., six tons sulphate of magnesia at £6. 11s. per ton.

Condensing Plant.—The Klein Engineering Co., Manchester, inform us that they have received orders recently for the following plants:—Per Siemens Bros. Dynamo Works: one Klein barometric jet condensing plant for 32,000lb. of steam per hour, to be erected at the Ark Mill, Bredbury; one Klein barometric jet condensing plant and cooler to deal with 17,000lb. of steam per hour, for the Falcon Mill, Bolton; one Klein barometric jet condensing plant for the Huddersfield Corporation, to deal with 30,000lb. of steam per hour. The above three plants are intended to give a vacuum of 28in. and to work in conjunction with exhaust steam turbines. Per Willans and Robinson: one Klein barometric jet condensing plant to deal with 35,250lb. of steam per hour, and to give a vacuum of 27½in. This plant is also to work in conjunction with exhaust steam turbine. Per Fraser and Chalmers: one Klein natural-draught chimney cooling tower to deal with 100,000 gallons of water per hour. East Ham Borough Council: one steel plate forced-draught cooling tower to deal with 60,000 gallons of water per hour. Barometric jet condensing plants and coolers have also been put in operation quite recently for Messrs. John Brown and Co., Atlas Works, Sheffield, and at the Bolton Corporation electricity works, the vacuum obtained being 28in. and 27½in. respectively, the plant at Messrs. Brown's working in conjunction with exhaust steam turbine. They have also in hand barometric counter-current jet condensing plant for Bombay.

BUSINESS NOTES.

LIGHTING AND GENERAL

India.—The Rangoon Cathedral is to be provided with electric lights and fans at a cost of Rs.7,000.

Colchester.—The Corporation electricity supply department will hold an exhibition during the week commencing Oct. 20.

Electric Landaulet Co.—The directors have declared an interim dividend for the first half of the current year at the rate of 5 per cent. per annum, free of income tax.

Worksop.—The Council have decided to reduce the amount asked for electric lighting purposes from £2,000 to £1,700, as the purchase of an economiser has been deferred.

Colne.—The Local Government Board have held an inquiry into the application of the Town Council for sanction to the borrowing of £5,550 for purposes of the electricity undertaking.

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King's Lynn.—The number of consumers connected with the Corporation mains number 592, with 28,479 lamps of 8 c.p. or equivalent. During the month of June there were generated 29,163 units.

Aberdeen.—The Town Council have authorised the electrical engineer to erect 13 electric incandescent lamps along the esplanade on the seaward side of the bathing station at the sea beach, at an estimated cost of £62.

Dundalk.—The Council are having a thorough inspection of the town made with a view to installing the electric light. Two schemes are under consideration, one involving a sum of £15,000 and the other £10,000.

Spain.—The Director-General of Telegraphs has conferred with Señor Ferrandiz, the Minister of Marine, with regard to the immediate establishment of a wireless telegraph station on the Spanish coast, opposite Tangier.

Erdington.—The Local Government Board have held an inquiry into the application of the Aston Corporation for sanction to borrow £17,619 for the purposes of a scheme to supply electricity within the urban district of Erdington.

Calcutta.—The number of units delivered to consumers during the four weeks ended July 26, 1907, from the mains of the Calcutta Electricity Supply Corporation were 632,582 compared with 574,479 in the corresponding four weeks of 1906.

South Metropolitan Electric Light and Power Co.—The transfer register of this company in respect to the 7 per cent. cumulative preference shares is closed until Aug. 31 for the preparation of dividend warrants payable on that date.

Bovey Tracey.—It is proposed to light Bovey Tracey by electricity generated by lignite at the Bovey Tracey lignite mines. The current will also be used to supply power to the Haytor iron mines. It is said that the current will be the lowest in the West of England.

Govan.—The Corporation Electricity Committee have had under consideration a report by the electrical engineer as to the institution of a bonus scheme in connection with the working of the department. The matter has, however, been delayed until the committee meeting in October.

Hackney.—The London County Council have granted the Hackney Borough Council a 20 years' loan of £14,000 for the provision of a 1,500-kw. steam dynamo, with accessories, which is required to meet the increasing load. This is part of the larger loan of £22,704 for generating plant, mains, etc.

Paignton.—The Lighting Committee reported at the last meeting of the Urban District Council that the Paignton Electric Light Bill was at present before the House of Lords, but steps were being taken to obtain a suitable site in the district for the erection of a generating station and refuse destructor.

St. Albans.—The North Metropolitan Electric Power Supply Co. have placed an order with Messrs. Heenan and Froude for a refuse destructor, to be erected in conjunction with the electric power station which they are about to erect for the supply of electric energy in the city and rural district of St. Albans.

Southend.—The electrical engineer has presented to the Town Council a lengthy report recommending extensive plant extensions, including condenser, engines and dynamos, new boilers, etc., at an estimated cost of £25,000, at the electricity works. The Council will consider this report at their next meeting.

Rawtenstall.—The Town Council have decided that £34,000, and not £29,000, shall be the amount for which sanction is to be obtained from the Local Government Board to provide an electricity generating station at Hareholme, and the necessary mains and equipment for a general electricity supply for the borough, including current for tramway purposes.

Coatbridge.—The electricity company's accounts for the year ending Dec. 31, 1906, show an expenditure on the capital account of £8,907, mainly on account of machinery and mains, and making in all to Dec. 31, 1906, a total expenditure of £92,238. The net revenue account for the year, after providing for interest and other charges, shows a loss of £2,154.

Ashton-under-Lyne.—The Council have decided to apply to the Local Government Board for sanction to the borrowing of the sum of £11,673 necessary for defraying the cost, charges, and expenses incurred or to be incurred by them in the execution of the provisions of the Ashton-under-Lyne Electric Lighting Order, 1902, and of the Electric Lighting Acts, 1882 and 1888.

Hurstpierpoint.—The Council, after meetings and interviews, have refused to accept the local gas company's terms for lighting and extinguishing the public lamps, and there being no other lighting authority in the district the town is in darkness. Some of the more enterprising inhabitants are suggesting the installation of electric light, for which there is undoubtedly room.

Wakefield.—A Local Government Board inquiry has been held relative to the City Council's application for permission to borrow £7,250 for the purposes of their electricity undertaking. The money is required for meeting extensions of mains, etc., due to the increase in the number of consumers. There was no opposition, and on the conclusion of the formal proceedings the inspector viewed the works.

Newton.—At the last meeting of the Urban District Council the Lighting Committee recommended that the street-lighting contract run its full term of 10 years, provided the Urban Electric Supply Co. would substitute for the present lamps throughout the Council's district lamps of equal lighting power to those which had been approved by the Council in the Kingsteignton-road. The report was adopted.

Huddersfield.—Important developments in connection with the electric light and power works are contemplated by the Council. The cost involved is £40,000, and the expenditure under this head will commence in 1908 and continue over the following year. About £10,000 of the total sum will be borne out of revenue or depreciation and contingency funds. The balance of £30,000 will be charged to capital account.

Portsmouth.—At the last meeting of the Town Council the annual accounts and balance-sheet of the electric light works were submitted, and a recommendation of the committee that £10,853. 5s. 11d. should be dealt with as under was carried by the Council: insurance fund account, £1,000; reserve fund account, £5,991. 5s. 11d.; in aid of the general district rate, £3,500; and a revenue contribution to capital outlay, £362.

Bastian Meters.—The directors of the Bastian Meter Co. invite applications from responsible firms willing to act as agents in defined districts throughout the United Kingdom. Upwards of 40,000 of these meters have been sold, and that they have stood the test of time is sufficiently evidenced by the fact that many of them have been in practical use for nearly 10 years. Full particulars are given in our advertisement columns.

Lewisham.—The Borough Council having declined to accept the offer of the South Metropolitan Electric Light and Power Co. to light the public lamps in the High-street, Lee, the company have arranged with shopkeepers at Newton-parade to provide Excello arc lamps in four large private standards facing a terrace of shops. The charge will be but nominal, as the company wish to demonstrate to the public with up-to-date lighting.

Germany.—A great ship elevator has just been completed at Henrichenburg, Germany, which connects two canals having a difference in level of 45ft. The vessel is transported in a movable tank, and the elevator movements are controlled by four electrically-driven screw spindles, each 80ft. long. The gates of tank and canals are locked until accurate connection is made, and as they are raised all leakage is prevented by rubber jointing.

Stock Exchange.—The Stock Exchange Committee has appointed special settling days as under: Wednesday, Sept. 4, Dunlop Rubber Co., 181,881 shares of £1 each, fully paid, Nos. 1 to 181,881, ex all dividends hitherto paid; Thursday, Sept. 5, Dunlop Rubber Co., 38,119 shares of £1 each, fully paid, Nos. 181,882 to 220,000. The committee have also ordered National Telephone Co.'s further issue of £616,425 deferred stock to be quoted in the official list.

Coventry.—A Local Government Board inquiry has been held into an application of the Corporation to borrow a further sum of £27,000 for the purposes of their electricity undertaking. It was stated the amount formed part of a larger scheme, the present plant being insufficient to meet the demands for electric energy. It transpired, too, that in one month last winter the department had applications for about 3,000 h.p. in motors. There was no opposition to the application.

Association of Engineers-in-Charge.—On Saturday, Aug. 24, the members of this association will pay a visit to the works of the Associated Portland Cement Manufacturers (1900) at Northfleet. The association's complete programme for the ensuing session has not yet been disclosed, but we understand that the president-elect, Mr. W. H. Patchell, will read his presidential address on Wednesday, Nov. 13, on which occasion, the president, Mr. W. T. Hatch, has consented to be present and install his successor.

Lancashire.—Various owners of cotton mills and bleach works situated along the banks of the River Irwell are about to adopt electricity as the driving power for their machinery, and will generate their own current. The Kearsley Spinning Co. (a new concern), on the banks of the Irwell at Farnworth, have put down plant and generate their own current. There are now some 50 cotton-spinning and weaving mills, to say nothing of bleach works, in Bolton and Manchester districts alone which have adopted electricity, wholly or in part, for motive purposes.

Swansea Telephones.—The whole of the former outside staff of the Swansea Corporation telephonic system, about 30 men in all, have received notice to terminate, at an hour's notice, their contract under the Corporation. At the same time the district manager (Mr. Gauntlett) points out that the National Telephone Co. will be prepared, under the company's terms and conditions, to re-engage the men according to their ability. The engineer of the National Telephone Co. has been seen in reference to the notice, and he says the men will have to submit to examination as to the knowledge they possess in regard to telephonic work. The men, however, refuse to accept employment under these conditions.

An Echo of the Electrical Exhibition at Olympia.—The Easton Lift Co., of Broad Sanctuary-chambers, Westminster, made an important exhibit of two electric lifts at the recent electrical exhibition, which during the time it was open carried over 400,000 passengers. The advantages of providing an additional and quick means of access to the galleries in the building other than the numerous staircases was so apparent, and the working of the lifts so highly satisfactory, that the New Olympia Co. have now placed a contract with the Easton Lift Co. for the permanent erection of two of their latest and most recently improved types of electric passenger lifts. This order in itself shows the lasting effect which the recent electrical exhibition has doubtless had in many other directions.

Manchester and Salford Electrical Exhibition.—We understand that the Corporations of Manchester and Salford have decided to take joint action in promoting an electrical exhibition to be held in their district during the latter part of next year. The exhibition is to have the support of the Municipal Electrical Association, the National Electrical Manufacturers' Association, and the Electrical Contractors' Association. The chief electrical engineers of Manchester and Salford (Mr. S. L. Pearce and Mr. V. A. H. McCowen) are acting as consulting engineers to the scheme. Mr. C. S. Northcote is to be general

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manager to the Executive Committee, which will consist of representatives from the municipalities and supply companies, and the afore-named associations, while Mr. Walter Davenport will act as organising secretary.

Hartlepool.—The Town Council have again considered the draft agreement, under which it is proposed that the electric lighting powers obtained under the provisional order by the Council, and at present leased to the Northern Counties Electricity Supply Co., shall be transferred to the Cleveland and Durham Power Co. The question was before the Council last week, and the agreement was then opposed on the ground that the provision that the Cleveland Co. would supply light for public purposes for 14 years at 2d. per unit committed the town to taking the light for that period. It has now been decided that the agreement be accepted, subject to the addition of a clause relieving the Corporation of any obligation to take the light from the Durham and Cleveland Co. after March 31, 1911, the date upon which the present agreement with the Northern Counties Co. will expire.

Lowestoft.—At a recent meeting of the Electric Light Committee the engineer reported that there are now connected to the mains 782 consumers, representing 39,247 8-c.p. lamps. Since the last meeting 12 consumers, representing 64 8-c.p. lamps, have been connected. A letter dated July 23 from the engineer to the Great Eastern Railway Co. stated that there will be no objection raised by the company to the Corporation laying cables under the company's property, nor will any objection arise in connection with the Norfolk and Suffolk Joint Line, on the Corporation entering into one of the company's usual agreements and also paying an easement rental of 17s. per annum so far as the two Great Eastern Railway crossings are concerned and 8s. per annum so far as the Norfolk and Suffolk Joint Committee's line is affected. The report was adopted.

Radcliffe.—At the last meeting of the Electricity Committee the Works Sub-Committee reported that they had considered the alternative schemes submitted by the electrical engineer for the provision of additional generating plant, to be included in the proposed application to the Local Government Board for sanction to additional borrowing powers, and had decided to recommend the No. 2 scheme for additional generating plant, providing for the 250-kw. steam dynamo set. The scheme provides for plant extensions, £3,500; cable extensions, £7,200; motors, £2,000; meters and instruments, £300—total, £13,000; and the sub-committee recommended that application be made to the Local Government Board accordingly. It was resolved that the scheme submitted by the electrical engineer, and approved by the Works Sub-Committee, for extensions of plant and cables, and provision of motors, meters, etc., be approved and adopted, and that application be made to the Local Government Board for their sanction to the borrowing of £13,000 therefor, repayable over a period of 30 years.

Wireless Telegrams to Canada.—Mr. Marconi is leaving England for Canada to inaugurate, about Sept. 12, a Transatlantic wireless telegraph service. The Irish station at Clifton is now finished, and the Canadian station near Cape Breton, which is expected to be completed next week, is already so far advanced that communication has been established for a week or more, and the working is stated to be giving great satisfaction. The rates to be charged are as follows: ordinary messages, 5d. a word, plus land charges; Press messages, 2½d. a word, plus land charges. So soon as the service is officially declared to be open, messages for wireless transmission will be accepted at any post office in the United Kingdom. Before, however, the name and address of the person for whom it is intended must come the words, "Expanse Ballyconnelly," which is the telegraphic address of the Marconi station in Ireland. It is expected that there will be a greater rush of business to begin with than the single station on each side can cope with, but it is proposed to increase the number of stations as early as possible.

Telephone for the Deaf.—A miniature telephone has been invented by the chief of the Swedish Government Telephone Bureau, which the American consul at Gothenburg states is expected to be of great convenience to employés at the telephone stations, and also to persons with defective hearing. The consul has described it as follows: In front of the membrane of this miniature telephone, the dimensions of which are 0·472in. and 0·630in. is screwed a cover with an elongation of hard rubber suitable to insert into the ear. When in use, this receiver is put into the auditory passage of the ear, and the connection consists of line cord resting on or behind the ear, in the same way as pencils or eyeglass cords are sometimes carried, no helmet or extra fixtures being needed. It is suggested that this small telephone may be very useful to persons with dull hearing, who are usually better able to carry on a telephone conversation than an ordinary one. It is claimed that the microphone, nicely mounted, could be carried in the shirt front, that the receiver can hardly be noticed when carried inserted in the ear, and that both can be connected to a dry-cell battery and an induction coil carried in the pocket. In case extra strengthening of the sound is needed, a receiver can be carried in each ear.

Electricity v. Steam in America.—Messrs. Barclay Bros., granite manufacturers, Barre, United States, America, have recently installed electric power in place of steam. They had outgrown their former equipment on account of increasing business, so found it necessary to either add to their steam plant or make some other change. After careful investigation they decided in favour of electricity, installing the same on the lines of modern engineering and shipbuilding plants—that is, to run each machine, or group of machines, with an individual motor. In this way much shafting and gearing has been done away with, and they now have 10 motors in successful operation. These motors range from 5 h.p. to 50 h.p., and aggregate 175 h.p. The Consolidated Lighting Co., which supplies the power, has taken considerable pains with the wiring and connections, the larger motors being equipped with oil switches. The members of the firm expressed themselves pleased with the power so far, but state that it will take about a year before they can tell how the cost compares with that of steam power. Heretofore it has been considered that in the larger plants steam power was cheaper than electricity, consequently their new departure will be watched with interest. The firm has also been making important improvements at their light quarry, having just erected another 40-ton derrick and installed a new four-drum hoisting machine.

Electricity in Mines.—The demand for increased power for mines and collieries has led Messrs. Richardsons, Westgarth, and Co. to considerably extend their steam-turbine department, and they are already doing a large business in this direction, as well as in connection with the supply of complete equipment for electrical power stations. One such contract now being carried out is that for the Tyneside Electrical Power Development Co. Another large contract in progress is a pumping installation at the Carville power station of the Newcastle Electric Supply Co., consisting of seven high-efficiency pumps having a combined duty of nearly three million gallons per hour. The plant will supply condensing water for this very large turbine power station, and was based on the high water economy resulting from the "Contraflo" condensing system with which this station is supplied. A large installation, representing one of the most interesting examples of the application of electrical power for colliery purposes, has been carried out at an important group of Messrs. Bolckow, Vaughan, and Co.'s collieries in South Durham. At the Binchester, Auckland Park, and at Newfield collieries three power stations have been completed by the Electrical Co., of Charing Cross-road, W.C. Each group of pits has its own central generating station, at which steam at 150lb. pressure is obtained from boilers fired with coke-oven gas. The three stations named contain seven 200-kw. sets, consisting of the Electrical Co.'s three-phase generators, suitable for an output of 200 kw. at 2,400 volts at a periodicity of 60 cycles. Three sets have been installed at Auckland Park, two at Newfield, and two at Binchester colliery. The engines are Messrs. Willans and Robinson's "central-valve" type, running at 360 r.p.m., the exciters for the generators being belt-driven from a pulley mounted on extension to the generator shaft.

TRACTION.

Madrid.—An electric tramway is to be built from the Pasco de tas Acacias to the Calle del Pacifico by the Sociedad Hidraulica Santillana.

Geneva.—The traffic receipts of the Geneva Tramways Co. (1906) for the month of July, 1907, amounted to £11,086, an increase of £914 on 1906.

Sydney.—The construction of a tramway from Addison-road to Dulwich-hill has been sanctioned by the New South Wales Public Works Department.

Gateshead-on-Tyne.—The Gateshead and District Tramways Co. are considering a scheme for extending their tramlines to the Mechanics' Institute, Wrekenton.

Arbitration Award.—Notification has been received at Haslingden that the award in the arbitration between the Haslingden and Rawtenstall Corporations and the Accrington Steam Tramway Co. is ready and may now be taken up.

Tramways in Yorkshire.—The Liversedge Council are protesting to the Board of Trade against the proposed transfer of the Yorkshire (Woollen District) Electric Co.'s undertaking in the district until the latter carried out their original promise to make a line of tramway between Hightown Heights and Cleckheaton, *via* Hartshead Moor.

Dundee.—The Dundee Tramways Committee are losing no time in connection with the work of extending the system to Downfield and Craig Pier. For an extra 2s. 6d. per ton the successful contractors for rails—E. and W. M'Lellan, Glasgow—have guaranteed delivery in September, and with a view to facilitating an early execution of the contracts the committee yesterday agreed to accept the offer. The quantity of rails required is some 356 tons, so that the additional cost is really small, amounting to £44. 10s.

Railways and Tubes.—Lord Stalbridge, presiding at the annual meeting of the London and North-Western Railway Co., referred to the advantage the company gained from the recent tube extensions. Since the opening of the City and South London extension to Euston and the Hampstead and Charing Cross Tube Railways they had, he said, been doing an increased business every day. The new tube railways were a great convenience to the public who liked to join or leave the London and North-Western main-line trains at Euston.

Tramcar Noises.—The General Electric Tramway Co. were summoned at West Hartlepool last week for nuisance caused by the "clattering" of four cars in their service. On the application of defendants' counsel an adjournment was granted in order to enable the company to put the cars right. The town clerk, however, intimated that even though the cars were put right he must, if the Corporation thought fit, come to court again. He suggested that the cars should be taken off the line altogether, and that the whole stock should be lubricated twice daily instead of once.

Aberdeen.—There has been no little bother in Aberdeen as to whether the general manager of the tramways or the electrical engineer should prepare the specifications for several new tops for cars, and it was agreed by a majority of one vote in the Council that the duty should devolve upon the manager of the tramways. Notice of motion appeared on the agenda for the last meeting to rescind the Council's previous resolution and to reconsider the matter, but the councillor in whose name the notice of motion stood wisely withdrew it. We hope that the matter is now amicably settled.

London Tubes.—An important arrangement has just been concluded between the Hampstead Tube and the Central London Railway

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for the issue of through tickets between their respective systems. This is the first time in the history of the Central London Railway that through tickets have been issued with any other company, and the new arrangement will tend to bring the Hampstead and Highgate districts into closer touch with the City and West-end. As an instance of the through fares to be charged, it may be mentioned that from both Hampstead and Highgate the fare to the Bank is 3d.

North London Tramways.—The electrification on the conduit system of the London County Council's tramway from Highbury to the Archway Tavern at Highgate is proceeding very rapidly. The whole of the work at the Highgate terminus has been completed. At that point four double lines of tramways converge—the horsed tramways from the City and those from Euston-road, the Highgate-hill steep-grade tramway, and the electric tramway which runs along the Archway-road and the Great North-road from Highgate to High Barnet. The work has been carried out within a few weeks without a hitch or accident of any kind. All the old rails in the triangular space in front of the Archway Tavern have been taken up and the new heavy rails with the centre slot laid in such a manner that the whole of the four tramways mentioned may eventually be joined up.

Mitcham (Surrey)—Work is proceeding very rapidly in connection with the extension of the London County Council tramways from Tooting-broadway, *via* Mitcham and Merton roads, and in the course of a few weeks the route between the Embankment or any of the London bridges to Hampton Court or Croydon will be completed. The extension along the Merton-road to the county boundary will connect with the London United Co.'s line to Kingston and Hampton Court, and the through journey from the bridges will, as fares stand at present, be 7d. for the whole distance. The Mitcham-road link will enable the cars now running from the Hop Exchange to Tooting to join up at the South Metropolitan Co.'s line from Tooting Junction to Sutton and Croydon, whilst another change at the latter place will enable the traveller to reach Purley, the present terminus of the Croydon Corporation tramway.

Leeds-Bradford.—A through tramcar service between Leeds and Bradford is imminent. The trial car of the Bradford Corporation has done its work well, and now that the period of observation enforced by the Board of Trade has been completed satisfactorily the Tramways Committees of the two cities are negotiating for a permanent through service. The Board of Trade approval is practically all that remains in the way of the establishment of this through service, and the settlement of this detail should be simply a formality. The local papers say that in the probable event of an agreement being arrived at for the inauguration of such a service, the Corporations of Leeds and Bradford will each fit up 12 cars to meet the requirements of the different gauges in the two cities, and this will be sufficient to maintain a through service equal to that now in operation between Leeds and Stanningley.

South Shields.—The *Newcastle Chronicle* states that there is much to be said in favour of the tramway extension advocated by the manager of the South Shields Corporation system, and outlined in these columns last week. When the Corporation took over the tramways of the borough and introduced a system of electric cars in place of the antiquated horse trams, they decided to drop the riverside line which was patronised very largely by workmen employed at the various shipbuilding yards and workshops in that locality. There is now little room for doubt that if served by electric cars this section would prove sufficiently remunerative to justify the district being "tapped," and this is one of the extensions suggested. Perhaps the most important of the proposals at present engaging the attention of the Town Council is the construction of a light railway along the coast in the direction of Marsden, and sooner or later, in the interests of the place as a holiday resort, this will have to be undertaken.

Leytonstone.—A special meeting of the Leyton District Council has been held to consider the desirability of supporting the request of West Ham to the Board of Trade to withhold its consent to the surface-contact system as proposed by the London County Council consequent upon the borough of Stepney refusing to consent to the overhead trolley system through its district, until further application had been made to and considered by the Stepney Borough Council to withdraw its objection. It was stated that at the time the horse tramways were acquired from the North Metropolitan Tramways Co. the Board of Trade had in view the possibility of acquiring the same running facilities between West Ham and Leyton to Aldgate as were then in operation, and the hope was expressed that those facilities would be continued when municipal electrification of the lines in East London took place. Poplar had, after refusing to allow the overhead trolley system, given way, and it was hoped that Stepney would ultimately adopt a similar course. The Leyton Council have decided to strongly support West Ham's application to withhold consent.

Tube Train Hustling.—In the City of London Court, last week, a Clapham gentleman sued the City and South London Railway for damage for personal injuries suffered while travelling on their line. Plaintiff's case was that on March 18, at 6 p.m., he went to the defendants' Elephant and Castle Station with the intention of going to Clapham. When he reached the platform of the station there were several people getting out of the train which was then waiting. Plaintiff waited until all the passengers had got out, and then, while he was attempting to board the train, the guard slammed the gate. He got on to the footboard of the carriage, and stayed until the train was entering the tunnel. Seeing that he would probably be killed by being crushed against the tunnel, he bounded off, but not before he had been severely knocked about by the jolting of the train. As he fell into the bed of the railway his clothes were much torn and his knee was hurt. For two weeks he was out of business, and it was most extraordinary that he was not killed. He had the presence of mind to lay hold of the hydraulic pipe in the tunnel, or he would assuredly have gone under. He was very much dazed. When the guard returned a little while after he was much astonished at finding that he (plaintiff) was still alive. For the defence, the guard declared that the plaintiff wished to catch the train, and did not reach it until it was in motion. The gate of the carriage was shut before the plaintiff got near it. It was certainly miraculous that the plaintiff was not killed. He told the plaintiff to keep back, but he simply came on, and stood outside the gate. If he could have laid hold of the plaintiff he would have taken him on. They might have both gone under then. The jury found for the defendants, and the judge did not think there was any negligence. Judgment for the defendants, with costs, was given.

London County Council Tram Men.—The dissatisfaction felt among the tramway men employed by the London County Council with regard not only to the question of medical examination for drivers, but in respect of hours worked and wages earned, continues to spread throughout the Metropolis. Meetings have been held at Poplar, Stamford-hill, Finsbury Park, Highgate, Streatham, Battersea, and Clapham, at all of which resolutions vigorously protesting against the order recently issued calling upon drivers to undergo a medical examination have been unanimously passed, and at some of the meetings motions have been carried demanding an eight hours' day, a 7s. minimum per day for motormen, the granting of a week's holiday annually, and the establishment of a board of conciliation. While the tram-drivers are agitating against the enforcement of new regulations, it might be of interest to hear what medical men have to say on the matter. A well-known physician (Mr. E. Danvers-Atkinson) writing to the *Telegraph* says: "My plea for asking for space is my personal experience derived in similar work for motor-cab companies, in which every man has to undergo medical examination for fitness before he is allowed charge of a cab. In the course of testing large numbers of men for this work, I have come upon instances, not only of heart disease, but of applicants suffering from the earlier stages of such a grave malady, for example, as general paralysis of the insane, or bearing signs, slight as a rule, of psychical degeneracy and unfitness. As such early indications would not be apparent to a layman, it is obvious what an additional safeguard the public derives from having such persons excluded from driving a motor vehicle. Sudden death from heart disease is by no means the only danger we must be protected from, and the possibilities to life and limb should a driver be the unfortunate sufferer from early brain or nerve disorder may be easily surmised. With the increased pace and congestion of traffic in the streets, the problems presented to a driver are more sudden and complicated. Disease or unfitness must not have place in him to paralyse his mind or palsy his hand at a crucial moment. Judging from my experience of the immensely enhanced safety the public is provided with by the action of the companies I refer to, there is left no room for doubt that public opinion should back the London County Council in its endeavour to insist upon having the tram drivers medically examined in every case." It is to be hoped that the public will not countenance the attitude of the men.

Bradford.—The report of the general manager of the Bradford Corporation tramways for the year ending March 31, 1907, states that for the first time in the history of municipal tramway operation in the city it is possible to make a fair comparison between two consecutive years' workings, both as regards income and expenditure. Practically the route mileage was the same during the past two years. The car mileage run in 1906-7 was 5,167,261, being 133,000 miles more than in the previous year—about 2 per cent. It is, however, possible to make exact comparisons by comparing expenditure and income on a car mileage basis. The total revenue for the year from all sources, except bank interest, was £237,511, an increase of £8,533. It may be assumed that the running of the extra 133,000 car miles was necessary to earn this extra amount. This may be summed up to mean that with an increase of car mileage of 2 per cent., 3·6 per cent. more money was earned. The number of passengers carried was 46,728,977, as compared with 45,331,288 in the previous year, an increase of 1,397,689, or 2·9 per cent., which means that on an average calculation the population served was carried 144 times during the 12 months, or that on an average each person in the tramway area travelled 144 tmes on the trams during the year, as against 139 in the previous year. The total expenditure, excluding interest, sinking fund, etc., was £164,987, thus leaving a gross profit of £72,524, against £70,279 in the previous year, showing a net increase in gross profit of £2,245. This means that with an increased expenditure of £6,287 an increase of revenue of £8,533 was earned. When it is remembered that during the year alterations in policy have had the effect of increasing the price paid for electricity to the extent of ¼d. per unit, and that this represents an increase of £5,534, and also that free holidays have been granted to the men, which has cost the department approximately £1,000, it must be gratifying to note that the actual increase of expenditure is, comparatively speaking, so small. The parcels department earned £5,004 during the year, as against £4,035 received from this source in the previous year. The expenditure also increased from £3,508 to £4,032, and the profits from £526 to £972. The gross or trading profit of £72,524 and interest of £3,231 have been allocated under the following heads (the first figures relate to 1906-7 and the second to the year 1905-6): interest on capital absorbed, £25,020 (£25,838); income tax, £2,543 (£2,231); rent of leased lines, £4,173 (£4,172); repayment of mortgage loans, £1,063 (£980); sinking fund, £28,420 (£27,178). The balance of £14,536 was the net surplus for the year's working, as against £11,637 in the previous year. Of this amount £10,000 has been taken in relief of rates and the balance passed over to the reserve and renewals account. In conclusion, Mr. C. J. Spencer, the manager, says: "A concern with a capital of nearly £1,000,000 should have at its back a considerable reserve fund, and the amount that has been mentioned from time to time—namely, £90,000 to £100,000—is not too much money to have in a fund of that description. Whilst, therefore, I cannot recommend the

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committee to hand over large sums of money for the relief of the rates, etc., yet I do not think it fair to consider that an indication of the unprofitableness or unsoundness of the tramways undertaking. An examination of the balance-sheet will show that we have repaid £145,886 already, equal to 16 per cent. of the original debt, and that a substantial relief from interest from that amount has already made itself felt. We have also £54,160 ready for the payment of loans as they become due, in addition to the reserve fund of £38,024. I think that most concerns would consider that they were fairly sound under similar circumstances."

PROVISIONAL PATENTS, 1907.

AUG. 8.

18029. Improvements in electrical switches. Andreas Peter Lundberg, Gustav Charles Lundberg, and Percival André Lundberg, Queen Anne's-chambers, Westminster, London. (Complete specification.)

18022. Improvements in and relating to controlling devices for electric circuits. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

18023. Improvements in and relating to fluid-pressure engines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

18032. New form of primary battery. Henry Ernest Fry, Godmanstone, Dorchester, Dorset.

18044. Improvements in monophase shunt electric machines. Felten und Guilleaume-Lahmeyerwerke Act.-Ges., 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Aug. 11, 1906, being date of application in Germany.) (Complete specification.)

18045. Improvements in inverted repulsion electric motors. Felten und Guilleaume-Lahmeyerwerke Act.-Ges., 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Aug. 15, 1906, being date of application in Germany.) (Complete specification.)

18053. Improvements relating to the manufacture of filaments for incandescent electric lamps. Rudolf Jahoda and Electrische Gluhlampenfabrik "Watt," 7, Southampton-buildings, London.

18033. Improvements in locking apparatus for locking electric light glow lamps to holders. William John Bodell, 18, Fulham-place, Paddington, London.

AUG. 9.

18082. Improvements in carbon electrodes. Joseph Theodor Szek, 53, Chancery-lane, London.

18111. Improvements in insulating material. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

18112. Improvements in vapour condensers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

AUG. 10.

18152. Improvements in apparatus for determining the direction of space telegraph signals. John Stone Stone, 7, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Aug. 17, 1906, being date of application in United States.) (Complete specification.)

18163. Improvements in automatic telephone exchanges. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, London. (Siemens und Halske Akt.-Ges.) (Complete specification.)

AUG. 12.

18187. New or improved means for signalling the approach of tramcars at cross roads where overhead electric wires are employed. George Allen Bailey, 4, St. Ann's-square, Manchester.

18210. Improvements in or relating to electrolytic processes and apparatus therefor. Joseph Henri Monge and C. Arzano, 111, Hatton-garden, London. (Complete specification.)

18227. Improvements in or in connection with holders for electric incandescent lamps. George Davis, Queen Anne's-chambers, Westminster, London. (Complete specification.)

18243. Improvements in electric arc lamps. Stanislaus Szubert, Thanet House, Temple Bar, London. (Complete specification.)

18245. Improvements relating to electrically-driven vehicles. Robert Bolton Ransford, 24, Southampton-buildings, London. (Compagnie Parisienne des Voitures Electriques (Procédés Kriéger), France.). (Complete specification.)

18251. Improvements in and relating to electric valves or rectifiers of oscillatory currents. Axel Orling and James Buckland Palmer, 22, Southampton-buildings, London.

18260. Improvements in incandescent lamps and method of making the same. George Francis Morrison, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Sept. 24, 1906, being date of application in United States.) (Complete specification.)

18259. Improvements in and relating to electric heating devices. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

18261. Improvements in and relating to dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

AUG. 13.

18287. Multiplex telegraph apparatus, the intermittent contact apparatus to be applied to other purposes. Benjamin Herbert Thorogood, 36, Knightland-road, Clapton, London. (Complete specification.)

18288. Improvements in apparatus for limiting and controlling the supply of electric current. Guy Carey Fricker, 46, Lincoln's-inn-fields, London.

18295. Improvements in electrical switch cut-outs applicable to the handle bars or steering wheels of motor cycles and the like. John Robert Smith and James Little Blain, 276, High Holborn, London.

18308. Improvements in omnibus electric signalling circuits. Charles Hustwick Ellison and Charles Mark Jacobs, Birkbeck Bank-chambers, Southampton-buildings, London.

18319. Improved apparatus for automatically limiting an electric current to a predetermined value. John Owen Girdlestone and John William Jones, 16, Davies-street, Berkeley-square, London. (Complete specification.)

18330. Improvements in and relating to electric heating devices. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

18331. Improvements in and relating to protective devices for electric systems and apparatus. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

18332. Improvements relating to electric telemechanic transmitting and receiving apparatus. Jean Baptiste Marie Pierre Henry Roslin D'Ivry, 7 Southampton-buildings, London. (Complete specification.)

AUG. 14.

18346. Improvements in shade holders and shades, specially applicable for electric incandescent lamps. Charles William Dawson, 30, Park-row, Leeds.

18348. Improved method of making electrodes for electric storage batteries. William Fennell and William Pagden Perry, 68, Dudley-road, Tipton, Staffs.

18368. Improvements in telephone systems, also applicable for telegraphy. George Benjamin Oscar Sleeboe, 65, Chancery-lane, London.

18369. Improvements in dynamo-electric machines. John MacDonald, 65, Chancery-lane, London.

18398. Improvements in the manufacture of steel and in electro-metallurgical induction furnaces for use therein. Hans Biewend, 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Aug. 14, 1906, being date of application in Germany.) (Complete specification.)

18406. Improvements in electric switches. John William Ewart, 4, South-street, Finsbury, London. (Complete specification.)

18407. Telephone call register. Adolph Ries, trading as Ad. Ries and Co., 15, Charles-street, Hatton-garden, London.

AUG. 15.

18441. Improvements in connection with electromagnets. Percival Pinckney, Langland-terrace, Brynmill, Swansea, Wales.

18444. Improvements relating to marine electrically-controlled steering gear. Bernard Parker Haigh, 73, Comely Bank-road, Edinburgh.

18498. Operative system for electric railways. Otto Böhm, 322, High Holborn, London. (Date applied for under Patents Act, 1901, Aug. 18, 1906, being date of application in Germany.) (Complete specification.)

18513. Improved spark arrester for electric arc lamps. William James Davy, 40, Chancery-lane, London. (Complete specification.)

18514. Improvements in and relating to protective devices for electric transmission systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

18515. Improvements in protective devices for electric transmission systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

AUG. 16.

18537. Improvements in or connected with electric automusical instruments. Thomas Ernest Raymond Phillips, 15, Water-street, Liverpool.

18557. Automatic puncture indicator to work by electricity, clockwork, or pneumatic for motorcars and other vehicles. Thomas Charles Santler and Walter Ring Santler, Malvernia Works, Malvern Link.

18571. Improvements in apparatus for finding true magnetic divergence, applicable also for finding geographical

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divergence, and generally for measuring the intensity ratio of two electric currents. Louis Dominique Joseph Armand Dunoyer, 70, Chancery-lane, London. (Date applied for under Patents Act, 1901, Aug. 16, 1906, being date of application in France.) (Complete specification.)

18573. Improved means for working or controlling the illumination of electric lamps or signs. James Cole, 1, Broad-street-buildings, Liverpool-street, London. (Complete specification.)

18582. Improvements in and relating to protective devices for electric systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Allgemeine Elektricitäts Ges., Germany.)

AUG. 17.

18634 Improved terminal device for electric batteries. Harry Jones Andrew and Trevor Bartlett Little, 33, Cannon-street, London.

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Sept. 5.)

1906.

10994. Suspension of wires, cables, and the like for electric traction. Pringle.

11114. Wireless telegraphy and telephony. Clarke and Barr.

17786. Electricity supply systems. Wilkinson.

18329. Electric conductors. Fuller and Fuller.

18336. Thermal electric contact makers. Ogle.

18532. Field magnets for dynamo-electric machines. Bruce Peebles and Co. and La Cour.

18575. Apparatus for signalling or communicating messages or the like, or displaying advertisements, by means of electric lamps. Heywood.

18745. Methods of manufacturing conductive filaments and other incandescing bodies for use in electric lamps or other apparatus. British Thomson-Houston Company. (General Electric Company.)

18749. Manufacture of electric conductors from refractory metals and materials suitable for use in electric lamps, furnaces, and other apparatus. British Thomson-Houston Company. (General Electric Company.)

18874. Electric incandescent lamps. Lederer.

19094. Electric incandescent lamp. Wallace.

19219A. Electrical resistance device. Watkinson and Payne. (Date applied for under Rule 5, Patents Rules, 1905, Aug. 28, 1906.)

19479. Electrolytic resistance. Schäfer.

19756. Electromagnetic variable gear for motorcars, motor cycles, and the like. Mitchell.

20043. Electromagnetic switch. Newbold.

20456. Electric alarm devices for notifying attempts at breaking or opening locks. Bloch.

20929. Insulating studs and the like methods of making the same. British Thomson-Houston Company. (General Electric Company.)

21338. Application of the electric arc for producing reactions in a gaseous mass, and apparatus therefor. Naville, Guye, and Guye.

23550. Electric arc lamps. Davy.

23800. Means of automatically electrically connecting and mechanically suspending an arc lamp or the like and releasing same for lowering. Stevenson and Williams.

28602. Wireless telegraphy and telephony. Poulsen. (Date applied for under International Convention, Dec. 15, 1905.)

29244. Electric torch as used for surgical and dental oporations. Larard and Dearden.

1907.

1432. A balanced electro-mechanical tractor equipment alternately or simultaneously receiving or generating its driving power. Feron. (Date applied for under International Convention, Jan. 20, 1906.)

2228. Electrical resistance computing scale. Thomas.

3599. Telegraphony. Morin.

5547. Electric cables containing induction coils. Siemens Bros. and Co. and Dieselhorst.

5655. Process of electrically reducing oxide ores and the like. Petersson.

6199. Incandescent electric lamps. Foreman.

7497. Method for the manufacture of tungsten filaments for electric lighting and heating by the reduction of tungstic acid. Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, March 30, 1906.)

9499. Devices for directing the arcs of electric arc lamps. Deutsche Beck-Bogenlampen Ges. (Date applied for under International Convention, Dec. 21, 1906.)

9574. Electric arc illuminating apparatus, more particularly for use in telegraphy. Schmidt.

13262. Receivers for electromagnetic waves. Artom. (Date applied for under International Convention, Jan. 10, 1907.)

COMPANIES' STOCK AND SHARE LIST.

Name	Amount paid.	Last price
Commercial and Industrial.	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 —	½-⅝
—— Ord., 1 125,000	1 ..	½-¼
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 —	9/16-11/16
British Aluminium Co., Ordinary, 2,001-40,000	5 ..	4½-5½
—— 7 per cent. Cum. Pref., 1-40,000	5 ..	5-5½
—— "A" 6 per cent. Cum. Pref., 1-20,000	5 ..	5-5¼
—— 4 per cent. Funding Certificates, 1-20,000	5 ..	3¾ 4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	10? ..	100-103
—— 5½ per cent. Loch Leven Deb (Reg.), Red., 1-3,000	100 ..	96-99
British Insulated and Helsby Cables, Ord., 1-100,000	5 —	6¾ 7¼
—— 6 per cent. Cum. Pref., 1-100,000	5 —	5⅞-6⅛
—— 4½ per cent. Mortgage Debentures	100 —	1 1-1.4
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 —	87 91
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	3 —	1-1½
—— 4 per cent. Mortgage Debenture Stock	100 —	59 64
Brush Electrical Engineering, Ordinary, Nos. 1-105,751	2 ..	¼-⅜
—— Non. Cum., 6 per cent. Pref.	2 —	⅞-1¼
—— 4½ per cent. 1st Debenture Stock	100 —	88-91
—— 4½ per cent. 2nd Debenture Stock	100 ..	7 -7¼
Callender's Cable, Debentures	100 —	105-108
—— Ordinary	5 —	9½-10¾
—— 5 per cent. Pref.	5 ..	5¼-5⅝
Consolidated Electrical Co., Ordinary, 1-110,000	1 ..	⅛-¼
Crompton and Co.	3 ..	1⅞-2⅛ xd
—— 5 per cent. Debentures	100 —	93½-96½
Dick, Kerr, and Co., Ordinary, 1 250,000	1 —	1⅜-1⅝
—— 6 per cent. Cum. Pref., 1-305,000	1 ..	1-1¼
—— 4½ per cent. Debenture Stock, Red.	100 ..	101-104
Edison and Swan United, "A" Shares, 1-99,261	3 —	1¼-1⅜
—— "A" Shares, 01-017,139	5 —	2¼-2⅜
—— 5 per cent. Debentures	100 —	8 1-92
—— 4 per cent. Deb. Stock, Red.	100 —	83 85
Electric Construction, Nos. 1 to 112,100	2 —	5/16-7/16
—— 7 per cent. Cumulative Pref.	2 —	1⅛ 1⅜
—— 4 per cent. Perp. 1st Mort Deb.	100 —	77 81
Electrolytic Alkali Co., Ordinary, 1-202,218	1 ..	⅛-⅜
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	—
General Electric Company (1900), 5 per cent. Cum. Pref.	10 —	8-8½
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	92 96
W. T. Henley's Telegraph Works, Ordinary	5 —	11½-12½
—— 4½ per cent. Preference	5 —	5-5⅛
—— 4½ per cent. Debentures	100 ..	105½ 107½
India Rubber, Gutta Percha, and Telegraph Works	10 ..	14½ 15½
—— 4 per cent. Debentures	100 —	97-99
National Electric Construction Co., 1-170,000	1 ..	27/32-31/32
Parker, Thos., Limited, Ordinary	10 —	10-10½
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5 ..	3¾-4
Telegraph Construction and Maintenance	1[illegible] —	31-33
—— 5 per cent. Bonds	10[illegible] —	99 02
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10 ..	9¼-9½

Electric Lighting and Supply.—

Name.	Amount paid.	Last price
	£	£
Adelaide Electric Supply Co., 6 p. c. Cum. Pref., 1-10,000	5 ..	4½-5¼
Bournemouth and Poole, Ordinary	10 —	9¾ 10¼ xd
—— 4½ per cent. Cum. Pref., 7,501-15,000	10 —	9¾ 10¼ xd
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10 —	10 10¼ xd
—— 4½ per cent. Debenture Stock, Red.	100 —	99 101 2 xd
Bromley (Kent) Electric Light and Power Co.	5 —	4⅜-4¾
—— 4½ per cent. 1st Debenture Stock, Red.	100 —	98 100
Brompton and Kensington, Ordinary	5 —	7⅛ 8¼ xd
—— 7 per cent. Preference	5 —	7⅜ 7⅝ xd
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5 —	6¾ 7⅜
—— Nos. 80,001-100,000	4 —	6¼ 7¼
Cambridge Electric Supply Company, £10 Ord.	8 —	13⅛-13⅝
Canadian General Electric Co., Common Shares	$100 ..	108-112
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100 —	99-102
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5 —	3¾ 3⅞ xd
—— 4½ per cent. Cum. Pref., 1-80,000	5 —	3⅞ 4¼ xd
—— 4 per cent. Debenture Stock, Red.	100 —	95 98
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5 —	3¼ 3¾
—— ditto (1903) 40,001-80,000	5 —	3¼ 4¼
Chelsea Electricity Supply	5 —	3¼ 4¼
—— 4½ per cent. Debentures	100 —	101-104
Chicago Edison Co, 1st Mt. 5 p. c. 30-yr. Gld. Bds, Red., 1-1,200	$1000 ..	98-101
City of London, Ordinary	10 —	9-10
—— 6 per cent. Cumulative Pref.	10 —	10¾-11¾
—— 5 per cent. Debenture Stock	100 —	121-124
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 —	96 99
City of Wellington Electric Light and Power Co, 5 per cent. Registered 1st Debs., Red., 1-1,63[illegible]	50 ..	50 53
Cordoba Light and Power Co., 1st Mt Stl. 5 per cent. Bds., Red., 1-1,000	100 ..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-[illegible]0,000	5 ..	4¼-5
—— 5 per cent. Preference, 1-50,000	5 ..	4¾-5
County of London Electric Supply, Ordinary	10 —	7-8
—— 6 per cent. Cum. Pref.	10 —	10¼-11¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 —	106-109
—— 4½ per cent. 2nd Debentures Prov. Certs.	100 —	94-97
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5 —	¾-1
—— 6 per cent. Cum. Pref.	5 —	1¼-2
—— 4½ per cent First Mort. Deb	100 —	76-81
Electrical Development Co of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, [illegible]0,751-15,75[illegible]	— ..	78-79 pcn.
Electric Lt & Traction Co of Aust., 6 p.c Cm Pf., 1 30,000	5 —	24-28
—— 5 per cent Debenture Stock Red	100 —	85½ 89½
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red	100 —	94½ 96½
Folkestone Electric Supply, Ord. Nos. 1-10,000	5 —	4⅜-5¼
—— 4½ per cent. First Deb. Stock, Red.	100 —	96 99
Hove Electric Lighting, Ord., 1-13,000	5 —	6¾-7¼
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100 ..	103-106
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk. Red.	100 —	94-97
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1 —	—
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5 —	2¼-2¾
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100 —	94-97
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 —	9¾-10¼
London Electric, Ordinary	3 —	1⅜-1⅝
—— 6 per cent. Pref.	5 —	4¼-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 —	93-96

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Name.	Amount paid. £		Last price £
Madras Electric Supply Corporation, 5 per cent. Construction Deb. Stock., Red. (Prov. Certs.), all paid	100	..	94-97
Metropolitan Ordinary, 100,001-300,000	5	—	5¼ 6¼
—— 4½ per cent. First Mortgage Debenture Stock	100	—	103 107
—— 4½ per cent. Cum. Pref.	5	—	4⅜ 5¼
—— 3½ per cent. Mortgage Debenture, Red.	100	—	87 92
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds., 1935, C 1-1,000 ($100), D 1-5,000 ($500), M 1-4,400 ($1,000)	—	..	74-76 p.c.
Mexican Light and Power Co., Capital Stock	$100	..	40-42
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14,000 ($1,000)	—	..	£2-81
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	—	86-88
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,000	5	—	6¼ 7
—— do., 57,001-75,000	5	—	6⅜-7
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid)	5	—	6¼-7
—— 5 per cent. Pref., 1-57,000	5	—	5 5¼
—— do., 75,001-87,500 (issued at 10s. prem., 4s. paid)	5	..	5-5¼
Notting Hill Electric Lighting	10	—	11 12
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	—	96 98
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	—	5¼ 6⅜
—— 4 per cent. Debenture Stock	100	—	95 97
River Plate Electricity Co., Ord., 1-119,687 & 120,501-120,507	1	..	⅞-¾
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	..	⅞-1
—— 4 per cent. Debenture Stock, Red.	100	..	95-98
Rosario Electric Co., 5 per cent. Cum Pref., 1-20,000	5	..	5-5¼
—— 5 per cent. Cum. 2nd Pref., 1-15,000	5	.	5-5¼
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	—	96 98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	—	..	99 101 p.c.
Smithfield Markets Electric Supply, Ord. 1-12,000	5	—	½-1½
—— 4 per cent. Debenture Stock	100	—	71-75
South London, Ordinary	5	—	2-2½
South Metropolitan Electric Light and Power, Ord.	1	—	⅞-1
—— 7 per cent. Cum. Pref.	1	—	1⅛-1⅜
—— 4½ per cent. 1st Mort. Deb.	100	—	100-103
St. James's and Pall Mall, Ordinary, 101-20,080	5	—	7⅜ 8⅜
—— 7 per cent. Pref.	5	—	6⅜ 7⅜
—— 3½ per cent. Deb.	100	—	86 91
Urban Electric Supply Co., Ordinary, 8-30-007	5	—	1½ 2¼
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	—	2-3
Westminster, Ordinary	5	—	8⅜ 9¼ xd
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	—	5-5⅛

Electric Tramways.—

Name.	Amount paid. £		Last price. £
Anglo-Argentine, 5½ per cent. Cum. Pref., 1-260,007	5	—	6-6¼
—— Ord.	5	—	8¼ 8⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100	—	131-134
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	—	102-106
Barcelona Tramways, Ord., 1-20,000	10	—	—
—— 6 per cent. Cum. Pref. Shares, 1-10,000	10	—	—
—— 5 per cent. Deb., Red., 1-500	100	—	—
—— 4½ per cent. Red. Deb. Stock	100	—	—
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1	—	⅜ ⅞
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	—	13/16-15/16
Birmingham and Midland Trams., 4½ p c. 1st Db. Stk., Red.	100	..	94-97
Blackpool and Fleetwood Tramroad	10	—	15⅝-13⅝
Bombay Elec. Supply & Trams. Co., 6 per cent. Cum. Pref.	8	..	7⅜-8¼
—— 4½ per cent. Deb. Stock, Red.	100	..	94-96
Brisbane Tramway Invest., Ord., 1-75,000	5	—	3 3/16 3 7/16
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	—	4 13/16-5 1/16
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	—	96-100
British Columbia Electric Railway Co., Ord. Def.	100	—	127-132
—— Ord. Pref.	100	—	110-114
—— 5 per cent. Cum. Perpetual Pref. Stock	100	—	103-106
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	—	100-103
—— 4½ per cent. Vancouver Power Deb.	100	—	100-102
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	—	2⅜-2¾
—— 6 per cent. Cm. Pf., 30,001-60,000	10	—	6⅜-7⅛ xd
—— 5 per cent. Perpetual Debenture Stock	100	—	100-103
—— 4½ per cent. 2nd Deb. Stock	100	—	78-81
Buenos Ayres and Belgrano Trams.	5	—	4⅛-4⅜
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	—	4⅜-4½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	4⅜-4½
—— 5 per cent. Deb. Stock, Red.	100	—	105-115
—— Prov. Cert., all paid	100	—	100-103
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100	—	92-97
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb. Bonds, Red., 1-1,500	100	..	99-103
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	..	101-106
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	93-96
Calcutta Tramways, 1-105,000	5	—	7⅛ 8
—— 105,001-137,610	5	—	5⅛ 5⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	—	102-106
Cape Electric Tramways, Nos. 1-480,000	1	—	5/16 7/16
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	—	4¼-5
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100	—	98 101
City of Buenos Ayres Trams. Co. (1904). 1-248,000	5	..	5¼-5⅜ xd
—— 4 per cent. Deb. Stock, Red. 1985	100	..	97-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	00	—	94-98
Cork Electric Tramway and Lighting Co., Ordinary	10	—	13¼-14½
—— 6 per cent. Cum. Pref.	10	—	13-14
—— 4 per cent. Debentures	100	—	98-101
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	—	13¼-14½
—— 6 per cent. Pref., Nos. within 1-60,000	10	—	12⅜-13⅜
—— 3½ per cent. Mort. Debs., 1-3,000 Red.	100	..	93-97
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100	..	98-101
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6,957	$1,000	—	82-87
Imperial Tramways, Ordinary	all	—	18-19
—— 6 per cent. Cum. Pref.	all	—	14-14¼
—— 4½ per cent. Deb. Stock	100	—	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5	—	1 1⅛
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	—	66-71
Kalgoorlie Electric Tramways, 1-250,000	1	..	5/32-5/32
—— 5 per cent. "A" Deb. Stock	100	..	88-93
—— 6 per cent. "B" Deb. Stock	100	..	78-82
Kidderminster and District Lighting and Traction, Pref.	5	—	8-8½
Lancashire Up'ted Tramways Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	—	94-97
—— £296,500 2nd Mort. Deb Stock	—	—	—
—— £83,330 Deferred Deb. Stock (all fully paid)	—	—	—
Lisbon Electric Tramways Limited, Ord., Nos. 1-594,188	1	..	1 1/16-1 5/16
—— 6 per cent. Cum. Pref., Nos. 1-425,553	1	—	1 1/16-1 3/16
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100	..	95 98
London United Trys. (1901), 5 per cent. Cum. Pref.	10	—	7⅛ 8⅜
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	—	84-88
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Red.	100	—	96-99

Name.	Amount paid. £		Last price. £
Manila Elec. R.R. and Lghtg. Corp., 5 p.c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000	..	90-92 xd
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 23,436-25,000	5	..	4⅜-5¼
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	—	97-100
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	—	3/32 5/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	—	27 32-31 32
—— 4½ per cent. Deb. Stock, Red.	100	—	84 87
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	—	..	83½-85½ p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	—	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 601-2,000 (1922)	100	—	101-103
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	—	⅜-½
Oldham, Ashton, and Hyde Tramway, Ordinary	10	—	12
—— 5 per cent. Cum. Pref.	10	—	8⅜-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100	—	100-104
Potteries Electric Traction, Ordinary, 1-245,000	1	—	5/16-9/16
—— 5 per cent. Cum. Pref., 300,001-545,000	1	—	⅜-½ xd
—— 4½ per cent. Debenture Stock	100	—	96 98
Provincial Tramways Co., Ordinary, 1-24,912	10	..	4½-5
—— 6 per cent Cum. Pref., 1-10,000	10	..	10¼-11¼
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-30,000	5	..	5¼-5⅜
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	97-99
Sao Paulo Tramway Light, and Power Co.	$100	..	103-108
—— 5 per cent. 1st Mort. Deb., Red. 1929. 1-11,000	$500	..	92-94 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1	..	⅛-1
—— 4 per cent. Deb. Stock, Red. 1940	100	..	80-84
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs, Red., 1-1,600	100	..	84-88
Yorkshire (West Riding) Elec. Tram Co., Ord., 70,001-110,000	5	..	1-1¼
—— 6 per cent. Cum. Pref., 1-46,261	5	..	¾-⅞
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	87-90

Electric Railways.—

Name	Amount paid. £		Last price £
Central London, Ordinary	100	—	71-73 xd
—— 4 per cent. Pref.	100	—	83-91 xd
—— " " deferred	100	—	53-56
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	—	102-105
City and South London, Consolidated Ordinary	100	...	44-46 xd
—— 4 per cent. Debenture Stock	100		102-105
—— 5 per cent. Pref. Stock '91	100	—	117-121
—— " " " '95	100	—	115-118
—— " " " '01	100	—	110-113
Liverpool Overhead, 5 per cent. Pref.	10	—	10-10¼
—— Ordinary, 1-50,000	10	—	3⅜-4⅛
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	—	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	...	64-67

Telegraphs and Telephones.—

Name.	Amount paid. £		Last price. £
Amazon Telegraph Co., 1-25,000	10	..	3-3¼
—— 5 per cent. Debs., Red., within 1-1,069	100	..	85-88
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000	$1,000	..	90-92
Anglo-American Telegraph Co., Ordinary	100	..	60-63
—— 6 per cent Preferred Ordinary	100	...	105¼-106½
—— Deferred Ordinary	100	...	16½ 17
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort Deb. Stock, Red.	100	...	101-104
Chili Telephone Co., 1-44,000	5	...	6-7¼
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100	...	92-94
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	...	7-8
—— 10 per cent. Preference, 1-6,000	10	...	15⅜-16⅜
Direct Spanish Telegraph Co., Ordinary	5	...	3⅜-3⅝
—— 10 per cent. Cum. Preference	5	...	9-9¼
—— 4½ per cent. Debs., 1-600	50	...	99-101
Direct United States Cable Co.	20	...	14⅜-15⅛
Direct West India Cable Co., 4½ per cent. Debs., Reg. within 1-1,200. Red.	100	...	99¼-101½
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100	...	97¼-100¼
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8,000, 1913	25	...	98¼-100¼
Eastern Extension, Australasia and China, 1-300,000	10	...	12⅜-13⅜
—— 4 per cent. Mort. Deb. Stock, Perp.	100	...	102-104
Eastern Telegraph Co., Ordinary Stock	100	...	133-138
—— 3½ per cent. Preference Stock	100	...	86-88
—— 4 per cent. Mortgage Debenture Stock	100	...	103-105
Great Northern Telegraph Co. (of Copenhagen)	10	...	34-36
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1,200, Red.	100	...	99¼-101¼
Indo-European Telegraph Co.	25	...	56-58
Marconi's Wireless Telegraph Co., 1-256,127	1	...	⅛-¼
—— 256,128-384,190	1	...	⅜-½
Monte Video Telephone Co., Ordinary, 1-72,680	1	..	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492		...	¾-1
National Telephone, Preferred	100	...	106-108
—— Deferred Stock	100	—	105-107
—— 6 per cent. Cum. First Pref.	10	—	11-13
—— 6 per cent. Cum. Second Pref.	10	—	10-12
—— 5 per cent. Non. Cum. Third Pref.	5	—	5 5/16-5 9/16
—— 3½ per cent. Deb. Stock, Red.	100	—	86-92
—— 4 per cent Deb. Stock, Red.	100	—	100½-102½
Oriental Telephone and Electric Company	1	..	¾-1⅜
—— 6 per cent. Cum. Pref.	1	..	1 3/16 1 5/16
Pacific and European Tel., 4 p c. Guar. Debs., Red., 1-1,000	100	...	97-100
United River Plate Tele. Co., Ordinary, 1-100,000	5	...	6¼-7¼
—— 5 per cent. Cum. Pref., 1-40,000	5	...	5-5½
—— 5 per cent. Debenture Stock, Red.	100	...	—
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	...	98-101
West African Telegraph Co.	10	...	10-10¼
West Coast of America, 1-30,000 and 53 001-53 003	2½	...	1¼-1⅜
—— 4 p c. Debs., 1-1,500, Gua. by Western Telegraph	100	...	97-100
West India and Panama Telegraph Co., Ordinary	10	...	7/16 9/16
—— 6 per cent. Cum. 1st Preference	10	...	7¼-7⅜
—— 6 per cent. Cum. 2nd Preference	10	...	6¼-6⅜
—— 5 per cent. Debs., Red., 1-800	100	...	99-102
Western Telegraph Co., 1-107 930	10	...	13-13¼
—— 4 per cent. Debenture Stock, Red.	100	...	100-103

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1907.	1906.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Aug 14	1,660	1,569	+ 91	+ 41*h*	25½	25	May 31	64 071	15,530,351	1,379,723	0 98	11·14	2,512	6·45
Ayr Corporation	,, 17	524	492	- 32	—	8	8	,, 15	14,528	3,316,380	353,945	1	9·71	1,830	5 16
Baker Street and Waterloo Ry.	,, 17	2 010	1,233	+ 737	+ 7,218	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 18	1,088	1,099	- 11	- 374	23 53	3·53	March 31	55,025	11,145,531	1,309,903	1·18	10·08	2,338*b*	6·03
Birmingham Corporation	,, 17	5 938	—	—	—	56½	—	,, 31	17,133	4,709,788	266,526	·86	14·5	8 866	—
Blackburn Corporation	,, 14	1,186	1,037	+ 168	+ 955	24	24	,, 25	48,875	8,661,720	986 953	1·35	11·89	2,036	7·44
Blackpool Corporation	,, 15	3 318	3,288	+ 30	- 1,662	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	,, 17	2,052	2,297	- 245	- 940	16½	16½	Dec. 31	31,846	2,325,677	579,264	3·28	13 19	—	7·27
Bolton Corporation	,, 18	2 351	2,263	+ 88	+ 2,693	42	40	March 31	95 766	20,205 196	2,161,130	1·13	10 63	2 394	6·14
Bournemouth Corporation	,, 14	2,349	2,484	- 135	+ 416	17·41	16·82	,, 31	55,276	10,058,288	1,121,623	1·32	11·83	3 226	7·19
Bradford Corporation	,, 17	4,837	4 776	+ 61	+ 2·5	95	95	,, 31	230,085	47,108,000	5,053,392	1·172	10·927	2,795	—
Brighton Corporation	,, 18	1,155	1,350	- 195	- 2,254	9½	9½	,, 31	50,339	11,321 160	1,152,828	1·06	10·48	2,914·8	8·0.4
Bristol Tramway Company	,, 16	5.154	4,976	+ 178	—	51½	51½	Dec. 31	259,799	45,312,373	6 127,135	—	—	—	—
Burnley Corporation	,, 17	1,318	1 267	+ 51	—	40	40	March 31	57,992	11,092,704	1,197,772	1·31	11 61	5,388	8·17
Burton Corporation	,, 18	318	352	- 34	- 337	8½	8½	,, 31	17 950	3,878,269	454,082	1·07	9·21	2,078	6·76
Cardiff Corporation	—	—	—	—	—	32 62	†32·26	,, 31	112,209	24,134,363	2,770,049	1·12	9 72	3,782	9·44
Carlisle Tramways Company	,, 17	200	212	- 12	- 413	8·5	8·5	Dec. 31	10,713	2,935 002	359,756	—	7·14	—	5 18
Central London Railway	,, 17	4,265	4,976	- 711	- 3,266	6	6	,, 31	347,588	4,875,547	1,281,214	1 86	65·10	57,931	35 80
Charing X, Euston, & Hamp. Ry.	,, 17	2,320	2,955	- 635	—	8	—	—	—	—	—	—	—	—	
City and South London Railway.	,, 18	2,810	2,400	+ 410	+ 4,481	6¼	6¼	,, 31	—	—	—	—	—	—	—
Colchester Corporation	May 8	195	195	—	—	8	8	March 31	10,588	2 457,553	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	Aug. 15	—	588	- 26	—	15¼	15¼	Dec 31	24,895	5,814 376	882,256	1 01	6·64	—	4 69
Darwen Corporation	,, 16	275	267	+ 8	- 9	7 23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	,, 17	328	354	- 26	- 724	4½	4½	,, 31	11,250	2 853,200	284,343	·94	9·49	2,500	
Dublin and Lucan Electric Ry.	,, 16	166	147	+ 19	+ 564	6¾	6¾	Dec 31	6,358	402,511	110,738	3·79	13·78	942	7 33
Dublin U.T.	,, 16	7,605	5,460	+2,145	—	48½	48½	,, 31	267,489	50,050,949	7,077,372	1·28	9·07	691	5 65
Dundee City Tramways	,, 14	1,142	1,077	+ 65	+ 355	22	22	May 15	57,154	13 086 396	1,005 911	·906	11·96	2,180	7·42
East Ham Corporation	,, 16	1,027	876	+ 151	- 256	14	14	March 31	56,652	3,689,658	863,816	·64	10 18	2,994	6 79
Glasgow Corporation	,, 17	192,497	189,791	+2,706	— *h*	79½	79½	May 31	756,480	195,767,519	17,946,595	—	10 12		—
Gloucester Corporation	July 10	278	304	- 26	—	15	15	March 31	15,465	3,902,077	563,595	·60	6·58	969	5·32
G.N., Piccadilly, and Brompton	Aug. 17	3,405	3,590	- 185	—	9	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	37	37	,, 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 17	1,839	1,719	+ 120	+ 1,323	35	35	,, 31	69,938	12 838,150	1 665,262	1·24	9·71	1,923	—
Hull Corporation	,, 17	2,525	2,285	+ 240	+ 2,378	26	26	,, 31	112,651	27,102,921	2,910,698	1	9·29	—	—
Ilford Corporation	—	—	—	—	—	10½	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 14	147	139	+ 8	+ 166	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	11,586	3,626,656	419,800	·737	6 62	1,480	5·22
Lancashire United Tramways	,, 14	1,311	1,025	+ 316	+10,530	38½	28	—	—	—	—	—	—	—	—
Leeds Corporation	,, 10	8,119	7,491	+ 654	+ 4,982	89½	89½	March 25	298,233	64,223,666	7,121,038	1 10	10·02	351	—
Leicester Corporation	,, 17	2,148	2 068	+ 79	—	42	42	Dec. 31	26,011	12 039,252	1,229,507	1	9·79	—	4 82
Liverpool Corporation	,, 10	14,802	12 410	+2,392	+ 7,042	104	104	,, 31	547,625	116,642 663	12,166,419	—	—	—	—
Liverpool Overhead Railway	,, 18	1,610	1,648	- 38	+ 971*h*	6·65	6 65	June 30	81,302	11,171,865	1,024,275	—	—	—	—
London County Council	,, 3	31 259	25,509	+5,750	—	98	98	—	—	—	—	—	—	—	
Lowestoft Corporation	—	—	—	—	—	6	6	Sept. 30	14,511	3,128,857	359,435	1 08	9·68	2,630	6 48
Maidstone Corporation	—	—	—	—	—	2	2	March 31	4,740	850 121	112,227	1 33	10 13	2,370	
Manchester Corporation	,, 17	15,489	13 680	+1,809	+23,537	149	149	,, 31	631,956	126,900,875	14,123,124	1·19	10·73	4,299	6 99
Metropolitan District Railway	,, 18	6,564	6,518	+ 46	+ 327	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 18	13,658	13,3.9	+ 339	+ 3,429	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 17	168	154	+ 14	+ 56	2¾	2¾	,, 31	6,159	1,992,647	206,358	82	7 14	2,239	—
Newcastle-on-Tyne Corporation	,, 17	3,909	3,821	+ 88	+ 537	50	50	,, 31	197,849	43,063,934	4,326,152	1 07	10·98	3,957	7·0
Newport (Mon.) Corporation	June 29	639	628	+ 11	+ 1,397	15¼	15¼	,, 31	30,356	7,252,535	783 435	—	9 29	—	6·4
Oldham Corporation	—	—	—	—	—	34	34	,, 25	65,553	13,466,245	1,504,740	1 16	10·45	1,885	—
Portsmouth Corporation	May 25	2,330	1 578	+ 752	+ 632	28½	28½	,, 31	95,702	19,625,329	197,499	1·17	11 63	—	—
Reading Corporation	Aug. 15	655	676	- 20	- 591	33½	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	11·23	21·29	,, 31	14,881	2,837,110	386,547	1·24	9·24	1,102	7 92
Rotherham Corporation	—	—	—	—	—	9½	9½	,, 31	23,569	5 251,472	593,054	1 07	9·53	2,612	7·49
Salford Corporation	,, 19	4,900	4,542	+ 358	+ 2.17)	70¾	70¾	,, 31	214,111	39,213,560	4,894,580	1·28	10 29	—	—
Scarborough Tramways Co.	—	—	—	—	—	4½	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 18	5,645	5,194	+ 451	—	35¾	35¾	,, 25	210,545	63,952,283	6,049,899	·903	9 543	3,653	6·477
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,365	9 294,771	1,108,369	1·27	11·02	—	7 83
Southend-on-Sea Corporation	,, 14	759	757	+ 2	- 362	9	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	,, 31	39,550	6,766,031	1,027,730	—	9 23	—	4·75
Sunderland Corporation	,, 4	1,560	1,692	- 131	- 272	20	20	,, 31	64,858	15,364 463	1,495,f 85	1·004	10·36	—	6·37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	4,937	1,315,757	102,751	0·87	11 53	1,371	—
Torquay Tramways	Aug 15	356	—	—	—	5·16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 17	983	944	+ 39	—	12 68	12·43	,, 31	43,607	7,995,451	862,123	9·27	12·14	3,132	7 50
Warrington Corporation	—	—	—	—	—	9	9	,, 31	17,057	4,418 225	403 363	—	9 85	—	6·33
West Ham Corporation	,, 15	2,218	2,145	+ 73	+ 1.319	14·7	14 7	,, 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	,, 14	826	815	+ 11	+ 277	20	20	,, 31	41,905	8,847,066	950,338	—	10 583	2,062	6·1o

† And 98 miles of interlacing track. *a* Train mile. *b* Per mile of single track. *h* Half-year's figures. *k* Double track

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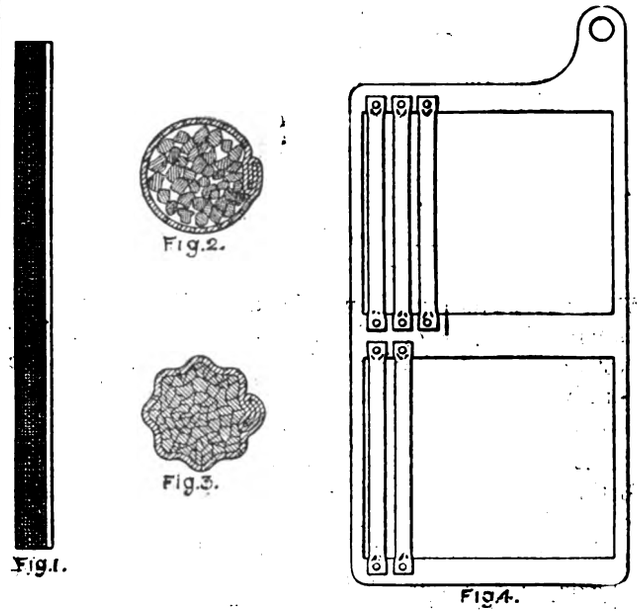
NOTES.

Accrington Tramways Arbitration.—The dispute as to the purchase price of the Accrington Steam Tramway Company to be paid by the Haslingden and Rawtenstall Corporations was submitted to arbitration before Sir Colin Scott-Moncrieff, who has now issued his award. For so much of their undertaking as belonged to the borough the directors of the company asked from Haslingden £24,203. They have been awarded £14,203, which includes the depôt and its land. From Rawtenstall the company asked £7,375. They are awarded £4,252. The Corporations bear the costs. The Haslingden authorities are arranging with the company to continue their running of the cars until the end of the year. They propose to commence electrifying the system as early after Christmas as the weather permits, and meanwhile are negotiating with the Accrington and Rawtenstall Corporations as to through running powers.

Capacity of Absolute Condensers.—The August issue of the American *Physical Review* contains a paper on the effect of frequency upon the capacity of absolute condensers, by Mr. J. G. Coffin. The calculations of the paper were undertaken to find out how completely a condenser is charged and discharged when the condenser surface has a high resistance, such as silvered glass, tinfoil, etc. Mr. Coffin has attacked the problem mathematically, and in order to do so he has assumed the simple case of a uniform strip and that of an angular strip, the latter corresponding to a circular plate condenser. The results showed that when the surface resistance is high, the capacity falls off to an enormous extent for comparatively low frequencies. A plot showing the ratio, γ, of the apparent acting capacity to the ordinary capacity was made for both cases so that for any value of $\mu^2 = \omega\, C\, R\, \rho^2$ we may read off the corresponding values of γ, where C R and l or ρ may have any values whatever. The solution for the uniform strip is also one for a cylindrical condenser in which the current enters at one end, as the lines of flow are evidently along the generators. Mr. Coffin has found that the capacity of a condenser diminishes with increasing frequency as well as the self-induction of a coil, so that their effects are additive; and in all work in which high-frequency currents are employed the experimenter, says Mr. Coffin, must assure himself that the corrections pointed out are negligible for the work in question, and, if not, to apply them.

Poles for Overhead Lines.—The Forest Service of the United States Department of Agriculture have recently issued a bulletin on the seasoning of wooden poles required for supporting overhead transmission lines. This is a matter which has escaped the careful consideration that its importance merits, for it has been shown from reports of the experience in Germany, Austria, and elsewhere on the Continent that have appeared in these columns, that the life of wooden poles depends to a large extent on the methods employed in preserving them. The American investigation was undertaken to discover the best conditions for seasoning poles and to indicate the best season for cutting them; the results of which are given in a large number of elaborate tables. The conclusions arrived at may be briefly stated as follows: Winter-cut wood seasons more regularly than that cut at other seasons, but does not, for many months, at least, reach as low weight as spring-cut wood seasoned equally long. In timber of approximately the same age and growth, that cut in winter will have the greatest specific gravity, and that cut in autumn the least. The shrinkage of round timbers in air seasoning is very slight, and may be disregarded. If poles are carefully cut, checking during air seasoning is comparatively slight. If split or shaken in felling, however, serious checking may result. From the standpoint of seasoning, spring and winter are the best times for cutting. Other considerations, such as custom, availability of labour, and susceptibility to decay, make winter cutting preferable.

Edison Storage Battery.—A patent has been granted in the United States to Mr. T. A. Edison which relates to improvements in his form of cobalt-nickel alkaline storage battery, designed to reduce to a minimum the amount of active material in the forms of flakes or films on cobalt or a cobalt-nickel alloy, and to secure a maximum degree of conducting capacity. A unit tube (as shown in Fig. 1) is formed from a thin perforated sheet of sheet iron or nickel, thinly coated on each side with cobalt-nickel alloy. After the seam is formed the tube is subjected to a high temperature in hydrogen to weld the seam, after which the tube is filled with active material and then corrugated longitudinally, as shown. The tubular units



are then secured by rivets to grids, as shown in the illustration.

Canadian Government and Wireless Telegraphy.—Sir Wilfrid Laurier, the Canadian Premier, has now intervened in the dispute between the Acting Minister of Marine and the Marconi Wireless Telegraph Company. The *Times* reports that at Ottawa on the 9th inst. Sir Wilfrid brought together representatives of the Marine Department, the Marconi Company, and the Shipping Federation, who stated their varying views in turn. On behalf of the department it was argued that no company should have a monopoly of wireless telegraphy in Canada, and that the Marconi Company should accept the licences which the department had discretion under the law to offer. Mr. Oppe, the company's general manager, argued that the Government's action amounted to confiscation; and Mr. Hugh A Allan, of the Allan Line, speaking for the shipping interest generally, urged that the dispute should be quickly ended in view of the importance of wireless telegraphy as a safeguard to navigation. The Prime Minister, having heard the contending parties, advised the company provisionally to accept the licence now offered, on the understanding that this would not prejudice them in applying for licences of a different kind. The Government, he declared, would carry out its contracts with the company. He also announced that the Government was ready to grant a fiat for a hearing of the matters at issue before the courts. Mr. Oppe promised consideration for the course suggested by the Prime Minister. He has since

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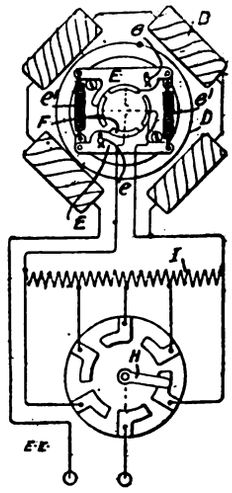
stated that the company will meet the Government's reasonable views as far as possible, but cannot agree to any conditions adversely affecting the company's patents or contracts.

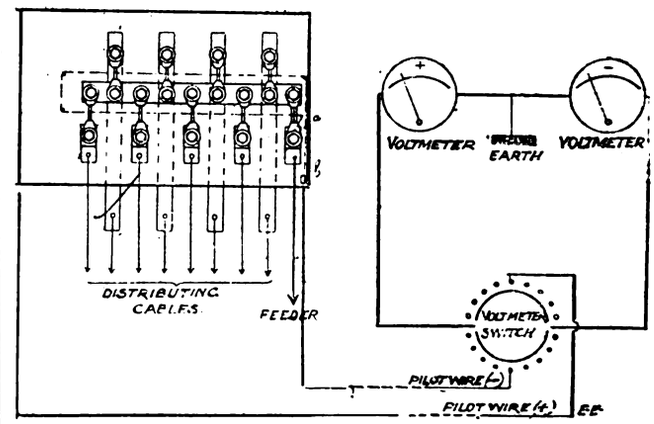
Motor Starting.—An invention recently patented by the British Thomson-Houston Company relates to means for increasing the torque for starting a single-phase induction motor. When used, for example, for driving a fan, the rotor, D, carries a centrifugally-actuated switch, E, which, when the machine is at rest, short-circuits the regulating inductance coils, I, by means of stationary contacts, F. The contacts, F, are in pairs cross-connected.



When the motor speeds up, the arms, E, overcome the the force of springs, e', and are thrown outwards on their pivots, e, thus allowing a regulating switch, H, to become operative. This invention is said to be applicable to any kind of motor having regulating inductances.

The Magnetic Character of Vessels.—Captain W. Bartling's paper to the North-East Coast Institution of Engineers and Shipbuilders at Newcastle giving the results of a number of interesting experiments and observations on the development of magnetic character of the s s. "Thueringen" during the completion of the construction of the ship, a full account of which appeared in our issue of May 31, evoked an interesting discussion, which is reported in the latest issue of the *Transactions* of the institution. It will be remembered that as a simple and effective solution of the compass question Captain Bartling recommended the use of unmagnetic material for the ship, and mentioned that his company had used unmagnetic nickel steel in their newer ships in the near vicinity of the standard compass with good results, the alloy containing 23 per cent. nickel. He further expressed the hope of arriving at a λ of from 0·9 to 0·95—an improvement of about 15 per cent. Lord Kelvin, in a communication on the subject, says: "The attainment of a value of λ considerably lower than 0·9 in a large ship now being built for Captain Bartling's company is a result very valuable in respect to the adjustment of the compass for heeling error, as will be seen by the following passage extracted from a leaflet describing my new vertical force instrument of 1906: '§ 6. If, by deflector observations or otherwise, the adjuster knows the ratio of the horizontal magnetic force on the compass, when corrected in its actual position in the ship, to what it would be if there were no iron in the ship, he should use this ratio instead of "nine-tenths" in the rule for adjusting the slider.'" Captain Bartling's important remarks should prove an inducement to shipbuilders to endeavour to arrange as little as possible of magnetic material in the neighbourhood of a position chosen for a standard compass.

An Automatic Fuse Indicator.—A simple and safe arrangement for indicating at the central station the blowing of any fuse in the feeders or in the distributing network is described in a recent number of *Elektrotechnik und Maschinenbau*. It involves the use of no special apparatus beyond the ordinary pilot wires, voltmeter, and voltmeter switch. The arrangement is shown in the diagram, and its action depends on the burning through of the thin wire connection, a b, between the feeder and its pilot wire whenever a fuse blows. When this occurs, the corresponding pilot wire can be readily picked out at the station by the fact that it indicates no voltage on the voltmeter. If the indication is to be automatic, it is only necessary to insert a relay in each pilot-wire circuit arranged to indicate when the current ceases—all the pilot wires being connected in parallel at the voltmeter switch



The arrangement is best applicable to open strip fuses, though it can also be used with enclosed fuses if a hole is provided through which the indicator wire can be threaded. The indicator wire is usually a thin well-insulated wire—*e.g.*, A.E.G. enamel wire—laid directly across the fuses without any tension arrangement.

Working Agreement in the Engineering Trades.—By a vote of 12,996 to 9,062 in a ballot of their branches, the members of the Amalgamated Society of Engineers have accepted and confirmed the new working agreement provisionally arranged by their officials with the Federation of Engineering Employers. As the *Economist* points out, the agreement is between that federation, which covers the whole country, and the United Machine Workers' Association, and the Steam-Engine Makers' Society, as well as the Amalgamated Society of Engineers—that is to say, it includes the whole engineering industry of the United Kingdom. The terms of the agreement were arranged after a prolonged series of conferences last spring, and they have been before the men since May last. The agreement is to replace what were called the conditions of settlement of the great strike of 1898. These conditions have worked well, and have certainly prevented any strikes or serious disputes since they were in force, but they have a disagreeable flavour about them, because they were associated—in the minds of the men only—with a lost battle. The new treaty affirms the rights of trade unionism, but also recognises the rights of employers to employ free labour if they please, and the right of every non-union workman to work even in a "union shop." But while the existence of non-union labour is respected by the trade unions, the Federation of Engineering Employers undertake not to object to the employment of any workman on the ground that he is a trade unionist. The provisions for avoiding disputes are the features of most economic value in the agreement. These provisions are on the lines of the 1898 agreement, which have worked well, and it is mutually agreed that when a dispute occurs there shall be no stoppage of work until the whole method of procedure provided for has been carried

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through. The significance of the affair is that the agreement is deliberately confirmed by the men after months of consideration of the text, and after years of experience of ts principles and policy. Here we have an object lesson in ntelligent trade unionism.

Epping and Telephone Poles.—The threatened invasion of the National Telephone Company has aroused to fury the æsthetic soul of picturesque Epping. It all occurred in this way. The business people in the little town desired to be connected by telephone to the outer world. The National Telephone Company were appealed to, and they, in turn, obtained the consent of the Essex County Council to erect poles in the town. But a deputation waited upon the local District Council to urge that "the beauty of the town should not be sacrificed to the economic considerations of the Telephone Company." This appeal to the sentimental side of the Urban District Council had its effect, for the latter consented to try to persuade the County Council to postpone the sealing of the wayleave agreement, in the hope that the invading company might be induced to adopt an alternative—*i.e.*, to carry the wires underground from the outskirts of the town to the exchange. But a soulless company is no respecter of beauty; with it economic considerations are paramount, and in exploiting a district the question is not whether natural beauty will be despoiled, but whether revenue will balance against the expenditure. The National Telephone Company, however, have not been so wanton as some of the good people of Epping picture them. They have expressed their readiness to meet, if possible, any reasonable requests with regard to the placing of poles and wires. Some sort of compromise has been effected, by which only five poles are to be erected in a place of comparative obscurity where they cannot spoil the old-world charm of the little town. But the "sentimentalists" of Epping are still unappeased, while the company must be considerably hampered in their operations by the lack of room which the position wherein the five poles will be erected permits.

Greenwich Observatory and London County Council Generating Station.—The report of the Astronomer Royal to the Board of Visitors of the Greenwich Observatory has just been issued, and attention is once more called to the danger which is said to threaten the astronomical efficiency of the observatory from the working of the generating station of the London County Council. Sir Wm. Christie says that if the recommendations made in the report presented to Parliament by a special committee are all strictly carried out, the work of the observatory may not be seriously interfered with, though further experience when the generating station is completed and in full work may modify this view. The Astronomer Royal considers that the recommendation of the committee that the question as to the effects of vibration and discharge from chimneys should be further reviewed after, say, two years is of great importance for the protection of the observatory in the future. As regards vibration, he says that test experiments made last summer showed that the vibration from the engines of the completed portion of the generating station can be effectually damped out when the film of mercury in the amalgamated trough is as thin as practicable. But though the tremors which are undoubtedly caused by the generating station may be masked by the use of a very thin film of mercury, it is a question whether they do not cause the telescopes to oscillate to such an extent as to interfere with the delicate work of which they are capable, such as the observation of close double stars with the large telescope. Further experience is required to decide this. The danger to be feared from the chimneys and the heated gases they discharge in the immediate neighbourhood of the Greenwich meridian is, he adds, more insidious, as the effect on the accuracy of observations of stars near the north horizon may only become apparent in course of years, when it is found that the results are untrustworthy from this cause. The recommendations of the committee in this respect represent the minimum which is absolutely necessary, and a further reduction in the height of the chimneys may be required to safeguard the Greenwich meridian work.

Modern Methods of Treating Observations.—A communication made by Mr. W. P. Elderton before Section A of the British Association dealt with the application of recognised statistical processes to meteorological statistics. The terms mean, median, and mode were defined, and the methods of calculating their values given, with examples from rainfall statistics. The "method of moments" was described, and as an application a parabolic curve was fitted to statistics of rainfall in the East of England. The standard deviation was then explained, and it was pointed out that this function measures the way the observations are scattered about their mean. The importance of calculating a "standard deviation" or a "probable error" corresponding with means was then insisted on; the mere statement of a mean is statistically insufficient, and of no use for comparative purposes until we know what deviations from the calculated value may arise. The remainder of the communication dealt with correlation. The coefficient of correlation was first explained, and it was shown how it can be calculated. The rainfall in the East of England was compared with that in the North of Scotland and in the Channel Islands In the former case the coefficient of correlation is very small, and about equal to its probable error, so that we cannot conclude that there is any correlation; but in the latter case the coefficient is found to be $\cdot 374 \pm \cdot 065$, and indicates that there is a distinct connection between the rainfall in the East of England and that in the Channel Islands Another example taken was rainfall and typhoid cases in Surrey districts, the water supply of which is obtained from river sources. The coefficient of correlation is ·116, with a probable error of ·073, so that it is impossible to assert definitely that there is any relation between rainfall and typhoid—at any rate on the evidence afforded by these statistics. Reference was made to a paper on barometric heights by Prof. Karl Pearson, F.R.S., and Dr Alice Lee, and to the use of the coefficient of correlation by Dr. Gilbert T. Walker, F.R.S., in his interesting memoranda on the meteorology of India. The author concluded with an appeal for the more scientific treatment of statistics by modern methods.

The Home Office Regulations.—In October, 1904, the Home Office issued in draft certain regulations based on existing requirements of the Board of Trade having reference to the use of electrical energy at medium pressure. Many difficulties, however, arose in regard to their enforcement as regulations under the Factory Act, and it was found necessary in consequence to prepare a revised code. A draft of the revised regulations has just been issued, and appears elsewhere in our columns. It is noteworthy that the new regulations are intended to apply to premises where the pressures are above 130 volts continuous and 65 volts alternating. In adopting these limitations as the basis of pressure, the Home Office seems to have been guided by the fact that the serious accidents from shock brought to its notice have been at pressures exceeding those named, though it is realised that danger may exist at still lower pressure. The new regulations indicate broadly the dangers to be avoided and the nature

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of the precautions required, rather than define particular means of securing safety. It appears often to be thought that where the supply of electrical energy is at low pressure there is no danger of shock, or, rather, that there is no danger to life from shock at such pressure. It has, however, been abundantly proved that this is not the case. Fatal cases of shock at low pressures are by no means of rare occurrence. Accidents from shock may occur by a person making contact simultaneously with two live conductors at different pressures, but more usually by merely touching one conductor whilst being in contact with the ground. A mere momentary contact with a conductor at low pressure, even when standing on damp ground, may not produce a serious shock, but a person who happens to grasp the conductor may be quite unable to release his hold, and the shock is prolonged until assistance comes. In such circumstances it may take only a few seconds for the shock to prove fatal. The dividing line between the conditions which will render the shock merely trifling and those which will render it fatal is so narrow that it becomes necessary to provide, so far as is practicable, that no shock shall be received at all. The regulations will not come into force until January next year; in the meantime objections will be considered by the Secretary of State, and may even be the subject of a full inquiry.

Lighting from Destructor Plant.—An experiment with refuse-burning plant as a means of lighting the Williamsburg Bridge across the East River, New York, has been abandoned, and the structure is to be illuminated in future by the New York Edison Company. The *Electrical World* of New York gives some interesting data as to operating the plant. The refuse collected at the station was supplemented with coal at times for feeding boilers supplying steam to two 100-kw. and one 50-kw. electric generating units. It was estimated at the time that the plant would save the city about £2,000 yearly. The generators supplied 180 arc lamps, 767 incandescent lamps, three electric motors, and 20 electric heaters. The following figures are given for the year 1906: cost of destructor, buildings, equipment, and boilers, £12,418; cost of generating plant, wires, lamps, etc., £12,051; cost of operating destructor, including repairs, supplies, coal, and interest at 4 per cent., £9,005; cost of operating electric plant, including depreciation at 5 per cent. and interest at 4 per cent., £6,284; actual saving to the street-cleaning department as compared to the cost of final disposition, £1,610; actual cost to the street-cleaning department to effect the above saving, £7,394; estimated cost of running the lighting plant with coal as fuel, £11,446. Our contemporary does not give the total kilowatt-hours of energy generated so as to compare the cost of energy per kilowatt-hour, as compared with the cost if supplied by a central station. The city's engineers, however, admit that the plant was being operated at a loss and was unsatisfactory at all times as a lighting plant. Various reasons are given. A large part of the difficulty encountered in the work of keeping up steam in the boilers was the accumulation of slag, which choked the flues and ran back on the grates. This slag was caused by sand, glass, etc., in the rubbish which escaped the pickers. Besides this, the quality of the fuel caused great variations in the heat obtainable, and the necessity of opening the large feed holes for putting large articles, such as sofas, barrels, boxes, etc, into the fire caused contractions which ruined the destructors. Another condition which was inimical to economical operation was the necessary rehandling of the rubbish. This came in during the day, and the lighting plant was run at night, so that in the meantime the rubbish had to be stored. In addition, the heavy lighting load came during the winter months, and the quantity of rubbish gathered in winter is not near so much as is gathered in summer. The plant has had a two years' trial, and the result is that it has been found to be a failure.

University College of London Extensions.—When the new session opens on Oct. 1 the extensions to each of the engineering departments at University College will be completed. By the removal of University College School to Hampstead the south wing of the college buildings that has hitherto been utilised for that school is set free for university purposes. The plans for the alteration and adaptation of this wing for university purposes were prepared early in the year, and almost on the very day that the school concluded its work the builders began operations so as to complete the work in time for the session 1907-8. The chief features of the extensions are as follows: In the mechanical engineering department, which is under the direction of Prof. J. D. Cormack, a new hydraulic laboratory will be provided in the basement, and also additional space for experimental work in mechanical engineering during the second and third years. A separate laboratory will be set aside for research work, thereby leaving the main laboratory entirely free for undergraduate work. In the department of electrical engineering, which is under the direction of Prof. J. A. Fleming, the present lecture-room, which faces on Gower-street, will be replaced by a large new lecture-room with a small demonstration class-room adjoining it, which will face south and be entirely removed from the noise of traffic. The old lecture-room will be fitted up as an experimental room for advanced students. The electrical engineering department will also contain a fine research laboratory with apparatus and preparation rooms adjoining. The department of applied mathematics, under Prof. Karl Pearson, which is immediately above the electrical engineering department, will also receive considerable extensions, thereby setting free the existing accommodation for the work of engineering students, and providing new accommodation for those taking civil and municipal engineering. The extensions to the department of applied mathematics will also provide two special research laboratories. Extensions will be made to the drawing office, which will make it possible to reserve benches for the entire use of each of the students working therein. Adjoining the drawing office will be a large museum of apparatus and diagrams. Many of the leading engineering firms have already presented apparatus for exhibition in this museum. In addition to these improvements, a large room of 50ft. by 20ft. has been set aside for the use of the Students' Engineering Society, of which Sir Alexander Kennedy was the founder This society organises meetings, with lantern demonstrations on special topics interesting to engineering students, and also arranges visits to works both at home and abroad. It may be useful to intending students to add that the fees have been rearranged under a scheme which provides a composition fee of 120 guineas for the complete three years' course in any one of the branches of mechanical, electrical, municipal, or civil engineering, this fee being payable in three instalments of 45, 40, and 35 guineas.

Australian Affairs.—The trunk telephone line connecting Sydney and Melbourne was officially opened last month. This new link between Melbourne and Sydney is a little over 600 miles in length, and is composed of two exceptionally strong and heavy copper wires, weighing 600lb. to the mile, interlaced and hung for the most part on existing telegraph poles, many of which were strengthened for the purpose. The cost to Australia has been £46,686, of which £33,053 has been spent in New South Wales and £13,628 in Victoria. The work was done by contract in

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New South Wales territory and by the Post Office departmental gangs in Victoria. Construction progressed simultaneously in each State, and the whole undertaking took under four months to complete—a very creditable performance when allowance is made for all the difficulties to be overcome. The quantity of copper used totalled 330 tons, and about 33,000 insulators were required. Though the line was opened with much *éclat* and aroused a good deal of public interest, it has so far not proved popular. The patronage of the public for the first few days after the opening was very scant, and it yet remains to be seen whether this will increase later. During the first four days the traffic averaged 16 calls per day. The reason for this is probably due to the high charge of 6s. for each three minutes' conversation. Should the revenue continue along the present basis a very large deficit is assured, and although it is strongly urged locally that the revenue is not likely to show an increase until the rates are considerably reduced, the Postmaster-General shows no disposition to initiate any change. The operation of this line will be watched with interest, for we gather from a statement made by the Postmaster-General that the extension of the trunk line to Adelaide and Brisbane depends a great deal on the success of the line between Sydney and Melbourne.—The report of the conference, consisting of Captain R. Creswell, naval director; Colonel Bridges; Mr. J. Hesketh, chief electrical engineer, Postmaster-General's department; and Lieutenant Peel, R.N., in connection with the establishment of a system of wireless telegraphy in Australia has been issued. It is stated that the adoption of a system of wireless telegraphy will add materially to efficiency in defence. It would enable the outposts to be advanced at least 200 miles beyond the sea frontier, and from this point of view it was strongly recommended. For general shipping and commercial purposes the advantages were no less important. It would contribute to the increased safety of life and property at sea, and also facilitate the notification of movements of ships and passengers.—When the electric railway was authorised to be extended in the locality; the residents of Brighton were promised a supply of electricity from Elwood power-house, Melbourne, for house illumination. This has not yet been done, and an influential section of the ratepayers have in consequence approached the Railway Commissioners on the matter. The latter have replied that the matter of the supply of electric power for public use will have to remain in abeyance until the return of the expert who is at present engaged in inquiring into the general question of the electrification of the suburban lines.

Electrical Exhibitions.—As was announced in these columns last week, the Manchester and Salford Corporations have now definitely decided to hold an electrical exhibition in their district during the latter part of next year. There should be little doubt as to the success of the exhibition, which has the support of the Municipal Electrical Association, the National Electrical Manufacturers' Association, and the Electrical Contractors' Association, as well as of the Corporations concerned, and exhibitors should reap as great a reward as at the exhibition in London two years ago. Our attention has also been called by a communication from the Institution of Electrical Engineers to the Franco-British Exhibition which will be held next year in London. The Institution have appointed a committee under the chairmanship of their president, Dr. Glazebrook, F.R.S., to supervise the interests of the electrical trade at that exhibition, which, we suppose, will be of a general character, and not a trade exhibition in the true sense of the word, as was the late electrical exhibition at Olympia, and the forthcoming Manchester and Salford exhibition will be.

Railway Electrification in New York.—The completion of the work in connection with the electrification of the New York, New Haven, and Hartford Railroad revives interest in the questions that have arisen concerning the adoption by the company of single-phase locomotives for hauling its trains throughout the electric zone. It has also formed the occasion for Mr. E. H. McHenry, a vice-president of the company, contributing to our American contemporaries a lengthy communication in justification of the system chosen. A notable feature of the system is the departure from the "third-rail" construction, which has for long been the accepted method in the States, and the adoption of overhead construction. Many important problems were involved in this change, which was, perhaps, rendered more desirable by reason of the high pressure employed for distribution—11,000 volts. The catenary construction has been adopted, and as the section of the road contains a number of tracks that could not very well be broken by pole lines, the company were obliged to have recourse to the solid, but costly, method of bridge construction. The double catenary, with its triangular trolley wire support, is the most characteristic feature of the actual line construction. In some respects the line was a trying one for high-voltage distribution, since at some points the conductors are necessarily low, but unusual precautions have been taken in the matter of safety, and ample means have been provided for automatic protection and the cutting out of sections on which troubles may occur. The insulators have been subjected to severe tests. They are of special construction, and are designed to withstand a shop test of 50,000 volts and a working load of 20,000lb. An interesting feature of the installation is the use of three-phase generators, and the operation of all of the trains from one leg of the circuit. This is accomplished by connecting all of the trolley wires in multiple for one conductor, using the track as a second, and carrying an auxiliary wire the length of the line for miscellaneous power purposes. The choice of frequency was practically fixed by the manufacturing companies within limits of 15 cycles and 25 cycles. The comparative merits of the two frequencies are subjected to careful analysis by Mr. McHenry, who gives in detail the reason why 25 cycle distribution was adopted. This was chiefly because the adoption of the lower frequency would have materially impaired the commercial value of the system as a whole, in restricting or preventing its extension for many other uses incidental to railway operation. The standard power and railway frequency in general use is 25 cycles, and as the New Haven Company already owned a number of power-houses generating current at this frequency for standard trolley operation, and, in addition, had equipped many of its shops with 25-cyle motors, the adoption of 15 cyles would have required the abandonment of a large amount of standard apparatus, or the interposition of costly and inefficient means of translation. Then again, the lighting of stations and other buildings was quite an important factor, as 25 cycles is the lowest frequency at which the carbon-filament lamps in general use can be satisfactorily operated. It was also considered desirable to provide for operation in parallel with the 25-cycle generators already adopted by the New York Central Company. It was considered, however, that the practical commercial value of the higher frequency outweighed the more theoretical merits of the lower one. It is yet too early to furnish definite comparisons of cost of the two methods, but Mr. McHenry states that the company's engineers indicate that the total as well as the operating costs of a single-phase installation are much less than that of the continuous-current system.

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GREAT WESTERN RAILWAY.

Electric Power and Lighting and the Electrification of the Hammersmith and City Railway.

(*Concluded from page 260.*)

ELECTRIC TRAINS.

For the service between Hammersmith, Kensington (Addison-road), Aldgate, and Whitechapel 20 electric trains have been provided by the Great Western and Metropolitan Railways. The cars are of the closed vestibule type, with doors only at the ends and sides of the vestibules, the car frame being stiffened by a partition half way along its length. Each train is composed of six cars, approximately 52ft. long by 8ft. 9in. extreme width. Each car is carried on two four-wheel bogies, those of the front and rear cars each being equipped with two motors. The train has a total seating capacity of 320 passengers, with additional room for about 160 passengers standing, making a total passenger load of 30 tons, while the train itself, unloaded, weighs about 174 tons with electrical equipment complete. The arrangement of the cars is illustrated in our previous description, from which it will be seen that the two centre cars are divided into two portions, one portion of each being reserved for first-class non-smoking and smoking passengers; the rest of the train is divided equally between third-class smoking and non-smoking passengers. The driver's compartment is at the front end of each motorcar, and immediately behind this is a luggage compartment 8ft 4in. long. The side frames and roof of the cars are made of wood, built on steel underframes, while the seats and other interior fittings are made as nearly fireproof as possible, the floors being of Paris patent plastic cement. The cars are fitted with central buffers and automatic couplers.

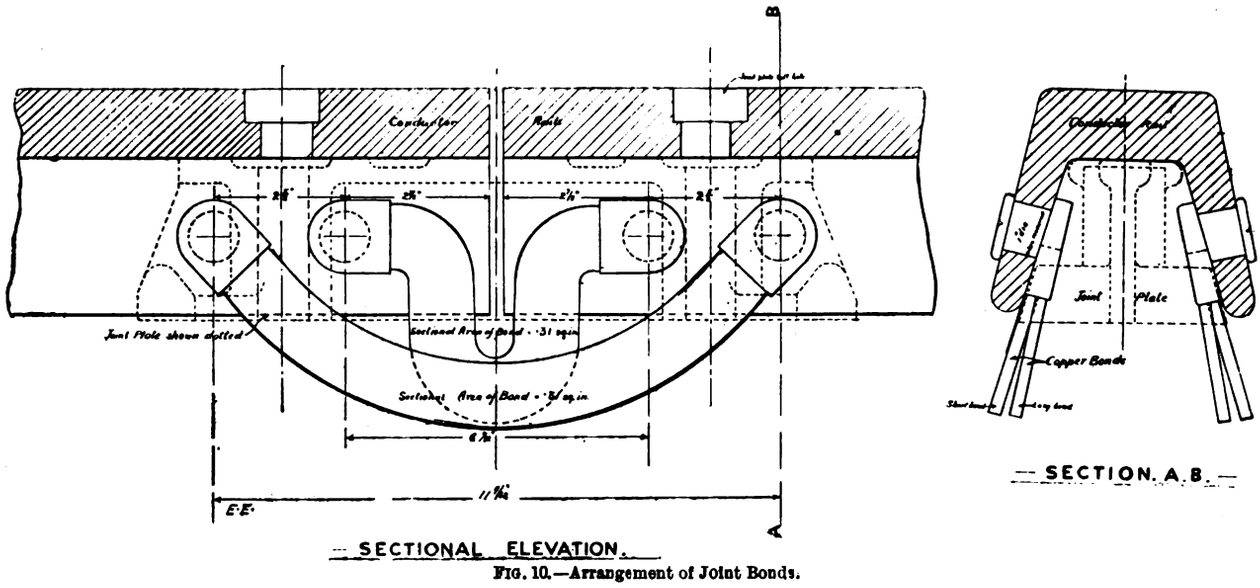

FIG. 10.—Arrangement of Joint Bonds.

The electrical equipment is of the B.T.H. "M" multiple-control type, the eight motors on the train being controlled from one or other end of the train in whichever direction it happens to be going. Positive and negative train cables have been fitted throughout the train, as well as the 10-core multiple-control cable, in order to avoid interrupting the supply of current to the motors and to the lights in the train where gaps occur in the conductor rails. A switch board is fitted in the driver's compartment on each motorcar by which the main or control circuits to either pair of motors under that car can be cut off if desired. On this switchboard is also placed a switch for setting and tripping the motor circuit breakers throughout the train, as well as double-pole switches for the supply to the controller and compressor. This switchboard is fixed in the wall between the driver's compartment and the luggage compartment,

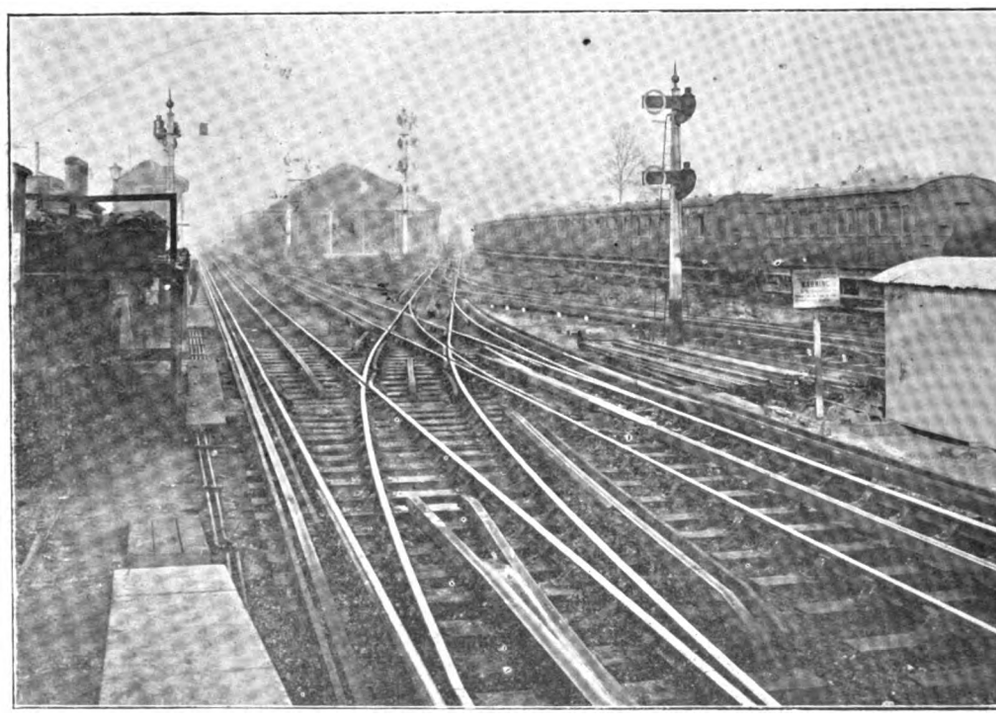

FIG. 11.—View of Conductor Rails at Junction at Car Sheds at Hammersmith.

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and all the terminals and cables at the back of the board are readily accessible by opening a door in the luggage compartment. The motors are of the G.E. 76 type, with two bearings on the main axle, and supported from the outside of the fixed bolster of the bogie frame by a special nose cast on the motor frame. The contactors for operating the various motor circuits are placed in boxes bolted to the underframes of the cars, and readily accessible by anyone standing at the side of the cars. The resistances are also hung from the underframe under the centre of the car, where they are suitably protected from accidental injury, but get sufficient ventilation to keep them quite cool in ordinary working. Each pair of motors when starting the train is connected in series with suitable resistances, which are cut out in four steps until each pair of motors is connected direct in series across the full voltage supply. By an ingenious method of arranging the switches, each motor is then separately connected with a suitable resistance across the full voltage without any interruption to the supply occurring. The resistances are then cut out in four steps until the full parallel position is obtained. To effect this result, 14 contactors with suitable interlocking contacts are required for each pair of motors. The controller is fitted with the "Deadman's" handle, so arranged that should the driver release his hold, once the reverser handle has been put to the forward or reverse position, the controller current is cut off and all contactors open, cutting off current to the motors, and the brakes are applied throughout the train. The circuit-breaker switch is so arranged that the circuit breakers can be tripped with the controller in any position, but they cannot be set again until the controller handle is in the "off" position. The main controller handle can be locked in the "off" position by setting the reverser handle in a position midway between forward and reverse, but it is not possible to move the reverser handle into this position unless the main controller is in the "off" position. When in this mid-position the reverser handle can be removed from the controller, but not otherwise. The eight motors are capable of accelerating a fully-loaded train at the rate of 1·6ft. per second with a track voltage of 600, the momentary maximum current per motor not exceeding 320 amperes, while the average maximum is about 280. The trains are lighted and heated throughout by electricity, and by means of a change-over switch each car can be lighted separately by flexible cables from the trolley wires in the shed, without making the shoes or other main circuits alive

CABLE TERMINAL

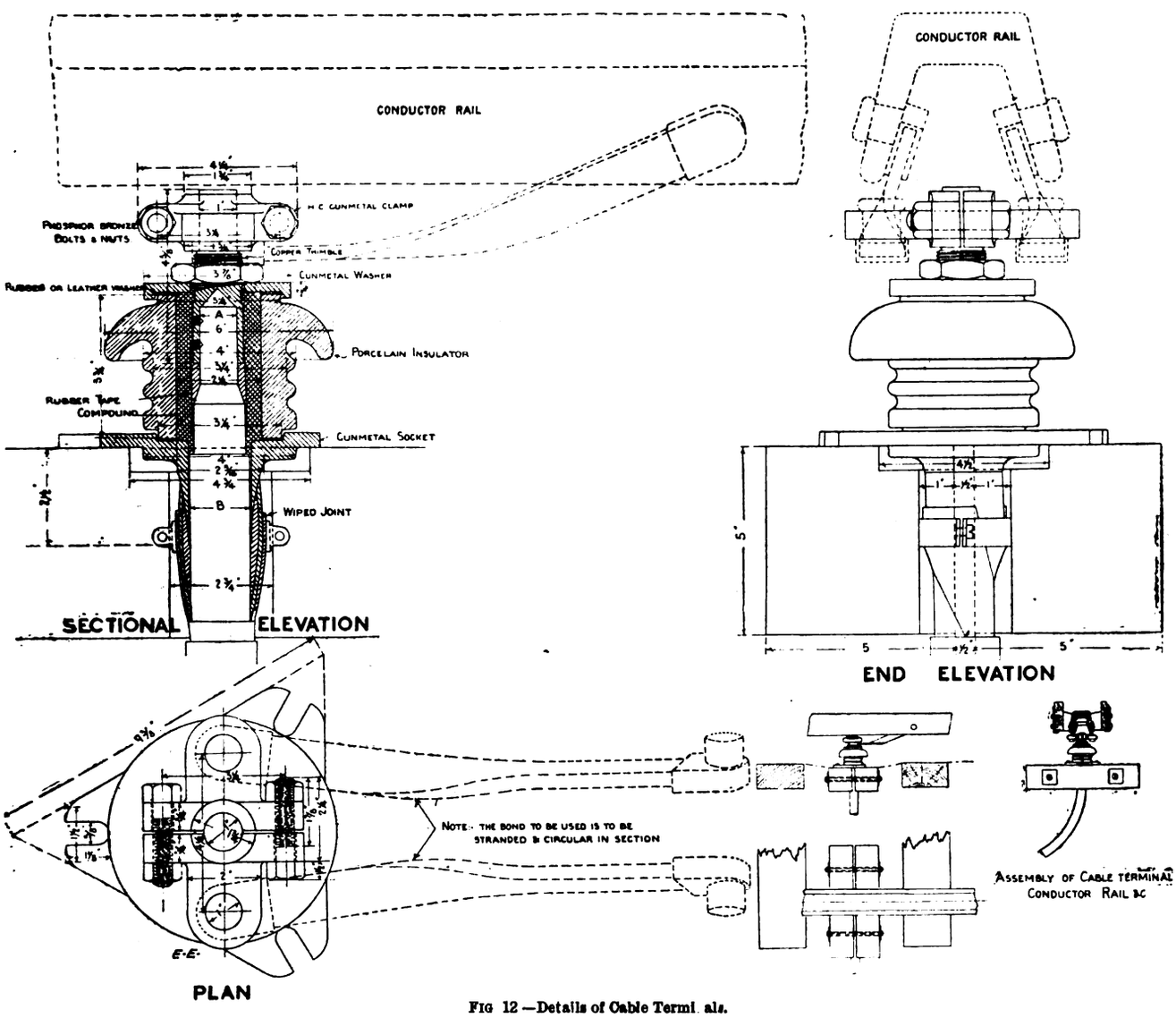

FIG 12.—Details of Cable Terminals.

TRAIN SHEDS.

The 20 electric trains are accommodated in new sheds built by the Great Western Railway Company at Hammersmith. Inspection pits are provided under all the motor-cars. The buildings are of red brick, the roof, which is partly glazed, being supported by steel principals. Roller doors are fitted to the entrance of every bay. Offices and stores are being provided at the south end of the repair shed, and messrooms, etc., for the staff in the grounds outside. Electric current is supplied to the trains throughout the large and small sheds by means of positive and negative overhead trolley wires, which are supported by wooden battens and bridge hangers from lines of "H" joists placed above and slightly to the side of each track and bolted to the underside of the roof principals. Current is collected from these trolley wires by means of small trolleys on four wheels which run on the bottom flange of the joists and to which are attached grooved

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rubbing contacts or collectors mounted on springs and insulators. From these collectors the current is conveyed to the trains by means of two flexible cables bound together with leather braiding, and reinforced by a stranded steel wire.

The repair shop is fitted with a 15-ton electric crane running the whole of its length. The three motions of the crane are worked by three separate series-wound motors, supplied with current at 600 volts from the distributing bars in the small shed. The controllers, which are of the tramway type, are placed in a horizontal position at one end of the crane girders, and are operated by ropes from the floor level, springs being fitted to return each controller to its "off" position as soon as the ropes are released.

The buildings for the generating station, sub-stations, distributing centres, and inspection chambers have been provided under the supervision of the Great Western Railway Company's engineers, who were also responsible for the trench work in connection with the system of cables. The whole of the rest of the work in connection with the generating station, sub-stations, distributing centres, and cable work were carried out to specifications prepared by Messrs. Kennedy and Jenkin, acting as consulting engineers to the Great Western Railway Company, and under their supervision.

The rolling stock was constructed to a specification prepared by the locomotive department of the Great Western Railway and the carriage and wagon department of the Metropolitan Railway Company. The electrical equipment of the trains was carried out to a specification prepared by Messrs. Kennedy and Jenkin, acting as consulting engineers to the Great Western Railway Company, and Mr. Thomas Parker, acting as consulting engineer to the Metropolitan Railway Company.

The car-shed has been provided and the permanent way equipped under the supervision of the Great Western Railway Company's engineers. The electrical equipment of the line and of the train sheds was carried out to specifications prepared by Messrs. Kennedy and Jenkin, acting as consulting engineers to the Great Western Railway Company, the laying, bonding, and jointing of conductor rails being done by the Great Western Railway Company.

POWER DEVELOPMENT ON THE KOOTENAY RIVER FOR THE WEST KOOTENAY POWER AND LIGHT COMPANY, LIMITED.*

BY ROBERT A. ROSS AND HENRY HOLGATE (MEMBERS).

The Kootenay River rises in the northern part of Windermere, in British Columbia, a short distance east of the head waters of the Columbia River, and flows southerly parallel to the north-flowing waters of the Columbia for 50 miles, thence through Fort Steele and across the international boundary into United States territory, flowing south and north-west for a distance of about 120 miles. It then enters Canadian territory again, and soon expands into what is known as Kootenay Lake, which receives a number of small streams in its northern arm. The lake discharges by way of the west arm, at the western end of which is the town of Nelson; the river keeps a south-westerly course to its junction with the Columbia River at Robson. The total length of the river is about 350 miles, and the area drained by it and its tributaries, above a point 10 miles below Nelson, is some 9,800 square miles, of which 2,500 square miles are United States territory. The minimum flow of the river, at a point about nine miles below Nelson, was found to be 5,850 cubic feet per second. These measurements were taken in January, 1905, when the water in the river was lower than at any season previously observed. The variations in flow of the river are very great, but no measurement of maximum flow has been made as far as is known. The periods of high and low water differ from those of rivers not situated in mountainous country, and in the case of the Kootenay River, which largely depends for its supply from the masses of melting snow on mountains of great altitude, the high-water period is comparatively late in the season, highest water being in June and July.

The power development herein described was built at the Upper Bonnington Falls, the lower falls having been partially developed some years ago by the same company. The site for the development of the upper falls was chosen on the north bank of the river (Fig. 1). The channel between the Rocky Island and the north bank was made use of for approach and tail race; the power-house was built in the river, and a cofferdam was built from the bank to the island, thus unwatering the whole site and diverting the water to the south of the island. Although the natural channel assisted materially in the development work, yet about 40,000 cubic yards of rock had to be removed to provide power-house foundations and tail race. The removal of this rock was somewhat difficult, owing to the confined area in which the work had to be done, the difficulty of disposing of it, the nature of the rock (Nelson granite) and the irregularity in direction of the seams in the rock, some of which had to be excavated under water. As a large part of the concrete work admitted of the use of large stones, those most suitable for the work were piled up in convenient places for this purpose, and a large quantity was passed through crushers and used in the concrete. The variations between high and low water above and below the falls do not correspond. The reason for this is that at present the flow of the river below the falls is restricted by a number of rocky islands. These hold back the flow of the stream, but it is the intention to improve this channel, so as to afford more channel area and more nearly equalise the rise and fall below the falls with the

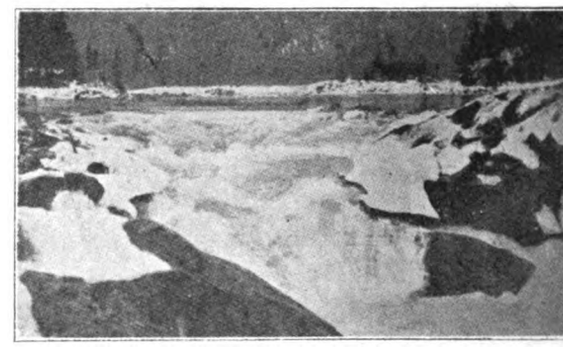

FIG. 1.—Site of Power Plant, Kootenay River.

rise and fall above them. Owing to these variations, which can never be entirely eliminated (except at a cost beyond commercial practicability), the vertical type of wheel setting was adopted, using all the head available at all stages of water, instead of adopting a head which would be nearly constant and which would involve the sacrifice of a large amount of power for periods when low water prevailed. Of course, when the natural head is least, the volume of water used is not important, as the quantity available is more than ample, but at periods of low water the head is greatest, and the vertical setting is an advantage, since it permits the use of the higher head. Had a horizontal wheel setting been adopted, the power-house floor would have had to be set above highest water, and, allowing the use of a draught tube of 24ft. at this altitude, the tail water would have had to be maintained at a level above low water, which would involve the loss of head for a considerable period of every year when water was low, and, consequently, when head was most valuable. It is the intention to increase the natural head by building a timber dam across the river to a height that will drown the rapids above the fall, thus affording an increase of head of 10ft., and the machinery and works are designed to meet this condition. This work will be done during the current year. There are no troubles from ice on this river.

It is possible to construct works at the outlet of the Kootenay Lake to maintain the lake level more nearly uniform, and thus to assist materially in reducing maximum discharge and increasing minimum discharge of the river below this point. This will render working conditions much better and increase the potentiality of the river considerably. However, the matter has not yet been

* Paper read before the Canadian Society of Civil Engineers.

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considered by the Government, though it would afford advantages of public benefit in the navigation of the lake, which is now, and will perhaps always be, a part of the transportation system of this district, owing to the great difficulty of constructing a railway from Kootenay Landing to Proctor, located 17 miles above Nelson. The power-house construction and arrangement are shown on the accompanying illustrations (Figs. 2, 3, and 4). The building is entirely of monolithic concrete construction, reinforced wherever necessary; the reinforcement consisting of round steel rods, and in some places of steel rails, which were used in parts of the structure under severe strain. The general scheme can readily be seen by referring to Fig. 4. The water enters the flume through the submerged openings between the piers, and can be shut off by gates or by stop logs, the latter being provided for, so as to render the gates accessible in case of emergency. Behind the gates are the screens, which are thus rendered accessible for repairs or cleaning if necessary. The water flows down to the tube formed in the concrete to the wheels, of which there are three on each shaft, two discharging into the upper draught tube, and one into the lower tube, uniting into a common discharge, which is placed below low water. The draught tubes are moulded in concrete and have no steel lining, being built up with the structure, cored openings in the monolith. Care was taken to secure a very smooth surface on the inside of all passages for water, and their curves and cross-sections were designed to offer as little resistance as practicable. The exciter turbines are similarly arranged, but are made to operate under a constant head by having the discharge at a higher level, which level is maintained by a weir. The pressure pumps, governors, and low-tension cables are all located in the chamber below the power-house floor, the only machinery on the floor being the generators,

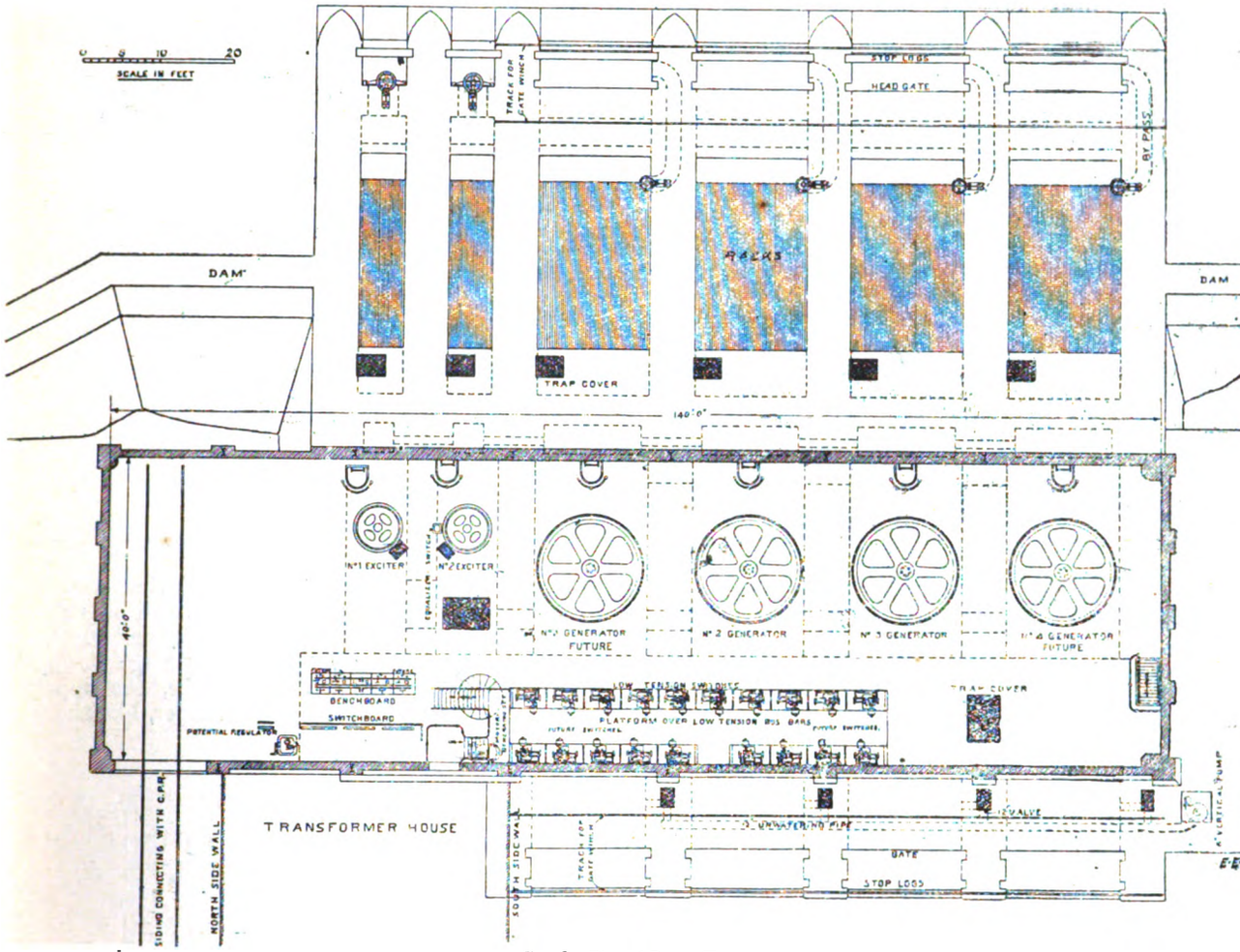

FIG. 2.—Plan of Power House.

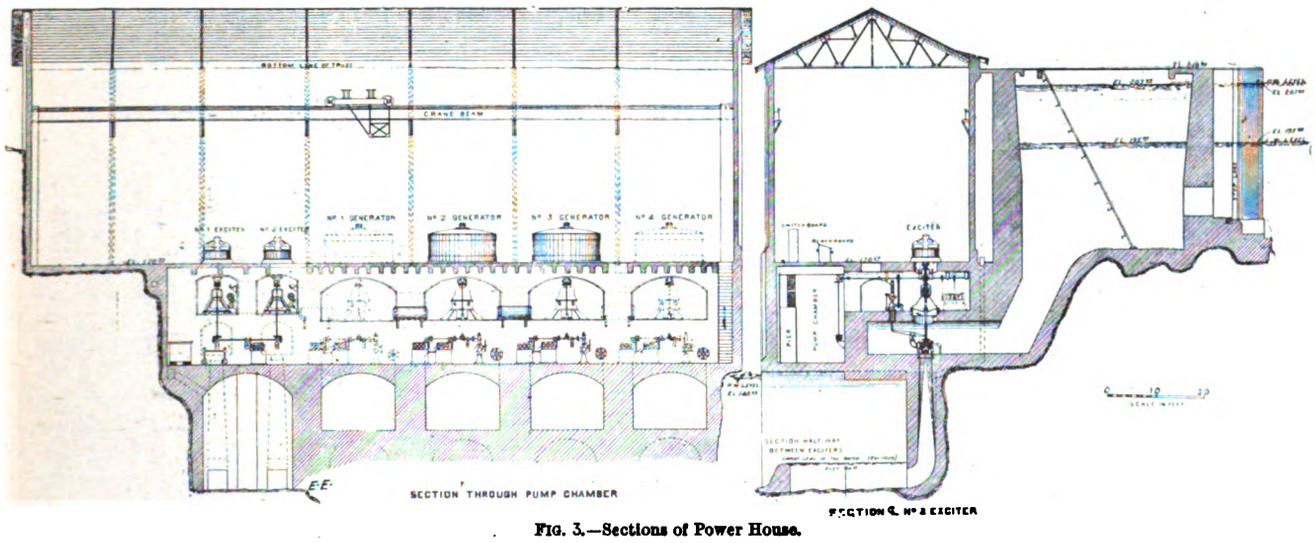

FIG. 3.—Sections of Power House.

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controlling board, and the low-tension switches. The crane travels the length of the power-house and over the railway track, so that all machinery can be handled from the car to place by the crane. Any leakage through the up-stream wall is taken care of in the air-space and drained off. The tail race openings are also provided with gates and stop logs, which can be closed, and any chamber can be emptied of its water by a system of drains and valves, leading the water from any one chamber to a well at the south end of the building, where a centrifugal pump throws it out into the tail-race. The headwater is admitted through a by-pass, as shown in Fig. 2. The whole scheme provides the greatest facility for inspection and making of-repairs when necessity arises.

The transformer house and switchroom are clearly shown in Figs. 5 and 6. The floor of the transformer room is at such a level as to permit of the transformers being wheeled on their own trucks from a flat car on the railway siding into place. The transformers are entirely separated from the switchroom by a concrete wall, and the whole building is of concrete, including the partitions and barriers. Owing to the peculiar location necessary for the transformer and switch building in relation to the power-house, it was necessary to throw arches over a gap in the rock to provide foundation for the building (this will be seen from Fig. 6). As this work is the largest single piece of concrete construction yet built in the province, it is satisfactory to be able to say that the whole of the cement used was manufactured in British Columbia, and successfully passed the rigid tests of the engineers prior to acceptance.

Hydraulic Machinery.—Each main unit is capable of delivering to its electrical generator 8,000 mechanical horse-power when operating under a head of 70ft. of water and when running at a speed of 180 r.p.m. The quantity of water required per unit is 1,260 cubic feet per second, or a volume equal to the flow of a river 100ft. wide, 5ft. deep, and moving with a velocity of 151·2ft. per minute. Each 8,000-h.p. turbine consists of three inward-flow Francis runners mounted on a vertical shaft, each runner being equipped with its own distributor and movable guide vanes. These distributors are bolted to heavy cast-iron base rings secured to the masonry. The runners are thus mounted in concrete pits, which form the turbine wheel casings and the draught tubes for carrying the discharge water to the tail race. The runners are made of special turbine metal of approximately 88 parts copper, 10 parts tin, and two parts zinc. Each is made in one piece, cast in cores and bolted to the hub. The hubs are made

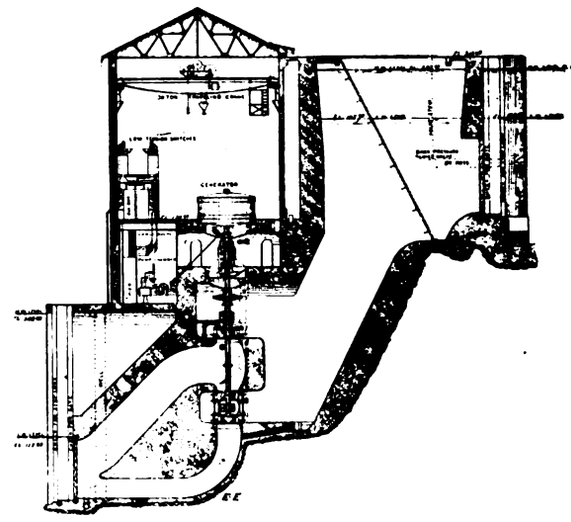

FIG 4.—Section of No. 2 Main Unit.

by enlarging the shaft at the points where the runners are attached, and heavy flanges are turned on the shaft above the hubs, to which the runners are securely bolted. The upper and intermediate runners discharge in opposite directions into a common draught tube, the upper one discharging downward. The lower runner, like the upper one, discharges downward also, but into its own individual draught tube. The chamber above the upper runner is by-passed to the draught tube, which relieves the pressure in the chamber, and thus eliminates the hydraulic thrust of this runner. As the other two runners discharge in opposite directions, the total resultant thrust on the shaft is theoretically zero. The thrust bearing, however, has been designed to take care of a generous amount of thrust over

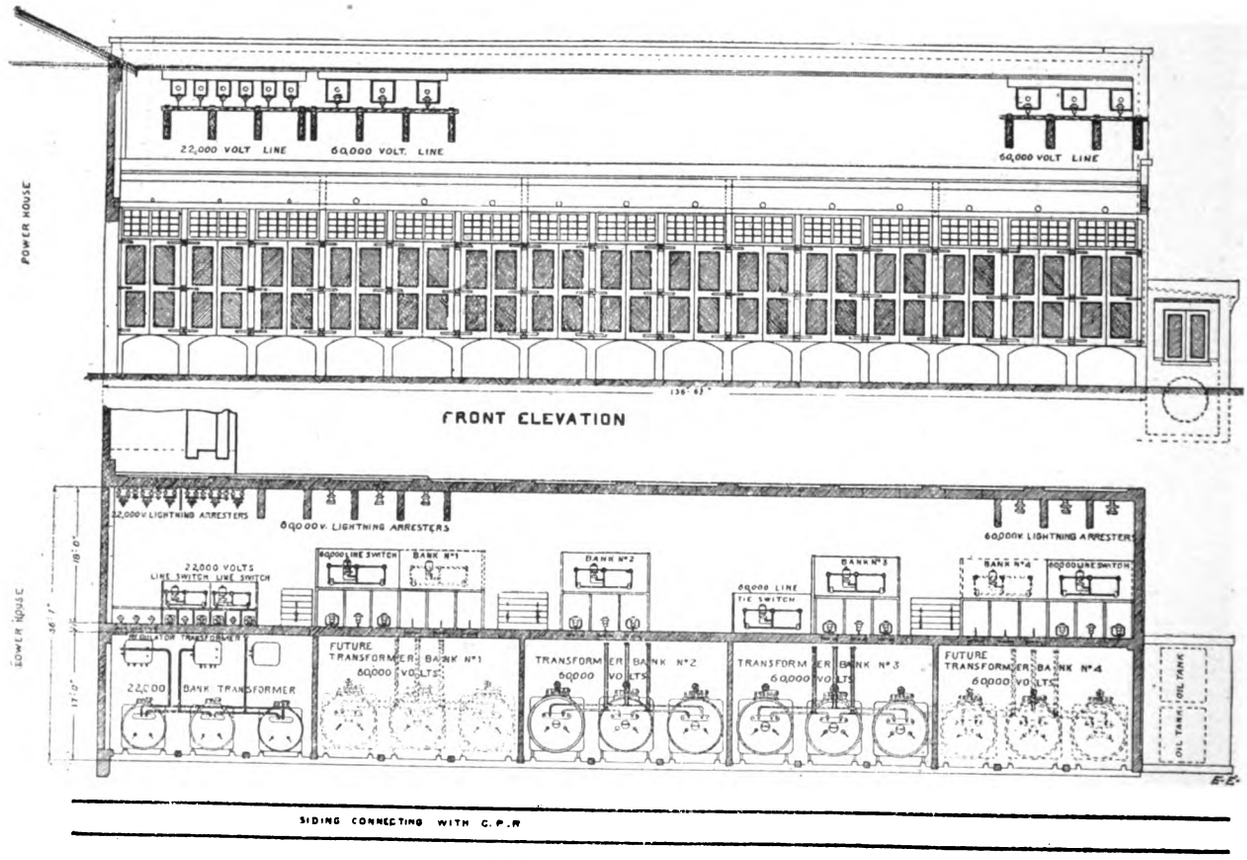

FIG. 5.—Plan of Transformer House.

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and above the dead weight of the revolving parts. The revolving parts consist of the rotor of the generator, the shaft in three sections, three runners weighing 4,000lb. each, couplings and bolts, making a total of 170,000lb. The thrust bearing consists of two specially close-grained cast-iron discs. The lower disc is supported by a ball seat, while the upper is securely held in place by an adjusting nut on shaft. The discs have raised lips on the outside and inside circumferences, so as to form an annular pressure chamber, into which the oil is forced under a pressure of 250lb., which lifts the revolving parts. When these parts are lifted the oil escapes between the surfaces of the discs, by this means supporting the total weight on a film of oil. The thrust bearing is covered with a cover fitted with glass peep holes. The oil is supplied to the bearing from a high-pressure triplex pump capable of working under a pressure of 500lb. per square inch. This pump is directly driven from the main turbine shaft by bevel gearing and countershaft. Each turbine has its own pump, oil-tank, piping, gauges, etc., which, in fact, is a complete system in itself, and independent of the governor system. An extra motor-driven pump, with piping, has been provided, which is arranged to act as a spare for any one of the main units or exciters, but its primary use is to supply oil to the turbines when starting up. The main turbine shaft is kept in alignment by three guide bearings. The upper guide bearing is built in conjunction with the thrust bearing. It is lined with Parson's white brass, and is lubricated by oil supplied under pressure. The intermediate and lower guide bearings, the former situated above the upper runner, and the latter between the intermediate and lower runners, are of lignum vitæ, made by driving lignum vitæ into the dovetail spaces in the bronze boxes. As these bearings are submerged, they are well lubricated with water and require little or no attention. The water is distributed to the runners through malleable iron movable guide vanes finished smooth, so as to offer little resistance to the water. These vanes are operated by means of links from one side of the vane. The links are connected up to the vane operating ring. The rings are operated by rods and levers from a vertical shaft which leads to the operating deck, where the governor is located. The revolving balls of the governor control a pilot valve attached to an equalising lever. This valve operates a relay valve, which in turn controls the main operating piston, which is connected to the vane operating shaft. An oil-pump, a pressure tank, and the necessary piping is furnished with each governor. In order to control the speed of the turbines from the switchboard, each governor is furnished with remote electric control. The two upper sections of the main turbine shafting are joined together by a cast-steel coupling 4ft. in diameter. The brake mechanism is fitted about the coupling, the outer edges forming the brake band. Two brake shoes are applied on the brake band, and a hand mechanism is arranged so that a force of 10,000lb. is brought on each brake shoe. Each turbine is guaranteed to give an efficiency of at least 80 per cent. when delivering 8,000 h.p., and operating under a head of 70ft. running at a speed of 180 r.p.m. The hydraulic machinery is all the product of the I. P. Morris Company, whose hydraulic engineer, Mr W. M. White, designed and carried out the work so successfully.

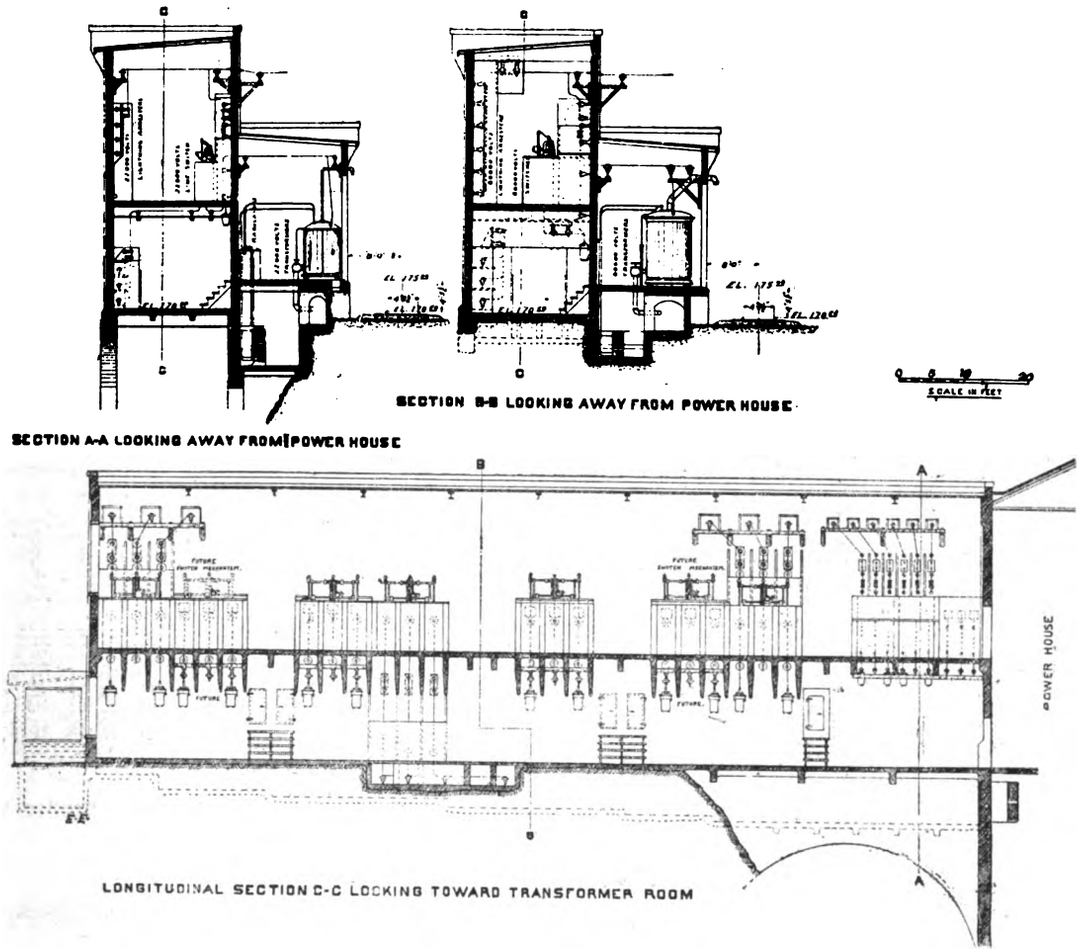
SECTION B-B LOOKING AWAY FROM POWER HOUSE
SCALE IN FEET
SECTION A-A LOOKING AWAY FROM POWER HOUSE
LONGITUDINAL SECTION C-C LOOKING TOWARD TRANSFORMER ROOM

FIG. 6.—Sections of Transformer House.

Electrical Development.—The general scheme of electrical distribution is so arranged that power can at present be delivered to Phœnix, 79 miles distant, at 60,000 volts; Grand Forks, 69 miles distant, at 60,000 volts; Greenwood, 83 miles distant, at 60,000 volts; and to Rossland, 32 miles distant (in the latter case over the existing lines of the old plant), at 22,000 volts. It will be seen that owing to the complication involved in tying-in to the old plant two transmission voltages were required, and, therefore, transformers, switching apparatus, etc., had to be provided for both. Fig. 7 shows diagrammatically the connections of the different plants and sub-stations. The whole of the power so far sold is used for mining work for large motor equipments, for the lighting and power of the mines, and the lighting requirements of the various mining towns above mentioned. In addition, it is thought that the company will be able at some time in the not distant future to sell power to the railways in the vicinity of Rossland for operating, especially on the heavy grades necessary in

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attaining the elevation of the Rossland Camp. The haulage over those grades at the present time is operated by steam locomotives of special type. In some cases these are geared, and switchbacks are established along the route in order to ease grades and for safety. As the heaviest grade does not exceed 4½ per cent., this is quite within the capacity of a modern electric locomotive of considerably less total weight than the present steam machines, and as the advent of the single-phase motor has rendered it possible to operate without the use of rotary converters or dynamo motor sets, the problem is much simplified.

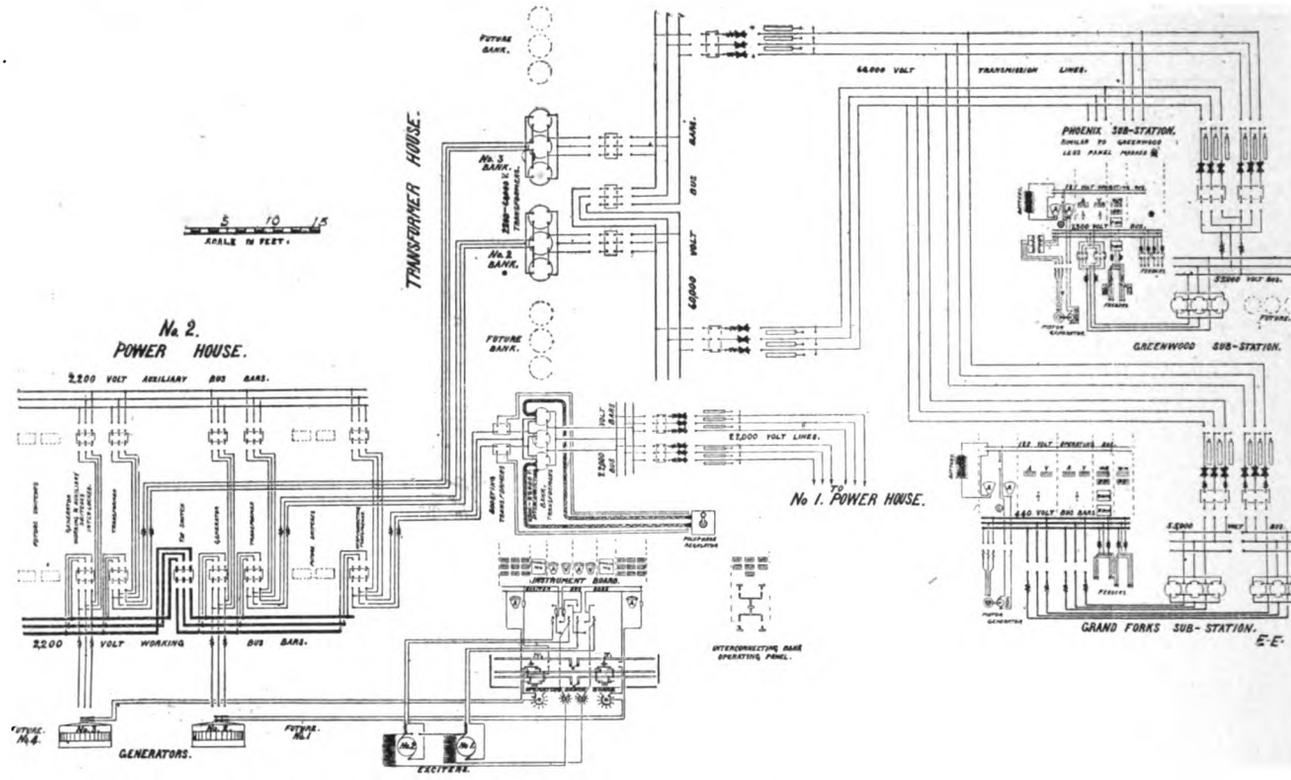

FIG. 7.—Diagram of Main Connections.

Generators and Exciters.—The generators are four in number, each of 4,500 kw. capacity at 2,200 volts and 80 per cent. power factor at a frequency of 60 cycles, being of the umbrella type and directly connected to vertical waterwheels. Two units only are at present installed. The exciters are two in number, each of a capacity sufficient to excite the entire equipment when finally installed. These are also of the umbrella type and directly connected to vertical wheels.

Generating Station Switchboard.—As will be seen from Fig. 2, current is carried at 2,200 volts to the 'bus bars, in compartments elevated above the station floor, and formed entirely of concrete, all parts being thoroughly barriered with the same material. The top of this 'bus-bar compartment, in which all operating transformers are placed, forms the base of a platform, upon which are mounted 19 2,200-volt oil switches, all being motor operated by distant control from the bench board. The bench board, which contains the controls for the whole of the station, including the 2,200-volt switches, 20,000-volt switches, 60,000-volt switches, togther with the speeders for the waterwheels, is situated in front of the instrument panel at the end of the station, all connections thereto being reduced to a pressure of not over 110 volts for safety. The general switching arrangement has been worked out on the basis of two separate and distinct plants, which may be coupled together or run separately on any transmission line or any bank of transformers. The cables for connecting to the low-voltage 'bus bars, and from thence to the transformer station adjacent, are all rubber covered and drawn into bituminous fibre ducts, which are embedded in the concrete floors, partitions, etc.

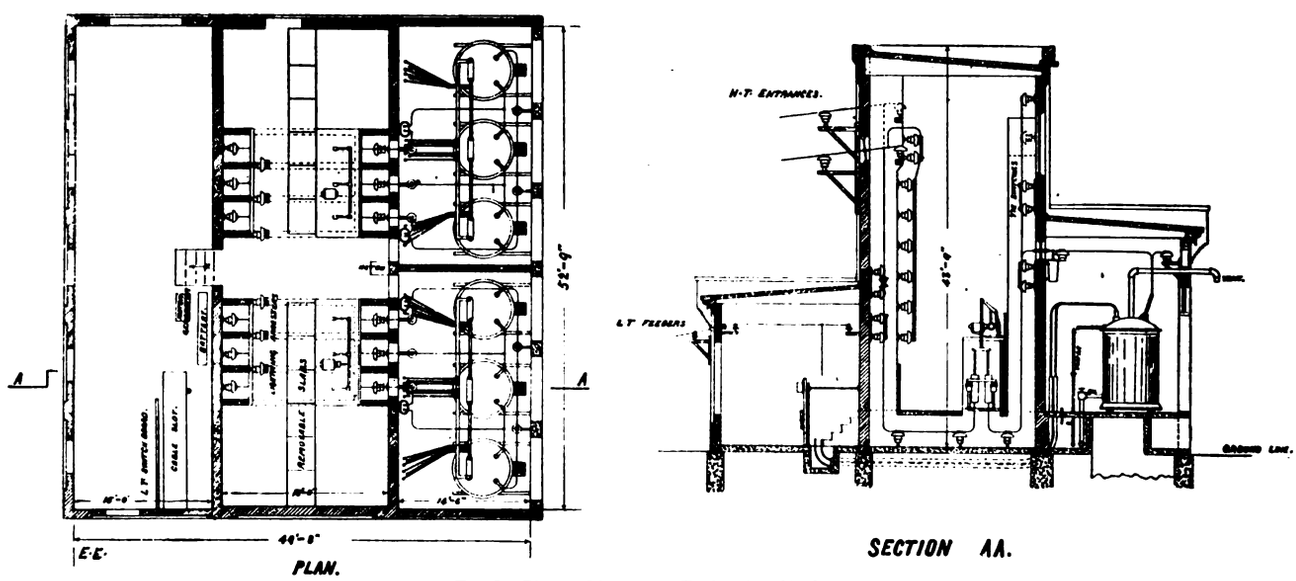

FIG. 8.—Plan and Section of Typical Sub-Station.

Transformer Station.—The transformer station is arranged for four banks of 60,000-volt transformers, each transformer being of 1,875 kw. capacity at 60,000 volts, and one bank

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of three transformers, each of 1,000 kw. capacity, at 20,000 volts for interconnecting between the station herein described and the old development, which is distant about one mile. Of these, two banks of 60,000-volt and one bank of 20,000-volt transformers have been installed. All of the switches throughout the transformer house are motor operated and controlled from the bench board in the same station. In every case live parts, such as wires, etc., are kept 3ft. apart and 18in. from all walls and barriers, and mounted on 60,000-volt insulators. The transformers are oil-filled and water-cooled, and have all the necessary connections for natural circulation of water and for handling of oil into and out of storage tanks by means of oil-pumps.

Sub-Stations: Phœnix, Grand Forks, Greenwood.—The design of these sub-stations, all of which are alike, is shown in Fig. 8. Both the transmission lines enter the tower through special entrances, consisting of plate glass and porcelain tubes, from whence the lines pass through the choke coils and disconnecting switches, and from there into the high-tension distant-control oil switches, and finally into the main transformers, being transformed in pressure from 50,000 to 2,200 or 440 volts, as required by the motor service. The transformers of 1,000 kw. each are located in banks of three in separate compartments, the necessary cooling water and oil piping and tanks being supplied. The transformers are mounted on trucks and arranged so that they can readily be run out of the compartments.

High-Tension Switchroom and Tower.—In this compartment are installed all the high-tension apparatus, lightning arresters, switches, etc. The floor of this compartment is raised 4ft. above the general level, this space thus rendered available being used for carrying the high-tension lines connecting between lines and switches. For convenience in inspecting and cleaning the lightning arresters, etc., an elevated walkway has been provided in this compartment. All low-tension cables are carried in fibre conduit set in concrete

Low-Tension Switchboard Room.—This room contains all the control apparatus for the high-tension switches, etc., as well as feeder panels for low-tension lines, also the storage battery for operating the motor-operated switches, motor-generator set for charging the batteries, etc. One end of this compartment is reserved as a storeroom for supplies. The construction of this entire plant was done by day labour under the supervision of the engineers. It was commenced in June, 1905, and water was admitted to the forebay Dec 24, 1906. Exciters were operated on Dec. 29, and one of the power units went into commission on the following day.

SYNCHRONOUS MOTOR COMPENSATION FOR LAGGING CURRENTS.

Following is an interesting contribution by Clarence P. Fowler to the columns of our esteemed contemporary the *Electrical World* of New York:

The advantages in the use of synchronous apparatus for the improvement of power factor are becoming better recognised with the increased utilisation of alternating currents for general power service. It may be of interest to note, therefore, some of the more important underlying principles which govern the operation of such apparatus when used for this purpose. Of the different classes of load which may be imposed upon alternating-current apparatus and networks, one of the most prolific sources of relatively low power factor conditions is found in the supply of power to induction motors. The current which an induction motor draws from a circuit to which it may be connected may be considered as made up of two components—namely, first, a power component in time phase with the impressed E.M.F., which is just sufficient to overcome the motor losses plus that necessary to drive the extraneous load to which the motor may be mechanically connected; and, secondly, a wattless magnetising component of current, which latter element gives rise to power factors below unity. The wattless or lagging component of the current is somewhat greater when starting from rest than under normal running conditions, as well as being relatively great under running conditions and when the motors are lightly loaded. From what has been said it is apparent that on a system in which induction motors form any considerable portion of the total load, low power factors are likely to be the rule, this condition becoming more aggravated on circuits where motors are frequently starting or operating at fractional loads. Since the induction motor produces loads on the supply system having low power factors, it becomes of importance to briefly discuss some of the more important effects of such conditions on the general electrical system, and which may be summarised as follows:

Effects of Lagging Wattless Currents on Power Station Equipment.

(*a*) *Regulation of Generating Equipment.*—Lagging wattless currents give rise not only to an increased generator armature current for a given amount of real power, but this increased current exists at a time when the armature coils have such a position with reference to the field that the magnetising action set up by the armature ampere-turns is directly opposed to those of the field turns, and is, therefore, demagnetising. To hold the generator E.M.F. constant under such conditions, it is, therefore, necessary to increase the field excitation by an amount which, in some cases, may be so great that should the generating equipment become suddenly relieved of a heavy inductive load by the opening of a circuit breaker the voltage may run up to the danger point before the attendant has time to reduce the field current to its proper value.

(*b*) *Heating of Generating Equipment.*—Due to the fact that low power factors mean increased current, and as a safe temperature rise, and, therefore, the rating of the generating equipment, is largely limited by the value of the armature current, irrespective of its phase relation, it is evident that the idle currents limit the possible amount of useful current which may be derived from an alternating-current generator. Further, as considered above under the head of regulation, the increased field current necessary with loads having low power factors give rise to increased field copper losses and core losses, which in turn result in additional temperature elevation.

(*c*) *Wear and Tear on Circuit-Interrupting Devices.*—The upkeep of circuit-interrupting devices is much greater with low power factors, due not only to the greater volume of currents ruptured, but also largely to the vicious arcs which invariably result when opening circuits supplying inductive loads.

Effects of Lagging Wattless Currents on the Supply Circuits.

(*a*) *Line Regulation.*—Low power factors result in increased line drop due to increased current necessary for a given amount of real power. Moreover, if a circuit possesses any considerable amount of inductance, which may be the case with a long-distance transmission line, then a condition exists with inductive loads which is favourable to increasing the total line drop, when there are lagging wattless currents. For example, if a circuit have a resistance drop of 5 per cent. of the delivered E.M.F. and a reactance drop of 15 per cent. of the delivered E.M.F., then the total line drop at 100 per cent. power factor would be only 6 per cent. of the delivered E.M.F., whereas at 60 per cent. power factor the total drop would be increased to 15 per cent. of the delivered E.M.F.

(*b*) *Line Loss.*—The increased current incident to low power factors causes increased line loss which is dependent upon the square of the total current flowing, so that a small decrease in power factor results in a much more rapidly increasing line loss.

The above review of some of the more important detrimental effects of lagging wattless currents suggests the desirability of neutralising these in the generating and transforming equipment and supply networks by supplying them from another source, if possible. This may be accomplished, as will be seen in what follows, by the use of synchronous apparatus in connection with the electrical system. The commercially obtainable synchronous machines capable of improving the power factor or of phase control, as it is sometimes called, are the rotary converter and

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the synchronous motor. In the first of these—the rotary converter—the action taking place in the armature is somewhat complex, owing to the manifold functions of the current entering the alternating-current side, and will be excluded from consideration here. It may be noted in passing, however, that the effects are quite similar to the effects obtained with synchronous motors.

The two usual methods of using the synchronous motor for the phase control of the load on alternating-current circuits and which are considered below are: (1) a synchronous motor may be used exclusively for compensating purposes, running perfectly free and not being required to perform any mechanical work; (2) a synchronous motor may be used partly for compensation and partly for converting electrical into mechanical energy. The use of the synchronous motor for phase control can perhaps be better understood by first outlining some of the inherent operating characteristics of this type of apparatus. The E.M.F. which is effective in determining the total amount of current which a synchronous motor will draw is, in a degree, analogous to the E M.F. which is directly responsible for current flow in the armature of an ordinary shunt-wound direct-current motor. With the latter type of motor the factors which determine the armature current for a given external load are the impressed E.M.F., counter E.M F., and the armature resistance. The counter E.M.F. is dependent on the field strength of the motor and its speed, and, as its name implies, is opposed to the impressed E M.F., the difference between the latter and the former giving rise to a resultant E.M.F. which, divided by the armature resistance in accordance with Ohm's law, fixes the value of the armature current, and which may be expressed by two simple equations thus:

$$E - E_c = E_r \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$I = \frac{E_r}{R} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where E = E.M.F. impressed on motor;
E_c = counter E.M.F. of motor;
E_r = resultant E.M.F.;
I = armature current;
R = armature resistance.

Since the torque produced by a direct-current shunt-wound motor is dependent upon the armature current and the field strength, it is evident from the two above equations that any change in current required to meet a change in load conditions, with constant impressed E.M.F., must be accomplished by a change in the magnitude of the counter E M.F. The counter E.M.F. for a given motor being dependent upon the field strength and speed it follows that if the former also remains constant, the changed current conditions, to handle new load, are brought about by a change in speed.

In a synchronous motor there are somewhat similar quantities to deal with—namely, the impressed E.M.F., the counter E.M.F., the resultant E.M.F., the armature impedance and current—all of which quantities may be expressed by two equations similar to those for the direct-current motor—thus:

$$E - E_c = E_z \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

$$I = \frac{E_z}{Z} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

where E = E.M.F. impressed on motor;
E_z = resultant E.M.F.;
C = armature current;
Z = impedance of armature.

Owing, however, to the alternating character of the E.M.F.'s acting on a synchronous motor, equation (3) cannot be interpreted in its true algebraic sense as with the direct-current motor, since the direction of these various magnitudes in the former have to be considered, and, in general, the impressed E.M.F., the counter E.M.F., and resultant E.M.F. of the synchronous motor are not directly in time phase one with the other. Since a synchronous motor must operate at synchronous speed or not at all, it follows that when the load changes on such a motor with constant impressed E.M.F. and field strength, the change in armature current demanded by the changed torque conditions cannot be produced by a decrease in speed, as with the direct-current motor. The counter E.M.F. of a synchronous motor is alternating, and generally similar to that of the E.M F. impressed upon its terminals and opposed to the latter, a change in current caused by a variation in load conditions being brought about by a change in magnitude of that component of the counter E.M.F. which is opposed to the impressed E.M.F. The above remarks can be illustrated by Fig. 1, which represents the direction and magnitude of the several E.M.F.'s and current in a lightly loaded synchronous motor. In Fig. 1 let O A represent the direction and magnitude of the E.M.F. impressed on a synchronous motor circuit. Let A B represent the magnitude and direction of the counter E.M.F. of the motor, which (since the motor is assumed to be lightly loaded) will have a large component directly opposed to the impressed E.M.F., O A, and, therefore, the angle O A B will be small, as shown. The magnitude and direction of the resultant E.M.F. will then be given by the line O B, which is directly active in forcing current through the armature impedance.

The armature impedance may be regarded as the total "virtual resistance" offered to the alternating current through the armature at the normal frequency for which the motor is designed, and is composed of ohmic resistance and magnetic reactance. With alternating current in the armature each of these elements gives rise to a voltage drop, which is called respectively the resistance and reactance drop. The virtual value of the resistance drop due to alternating current is the same as would be caused by a value of direct current, which is equal to the virtual value of the alternating current The reactance drop is dependent upon the rate of change of the magnetic lines surrounding the armature conductor locally, and may be considered as proportional to the rate of change of the

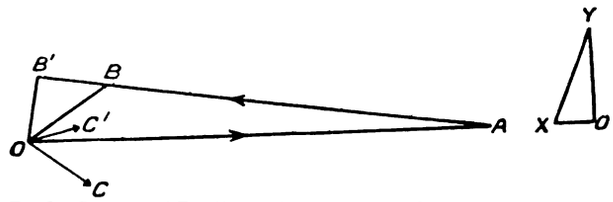

FIG. 1. - Current and E.M.F. Relations at No Load.

FIG 2.—Resistance, Reactance, and Impedance Relations.

current, and will, therefore, have its maximum value when the current has its greatest rate of change, or when the current is passing through zero, which is equivalent to saying that the reactance volts will be 90 time degrees (leading) from the resistance volts, with which the current is always in time phase. So that the resistance and reactance volts may be represented as the two sides of a right-angle triangle, with the hypotenuse representing the E.M.F. consumed by the total armature impedance.

In Fig. 2 let O X represent the magnitude and direction of the armature resistance drop in the synchronous motor, and let O Y represent to the same scale the magnitude and direction of the armature reactance and the resistance, which is not absolutely to the same scale, the magnitude and direction of the armature impedance drop. Now, by equation (4) above, the resultant E.M.F. is equal to the impedance drop, hence X Y of Fig. 2 and O B of Fig. 1 represent the same drop, and since the current is in time phase with the resistance drop, its direction will make the same angle with O B as O X does with X Y. Therefore, by laying off the angle C O B (Fig. 1) equal to the angle O X Y (Fig. 2), the direction of the vector representing the current will be given, and its magnitude will be dependent upon the ratio of O B (Fig. 1) to the armature impedance, the magnitude of this current may be represented by the length of the line O C (Fig. 1). Considering an anti-clockwise rotation of the vectors, it is seen from Fig. 1 that the current O C lags behind the impressed E.M.F., O A, by the time angle C O A. Next, let the excitation of the motor be increased, thereby increasing the counter E.M.F. from A B to A B', the resultant E.M.F. then taking up the position O B', and since the current makes the same angle with this resultant E.M.F. as before, the current will now swing around into the position O C'. The angle C' O B being equal to the angle C O B (in assuming these two angles equal it implies a constant ratio between the armature

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reactance and the resistance, which is not absolutely true for all values of current, but is near enough for most practical purposes). From the above it is seen (Fig. 1) that by increasing the field strength of the motor the current is caused to lead the impressed E.M.F., O A, by the time angle C' O A. Hence it appears that the synchronous motor has the property of introducing lagging or leading currents into an electrical system of which it forms a part.

In Fig. 1 the conditions prevailing in a lightly-loaded synchronous motor have been considered. Now suppose the motor to drive on external load, and, as before explained, the increased current necessary will flow because of a decrease in that component of the counter E.M.F. which is opposed to the impressed E.M.F., and which is accomplished by an increase in the angle between these two E.M.F.'s. This condition will be noted by reference to Fig. 3, in which the line O A represents the magnitude and direction of the E.M.F. impressed on the motor, A B representing the magnitude and direction of the counter E.M.F. of the motor running light, with O B and O C representing respectively the direction and magnitude of the light load resultant E.M.F. and armature current, as in Fig. 1. Let the load now be increased, such that the counter E.M.F. takes the position of the dotted line A B', the impressed and the counter E.M.F. remaining constant. The resultant E.M.F. may now be represented by the dotted line O B', and as the direction of the current will, as formerly, make the same angle with the resultant E.M.F. as the armature resistance volts make with the armature impedance volts, by constructing the armature impedance volts triangle in a manner similar to that

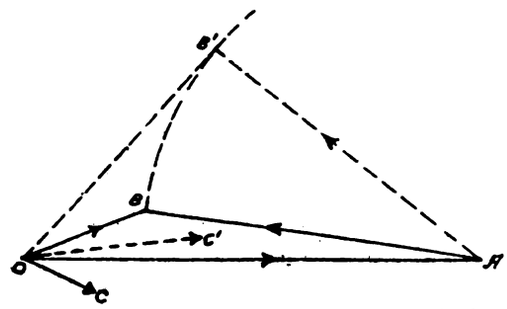

FIG. 3.—Current and E.M.F. Relations under Load.

previously described the direction of the armature current will be determined, with its magnitude depending, as formerly, upon the ratio of the resultant E.M.F. to the armature impedance.

After going through this construction, the armature current will now have the magnitude and direction of the dotted line O C', from which it is seen that the increased load has caused the current to increase in value from O C to O C', and to change its phase relation with reference to the impressed E.M.F. Hence the phase relation of the armature current in a synchronous motor with a given impressed and counter E.M.F. is dependent upon the load, and may even be made leading under certain conditions, such as those shown in Fig. 3. The ability of a synchronous motor to introduce leading currents into a system may be utilised to annul the effects of lagging currents and thereby raise the power factor, as will be seen in what follows. Suppose a 1,000-volt, three-phase circuit to have a connected induction motor load of 200 k.v.a. operating at an average power factor of 80 per cent. It is required to determine the kilovolt-ampere rating capacity, operating power factor, and counter E.M.F. (from which latter quantity the field strength may be determined when the armature reaction characteristics of the motor are known) of the necessary synchronous motor to bring the power factor up to unity when such a motor is used exclusively for compensating purposes.

The total current per lead representing the above induction motor load is $\frac{200,000}{\sqrt{3}\times 1,000} = 116$ amperes approximately. This current, as pointed out above, may be resolved into a power component in phase with the impressed E.M.F. and a wattless component in time quadrature therewith. As the power factor is assumed to be 80 per cent., the power component of the above currrent would be $116 \times 0{\cdot}8 = 93$ amperes approximately. This latter current may, therefore, be represented as one of the sides of a right-angle triangle with the hypotenuse representing 116 amperes. The wattless or magnetising component is, therefore, $= \sqrt{(116)^2 - (93)^2} = 70$ amperes approximately. These quantities are shown to scale in Fig. 4, in which O A is the impressed E.M.F, O C represents 116 amperes, the total current per phase required by the induction motor load, O D being 93 amperes, the power component of this load and D C 70 amperes, the wattless component. Now, since the synchronous motor current necessary to neutralise the current represented by D C will be leading the impressed E.M.F., O A, this leading current may be similarly resolved into two components (wattless and power), the former of which may be represented by a line equal and opposite to D C, and the latter, the power component (the motor is furnishing no mechanical torque), will be represented by a line in phase with O A, the magnitude of which will represent a current just sufficient to handle the losses in the synchronous motor itself. The power component will vary with the design of the motor, but as a fair average may be taken at 5 per cent. of the wattless component in this case, or 5 per cent. of 70 amperes = 3·5 amperes. Therefore, by laying off from O the length O E = 3·5 amperes on the scale chosen and in phase with O A and E F = D C = 70 amperes to the same scale at right angles to O A, which, combined with O E, gives O F, which represents the magnitude and phase relation of the total current per lead in the synchronous motor armature. This current, as represented by O F, on the scale chosen, measures 70·1 amperes, from which the total kilovolt-

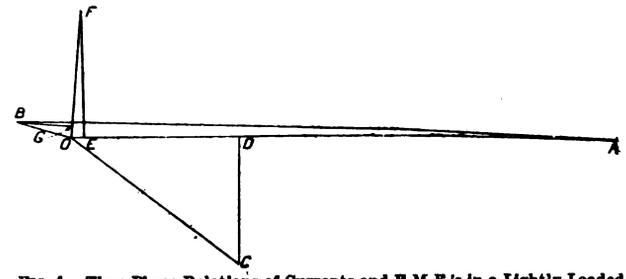

FIG. 4.—Time-Phase Relations of Currents and E.M.F.'s in a Lightly Loaded Synchronous Condenser.

ampere rating of the synchronous motor would be $\frac{70{\cdot}1 \times 1{\cdot}73 \times 1,000}{1,000} = 121{\cdot}3$ k.v.a.

The angle A O F between the current O F and the impressed E.M.F., O A, measures approximately 87deg., and the cosine of this angle, or, in other words, the power factor, is approximately ·05, or 5 per cent. Now if the synchronous motor armature has a full-load resistance drop of 2 per cent. of the impressed volts, or 40 volts, then this voltage may be represented to scale by the line O G, which will be in time phase with the armature current, O F, as in Fig. 1, and if the full-load reactance drop be 10 per cent. of the impressed E.M.F. of 100 volts, then this quantity may be represented by the line G B to the proper scale and at right angles to O G. The resultant of O G and G B will then be given in magnitude and direction by the line O B, which represents the full-load armature impedance drop. This drop has already been shown (Fig. 1) to be the resultant of the motor impressed and counter E.M.F. Hence by joining A and B the line A B is obtained, which represents, by its magnitude and phase relation, the counter E.M.F. of the motor, and on the scale assumed measures 1,200 volts, to which the ampere excitation of the motor will be proportional, and which may be obtained by reference to the performance curves of the particular motor in question.

The magnitude and phase relation of the resultant line current will evidently be the vector sum of the wattless and power component of the currents in the synchronous motor and that required by the induction motor load. These are represented in Fig. 4 respectively by E F and O E and D C and O D. The vector sum of these quantities is given in Fig. 5 by drawing the various vectors to scale, radiating from a common centre, X. In this diagram let O A represent the general direction of the impressed E.M.F. Draw

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X Y at right angles to O A to represent the magnitude and phase relation of the wattless component of the synchronous motor current, E F, and similarly from X draw X X′, representing the power component of the synchronous motor current in phase with the impressed E.M F., O A. From X draw X Y′ at right angles to O A, representing the wattless component of the induction motor load, D C, and likewise from X′ draw X′ X'_1, in phase with impressed E.M.F., O A, and representing the power component of the induction motor load, O D. Then since X Y and X Y′ are equal and opposite, the former representing a leading wattless current and the latter a lagging wattless current, their resultant will be zero. The resultant of the total line current will, therefore, be represented by the vector sums of X′ X′ and X′ X′, which is given by the direction and

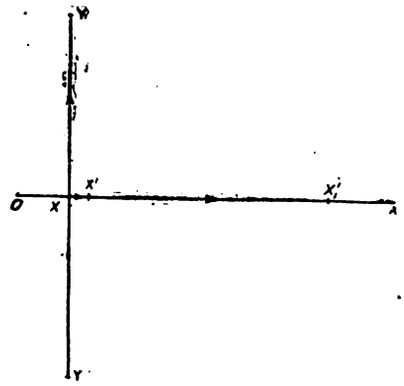

FIG. 5.—Vector Representation of Component Currents.

magnitude of the line X X'_1, and this on the scale chosen represents a line current of 96·5 amperes per lead. Hence it is seen that by the use of an over-excited synchronous motor the line current has been reduced from 116 amperes per lead at 80 per cent. power factor to 96·5 amperes per lead at 100 per cent. power factor, and from the previous discussion of some of the more important detrimental effects of low power factors on line and station equipment, it is at once apparent that the general regulation and efficiency of the system as a whole has been much improved by the use of the synchronous motor as a compensating agent.

The synchronous motor as used partly to convert electrical into mechanical energy, and partly for annulling the effects of lagging currents, will now be considered. Suppose

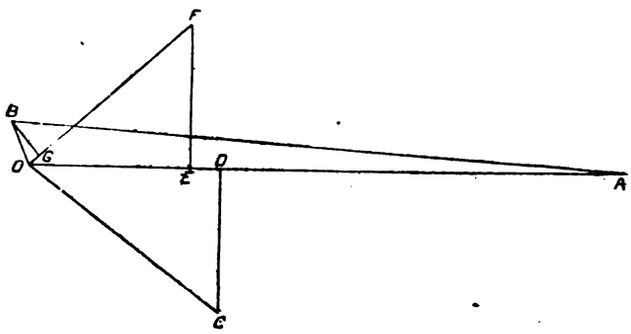

FIG. 6.—Time-Phase Relations of Currents and E.M.F.'s in Synchronous Condenser under Load.

a 500-k.v.a., 2,000-volt, three-phase synchronous motor operating with a real horse-power input of 75 per cent. of its normal capacity (including losses). It is required to find what induction motor load at 80 per cent. power factor may be supplied so that the power factor of the total load on the system will be 100 per cent., and so that the synchronous motor will not be overloaded. Also determine at what counter E.M.F. (to which the field strength is proportional) and at what power factor the synchronous motor should be operated to attain this result. Since the motor is three-phase and of 500 k.v.a. capacity operating at 2,000 volts, the full-load current per phase (including losses) $= \frac{500{,}000}{\sqrt{3}\,2{,}000} = 145$ amperes approximately. As the motor is operating at 75 per cent. of full-load current, the total current per lead under this condition $= 145 \times 0{\cdot}75 = 109$ amperes.

In Fig. 6 let O A represent an E.M.F. of 2,000 volts impressed upon the motor. Now, since the power component of the current is in time phase with the impressed E.M.F., O A, this current may be represented to scale by the line O E = 109 amperes. Since the total current rating of the synchronous motor has been found to be 145 amperes, this current may be resolved into a power and a quadrature wattless lagging or leading component (depending upon the field excitation), and as the power component is 109 amperes, represented by O E and O F, representing the full-load current of the motor per lead of 145 amperes, the remaining side of the right-angle triangle, E F, represents the wattless component of 96 amperes. The armature resistance volts will be in time phase with the total current, O F, and may be represented to scale by the line O G, which is assumed to be 1·5 per cent. of 2,000 volts, or 30 volts, and G B = 7·5 per cent. of 2,000 volts, or 150 volts, at right angles to O G, and which represents the reactance volts; the resultant of these two elements, O B, will then represent the armature impedance drop. This drop has been shown to be equal to the vector difference between the counter E.M.F. and the E.M.F. impressed upon the motor. Hence by joining A and B there is obtained the line A B, which represents by its magnitude and direction the counter E.M.F. at which the motor should be operated, and which scales 2,070 volts. The operating power factor for the synchronous motor is evidently given by the ratio $\frac{O E}{O F} = \frac{109}{145} = 0{\cdot}75$, or 75 per cent. Since E F represents the magnitude of the wattless leading component of O F available for compensating purposes, evidently this will also represent the magnitude of the wattless lagging component of the current which the induction motor load may have in order that the total line current may be in phase with the impressed E.M.F. As the power factor of the induction motor load is assumed to be 80 per cent., and as the wattless lagging component is represented by E F reversed or 96 amperes lagging, the tangent of the lag angle would be three-fourths, from which the power component of the induction motor load $= \frac{4}{3} \times 96 = 128$ amperes. Let this current be represented in Fig. 6 by O D in time phase with the impressed E.M.F., O A, and let D C at right angles to O D represent the wattless component, or 96 amperes, then O C represents the magnitude and phase relation of the total current per lead taken by the induction motor load, which on scale assumed measures 160 amperes. Then the total kilovolt-ampere induction motor load is $\frac{160 \times 1{\cdot}73 \times 2{,}000}{1{,}000} = 550$ apparent kilowatts.

Summing up, it appears from the above that a 500-k.v.a. synchronous motor operating at 75 per cent. power factor is capable of driving a mechanical load of $500 \times 0{\cdot}75 = 375$ real kilowatts in addition to compensating for the lagging element in an induction motor load of $550 \times 0{\cdot}80 = 440$ real kilowatts at 80 per cent. power factor, when the field strength of the synchronous motor is increased to such a point that the counter E.M.F. of the latter is 2,070 volts.

ON THE CONDUCTIVITY OF ELECTROLYTES IN PYRIDINE AND OTHER SOLVENTS.*

BY KENNETH SOMERVILLE CALDWELL.

I. *Comparison of Acids and pseudo-Acids in Pyridine.*

Although previous experimenters have compared acids and psuedo-acids as regards their conductivities in solvents which form hydrogen ions—*e.g.*, alcohols and mixtures of alcohols and water—no investigations have been carried out in solvents which are of such a nature that the acid is dissolved either entirely or partly in the form of a salt. Liquid ammonia would at once suggest itself as a suitable medium, more especially as a number of widely differing compounds have already been examined in this solvent, but owing to the obvious experimental difficulties it was

* Report of work carried out in Leipzig under the direction of Prof. A. Hantzsch, read before the British Association at Leicester.

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not employed. The attempt to substitute the saturated amine piperidine instead of ammonia yielded results of little interest, owing to the extremely small conductivity of solutions in this solvent. The unsaturated amine pyridine, on the other hand, proved to be more suitable. Members of the following classes of compounds were examined:

A. Acids which exist in one form only: (1) the strong mineral acids and sulphonic acids; (2) organic acids.

B. Acids which exist in isomeric forms—pseudo-acids: (1) nitro-compounds — (*a*) nitrohydrocarbons, (*b*) nitrophenols, (*c*) nitramines; (2) oximido-compounds — (*a*) oximido-carboxylic esters, (*b*) oximido-ketones and quinonoximes, (*c*) nitrolic acids; (3) compounds containing the group $-CO.NH-$; (4) related nitrogen compounds—*e.g.*, aminotetrazol, phenyloxytriazol carboxylicester; (5) ketonic-enolic compounds; (6) oxyazobenzenes.

The pyridonium halides in pyridine exhibit the same differences in conducting power that is noticed in solutions of their alkali salts in pyridine, methyl alcohol, and liquid sulphur dioxide; only in pyridene the difference is much more marked — *e.g.*, HCl . $\mu_{32} = 1{\cdot}16$, HBr . $\mu_{32} = 7{\cdot}12$, HI . $\mu_{32} = 27{\cdot}4$. With this exception, the "true" acids compared among themselves follow approximately the same order in pyridine as in water; a fact which also applies to the pseudo-acids. The stronger the tendency to pass into an isomeric form—*i.e*, the more completely the pseudo acid form is isomerised and ionised in aqueous solution—the better does its pyridine solution conduct. There is to a certain extent a parallel between the affinity constants in solution, aqueous solution, and the conductivities in pyridine. When, however, the true acids are compared with the pseudo-acids, it is noticed that in pyridine the latter yield very much better conducting solutions than do "true" acids, having approximately the same, or even very much greater, affinity constants. We may conclude that *when a hydrogen compound yields a pyridine solution of far better conducting power than is given by a true acid which in aqueous solution is dissociated to approximately the same extent as the hydrogen compound, the latter is a pseudo-dica.* Hexanitrodiphenylamine, for example, must be regarded as a pseudo-acid; for although, owing to its insolubility in water, its affinity constant has not been determined, the conductivity of its pyridine solution is far greater than that of all true acids, even the strongest mineral acids.

II. *On the Influence of Temperature on the Conductivity of Electrolytes.*

1. The influence of temperature on the conductivity of electrolytes may be expressed by the general equation

$$\frac{d\mu}{dt} = c\left(i.\frac{dv}{dt} + v.\frac{di}{dt}\right),$$

where i = concentration of the ions, v = mean rate of migration of positive and negative ions, t = temperature, and c = constant. If the effect of change of temperature on the rate of migration is the reverse of that of the degree of dissociation, a maximum in the temperature-conductivity curve is to be expected.

2. It may be deduced that, for a given electrolyte, the smaller the dielectric constant of the solvent the lower must lie the temperature of maximum conductivity.

3. These deductions are confirmed by the results of previous experiments on solutions in water, methyl, and ethyl alcohols, ammonia and sulphur dioxide, and especially by the results of the present investigation on solutions in pyridine. The influence of temperature on the electric conductivity of solutions in pyridine has been determined for a number of acids and pseudo-acids, as well as for silver nitrate. The temperature of maximum conductivity is well marked, and the curves have been followed up to and beyond this point.

4. The curves are represented closely by the parabolic equation $\mu_t = \mu_0(1 + b\,t + c\,t^2)$ and the theoretically deduced expression $a = \dfrac{\mu_t - \mu_\tau}{\mu_\tau\,(t-\tau)^2}$ is taken as a measure of the temperature effect.

5. The observation of Walden and Centnerszwer, that for solutions in liquid sulphur dioxide the temperature of maximum conductivity is higher the greater the conductivity, has not been confirmed for solutions in pyridine.

6. The comparatively rapid decrease in the degree of dissociation with increase in temperature may partly explain the fact that numerous substances which at ordinary temperatures yield good conducting pyridine solutions appear, according to boiling-point determinations, to be undissociated.

III. *Abnormally High Values of Ionic Conductivity.*

Solutions of salts which contain either the same cation or the same anion as the solvent itself (pyridonium salts in pyridine, formates in formic acid, acetates in acetic acid, and probably bromides in hydrobromic acid and sulphates in sulphuric acid) show in these solvents an abnormally high conductivity in comparison with all other salts. Since all salts are dissociated to approximately the same extent, the abnormally high values of the conductivity of the first class can only be explained by assuming an abnormally high value for the rate of migration of those ions which the salt has in common with the solvent. This abnormal value of the rate of migration is, however, only an apparent one. The ions of such salts react with the solvent with exchange of a labile hydrogen atom.

THE NEW ENGINEERING LABORATORY AT THE CITY AND GUILDS OF LONDON INSTITUTE, FINSBURY.*

BY PROF. E. G. COKER, M.A., D.SC.

The recent extension in the department of mechanical engineering at the City and Guilds Technical College, Finsbury, has been provided for by the City companies aided by a private donor. A new wing has been added to the college, in which accommodation has been found for an engineering laboratory, drawing offices, lecture, and preparation rooms. The principal feature of interest is the engineering laboratory, of about 4,000 square feet in area, on the basement floor. A part of this laboratory has been devoted to hydraulic equipment, which is mainly grouped with reference to a cast-iron channel, 80ft. long, and of square section 2ft. wide. At one end of this is a space for a vertical pressure cylinder for experiments on jets, impact on vanes, and the like. At the other end are measuring tanks, of a total capacity of 3,500 gallons, into which the water drains after passing over a weir in the main channel. There are also two subsidiary channels parallel to the main one, and draining directly into the measuring tanks. The water after use is raised to a roof tank of 5,000 gallons capacity by a centrifugal pump of 200 gallons capacity per minute, and it is returned to the laboratory by a falling main for use anew. The hydraulic machines already installed comprise an inward-flow pressure turbine, an outward-flow Girard turbine, a Worthington pump, a three-cylinder hydraulic engine, and a considerable amount of other apparatus for experimental work. The heat engines are all of moderate size, and are in most cases of special design for experimental work. A gas-engine of 12 h.p. is fitted for work with either town gas or suction gas from a Dowson producer. A refrigerating plant is arranged to work with either carbonic acid or ammonia by using interchangeable cylinders. An oil-engine, hot-air engine, steam-engines, and a compound air-compressor are also installed, while space has been left for future developments The equipment also includes a 10-ton Buckton testing machine and a varied collection of other apparatus for testing materials. The drawing office has accommodation for 100 students, and is divided by a glazed partition for convenience in teaching. The workshops have been entirely remodelled, and nearly all the old machine tools have been replaced by new ones. A new lecture theatre seats 100 students, and is fitted with the necessary appliances for experimental and lantern demonstrations. The paper was illustrated by a number of lantern views.

* Abstract of paper read before the British Association at Leicester.

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PORTSMOUTH AGAIN.

These accounts are so interesting that we return again to their consideration. In fact, tramway and electricity accounts have such a fascination for investigation that it is more difficult to refrain from discussion than to discuss. There are two classes of men in municipal work who have our entire support—the councillors who support their responsible officers in all that tends to efficiency with economy, and the responsible officers whose sole aim is efficiency with economy. If a poll of the latter could be taken, a huge majority would say that all their efforts are generally heavily handicapped because in the early stages of the installation neither efficiency nor economy were considered. We say this advisedly and purposely. Quite lately we have heard again and again of the engineer's plans returned for alteration because the estimated cost was too high. Now, in 99 per cent. of cases changes in design will militate against future efficiency and economy. A comparatively small sum is saved initially, and a heavier drain than necessary is subsequently continuous. If the real truth were known, many an installation is in that position, the upkeep and expenditure being annually greater than if due allowance had been made in the first instance. The people who are in fault are those who cannot realise the difference between the best and the makeshift. But this is not what we wish to say in connection with Portsmouth, nor to draw any particular lesson therefrom. The lack of prescience is too general to be specialised, but there is a topic of importance, and Portsmouth gives us detailed figures on the points "costs and charges." Thus 3,030,748 units generated for power purposes cost (all charges included) £10,352. 13s. 10d., or ·819d. per unit as against ·754d. last year. Excluding capital charges, the generating expenses came to ·537d. as against ·524d.—in fact, excepting miscellaneous supplies, every item was increased, and this increase also holds with the rates, interest, and sinking fund charges. The total working expenses per car mile, however, work out at 4·991d. as against 5·154d. As the total revenue came to 11·129d. per car mile, there was left after the payment of working expenses 6·138d. per car mile, and this sufficed to pay sinking fund, interest, income tax, and rent, still leaving £18,000 odd to be used for other purposes. Of this, £5,000 went in aid of the rates, the remainder being apportioned to funds for renewal, special reserve, extensions, etc. Without the finesse controversy about depreciation, etc., the plain fact must strike the reader that at any rate the undertaking at Portsmouth is a success. Now we are going to apply one case to another, or others, and shall be told such application is improper. Can't help it. We assume that electric tramways are a step in advance of horse trams or horsed 'buses, and that every step in advance means a greater benefit at an equal or less cost; that, therefore, the system which is supplanted is sooner or later doomed. These are general conclusions about which there can be no difference of opinion. Quite lately at a variety of meetings, especially in London, complaints have been made that the old order of things cannot continue because it is being pinched out by greater conveniences and lower prices. But is not that just what occurs in all the steps of progress, and can it be avoided? We say it is a law, fixed and immutable. With detailed accounts set out as those of Portsmouth are it is absolutely impossible to argue that the work is really done at a loss, and that the balance to the good is due to a juggling of the accounts. And we may say that the accounts of other places are as clear as those of Portsmouth, hence we cannot but come to the conclusion that the days

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of the horse for town traffic purposes are numbered. They must go the way of the flint-lock gun or the Highflyer coach—and good riddance, say we.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE TELEPHONE QUESTION.

SIR,—I find that the champions of the common-battery system are indisposed, as might be expected, to admit that their transmitter is as inefficient as I have described. When practical men differ on a point of fact it is best, if the nature of the dispute admits of such a solution, to submit the question to a test that will enable non-technical and unbiassed persons to form an opinion of their own. Fortunately, the merits of telephone transmitters as speech conveyors may be determined in this way, and I therefore venture to suggest that this transmitter question be cleared up by an actual trial designed to bring out the distinctive merits of various types. A jury of subscribers could readily determine the relative ability of various representative instruments to transmit prices from the Stock Exchange official list, or other difficult matter. The necessary conditions to be observed would be: (1) the transmitters to be used under service conditions, those of the common-battery class to form part and parcel of the London central exchange, deriving their current from the common battery there during the busy hours, while the others would be actuated by two local cells; (2) the circuits used to be perfectly balanced, so that if any transmitter is guilty of creating artificial noises the fact will become evident; (3) the speaker to be the same for all transmitters, and to be some independent person of good vocal capacity; (4) the identity of the various transmitters to be concealed under letters or numbers, so that the jury may adjudicate with perfect impartiality. My opinion is that such a trial would result in the condemnation of the common-battery transmitter both for short and long distances, but if the converse should prove to be the case, I would accept the verdict heartily and congratulate the manufacturers — British, American, or Scandinavian — whoever they might be Such an experiment, which ought to be welcomed by those having real faith in the instruments they champion, would clearly operate for the good of telephone users throughout the kingdom. Personally, I have no interest, monetary or otherwise, in any transmitter, receiver, or other telephonic instrument, and if I express myself forcibly and earnestly it is on general and unselfish grounds, and because I consider that a grave and very costly mistake is in course of perpetration. Because, too, experience has shown that the only way to raise the standard of telephonic efficiency in this country is to first raise the standard of rebellion.—Yours, etc.,

A. R. BENNETT.

SIR,—It is a minor point, of course, but it is extraordinary how Mr. Bennett's unfailing inaccuracy leads him to mis-state even current events. The third reading of the Telegraph (Money) Bill was taken, not, as he states, after his letter of Aug. 8, by 107 to 20, but on July 26, without a division. By the time Mr. Bennett's letter of July 29 appeared in your columns the Bill had passed through the Lords and received the Royal assent. How anyone so utterly careless in the most ordinary matters of fact can expect to be taken seriously on technical questions, where some approach to accuracy is necessary, passes my understanding.

With regard to the editorial remarks appended to my letter, I much regret not having made myself clear. In these matters probably the onlookers see most of the game, and, perhaps, those of your readers (if any) who have followed the controversy may have found my remarks clear enough. In case not, I might restate the case by saying that Mr. Bennett has made use of a difficulty well known to all telephone people, common to all languages, for the purpose of an utterly foolish and futile attack on what has become the standard method of telephone working throughout the world, and on the telephone transmitter which is well known to be the most powerful and most efficient.

Mr. Bennett's elaborate denunciations of the common-battery system and of the solid-back transmitters because mistakes sometimes occur with "five" and "nine," are unworthy of any technical journal. It would be just as sensible to denounce turbine steamers because some people get seasick on the Channel.

I note that in his last letter Mr. Bennett falls back on a *Daily Mail* reporter as an authority. Surely a consulting engineer cannot go lower, or will Mr. Bennett next give us something from *Answers* or *Tit-Bits*?

With regard to the latter part of the editorial note, I have never "abused" Mr. Bennett—I find him far too amusing on technical points—but I think most of your telephone readers would disagree with your remark, and as for the final sentence ("He certainly knows what he is writing about"), I think it is the most uncharitable thing yet said in this controversy.—Yours, etc.,

HERBERT LAWS WEBB.

35, Old Queen-street, Westminster, S.W.,
Aug. 26, 1907.

LIVE-STEAM HEATERS.

SIR,—When Mr. Wilkinson's paper on "Live-Steam Heating" was discussed by the Incorporated Municipal Electrical Association, he claimed to heat feed water to 10deg. below the steam temperature, and to make 7 per cent. saving; but in the discussion, experts, including Mr. Crosland and Mr. Stromeyer, very severely criticised his claims, the latter saying that Mr. Wilkinson's "discrepancies were so enormous that the only conclusion was that something must be wrong"; while Mr. Wilkinson himself said that "his paper had been torn in pieces, but he hoped to put it together again."

From the article on p. 273 of your current issue he has put it together again with a vengeance. He now claims that the water heated is 5deg. *higher* temperature than the steam which heats it, and he claims that "the last 10deg. F., bringing the water up to steam temperature, are worth more than 50deg. F. at any other part of the temperature scale." This must either mean that five times as many heat units are transferred from the gases to the boiler at the higher temperature, which is absurd, or else it is pure nonsense.

Not the slightest evidence of commercial saving of fuel is given, but two tests of *three* hours each are given, both at a moderate rate of steaming, though with a remarkably good coal for mechanical stokers; and as neither CO_2 nor temperature of escaping gases is given in either case, the results of these three-hour tests can hardly be taken seriously, especially as with the heater the impossible efficiency of 84·88 per cent. is claimed.

There is no great difference in the rate of combustion so there is no reason to suppose the temperature of the escaping gases was appreciably different in the two short tests; but it is perfectly obvious that the combustion in the one case was much better than in the other, and that by reversing the conditions of combustion, and carrying a higher furnace temperature when the heater was not used, the results would be reversed. So it might just as well be claimed that the live-steam heater makes a 12·9 per cent. loss instead of a 12·9 per cent. saving.

Such absurd claims for merely heating the water to steam temperature in one part of the boiler instead of in another part are simply amusing to those who are familiar with steam-boiler practice; but they may divert certain steam users from the very real and valuable saving due to heating feed water with exhaust (waste) steam, and lead them into futile experiments and consequent loss.—Yours, etc.,

CEPHAS.

Aug. 23, 1907.

FIRE PREVENTION

SIR,—It reads odd that a firm manufacturing fire-extinguishing appliances should have the experience we have of fires actually occurring on our own premises during

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the past 21 years, and it may teach others the value of being ready for such emergencies, as there is no doubt a very great number of conflagrations could have been prevented if firms had made a provision similar to ours.

1. Fire, January 1891, 8 45 a.m. All men out at breakfast except a sawyer who discovered fire by the gas-engine. The gas-bag ignited and flames spread to gas-meter and a file of mill orders. Two policemen kindly came in and assisted our man to put out the fire with our fire-buckets and a hand fire-pump before the public firemen arrived.

2. Fire, July 1896, 6.40 p.m. Clerk, looking around after workmen had left, trod on a wax vesta left on the floor by a careless person; it ignited and fired a heap of shavings. Small hose jet turned on and flame put out.

3 Fire, 1898 Gas company's men came to alter the gas-pipes and thoughtlessly disconnected a live 2in. main near their candle in cellar. Gas ignited and spread flame to floor and door. The two men got burned, and our men had to snuff out the flames with buckets and small hose jet.

4. Fire, January, 1899, discovered 7 a.m. Two-feet square of flooring and pigeon-holes 6ft. by 4ft in storeroom burning, through a negligent person having put hot ashes in a wooden box the previous evening Fire smouldered all night for want of air, as window and door were closed and fitted tightly. On door being opened the flames woke up, but a small tap hose jet snuffed them out.

5 Fire in 1902, 5 p.m. First-floor flooring, 3ft. by 3ft., destroyed through a carelessly fixed stove. Danger soon removed by a water-jet from fire-hose.

6 Fire in 1903, 7 p m., in blacksmiths' shop through a spark on a cleaning cloth left smouldering when men left at 6.15 p m Discovered by the caretaker when flames had extended to a tool box and file of papers. Small hose jet turned on and flames put out.

7 Fire in 1905. Heap of materials in open yard, supposed to be ignited by a spark from the District Railway locomotive near by, discovered by caretaker at 11 p m, who turned on hydrant hose and removed the danger.

8. Fire in February, 1907, 8.30 p.m. Insulating material on coils in electric motor resistance ignited through overload and burned partition near. Fire-buckets used.

9 July 31, 1907. Fire in yard outside mill discovered 11.30 p.m. by caretaker, who turned on hydrant hose and put out the flames before the public firemen arrived.

You see we have been saved nine times from the spread of fire, and this shows the value of being prepared—Yours, etc., J. H. HEATHMAN AND CO.

Parsons Green, London, S.W., Aug. 26, 1907.

THE BRITISH ASSOCIATION.

Address to the Chemical Section.

BY PROF. A. SMITHELLS, B.SC., F.R.S., PRESIDENT OF THE SECTION.

The year which has elapsed since the meeting of our section at York has been eventful in the most melancholy of ways—the losses sustained by our science have been unparalleled. The passing bell seems to have tolled almost without intermission as one after another of our masters has been taken from us: in Russia, Mendeléef, Menschutkin, and Beilstein; in France, Berthelot and Moissan; in Holland, Bakhuis-Roozeboom. Whilst in some of these cases we may find consolation in contemplating a length of life and sustained activity beyond what we might have dared to expect, in others our regret is increased by the sense of untimeliness and of vanished hopes. I am tempted to speak of the work of such mighty men as Berthelot and Mendeléef, to dwell upon the discoveries by which they transformed the whole fabric of chemical science, but this is not the occasion on which to offer an estimate of the labours of those who have passed away. I can only say that in the bond of brotherhood which the pursuit of science establishes among the different nations of the earth we who are Englishmen feel and deplore these losses as our own. I must not omit to allude also, as I do with deep regret, to the death in our own country of two such ardent and fruitful workers as Cornelius O'Sullivan and Robert Warington. These words were already in print when again we were called to mourn the loss of one of our greatest men, one who but a year ago was the subject of our special rejoicings, and whose vigour of body and youthfulness of spirit seemed to promise the long continuance of a noble and an extraordinarily fruitful life. We can at least feel thankful that William Henry Perkin lived long enough to learn in what honour and esteem his name was held, not only among his countrymen, but by all the chemists of the world, and by the leaders of those great industries of which he was justly acclaimed the founder. For more than a generation Sir William Perkin had been one of the most familiar figures at the meetings of this section, and greatly shall we miss his gentle presence, his wise counsel, and his valued contributions.

I can, perhaps, best occupy your time to-day by attempting to give some account of the present state of the scientific subject to which I have paid most attention. The topic of flame, after a long period of repose, has aroused much interest during late years, and I think we may say that some considerable progress has been made in its elucidation, although in this, as in all other subjects of scientific inquiry, the more closely we scrutinise it the more impressed must we be with what still remains unknown. One of the first questions that meet us in the study of flame is that of the temperature at which in any given case the phenomenon becomes evident. Here, I think, a great clarification of view has taken place. The old idea that there existed a fixed temperature at which inflammation suddenly took place cannot now be maintained, and the term "ignition temperature" has acquired a different meaning. It is now known that in a very great number of cases a mixture of two flame-forming gases, when gradually raised in temperature, will develop luminosity quite gradually, *pari passu*, with the chemical combination that is being induced. This phenomenon is, of course, known universally in connection with phosphorus, but is not so widely known in connection with other combustible substances. There are some simple facts that seem as if they never could gain admission to text-books, and I do not think I have known more than a single chemical book that is not likely to leave a student under the impression that the phosphorescence of phosphorus is an almost unique phenomenon. I do not know how many times the independent discovery has been made that sulphur, arsenic, carbon disulphide, alcohol, ether, paraffin, and a whole host of other compounds, inorganic and organic, will phosphoresce as truly as phosphorus itself; that, in fact, phosphorescent combustion is the normal phenomenon antecedent to what we ordinarily call flame.

This is, after all, only in harmony with the general truth that chemical combination between two gases does not set in suddenly, but comes into evidence quite gradually as the temperature is raised from a point at which the action, if it occurs at all, is so slow as to be negligible. The increase in the rate of combination is, of course, very rapid as compared with the increase of temperature, a difference of about 10deg. C. serving to double it. The interval between the beginning of phosphorescence and the production of vigorous flames may, therefore, be very short. In the case of phosphorus this interval, being from 7deg. to 60deg. C., includes ordinary atmospheric temperatures; hence the phosphorescence of phosphorus is a phenomenon that could not well be overlooked. If the prevailing terrestial temperature were below 7deg. C., at which, under normal air pressure, the phosphorescence of phosphorus ceases, it is possible that this element might never have acquired its peculiar reputation; it would not have shone in the dark, and in lighting it with a taper the phosphorescent interval would have been passed over as quickly as is ordinarily the case in the ignition of sulphur, paraffin, and other common combustibles. To make phosphorescence apparent in these last cases it is necessary to take special care to heat up a mixture of the combustible gas and air gently, and to maintain it at a temperature approaching, but not quite reaching, that of ignition. There is no simpler way that that used by Sir William Perkin, who brought the combustible substance near to or in contact with a massive metal ball previously heated to the suitable temperature.

The change from phosphorescence to ordinary flame is not sudden, but the appearance of ordinary flame is the end point of a continuous, though rapid, development. This end point is the temperature of ignition. What, then, determines the temperature of ignition? The answer to this question has been given with characteristic conciseness by van't Hoff as "the temperature at which the initial loss of heat due to conduction, etc., is equal to the heat evolved in the same time by the chemical reaction." We may obtain a clear idea of the meaning of temperature of ignition by supposing a combustible mixture of gases such as that of air and the vapour of carbon disulphide to issue through an orifice into an indifferent atmosphere. If we surround the orifice by a ring of platinum wire, which is gradually heated up by a current of electricity, a flame will gradually make its appearance. If, as soon as this is observed, the heating of the wire by the current be discontinued, the flame will disappear; it is, in fact, not self-supporting, but depends on the accessory supply of heat through the electrically heated wire. If now we raise the ring to a higher temperature we shall get a brighter flame, owing to an increased rate of chemical action, and at last we shall reach a point

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where it is possible to cut off the electric current without causing at the same time the extinction of the flame. This is the true temperature of ignition, the temperature at which the reaction proceeds at a rate just sufficient to overbalance the loss of heat by radiation, conduction, and convection from the burning layer of gases, so that the next layer is put in the same state, and steady combustion proceeds. Phosphorescence has been spoken of as degraded combustion, and, though literally the appellation is correct, I think it is liable to be misunderstood. Again, it is often supposed that phosphorescence is necessarily associated with the formation of incompletely oxidised products. This may be the case in a chemical system which is capable of affording different products at different temperatures, but it is not an essential feature; the phosphorescent combustion of sulphur, for example, affords nothing but sulphur dioxide.

Temperature of ignition is, then, neither a temperature at which combination suddenly begins, nor one dependent solely on the nature of the combining gases. It will vary with the proportion in which the gases are mixed and with their pressure and other circumstances. Notwithstanding the simplicity of this conception, it must be admitted that there are many obscure facts connected with the ignition of gases. The inflammability of gaseous mixtures is not necessarily greatest when they are mixed in the proportions theoretically required for complete combination; the influence of foreign gases does not appear to follow any simple law; the presence of a very small quantity of a foreign gas may exercise a profound influence on the ignition temperature, as in the case of the addition of ethylene to hydrogen. When a mixture of methane and air is raised to its ignition temperature, a sensible interval (about 10 seconds) elapses before inflammation occurs. These facts are cognate to others which have increased upon us so abundantly in connection with the influence of moisture on chemical change. The study of the oxidation of phosphorus in particular brings us among rocks and shoals. Apart from the influence of moisture on the combination we have the limitation of the process by a certain tension of oxygen and by minute quantities of a vast number of chemical substances, among which, in spite of much labour, no other common bond can be found. We do not know what oxide is initially formed in the oxidation, and the existence of the oxides P_4O and P_2O is as confidently disputed as it is affirmed. There is some reason for believing that the phosphorescence connected with phosphorus succeeds the formation of one oxide and accompanies the formation of another. The state of the oxygen, whether atomic, ionic, or molecular, which acts on phosphorus, the induced oxidation of other substances, the ionisation of air accompanying the oxidation—these are all matters concerning which there exists a bewildering literature that hangs over us like a cloud. The whole of my address would, in fact, not suffice for a summary of the state of our ignorance about the oxidation of phosphorus. The subject, simple as it appears at first sight, is really involved with a vast number of unsolved chemical problems the elucidation of which would throw much light on chemical action in general. I may, perhaps, bequeath the topic to some successor in this chair as one which may serve to illustrate the advance of knowledge since these present days of darkness.

The structure of flames has always been regarded as dependent upon the chemical changes taking place in the differentiated regions, but until recent times little attention has been given to any question beyond the cause of the bright luminosity of hydrocarbon flames. In a flame such as that of hydrogen or carbon monoxide, where we have some reason to suppose that the same kind of chemical transaction is taking place throughout the region of combustion, we should not expect to find a differentiation of structure; and, as a matter of fact, we do not find any. Erroneous ideas have gained currency from the use of impure gases, and hydrogen is still described as burning with a pale-blue flame, although Stas long ago stated that if the gas is highly purified, and the air freed from dust, the flame even in a dark room can only be discovered by feeling for it—a fact consistent with the line spectrum of water lying wholly in the ultra-violet. The presence of a very small quantity of free oxygen in carbon monoxide destroys the perfect simplicity of the single shell of blue flame with which the purified gas burns, and in other flames small quantities of gaseous impurities or of atmospheric dust give rise to features of structure and halos which have been frequently supposed to pertain to the flame of the combining gases. The fringe of a flame in air may be often tinged by the presence of oxides of nitrogen.

No flame better illustrates the relation of structure to chemical processes than that of cyanogen, where the two steps in the oxidation of the carbon are clearly marked out in colour. Apart from hydrocarbon flames, very few others have been carefully explored from this point of view. There is, unfortunately, no gas composed of two combustible gaseous elements; and, though such gases as the hydrides of phosphorus and sulphur do not fall far short of this, the experimental difficulties of an exact exploration of their flames are very great. We are thus prevented from studying the flame of a composite combustible in its simplest form. The flames of hydrocarbons have naturally been the subject of most frequent investigation. The use of single hydrocarbons instead of the mixtures present in coal gas and other common combustibles has simplified the study considerably. Two problems stand out prominently: one is to trace the steps in the oxidation of the hydrocarbon, the other to account for the bright patch of yellow luminosity. With regard to the question of the luminosity, I do not think there is any longer doubt about its being due essentially to the separation within the flame of minute solid particles of what is practically carbon. The separation seems to be adequately explained by the high temperature of the blue burning walls of the flame, which decomposes the unburned hydrocarbon within. In a similar way arsenic and sulphur and phosphorus are liberated within flames of their hydrides; but these elements, being volatile, do not appear as solids unless a cold object be placed within the flame. In the case of the hydride of silicon the liberated element at once oxidises to form the solid non-volatile oxide, which gives a bright glow. The mode in which a hydrocarbon yields carbon by the application of a high temperature has been the subject of experiment and of hypothesis; but neither the view of Berthelot, that the carbon results from a continuous coalescence of hydrocarbon molecules with elimination of hydrogen, nor that of Lewes, according to which the formation and sudden decomposition of acetylene is the essence of the phenomenon, appears to me to be in harmony with the experimental facts; and I am not aware that either view has secured any support from other workers in this field. It is certainly not easy to ascertain experimentally the changes undergone by a single hydrocarbon as its temperature is raised, and at the last it may be objected that the course of events in contact with the solid walls of a containing vessel is not necessarily the same as that within the gaseous envelope of a flame. I am glad to think that there is promise of further light on the subject from the work of Prof. Bone.

The course of oxidation of hydrocarbons has been the subject of very careful and fruitful study. The old view that a selective or preferential oxidation of the hydrogen always took place, that with a restricted supply of oxygen the hydrogen was oxidised and the carbon set free, is, I think, no longer maintained by anyone who has studied the question. The explosion of ethylene with its own volume of oxygen, which leaves us with practically all the carbon oxidised and all the hydrogen free, is fatal to this view. Again, when hydrocarbons are burned in a flame with a restricted supply of air, as is the case in the inner cone of the flame of a well-aerated Bunsen burner, there is clearly no separation of solid carbon, and the products of combustion, when withdrawn and analysed, disclose the presence of much free hydrogen and no unoxidised carbon. In describing this experimental fact I have spoken of it as the preferential oxidation of carbon. I have always thought it pedantic to quarrel with that expression; for, in speaking of a chemical transaction, we usually include only a description of the initial and final states of combination. I should be sorry, however, to detach the expression from the facts it describes, and to exalt it into a general doctrine. That would be quite inadmissible, and, if there is no danger of misunderstanding, it would be better to avoid using the expression.

(To be continued.)

ELECTRICITY IN FACTORIES.

Home Office Regulations.

There has just been issued a draft of the regulations which the Home Office proposes to make for the generation, transformation, distribution, and use of electrical energy in premises under the Factory and Workshop Act, 1901. The application of these regulations will be limited to premises where electrical energy in use is above 130 volts continuous and 65 volts alternating pressure. The regulations, 33 in number, are as follows:

1. All apparatus and conductors shall be sufficient in size and power for the work they may be called upon to do, and so constructed, installed, protected, worked, and maintained as to prevent danger.

2. All cables shall be covered with insulating material, and further efficiently protected where necessary to prevent danger; or they shall be so placed and safeguarded as to prevent danger.

3. Every switch, circuit breaker, and isolating link shall be: (*a*) so constructed, placed, or protected as to prevent danger; (*b*) so constructed and adjusted as accurately to make and to maintain good contact; (*c*) provided with an efficient handle or other means of working, insulated from the system; (*d*) so

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constructed or arranged that it cannot accidentally fall or move into contact when left out of contact.

4. Every switch and circuit breaker shall be so constructed as to be incapable of remaining in partial contact, or of maintaining an arc on breaking circuit.

5. Every fuse, and automatic circuit breaker used instead thereof, shall be so constructed and arranged as effectively to interrupt the current before it so exceeds the working rate as to involve danger. It shall be of such construction or be so guarded or placed as to prevent danger from overheating, or from arcing or the scattering of hot metal or other substance when it comes into operation. Every fuse shall be of such construction or be so protected by a switch that the fusible metal may be readily renewed without danger.

6. Every electrical joint and connection shall be of proper construction as regards conductivity, insulation, mechanical strength, and protection.

7. Efficient means, suitably located, shall be provided for cutting off all pressure from every circuit.

8. Every circuit shall be efficiently protected from excess of current, and every circuit arranged to carry more than 750 watts shall be separately so protected.

9. Where one point of a system is connected to earth, no single-pole switch other than a link for testing purposes shall be placed in any cable connected thereto.

10. Where one of the main conductors of a system is uninsulated and bare, such as a bare return of a concentric system, no switch, fuse, or circuit breaker shall be placed in that conductor, or in any conductor connected thereto, and the said conductor shall be earthed.

11. Every motor, converter, and transformer shall be protected by a switch or switches, suitably placed, and so connected that all pressure may thereby be cut off therefrom and from any apparatus in connection therewith.

12. Every electrical motor shall be controlled by an efficient switch or switches for starting and stopping, so placed as to be easily worked by the person in charge of the motor. Every electrical motor rated at more than ½ h.p. shall be further protected by a release that will automatically break the circuit if the current is interrupted, unless the motor is incapable of restarting automatically on the current being restored. In every place in which machinery is being driven by any electrical motor, there shall be means at hand for quickly stopping the motor.

13. Every flexible cable for portable apparatus shall be connected to the system either by efficient permanent joints or connections or by a properly constructed connector. Every portable apparatus and its flexible cable shall be independently controlled by a switch conveniently placed. Adequate precautions shall be taken against shock, due to leakage or other cause, in all places where the person handling the portable apparatus is not insulated from earth. In such places, and in any place where the pressure exceeds low pressure, the switch shall be so constructed as to break the circuit on each pole.

14. The general arrangement of switchboards shall, so far as reasonably practicable, be such that: (*a*) all parts which may have to be adjusted or handled are readily accessible; (*b*) the course of every cable may be readily traced; (*c*) conductors connected to different systems are kept apart, and can be readily distinguished; (*d*) all bare conductors are so placed or protected as to prevent danger from accidental short-circuit.

15. Every switchboard having conductors normally so exposed that they may be touched shall be located in an area or areas set apart for the purposes thereof, and suitably fenced or enclosed. No person except an authorised person, or a person acting under his immediate supervision, shall have access to any part of such area.

16. All apparatus appertaining to a switchboard and requiring handling shall, so far as practicable, be so placed or arranged as to be operated from the working platform of the switchboard, and all measuring instruments and indicators connected therewith shall, so far as practicable, be so placed as to be observed from the working platform. If such apparatus be worked or observed from any other place, adequate precaution shall be taken to prevent danger.

17. At the working platform of every switchboard and in every switchboard passage-way, if there be bare conductors exposed, or arranged to be exposed when live so that they may be touched, there shall be a clear and unobstructed passage of ample width and height with a firm and even floor. For low pressure and medium pressure the clear height shall not be less than 7ft. and the clear width not less than 3ft., and for high pressure and extra high pressure 8ft. and 4ft. respectively. Bare conductors shall not be exposed on both sides of a switchboard passage-way unless either the clear width of the passage is double that otherwise required, or the conductors on one side are so guarded that they cannot be accidentally touched. Adequate means of access, free from danger, shall be provided for every switchboard passage-way.

18. In every switchboard for high pressure or extra high pressure: (*a*) every conductor within reach from the working platform, or in any switchboard passageway, shall be so placed or protected as to prevent danger; (*b*) the metal cases of all instruments shall be either earthed or completely enclosed with insulating covers; (*c*) all metal switch-handles, and all metal rods connecting them with the switches, shall be earthed; (*d*) every switchboard in continuous use shall be so arranged that the conductors thereof can be made dead in sections, and no work shall be done at any section unless that section be (*a*) made dead, and (*b*) so separated by permanent or removable divisions or screens, from all adjoining sections of which the conductors are live, that the work may be carried out without danger.

19. All fixed coils, conductors, or terminals of generators, motors, transformers, or other apparatus, at high pressure or extra high pressure, and within reach from any position in which any person employed may require to be, shall be so protected as to prevent danger.

20. Where a high-pressure or extra high-pressure supply is transformed for use at a lower pressure, adequate means shall be provided to prevent the lower pressure system from being accidentally charged above its normal pressure by leakage or contact from the higher pressure system.

21. Adequate precautions shall be taken to prevent any metal other than the conductors from becoming electrically charged, and such metal shall be earthed where necessary to prevent danger.

22. Adequate means shall be provided and used for preventing any conductor or apparatus from being accidentally or inadvertently electrically charged when persons are working thereon.

23. Where necessary to prevent danger, insulating stands or screens shall be provided and kept permanently in position and shall be maintained in sound condition.

24. Portable insulating stands and screens, boots, and gloves, shall be provided and used when necessary to prevent danger, and shall be periodically examined by an authorised person.

25. Adequate working space and means of access free from danger, shall be provided for all apparatus that has to be worked or attended to by any person.

26. All those parts of premises in which apparatus is placed shall be adequately lighted to prevent danger.

27. All conductors and apparatus exposed to the weather, wet, corrosion, or to inflammable surroundings or explosive atmosphere, or used in any process or for any special purpose other than for lighting or power, shall be so constructed or protected, and such special precautions shall be taken, as may be necessary to prevent danger in view of that exposure or use.

28. Adequate periodical tests shall be made by an authorised person to ensure (*a*) that the insulation of all conductors and apparatus is duly maintained; (*b*) that no metal part of any apparatus, other than the conductors thereof, is electrically charged so that there is danger; and (*c*) that all earth connections are in order. Adequate periodical examinations shall also be made by an authorised person to detect any other defects from which danger may arise.

29. No person except an authorised person or a person acting under his immediate supervision, shall undertake any work where technical knowledge or experience is required in order to avoid danger.

30. Instructions as to the treatment of persons suffering from electric shock shall be affixed in all premises where electrical energy is used, other than for incandescent lighting at low pressure, and in all premises in which electrical energy is generated or transformed.

31. Every sub-station shall be of ample dimensions and substantially constructed of fire-resisting material; and shall be so arranged that no person can obtain access thereto otherwise than by the proper entrance, or can interfere with the apparatus or conductors therein from outside; and shall be provided with efficient means of ventilation and be kept dry.

32. Every sub-station shall be under the control of an authorised person, and none but an authorised person or a person acting under his immediate supervision shall enter any part thereof where there may be danger.

33. Every underground sub-station shall be provided with adequate means of access by a door or trapdoor, with a staircase or ladder securely fixed and so placed that no switchboard or bare conductor shall be within reach of a person thereon: provided, however, that the means of access shall be by a doorway and staircase if (*a*) any person is regularly employed therein, other than for inspection and cleaning; or if (*b*) there is moving machinery therein, other than ventilating fans; or if (*c*) there is extra high pressure therein.

These regulations come into force on Jan. 1, 1908, except as regards such parts of electrical stations as were constructed before July 1, 1907, in respect of which they shall come into force on July 1, 1908 Any objections of substance, made by employers, workpeople, or other persons affected, will be carefully considered by the Secretary of State, and will, if necessary, be the subject of full inquiry

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made by a competent person appointed by him. In that event all concerned will be entitled to a full hearing at the inquiry, and the report of the person holding it will be considered by the Secretary of State before the regulations are made. Every such objection must be in writing, and must state (*a*) the regulations or portions of regulations objected to; (*b*) the specific grounds of objection; and (*c*) the omissions, additions, or modifications asked for.

THE MEASURED-RATE v. FLAT-RATE SYSTEM IN THE TELEPHONE SERVICE.

The reasons of the General Post Office for the adoption of the measured rate service in lieu of the present flat-rate service tariff of telephone charges are given in a letter from the Postmaster-General to Mr. Herbert Shaw, secretary of the Newcastle and Gateshead Incorporated Chamber of Commerce, which we reprint from the *Newcastle Chronicle*, as follows:

Sir,—I am directed by the Postmaster-General to thank the Newcastle and Gateshead Chamber of Commerce for the opportunity offered, in your letter of Aug. 8, to lay before them the reasons for the adoption in the Newcastle area of the new measured-service tariff of telephone charges set forth in the circulars. The chamber will observe that the new rates are lower in many respects than the message-rate tariff hitherto in force at Post Office exchanges in the area. A subscription of £5 now covers 500 local calls instead of 480 as hitherto; and additional calls if contracted for in advance are charged at varying rates of 8s., 6s., and 4s. per 100 instead of 1d. each. Persons who require a number of exchange lines and extensions will find considerable advantages in the private branch exchange tariff.

The chief criticism of the new tariff is directed to the discontinuance of the "unlimited service" or "flat rate" system of charge (except as regards circuits to private residences), under which each subscriber pays a fixed amount irrespective of the quantity of the service which he enjoys. Such a system of charge must obviously be unfair and anomalous, inasmuch as under it the smallest user is charged the same amount as the largest user—and the service may vary from two or three hundred calls a year to many thousand calls—whereas the cost of the service varies with the amount of use. Such a system of charge would not be tolerated in the supply of any other public necessary, such as water, gas, or electric light, and it is only the force of custom and the demands of a limited number of large users which have secured its continuance hitherto in this country. A flat-rate system is not only unfair in its application to subscribers, but it does not correspond with the conditions of cost which apply to every telephone system. With the growth of the system its value is increased to subscribers, and it is a well-known fact that the cost of construction and maintenance increase in even greater proportion. A flat rate, if fixed with regard to the probable future cost of the service, must necessarily be prohibitive in amount during the earlier stages, and must, therefore, check development. If fixed on the basis of the cost of the service in earlier years, it must soon become unremunerative as that cost increases.

The measured-service system of charge has been adopted by all the largest telephone undertakings in the United States, and in many cases companies, which at first were strong supporters of the flat-rate system, have found that their increasing expenditure, in proportion to the number of subscribers, has involved them in serious losses. This general adoption of the measured-service rates has been coincident with a remarkable development in the number of telephones in use, and there can be no doubt that the business classes in the United States are fully convinced of the advantages of this method of charge. A special committee appointed in 1905 by the Merchants' Association of New York, which has the largest and most efficient system of any great city in the world, reported strongly against the flat-rate system, and in favour of measured-service rates. During the present year another report has been made by a committee of experts appointed by the City Council of Chicago to consider the most suitable conditions of the telephone service in that city, to the effect that the measured-service system is the only system suitable for adoption in that city. Your chamber will also no doubt remember that in this country the Select Committee of 1898, after having considered evidence as to the systems of charge adopted in various countries, reported strongly as to the disadvantages of the flat-rate system, and the advantages of a system which made the charges proportionate to the service; and that as a result of their recommendation the Post Office introduced the message-rate system in London. This system has been adopted by about 90 per cent. of the Post Office subscribers, and by a large proportion of the new subscribers of the National Telephone Company, and the number of telephones in use is now about four times as great as it was before the introduction of the new rates.

There is another serious objection to the flat-rate system which has been too much overlooked in this country—viz., its effect on the efficiency of the system. A subscriber who pays no more for his exchange line, however great the number of calls which he originates, tends to use it more and more frequently, and often for unnecessary or even frivolous calls, rather than incur the expense of a second line. The result of all this is undue congestion of the line, and the line is frequently engaged when calls are made for the subscriber by other subscribers. Such ineffective calls not only throw an unnecessary burden on the service, but cause extra trouble and waste of time to the other subscribers. Operating expenses are unduly increased, and the service is made unsatisfactory. There is no doubt that the high percentage of ineffective calls, which is a feature of the telephone system in Great Britain, is largely due to this cause, and that the only remedy is a system of measured service under which a suitable installation is provided for the subscriber in proportion to the actual quantity of service which he requires and receives. The objections to the flat-rate system outlined above seem to the Postmaster-General to merit the attentive consideration of your chamber.

The question of principle does not affect the amount of the actual charges which may be fixed for the measured service, but on this point I am to say that the Postmaster-General has no desire to secure more than a moderate return on the capital expenditure, after allowing for the repayment of the cost of the service, including maintenance and renewal of the plant. The new rates for the Post Office service have been fixed solely with a view to this result, and are based on the best information now obtainable as a result of the present telephone business of the Department. Their modification in future must depend upon the results of further experience. There is, however, no intention of imposing any unnecessary burden on the subscribers.

The Postmaster-General also desires me to say with reference to your further letter of the 17th inst., that he hopes that the reasons stated above will convince the Chamber of Commerce of the reasonableness of the new tariff, but if, after they have been considered, they think that a personal interview would be advantageous, he will be happy to arrange for one of his officers to visit Newcastle.

Extract from a report of an inquiry into the telephone service of New York:

A system which exacts an average uniform charge for widely varying degrees of service is obviously inequitable to the public. The flat rate is also harmful to the public in another way. Such a rate, comprehending all classes of business users and based upon the average of wide extremes, of necessity compels small users to pay a relatively higher rate than they would pay under a graded rate based upon the cost of the service used by them, and is, therefore, highly burdensome to such users, and presents a formidable obstacle to the development of the telephone system. This condition is, of course, detrimental to a telephone company as well as to its patrons. Moreover, the effect of a flat rate is to increase the individual use of the telephone equipment and the individual demand upon the operating force, thereby increasing operating expenses without providing additional income. Under a flat-rate system with a definitely restricted income it is imperative that the tendency of operating expenses to increase disproportionately by reason of unlimited calls be counteracted. The necessary economy can only be effected at the expense of efficiency. It is the opinion of this committee, therefore, that in large cities the flat rate with unlimited service is based upon a fallacy, that it is extremely unjust to small users, favours large users unduly, impedes expansion of the telephone business, tends to inefficient service, and that as a financial proposition it is unsound.

Extract from report on the telephone situation in the city of Chicago, dated April, 1907:

Measured rates should be adopted for general service, because: (*a*) They require each user to pay for his service in proportion to what he uses. This makes it possible for the telephone-operating company to base its rates for each class of service on the actual cost of the service, thereby bringing the service within the means of the largest number of people and expanding it so as to be of the maximum usefulness in the city. (*b*) Measured rates largely cut off frivolous and otherwise useless messages, thereby leaving the subscribers' lines open for all important messages. (*c*) The reduction of calls per telephone following the general use of measured rates results in a great reduction of the unavailing calls, which are now approximately one-third of the total calls in Chicago, and it thereby reduces the expenses of operating, and this makes a general reduction in the rates practicable. (*d*) The introduction of measured rates tends to level off the load curve, reducing the relative height of the peaks, so that the actual cost of operating for each

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message passed through the hands of the telephone company becomes less, and this also tends towards making a reduction in the price of telephone service practicable.

OPENINGS FOR CONTRACTORS.

ABERDEEN—New technical college (£150,000).

AMBLE—School for Northumberland Education Committee. Secretary, Mr. C. Williams, Pearl-buildings, Newcastle-on-Tyne.

BARNSLEY—Dwelling-houses and shops in Dodworth-road for the Oak Mills Estate Co., Barnsley.

BEXHILL — Town hall extensions. Architect, Mr. Hy. Ward, 8, Bank-buildings, Hastings.

BINGLEY—Shed at Britannia Mills, Bingley, for D. and R. England, Limited.

BIRKENHEAD—New central library. Architects, Messrs. W. E. Sproat and Elden, Warwick.

BIRMINGHAM—School at Edgbaston. Architect, Mr. H. T. Sandy, 22, Greengate, Stafford.

BIRMINGHAM—Telegraph stores for H.M. Office of Works and Public Buildings, Storey's-gate, London, S.W.

BLYTH (NORTHUMBERLAND)—General post office to be erected.

BRADFORD—Wesleyan church at Little Horton (£4,000). Architects, Messrs. Walker and Collinson.

BROMLEY (KENT)—Secondary school for County Education Authority (£12,000).

BURY (LANCS.)—Extension of tramcar depôt to be wired.

BUXTON—Cottage hospital to be erected by public subscription.

CANADA—Extension of transmission system to Kingston. Consulting engineers, Messrs. Connor, Clarke, and Mond, Toronto.

CHESTER — School at Love-street, County Borough of Chester. Architect, Mr. H. Beswick, Newgate-street, Chester.

CORNWALL.—Training college for the Cornwall County Education Committee.

DALMELLINGTON (AYR)—The Dalmellington Iron Co. propose sinking new pits, erecting workmen's cottages, and other works costing £10,000.

DARLINGTON—Alterations to the Cleveland Arms. Architect, Mr. W. T. Aggutter, 7, Horse-market, Darlington.

DESBOROUGH—Electric fire-alarm system for the Urban District Council Fire Brigade.

DOLGELLY—Duplicate set of crushing plant to be installed at Dolgelly copper mines.

DUNDALK—Public electric lighting scheme proposed (£10,000-£15,000).

DUNFERMLINE—Additions to Albany Works for R. E. Walker, Reid, and Co. Architect, Mr. J. Shearer.

DUNFERMLINE—The Albany linen works are to be extended (£6,000).

ECCLESTON (NEAR CHORLEY) — Weaving shed to be erected at Eccleston, near Chorley, by the Eccleston Mill Co., Eccleston Green, Eccleston, Lancashire.

EDINBURGH—Two tenements to be erected at Wheatfield-street for Mr. G. Marr.

EDINBURGH—Villas at Argyle-crescent, Portobello, for Messrs. R. and J. Scott.

EDINBURGH—Villas at Willowbrae-road for Mr. A. Miller.

ESSEX—Duplicate set of machinery may be installed by the South Essex Waterworks Co. (£4,000).

FAILSWORTH (MANCHESTER)—Cotton spinning mills to be erected.

FOOTS CRAY (KENT)—School at Longlands for County Education Authority (£5,243).

GAINSBOROUGH — Dwelling-house at Stow Park for Mr. Talbot Thornton. Architect and surveyor, Mr. Wm. Eyre. Gainsborough.

GREETLAND—Conversion of mechanics' institute, West-vale, into district council offices.

HITCHIN—German convalescent home at Benslow (£13,000).

HEYSHAM HARBOUR—Sawmill. Architects, Messrs. Harrison, Hall, and Moore, 73, Church-street, Lancaster.

HOLYHEAD—Church house to be built in Victoria-road.

HOPWOOD (LANCS.)—School for 600 children for the Heywood Education Committee.

ITALY—Smelting and rolling plant at Bagnoli for a new Italian iron mining company.

KINGHORN—First-class passenger steamer to be built at Messrs. Scott's yards for a Chinese firm.

KIRKCALDY—New factory for Fife Linoleum Co.

KIRKHEATON — Two dwelling-houses for Mr. John Broadbent; additions to houses owned by A. Ellis and A. Senior.

LLANELLY—Post office in John-street (£5,000). Office of Works, Storey's-gate, London, S.W.

LEIGH (YORKS)—New spinning mill to be erected at the Bedford end of Leigh by the Butts Spinning Co.

LONDON—Buildings in Church-street, Stoke Newington, N., for Mr. Thomas Taylor.

LONDON—Model dwellings for the St. Pancras Borough Council (£22,000).

LONDON—Moravian Church at Priory-road, Hornsey, N. Particulars from the Moravian Church, Fetter-lane, London, E.C.

LONDON—Alterations, etc., at 11, Ampthill-square for the St. Pancras Guardians. Mr. A. A. Millward, clerk, Town Hall, St. Pancras.

LONDONDERRY—Boot factory, warehouse, and shops for Mr. H. McKeown. Architect, Mr. P. H. Elliott, Exchange-buildings, Castle-street, Londonderry.

LOWESTOFT—Wesleyan schools in Crown-street (£3,500).

LUDLOW—Additions to workhouse. Architect, Mr. John Butters, Railway Station, Ludlow.

MAESTEG (WALES)—Offices for North's Navigation Collieries (1899), Limited. Mr. J. P. Gibbon, Mining Offices, Maesteg.

MACCLESFIELD—Laboratory at sewage works. Borough Surveyor, Town Hall, Macclesfield.

MACCLESFIELD—New weaving shed for the Globe Cotton Spinning and Manufacturing Co.

MARSEILLES—Electric lighting of the Municipal Opera House.

MONCKTON — Ventilating fan for New Monckton Colliery Co. (£10,000).

MONTROSE—Proposal before Harbour Trustees to establish a yard for the building and repair of steam drifters.

MULLINGAR—Laboratory equipment of new science hall, St. Mary's College. Rev. J. Kelly, C.C., The Palace, Mullingar.

NEWCASTLE-ON-TYNE—Extensions and improvements of plant at the works of R. and W. Hawthorn, Leslie, and Co. (£20,000).

NORTHAMPTON—Additions to the factory of the True Form Boot Co. for J. Sears and Co.

NOTTINGHAM—New Albert Hall to seat 2,500 people (£30,000).

NUNEATON—Secondary school in Leicester-road for the Council.

OLDHAM—The Dotcliffe spinning shed at Earley is being enlarged so as to hold about 400 looms.

PERTH—Reconstruction of infirmary. Architect, Mr. W. Mackay, Perth.

PETERHEAD—Dwelling-house in Victoria-road. Mr. G. M'Ghee, 79, King-street, Peterhead.

PICKERING—Workhouse to be enlarged.

PORTSMOUTH—Borough asylum to be extended (£24,000).

PUERTO RICO—Electric lighting plant, pumps, machinery, etc., for new sugar factory. Contractors, Mirrlees, Watson, and Co., Glasgow.

RAMSGATE—School for County Education Authority (£11,0˜0).

ROYTON (OLDHAM)—Company being formed in Oldham to proceed with Royton ring cotton spinning mill for the Royton Ring Spinning Co.

ST. AUSTELL—Motor and cycle shop to be erected at Foxhole for Mr. E. Martin.

SELKIRK—New technical school.

SKELMERSDALE—Additional looms to be erected at Merdale mill.

SHARDLOW—Laundry at workhouse for the Guardians.

SHAW—Rutland spinning mill being erected; erection of ring spinning mill at Higher Crompton spoken of.

SHEFFIELD—Factory extensions for the Hardy Patent Pick Co. (£5,000).

SHIPLEY—New church at Saltaire (£6,000). Architects, Messrs. T. H. and F. Healey, Bradford.

STAMFORD — Workshops, etc., for the Martin's Cultivator Co. Architect, Mr. J. T. Ward, Stamford.

STANLEY (CO. DURHAM)—Public-house at Wrenthorpe for the Leeds and Wakefield Breweries, Limited.

STAVERTON—Waiting room and other improvements at station for Great Western Railway Co. Particulars from the Architect, Paddington Station, London, W.

STIRLING—Four-storey tenement and shops and dwelling-houses in Barnton-street. Mr. W. Young, Taylorton.

STIRLING—Joiners' workshop in Dumbarton-road for the trustees of the late Mr. J. Wordie, West Nile-street, Glasgow.

STIRLING—Eight dwelling-houses in Bellfield-road for Mr. J. Somerville, 7, Randolph-terrace.

SUNDERLAND — Extension at technical college and engineering laboratories (£10,000) for the Sunderland Corporation.

SUNDERLAND—New hospital for the Infirmary Committee.

SWANSEA—King's Dock extension for the Swansea Harbour Trustees (£115,000).

TANFIELD LEA (CO. DURHAM)—The District Council have passed plans for 21 houses for J. Joicey and Co.

TRURO—Western towers of cathedral to be completed (£25,000).

TYNEMOUTH — Police station at Lawson-street, North Shields. Borough surveyor, Mr. John F. Smillie, Tynemouth.

WALTON-LE-DALE—Fire station and buildings for the Urban District Council. Mr. F. E. Dixon, 49, Lune-street, Preston.

WAYLAND (NORFOLK)—New workhouse for the Guardians.

WEST LANCASHIRE—The Rural District Council have passed plans for a house at Meanygate, Tarleton, for Mr. Wm. Ball; residence in Fulwood-avenue, Tarleton, for Mr. H. Hodge, Birkdale; and five pair of houses and stables attached in Birkdale Cop-road, Halsall, for Mr. J. Livesley.

WHITWORTH (LANCS.)—Bridge Mill, formerly owned by J. Hargreaves and Sons, acquired by Dura Mill, Limited, Whitworth, and to be fitted with new plant throughout.

WISBECH—Plant for the Wisbech Waterworks Co.

WORCESTER—Sanatorium for the directors of the R.A.O.B. orphanage.

YARDLEY—Schools for the Worcestershire Education Committee. Mr. A. B. Rowe, Worcester-chambers, Pierpoint-street, Worcester.

YORK—Bide-a-wee Café premises at Fulford to be turned into an electrically-equipped clothing factory for a Leeds clothing firm.

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LEGAL INTELLIGENCE.

BLISS v. MANCHESTER CORPORATION AND OTHERS.

Claim for Damages.

At the Manchester County Court last week, an action was heard arising out of a collision between a tramcar and a cab in April last. The plaintiffs were Charles Bliss and his wife, and the defendants were the Manchester Corporation and Messrs. Potts and Son, the owners of the cab.

Plaintiffs' case was that they entered the car proceeding towards town at Rusholme office. At the corner of Ackers-street the car collided with a hansom cab, one of the glass windows was broken in, and the sudden stoppage of the car threw four out of the five occupants to the floor. Mrs. Bliss received internal injuries, which had prevented her from attending to her business, and Mr. Bliss was cut and bruised, but not very seriously. The plaintiffs are general dealers, who carry on trade at various fairs and markets, and part of their claim was for the loss of sale of goods and for deterioration of perishable goods which the disablement of Mrs. Bliss prevented her from selling. It was alleged that the tramcar was going at an excessive speed, and that at the time of the accident the driver was looking back into the car. The principal point at issue was which of the defendants were liable for the accident.

The account put forward on behalf of the Corporation was that the cab came quickly out of Ackers-street, and ran right in front of the car before the driver had time to pull up. The car driver said his speed was between 10 and 12 miles an hour, and he denied that he was looking into the car. Other witnesses had gauged the car's speed at between 20 and 25 miles and 14 miles. The cab driver said he was driving his horse along Ackers-street at a "jog trot," and when he began to cross Oxford-street, in order to reach the stables in Leamington-street, he noticed the car about 50 yards away. He thought there was plenty of time to cross. When he got to the second tramlines he saw that the driver of the car was making no attempt to stop. He pulled his horse round, but the tram ran into the cab, stripped the harness off the horse, smashed both shafts and one wheel of the cab, and threw its driver into the road. The cabman thought the car was travelling at the rate of 16 or 18 miles an hour.

Judge PARRY said he considered that both the defendants were to blame. If the car had not been going at an excessive speed, its stoppage would not have jerked the passengers off their seats. The effect of the collision, too, showed that the car must have been travelling quickly. On the other hand, the driver of the cab, knowing the speed at which the tramcars travelled, especially late at night, ought not to have taken the risk of crossing the road in front of this particular car, which was evidently not far off when he came out of Ackers-street. He gave judgment for the plaintiff for £60 and costs against both defendants. The plaintiffs, he said, must choose from which of the defendants they would have their money, as it was not within his power to order contributions from both.

COMPANIES' MEETINGS AND REPORTS.

LANARKSHIRE TRAMWAYS.

Mr. A. R. MONKS presided at the half-yearly meeting of the shareholders of the Lanarkshire Tramways Co. held at the offices of the British Thomson-Houston Co., Cannon-street, London, on Saturday last. He stated that the receipts for the six months ending June 30 had amounted to £29,703, and the expenses to £16,051, leaving £13,651. From this sum had to be deducted £6,215 (contributions to local authorities), £608 as interest on debts, and £223 as interest on loans. This left £12,198, which, with the addition of £882 brought from last account, gave a balance for division of £13,081. The directors recommended payment of a dividend at the rate of 4½ per cent. per annum on the issued capital, and that £5,182 be carried to revenue new account. No provision had been made for depreciation in the accounts before the meeting, as the directors proposed to deal with the matter when the final accounts were made up at the end of the year.

The adoption of the report was seconded by Mr. H. C. LEWIS, and approved.

GREAT NORTHERN, PICCADILLY, AND BROMPTON RAILWAY.

The report of the Great Northern, Piccadilly, and Brompton Railway Co. for the half-year ended June 30 last states that the capital expenditure amounted to £165,461. The gross receipts on revenue account amounted to £106,570, and the working expenditure (including rates and taxes) has been £75,794. The number of passengers carried during the half-year, including estimated journeys by season-ticket holders, was 11,953,759. For the 16½ days to Dec. 31 last the number was 806,120. A deficiency of £5,270 on the net revenue account, after paying all rents, rent charges, and interest on debentures issued and sold, has been paid by the Underground Electric Railways Co. of London under their guarantee agreement. Warrants for the guaranteed dividend at the rate of 4 per cent. per annum on the share capital were sent to the shareholders on Aug. 2. The work on the Holborn-to-Strand section of the Company's railway is nearly completed, and the directors expect to open that section for public traffic in the month of December next. The opening of the Charing Cross, Euston, and Hampstead Railway on June 22 last will, it is expected, create a new and valuable traffic for this railway by means of the convenient interchange afforded at the Leicester-square Station, enabling passengers to get quickly to Camden Town, Hampstead, Golder's Green, and Highgate. Through bookings have been arranged between the two railways. The revenue account shows receipts as follows: passengers, £100,568; season tickets, £2,268; sundry, £3,712; transfer fees, £21—total, £106,570. Expenditure was as follows: maintenance of way, works, etc., £4,311; electric train working, £30,151; repairs and renewals of rolling stock, £2,850; lift expenses, £9,252; traffic expenses, £18,134; general charges, £3,803; compensation, £238; Government duty, £158; law charges, £828; rates and taxes, £6,063—total, £75,794. The balance carried to net revenue account is therefore £30,776. Adding sundries and £5,270 receivable from the Underground Electric Railways Co. of London the receipts on net revenue account are £36,326, which are dealt with as follows: rent charges, £4,750; interest on debenture stock, £22,262; general interest, £1,738; rents for rights-of-way and wayleave rents, £6,050; rents of property, £1,526.

ABERDEEN SUBURBAN TRAMWAYS.

The report of the Aberdeen Suburban Tramways Co. for the half-year ended July 31 states that the sum standing at the credit of profit and loss account is £1,699. The directors point out that there has been, as compared with the previous year, a decrease of revenue of over £250. This decrease is accounted for partly by the reduction of 2½ per cent on the commission payable by the Corporation of Aberdeen; partly by the severe snowstorm of December, 1906, when in one week there was a loss of revenue estimated at about £60, and partly by the exceptionally bad weather that has been experienced this summer. On the other hand, the directors have been able, through alterations made by the managing director, to reduce the traffic and working expenses by over £300. But against this, the charges for keeping the track clear of snow and for maintenance have been heavier than in previous years. The directors intend to pursue a policy of economy as far as is consistent with giving the public a good service. The directors again point out how much the Company is handicapped by the excessively high price payable to the Corporation of Aberdeen for electric power. The agreement with the Corporation expires on June 23, 1909, and the directors have been considering as to the steps to be taken at the expiry of the agreement. Should the Corporation not make a very substantial reduction on the price at present charged, the Company's only course will be to cease taking a supply from the Corporation and to generate electric power itself. The establishment of a generating station such as is contemplated would involve additional expenditure, and in view of this the directors recommend that no portion of the balance at the credit of profit and loss account should be meantime distributed as dividend. The directors, therefore, propose that the balance at the credit of profit and loss account should be applied as follows—namely: in adding to the amount at the credit of the renewal and depreciation account, which will then stand at £3,000, £1,000; in carrying forward, £699. The directors further inform the shareholders that repairs on the Donside track have been carried out at an expense of over £163, none of which has been charged to capital, and that a system of carriage of parcels, which will bring in additional revenue, has been established. They have every confidence that when a supply of electricity at a moderate charge has been obtained the Company should with careful management be able to pay a substantial dividend.

BAKER STREET AND WATERLOO RAILWAY.

The report of the Baker-street and Waterloo Railway Co. for the half-year ended June 30 last, to be presented at the meeting on the 4th prox., states that the expenditure on capital account amounted to £54,865. The gross receipts on revenue account amounted to £63,451. The working expenditure, including rates and taxes, has been £42,127. The balance of £6,745 at the credit of the net revenue account has been carried forward, and will be available for increasing the dividend on the preference shares from 3 per cent. to 4 per cent. if the net profits of the next half-year with the amount so carried forward are sufficient to pay the higher dividend. The directors have decided to postpone the commencement of the construction of the Paddington extension, and an agreement with the Underground Electric Railways Co. of London dealing with this matter will be submitted to the shareholders for approval at the meeting. The agreement also defines the liability of the Underground Electric Railways Co. of London for interest and administration expenses by providing that they shall be deemed to have undertaken and shall undertake to guarantee the payment of debenture interest and also dividend at the rate of 3 per cent. per annum until the postponed works mentioned in the agreement, including the Paddington extension (unless such works or any of them are meanwhile abandoned by the Company), are ready for opening for traffic. The directors report with deep regret the death of their chairman, Mr. Theodore J. Hare, who had been associated with the Company since its inception. The directors also deeply regret the loss sustained by the death of Sir Benjamin Baker, K.C.B., one of the constructing engineers. The directors have elected Sir George S. Gibb as chairman in place of Mr. Theodore J. Hare, deceased.

CHARING CROSS, EUSTON, AND HAMPSTEAD RAILWAY.

The report of the Charing Cross, Euston, and Hampstead Railway Co. for the half-year ended June 30 last states that the capital expenditure during the half-year amounted to £547,860. The work of construction having been substantially finished, the directors thought it desirable that the railway should be opened for public

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traffic before the final completion, and an arrangement was accordingly made with the contractors, the Underground Electric Railways Co. of London, which enabled the railway to be opened before it was handed over by the contractors. By this arrangement the contractors take all receipts and make all payments from the day of opening up to June 30 last, they paying the interest at the rate of 4 per cent. per annum on the issued debenture stock for the same period. The railway was opened for public traffic on Saturday, June 22, 1907. A very frequent train service is being run from Charing Cross to Golder's Green, and from Charing Cross to Highgate. Through bookings are now in operation with the Baker-street and Waterloo, the Great Northern, Piccadilly, and Brompton, the London and North-Western, the Midland, the South-Eastern and Chatham, and the City and South London Railways, and on Sept. 1 next through bookings will commence with the Central London Railway, which will create a new through route to the City, *via* Oxford-street, in addition to the existing route, *via* Euston and the City and South London Railway. Prior to the opening of the railway, Sir George S. Gibb was elected a director and chairman of the Company, and the Right Hon. Lord George Hamilton, P.C., G.C.S.I., and the Right Hon. Sir Algernon West, G.C.B., and W. M. Acworth, Esq., were elected directors.

BLACKPOOL AND FLEETWOOD TRAMROAD.

The half-yearly report and balance-sheet submitted by the directors of the Blackpool and Fleetwood Tramroad Co. shows that, including the sum brought forward from last half-year, the balance of profit, after providing for debenture interest, is £4,463, and the directors recommended a dividend at the rate of £4 per cent. per annum, which absorbs £3,000. A sum of £750 has been written off depreciation reserve and £500 put to general reserve, leaving a balance of £212 to be carried forward. The receipts from all sources amounted to £10,948.

NEW COMPANIES REGISTERED.

Huggett and Worthington, Limited.—Registered Aug. 19. Capital, £500 in £1 shares. Objects: to acquire the business of electrical and mechanical engineers and contractors carried on by H. P. S. Huggett and W. T. Worthington at 85, Bridge-street, Warrington, as Huggett and Worthington, and to carry on the same and the business of manufacturers of and dealers in electrical plant, engines, vehicles, fittings, and apparatus, etc. No initial public issue.

Dublin and Central Ireland Power Syndicate, Limited.—Registered Aug. 16, in Dublin. Capital, £10,000 in £1 shares. Objects: to carry on in Dublin, County Kildare, King's County, Queen's County, and elsewhere, the business of an electric power and power gas supply company in all its branches. Registered office: 7, Westmoreland-street, Dublin.

G. A. Steinthal and Boydell, Limited.—Registered Aug. 16. Capital, £5,000 in £1 shares (2,000 6 per cent. cumulative preference). Objects: to acquire the business of electrical engineers and contractors carried on by W. P. Steinthal at 41, Piccadilly, Bradford, and at 18, Cooper-street, Manchester, as G. A. Steinthal, and to carry on the same and the business of suppliers of electricity and electric installations, manufacturers of and dealers in electric, magnetic, galvanic, and other apparatus, etc. No initial public issue.

Turbine Development Co.—Registered Aug. 14. Capital, £10,000 in £1 shares (4,000 preference). Objects: to adopt an agreement with J. A. Smeeton, E. G. Brewer, B. W. Head, H. J. Heagerty, F. Irvine, H. J. Cooke, and H. G. Burford, and to carry on the business indicated by the title, etc. No initial public issue. Registered office: 7, Union-court, E.C.

Liens, etc., Registered.

Walter's Electrical Manufacturing Co., Limited, London, W.—Lien registered Aug. 14 for £2,000 5 per cent. debentures. No trustees. Charged on all the property, but not the uncalled capital.

London United Tramways, Limited.—Memoranda of satisfaction in full of a second debenture, dated Nov. 28, 1906, to secure £300,000, and of an agreement to issue debentures, dated May 10, 1907, securing an indefinite amount, have been filed.

Dolter Electric Traction, Limited (London).—Particulars of £50,000 5 per cent. debentures, created by resolution of June 27, 1907, have been filed, pursuant to Section 14 (4) of the Companies' Act, 1900. Property charged: the company's undertaking and property, present and future, including uncalled capital. No trustees.

D. Santoni and Co. (1906), Limited (Electrical and General Engineers, London).—Issue on Aug. 3 of a debenture for £110, part of series created May 31, 1907, to secure £2,750. Charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £2,640.

GLASGOW ELECTRICITY SUPPLY.

The Electricity Committee have just presented to the Glasgow Town Council the annual report of the Corporation electricity undertaking, embracing the year from June 1, 1906, to May 31, 1907. The quantity of electricity sold to private consumers during the past year was 24,677,993 units as compared with 19,921,162 units during the previous year, being an increase of 23·88 per cent. The number of consumers at May 31, 1907, was 15,497, as compared with 13,705 at May 31, 1906, being an increase of 1,792, or 13·08 per cent., during the year. There were 302 lighting consumers who consumed the equivalent of five hours or more per day of their maximum demand throughout the year, the consumption under this head amounting to 2,132,531 units in all. The total number of motors in use and supplied off the Corporation mains as at May 31, 1907, was 3,302, with a total horse-power of 19,805, as compared with 2,595, with a total horse-power of 11,954 as at May 31, 1906. The number of units consumed for power purposes was 9,758,231, of which 3,888,630 were sold at 1½d. per unit, 1,662,199 at 1d. per unit, and 4,207,402 at ¾d. per unit. The total number of arc lamps erected and in regular use in the streets as at May 31, 1907, was 837, as compared with 825 at the same date last year, and the quantity of electricity consumed for street and stair lighting was 1,655,005 units, as compared with 1,615,263 units during the preceding year. The number of 8-c.p. lamps, or the equivalent in other devices applied for, and recorded in the books of the department as being connected to the mains at May 31, 1907, was 1 404,563, as compared with 1,157,347 at the corresponding date last year, being an increase of 247,206. These figures are approximate only, as consumers make alterations without notice. The number of units consumed by private consumers, per lamp fixed, averaged out month by month, according to the date of connecting up, was 19·42 as compared with 19 last year, but this figure also cannot be taken as absolute for the reason above stated. The maximum load or demand made upon the generating stations during the year occurred on Dec. 24 last, when it was 19,646kw. as compared with 16,304 kw. last year, being an increase of 20·5 per cent. The total capital expenditure as at May 31, 1907, less depreciation written off stands at £1,587,436; the capital expenditure during the past year amounting to £261,056.

The revenue account shows favourable results, the gross revenue amounting to £244,844. 13s. 6d. and the working expenditure to £106,235. 10s. 8d. Out of the balance of £118,609. 2s. 10d. the committee had to meet the following statutory requirements: (1) interest on loans, £49,643. 4s. 11d.; (2) sinking fund, £24,141. 13s. 4d.—total, £73,784. 18s. 3d.; leaving a balance on the year's working of £44,824. 4s. 7d. From this balance there has been deducted £41,754. 18s. 7d. to meet depreciation written off capital account. The net surplus on the year's operation amounts, therefore, to £3,069. 6s., which has been transferred to the credit of the reserve fund account, now standing at £20,536. 6s. 2d.

The quantity of electricity generated and used for various purposes is shown in the following table:

	Year ending May 31. 1907		1906
Units generated	32,052,937	...	25,758,821
Sold to private consumers	24,677,993	...	19,921,162
For public lamps	1,533,166	...	1,525,505
Sold by contract	121,839	...	89,758
Used on works	2,081,919	...	1,529,148
Total accounted for	28,414,917	...	23,065,573
Percentage not accounted for	11·35	...	10·45

The following table shows the cost of working per Board of Trade unit sold:

	Year ending May 31. 1907 d.		1906 d.
Generation	·520	...	·508
Distribution	·105	...	·132
Management	·097	...	·102
Total	·722	...	·742
Rents and feu duties and taxes	·212	...	·237
Interest on loans, etc.	·452	...	·474
Sinking fund	·220	...	·224
Public lamps	·034	...	·040
Depreciation on mains, machinery, and meters	·381	...	·423
Total cost per unit sold	2·021	...	2·140
Gross receipts per unit sold	2·049	...	2·182
Balance on year's operations	+·028	...	+·042

PERSONAL.

Mr. W. E. Hart, deputy town clerk of Sheffield, has been appointed solicitor to the National Telephone Co. at a salary of £1,500 per annum.

Mr. Horace Boot, M.I.E.E., A.M.I.Mech.E., of 4, Great George-street, Westminster, S.W. (who is retained by the Tunbridge Wells Corporation as their consulting engineer), has been appointed consultant electrical engineer to prepare plans, specifications, etc., for the Chichester Electric Light and Power Co.

Mr. C. D. Greenhalgh, of Wakefield, has been appointed working assistant at the Malvern electricity works.

Mr. Richardson has been appointed acting inspector of electrical fitters in H.M. Dockyard, Portsmouth, vice Mr. McCarthy. Mr. Richardson was the chargeman employed on the electrical equipment of H.M.S. "Dreadnought," the trials of which were so successfully carried out.

The Tramway and Electric Lighting Committee of the Kirkcaldy Town Council are recommending that the salary of the burgh electrical

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engineer (Mr. O. F. Francis) be increased by £50, making his salary £350 per annum.

Mr. A. J. Stahl, electrical engineer, of the British Thomson-Houston Co., has resigned his position in order to take up on his own account an electrical engineering business in Sweden, where he is also going to represent some prominent English manufacturers, etc.

Mr. A. Wyllie, electrical engineer to the Walsall Corporation, has tendered his resignation on obtaining a similar appointment at Auckland, in New Zealand. Mr. Wyllie, whose salary in Walsall was £500 per annum, has been in charge of the Walsall electricity undertaking since its inception about 12 years ago.

Councillor Taggart, convener of the Tramways Committee, and the manager of the tramways, Mr. Pilcher, have been appointed delegates on behalf of the Aberdeen Corporation to the Municipal Tramways Association's annual conference, to be held at Manchester on Sept. 25.

The Willans and Robinson Atheltic Club at Rugby has been revived, and the inaugural sports' meeting held last week passed off very successfully. Mr. J. H. Lester has been appointed secretary to the club.

Mr. C. S. Anscomb has been promoted to the position of shift engineer at Cleveland and Durham power station. Bishop Auckland, in place of Mr. W. Burge, who is joining the staff of Messrs. Reyrolle and Co., Hebburn-on-Tyne.

Mr. A. E. Wilkins has resigned his position as chief electrical engineer at Monmouth to enter into business as an electrical engineer and contractor in Dublin. He has taken into partnership Mr. T. H. Burden.

The staff of the Wallasey Urban District Council's electricity department recently entertained to dinner Mr. J. A. Crowther, the engineer and manager, who was also presented with a framed photo of himself and a pearl scarf-pin as a mark of appreciation and respect.

APPOINTMENTS VACANT.

Science Master (Chemistry and Physics) for Grammar School, Tottenham, Middlesex. Salary £160, rising to £250. Apply to Headmaster.

Tester, etc.—Man for repairing and testing instruments for R.N. Yard, Gibraltar. Wages £2. 19s. 6d. per week. Apply to Electrical Engineer, H.M. Dockyard, Chatham. See advertisement.

Professor of Chemistry for Sydney University, New South Wales. Salary £900 per annum (pension of £400 per annum after 20 years' service). Particulars from Mr. T. A. Coghlan, Agent-General for New South Wales, 123-5, Cannon-street, London, E.C. Applications to be in by Sept. 16.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Leghorn.—The Municipality invite tenders for electric lighting. Tenders by Sept. 21.

Ovar.—The Municipality invite tenders for electric lighting of the town, to reach them by Sept. 4.

Paris.—Electric cables required for the Post and Telegraph Department, 103, Rue de Grenelle, Paris. Tenders by Sept. 30.

Swinton and Pendlebury.—Wiring public buildings for electric lighting. Tenders by Sept. 5.

Dublin.—High and low pressure cables. Particulars from City Electrical Engineer. Tenders by Sept. 9.

Beaufays.—The Mayor calls for tenders for an electrically-driven pump in connection with cement reservoir. Tenders by Sept. 14.

Madrid.—The Public Works Department invite tenders for the construction of three electric tramways in Barcelona. Tenders by Sept. 13.

Rio de Janeiro.—The Estrada do Ferro Central do Brazil invite tenders for machines and apparatus for railway workshops. Tenders by Sept. 14.

Melbourne.—One 500-kw. turbo-alternator, boilers, and other appliances are required for the State Railway of Victoria. Tenders by Sept. 23.

Brisbane.—The Postmaster-General invites tenders for telephones, cells, resistance coils, battery pole changers, operators' sets, etc. Tenders by Sept. 30.

Finchley.—The Urban District Council invite tenders for the supply of feeders, distributing mains, and other cables, network boxes, joint-boxes, etc. Particulars from Mr. E. Calvert, Electricity Works, Squire's-lane, Finchley, London, N. Tenders by Sept. 16.

Oystermouth.—The Urban District Council invite tenders for the installation of public and private electric lighting. Particulars from the District Surveyor, Mumbles, Glam.

Bexley.—The Urban District Council invite tenders for the supply of one 150-kw. tramway generator. Specification £1. 1s. Particulars from the Tramway Manager, Bexley, Kent.

Llandudno.—Tenders are invited for the supply of a battery booster, switchboard, cables, etc., by the Llandudno Pier Co. Particulars from the Secretary. Tenders by Sept. 2.

Aberdeen.—The Corporation Tramways Department invite tenders for six tramcar top deck covers. Specifications from the General Manager, Municipal Buildings. Tenders by Sept. 5.

Western Australia.—Tenders will be received at the office of the Deputy Postmaster-General, Perth, until noon on Sept. 30 for the supply of telegraph and telephone material. Deposits on tenders may be lodged at the Commonwealth Office, London.

Melbourne.—The Postmaster-General's Department invite tenders for 11 sets and a common-battery switchboard, and 3,000 subscribers telephones, etc., for the Windsor exchange. Tenders by Jan. 7.

Brisbane.—The Postmaster-General invites tenders for the supply and delivery at Brisbane of four sections of a common battery switchboard and 650 subscribers' telephones to specification No. 145. Tenders by Sept. 2.

Perth (Western Australia).—The Deputy Postmaster-General invites tenders for two desiccating apparatus, with motor-driven air-pump, for telephone cable work, and two ringing dynamometers, etc., to reach him by Sept. 6.

New South Wales.—Tenders will be received at the office of the Deputy Postmaster-General, Sydney, up to 2.30 p.m. on Oct. 23 for supply of 500 wall telephones to specification No. 183, and 100 party-line telephones to specification No. 171.

Memel.—The Harbour Construction Authority invite tenders for (1) electrically-driven tools and (2) for electric lighting for the inner harbour and station. Specifications (4s. each) from the Inspector of the Harbour Inspection Works. Tenders by Sept. 7.

Dover.—The Corporation Electricity Committee invite tenders for Welsh smokeless steam coal for the period from Oct. 1, 1907, to July 31, 1908. Particulars from Mr. L. W. Woodman, borough electrical engineer, Park-street, Dover. Tenders by Sept. 9.

Clonmel.—The District Lunatic Asylum Committee require suction gas plant and electric generators, accumulators, wiring, mains, switchboard, etc., for the new power-house which it is proposed to erect in connection with the asylum. Tenders by Sept. 7.

Victoria.—The Deputy Postmaster-General at Melbourne invites tenders for the supply and delivery of 11 sections of a branching system metallic-circuit switchboard for central exchange, Melbourne, in accordance with Victorian specification No. 146. Tenders by Oct. 8.

Manchester.—The Paving, Sewering, and Highways Committee invite tenders for laying underground telephone pipes (Contract No. 13), with other appurtenant works. Form of tender, etc., obtained on application at the Surveyor's Office, Town Hall, Manchester. Tenders by Sept. 7.

Adelaide.—The Deputy Postmaster-General for Queensland invites tenders for a common battery switchboard and 3,000 subscribers' telephones. Specification No. 166. Particulars may be obtained from the Commonwealth Offices, 72, Victoria-street, London, S.W. Tenders by Jan. 8, 1908.

Rangoon.—For pumping plant for Rangoon Municipality. Particulars, etc., of Messrs. Ogilvy, Gillanders, and Co., London agents to the Rangoon Municipality, Suncourt, 67, Cornhill, London, E.C., accompanied by a remittance of 10s., which will not be returned. Tenders to the Agents by Oct. 31.

Victoria.—The Deputy Postmaster-General at Melbourne invites tenders for the supply and delivery at Melbourne of 11 sections of a common-battery switchboard and 3,000 subscribers' telephones and other apparatus for telephone exchange, Windsor, in accordance with Victorian specification No. 148. Tenders by Jan. 7.

London, N.—The Metropolitan Asylums Board invite tenders for the supply of boilers, engines, pumps, etc., for the North-Eastern Hospital, Tottenham. Particulars from Mr. W. T. Hatch, engineer-in-chief, Embankment, London, E.C. Tenders by Sept. 4.

Cardiff.—The Guardians invite tenders for provision of telephones, necessary wiring, switchboard, etc., and alteration of present telephone service, at their Cardiff and Ely Workhouses. Particulars, etc. of Mr. Arthur J. Harris, clerk, Union Offices, Queen's-chambers, Cardiff, to be returned with specification attached by Sept. 14.

Dartford.—The Metropolitan Asylums Board invite tenders for alterations and additions to fire-alarm and telephone systems at the Gore Farm Hospital, Dartford, Kent. Specification, form of tender, etc., may be obtained at the office of the Board, Embankment, London, E.C. Tenders to be delivered at the office of the Board by 10 a.m. on Sept. 4.

Dublin.—For signalling (about 14 working levers) of the new station at Keady, for the Castleblaney, Keady, and Armagh Railway Co. Plan and specification may be seen at the office of Mr. W. H. Mills, engineer-in-chief, Great Northern Railway Co. (Ireland), Amiens-street Terminus, Dublin. Tenders to Mr. T. Morrison, secretary, Amiens-street Terminus, Dublin, by Sept. 16.

New South Wales.—With reference to an announcement inviting tenders for the supply and construction complete of a pneumatic tube service to the General Post Office, Sydney, from the Pacific Cable Board's Office, Royal and Stock Exchanges, etc., the Postmaster-General for New South Wales give notice that the date for the receipt of such tenders has been extended from July 10 to 2.30 p.m. on Wednesday, Oct. 16 next.

Croydon.—Tenders are invited for the supply of trolley wire and other overhead material for the Croydon Corporation tramways. Specification and form of tender may be obtained on application to the Tramways Manager, Tramways Depôt, Thornton Heath, Surrey, upon deposit of £1. 1s., which will be returned on receipt of a *bona fide* tender. Tenders to be sent to Mr. F. C. Lloyd, town clerk, Town Hall, Croydon, by 11 a.m. on Sept. 9.

South Australia.—The Postmaster-General, Adelaide, invites tenders for the supply of lead-covered telephone cables as follows: 7½ miles 208 pair, paper-insulated, lead-covered, 12½lb. conductors; 3½ miles 156 pair ditto; 4 miles 104 pair ditto; 2½ miles 78 pair ditto; 7 miles 52 pair ditto; 2½ miles 26 pair ditto; and 700 yards

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104 pair light lead-covered, silk and cotton insulated. Particulars may be obtained from the Commonwealth Office, London. Tenders to the Deputy Postmaster-General, Adelaide, by Sept. 25.

Erith (Kent).—The Urban District Council invite tenders for the supply and erection of the following plant at their sewage-disposal works, Manor-road, Erith: an electrically-driven air-compressor, including three-phase motor, switchgear, cable connections and pipework. Copies of the specification, etc. (£2. 2s.), from Messrs. Hawtayne and Zeden, consulting engineers, 9, Queen-street-place, London, E.C., or from Mr. Charles H. Fry, clerk, Council Offices, Bexley. Tenders by Sept. 2.

New South Wales.—Tenders will be received at the office of the Deputy Postmaster-General, Sydney, until 2.30 on Oct. 23 for supply and delivery of the following material at the Departmental Stores, Sydney: 11 tons galvanised iron wire, 400lb. per mile, as per specification No. 164; 1,600 large best white porcelain insulators, as per specification N.S.W. No. 17, and sealed pattern N.S.W. No. 5. Specifications, general conditions, and sealed patterns may be seen and tender forms obtained at the General Post Office, Sydney, Melbourne, Brisbane, and Adelaide.

Maidstone.—Tenders are invited for four electrical motors and centrifugal pumps, each capable of delivering 150 cubic feet of sewage, and three electrical motors and centrifugal pumps at 225 cubic feet per minute, together with two motor-driven air injectors, two travelling cranes, switchboard, starting switches, workshop fittings, and other appliances and connections, including a complete electric light installation, for the sewage-disposal works. Plans, etc., and form of tender from Mr. G. R. Strachan, 9, Victoria-street, Westminster, London, on and after Sept. 3. Tenders by Oct. 1. See advertisement.

Dundee.—The Electricity Committee invite tenders for the supplying and laying of (*a*) extra high-tension armoured feeder cables, laid direct in the ground; (*b*) low-tension armoured and low-tension, paper-insulated, lead-covered feeder cables and distribution cables, laid direct in the ground, and on the solid system in wood troughing. Conditions, specification, forms of tender, etc., may be had of Mr. H. Richardson, engineer-in-chief, Corporation Electricity Supply Department, Dudhope-crescent-road, Dundee. Tenders to Mr. W. H. Blyth Martin, clerk to the Corporation, City Chambers, Dundee, by Sept. 2.

Bristol.—The Electrical Committee invite tenders for the supply, delivery, and erection of one 300-kw. and two 500-kw three-phase to direct-current converters (6,000 to 500 volts) with balancers and starters; extra high-tension, alternating-current, and low-tension direct-current switchgear; 10-ton hand travelling crane. Also the supply, delivery, laying, and jointing of 24 miles (approx.) of ·05 square inch three-core paper-insulated B.O.T. sheathed lead-covered cable, together with the necessary troughing and filling; and the construction of the necessary converter station, inclusive of foundations. Tenders to Mr. H. Faraday Proctor, City Electrical Engineer's Office, Temple-back, Bristol.

Gothenburg.—The Commercial Intelligence Branch of the Board of Trade are notified by his Majesty's Consul at Gothenburg that tenders are invited for supply of the electrical equipment for the Government power station at Trollhattan, comprising three electric generators for direct current, each of 350 kw.; one accumulator battery of 4,800 ampere-hours capacity; four three-phase generators, each of a maximum of 11,000 kilovolt-amperes; 12 transmitters, each of a maximum of 3,670 kilovolt-amperes; connections; regulators; and control tables. Sealed tenders, marked "Anbud a elektrisk utrustning for Statens kraftverk," should be sent to the Managing Director of the Royal Trollhattan Canal and Waterworks, Trollhattan, Sweden, by noon on Oct. 1 next. Tenders are binding until Jan. 1, 1908. Delivery is to be completed by Sept. 1, 1909. Further information may be obtained from the Managing Director, from whom a copy of the programme can be had against a deposit of 50 kronor, which will be returned on receipt of a tender in accordance with the programme.

RESULTS OF TENDERS.

Maidstone.—The Corporation have accepted the tender of Dick, Kerr, and Co., at £7,500, for the Tovill tramway extension.

Freebridge Lynn.—The Guardians have accepted the tender of Plowright, Pratt, and Harbage, at £10. 16s., for electric bells for the workhouse.

Manchester.—An order for the complete electric lighting of the Brunswick Mill, Manchester, has been placed with the British Thomson-Houston Co.

Keighley.—The contract for the complete equipment for electric light and power for the Grove Mills has been placed with Siemens Bros. Dynamo Works.

Stalybridge.—Messrs. T. Burley and Son, of Hyde, Manchester, have secured an order for superheaters from the Stalybridge, Hyde, Mossley, and Dukinfield Electricity Board.

Maidstone.—On the recommendation of the Electricity and Light Railways Committee, the tender of Harris and Anderson for the supply of a water purifier for £290 has been accepted.

Stirling.—The Corporation have accepted the tender of Crichton and Stevenson for supply to the electricity station for one year to June 30, 1908, of Carmuir dross coal, at 9s. 8d. per ton.

Bristol.—The Electricity Committee recommend the acceptance of the tender of Bruce Peebles and Co., 1, London-wall-buildings, London, E.C., for two 500-kw. and one 300-kw. Peebles-LaCour motor converters.

Dublin.—The Corporation, on the recommendation of the Lighting Committee, have accepted the tender of Ferranti Limited for substation switchboard at £2,068. 2s. and feeder panels at £340. 5s., and the tender of the British Electric Transformer Co. for transformers at £2,320. 9s. 7d.

Winnipeg.—The City Authorities have recently accepted the following tenders for the supply of arc lighting apparatus: Canadian General Electric Co., for three 50-light C.C. transformers and panels, also 12 lightning arresters at £562; Packard Electric Co., for 100 arc lamps and cut-outs at £540.

Dundee.—The following tenders have been accepted: For (1) the construction of nearly one mile of double line of tramway, and (2) steel tramway rails, points, crossings, etc., for the Town Council: D. Horsburgh, 98, Albert-street, Dundee, construction of tramway, etc., £6,963. 19s. 11d.; P. and W. Maclellan, 129, Trongate, Glasgow, rails, £2,766. 0s. 4d.; Hadfield's Steelfoundry Co., Tinsley, Sheffield, points and crossings, £690; Bayliss, Jones, and Bayliss, Victoria Works, Wolverhampton, tie-bars, etc., £117. 10s.

New South Wales.—The Postmaster-General has accepted the following tenders: Lohmann and Co., 9, Castlereagh-street, Sydney, 50 miles vulcanised indiarubber copper wire, No. 20 S.W.G., £7. 16s. per mile; Oswald Haes, United-chambers, 2, Hunter-street, Sydney, 90 miles No. 20 S.W.G. indiarubber-insulated and paraffined cotton-covered copper wire, £2. 16s. 6d. per mile; Zwicker, Tod, and Co., 205-7, William-street, Melbourne, 50,000 best white porcelain insulators, medium, fitted with iron pins, 6½d. each, 20,000 ditto, without iron pins, 2¼d. each, 500 ditto, small, fitted with swan-neck iron pins, 3¾d. each, 1,000 ditto, fitted with straight-stem iron pins, 3¾d. each; G. R. Hodson, 58, Clarence-street, Sydney, 20,000 best white porcelain insulators, medium, fitted with iron pins, 6½d. each; Paton and Russell, 34 and 36, Market-street, Sydney, 1,600 wall telephones, complete, £3. 1s. 3d. each; their offer has also been accepted to supply 300 telephone wall sets complete, No. 345, £3. 9s. 9d. each, 200 table telephones complete, Ericsson's, magneto, for metallic circuit branching system, £3. 10s. each, 50 Ericsson's combinations for micro telephones 18s. each, and 20 at 19s. 6d. each, 100 Ericsson's junction switches, No. 450, 19s. 6d. each; J. A. Newton and Co., 380-2, Bourke-street, Melbourne, 150 coin attachments, £202. 10s.; R. B. Hungerford, Hoffnung's-chambers, 163, Pitt-street, Sydney, 1,000 metallic plugs for switchboards, 1s. 9d. each, 600 switching three-conductor multiple branching cords, W. E. Co.'s, 3s. each.

Exhaust Utilisation Plants.—The following contracts for Rateau patent exhaust steam utilisation turbo plants have been placed with Mr. P. T. Mitchell, Westminster: J. Summers and Sons, Shotton, Flintshire, 500-kw. direct-current set, 220 volts, complete with surface condensing plant, water type accumulator, and pipework; Butterley Co., Britain Colliery, near Derby, one 200-kw. direct-current set, 230 volts, complete with condensing plant, pipework, cooling plant, water type accumulator; Edinburgh Corporation, two 1,000-kw. direct-current turbo-generators; W. Beardmore and Co., Glasgow, one 1,000-kw., 230 volts, continuous-current turbo-generator condensing plant (condensing plant suitable for 2,000 kw.), piping, cooling tower, and water type accumulator; Stewarts and Lloyds, Mossend, Glasgow, one 1,000-kw. turbo-alternator, condensing plant suitable for 2,000 kw., piping, cooling tower, switchboard, overhead travelling crane, and water type accumulator; Glenarnock Iron and Steel Co., Glasgow, one 1,000-kw. turbo-generator, condensing plant, pipework, and water type accumulator; Oakdale Collieries, Argoed, Sirhowy Valley, G.W.R., one patent water type accumulator suitable for 1,000 kw. (the main contractors in this instance are Dick, Kerr, and Co.); Powell-Duffryn Steam and Coal Co., one 500-kw. three-phase turbo-alternator, condensing plant, and pipework. Repeat order: Nobel's Explosives Co., one 300-kw. turbo-generator, 220 volts (main contractors, Mirrlees, Watson, and Co.). There is at the present time over 70,000 kw. in operation or under construction.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Marseilles.—It is proposed to furnish electric lighting for the Municipal Opera House.

Desborough.—The Urban District Council have decided to establish an electrical fire alarm for the fire brigade at a cost of £45.

Weymouth.—The new telephone extension covering the whole of the Upwey and Broadwey district was opened on Friday last.

Liverpool District Lighting Co.—The directors announce an interim dividend of 2½ per cent. for the half-year ended June 30.

Greenock.—The accounts of the electricity department of the Corporation show a surplus on the year of between £200 and £300.

Maidstone.—The Rural District Council have decided to extend the main from Cornwallis-road to Tonbridge-road at an estimated cost of £160.

China.—At Chunking a cotton-cloth factory has just been opened. The looms are of Japanese make, though the motive power is not at present electricity.

Southend.—The Southend Corporation have sent an invitation to the Municipal Electrical Association to hold their annual conference at Southend next year.

Heswall.—A poll of the inhabitants is to be taken as to acceptance or rejection of the offer of the promoters of a scheme to supply the district with electricity.

Dundalk.—The Council are having a thorough inspection of the town made with a view to installing the electric light. Two schemes are under consideration, one involving a sum of £15,000 and the other £10,000.

Machinery and Engineering Exhibition.—Preparations are being rapidly pushed forward at Olympia for this exhibition, which,

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under the presidency of Sir Alexander Kennedy, will be opened on Sept. 19 next.

Bury.—The Local Government Board have sanctioned the borrowing of £8,906 by the Town Council for the provision of additional plant at the electricity works.

Dundee.—The system of electric light installed into St. Mary's Parish Church by Messrs. Maxwell, Sons, and Co. was used for the first time last Sabbath. The effect was very pleasing, and the work reflects great credit upon the contractors.

Honley.—The District Council having received strong complaints from the residents at Woodbottom owing to the deficient gas lighting of the neighbourhood, the Council have decided to replace two gas lamps in New-road side by seven electric lamps.

Electrical Measuring Instruments.—Messrs. Archibald Constable and Co. beg to announce that they will publish during the autumn a new and comprehensive work on electrical measuring instruments, recorders, meters, etc., by Mr. Kenelm Edgcumbe, M.I.E.E.

Barnstaple.—Messrs. Shapland and Petter have offered to take electric current for motor power (day load) at 1d. per unit for a minimum consumption of 50,000 units per annum, but the Town Council have replied that they cannot charge less than 1½d. per unit.

Murton Colliery.—At a special meeting of the Parish Council it was decided to fix the amount for lighting during the winter months at £110. In the past the parish has been lighted by gas lamps, but by the end of September it is expected that electric lights will be in use.

Canada.—The Northumberland and Durham Power Co. are considering the question of transmitting power to Kingston. The point of development will be Healey Falls. Messrs. Connor, Clarke, and Monds, consulting engineers, of Toronto, are making a report on the project.

Brighouse.—It is very probable that at the next meeting of the Town Council, or very soon thereafter, an agreement will be settled between the Corporation and the Yorkshire Electric Power Co., by which the latter will supply in bulk all the electricity needed in the borough.

Devonport Dockyard.—Electric searchlights are to be mounted on the fishery surveying vessel "Julia." The projector is of the 20in. diameter type, hand-worked, the mirror giving an effective range of beam of about one mile. The work is to be carried out at Devonport Dockyard.

Oldham.—At the last meeting of the Corporation Electricity Committee it was reported by the engineer that the number of lamps connected to date was 613 arc, an increase of two since the last meeting; 23,012 incandescent, an increase of 40; and 336 motors, etc., an increase of one.

Electric Underground Railways for New York.—It is proposed to construct a system of electric underground railways in the city. The scheme is estimated to cost two millions sterling, and Mr. Frick, the well-known Pittsburg steel magnate, is said to be one of its principal backers.

City of London.—From the report of the city engineer we learn that the total length of City subways is 1 mile 947 yards; gas-mains, 2 miles 693 yards; water-mains, 2 miles; electric light conduits, nearly 5 miles; pneumatic tubes, 1 mile 1,353 yards; and telegraphs and telephones, 2 miles 1,145 yards—or in all over 13 miles.

Chelmsford.—Orders to the value of nearly £30,000 have been placed with Messrs. Crompton and Co., of the Arc Works, Chelmsford. A large part of the work is for the Admiralty, and will include one of the largest alternators ever turned out by the firm. These large orders will mean full time and extra hands for some time to come.

The Short Sea-Trip Season.—The management of the New Palace Steamers announce that they are unable to accede to numerous requests that they should extend the season of running their popular and comfortable boats, the "Royal Sovereign" and "Koh-i-Noor," and the date fixed for the last trips—Monday, Sept. 9—will be adhered to.

Pontypridd.—The monthly report of the Pontypridd electrical engineer presented to the Council on Tuesday last showed a satisfactory increase in revenue. The receipts for the supply of electrical energy totalled £454. 4s. 10d., or nearly £100 in excess of the revenue for the corresponding month of last year; the wages bill showed a decrease of £50.

Hetton.—The Council have considered the scheme for electrically lighting the streets. The cost of the present lighting by gas is £1. 13s. per lamp, the electric company having tendered the best-pattern lamp for 30s. and another at 27s. The Council agreed as an experiment to place 10 electric lamps of the 27s. type between the cemetery and Hetton-le-Hole.

Lourenco Marques.—During the past year the value of electric and telegraphic materials arriving at the Portuguese port of Lourenço Marques, in South Africa, amounted to £75,267, compared with £49,344 in 1905, and £18,634 in 1904. The United Kingdom sent goods to the value of £61,278, and Germany £13,873, while the United States made up the remainder.

Italy.—It is stated by the journal *Elettricita* that the Italian Finance Minister has confirmed the agreement between the Italian Government and a private company for the exploitation of the southern Italian ore mines. The company, which has just been formed with a capital of £800,000, will erect large plant for smelting and rolling iron at Bagnoli, near Naples.

Stirling.—At the last meeting of the Council it was reported that during the four weeks ending June 8 15,888 units of electricity had been generated at the power station, as against 12,188 for the same period last year; for four weeks ending July 6 13,934 were generated, as compared with 10,624 for the corresponding period last year; for the four weeks to Aug. 3 12,779 were generated, as against 12,255 last year.

Ceylon.—The Commercial Intelligence Branch of the Board of Trade are notified by the Crown Agents for the Colonies that manufacturers of electrical supplies, plant, fittings, and measuring instruments are invited to send their latest catalogues and price lists for the use of the Government of Ceylon. The catalogues should be endorsed "Catalogues of Electrical Materials," and be addressed to the Comptroller of Government Stores, Colombo, Ceylon.

America and Wireless Telegraphy.—The American War and Navy Departments are extending their systems of wireless telegraphy extensively, and have just completed arrangements for co-operating in improving the communications in Alaska by the erection of additional wireless stations. The battleship "Kansas" is also to be fitted with the wireless apparatus, having a sending radius of 500 miles, and Seattle and San Francisco are to be similarly connected.

Birkdale.—The Birkdale Electric Supply Co. have just completed the erection of a new Deisel engine at the Birkdale electricity works, and the appliance is now in operation. The fuel used is paraffin, and the object is to avoid, as far as possible, the emission of black smoke. The Deisel engine is worked during the whole of the day, but at night resort is made to the ordinary method. The advantages of the new process from the public point of view are obvious.

Mountain Ash.—At the last meeting of the Council the Electric Lighting Committee recommended that negotiations be opened with the South Wales Power Co. as to terms for the supply of electrical energy other than that contained in the agreement of Oct. 10, 1905, and that the clerk apply to the Local Government Board for sanction to borrow the sum of £4,630 for erecting the electric lighting works necessary to save the Council's electric lighting order. The recommendation was adopted.

Canada.—The negotiations entered into some months ago by the city with the Peterborough Light and Power Co. for the purchase of the electric light plant has fallen through. The company refused to go any further with the matter unless the Ontario Hydro-Electric Power Commission agreed to sanction any agreement entered into by the ratepayers and the company. The Council have decided, therefore, to apply to the Hydro-Electric Power Commission to acquire water-power privileges and construct the necessary works to supply power.

Aberdeen.—A meeting of the Gas and Electricity Committee of the Aberdeen Town Council was held on the 26th, when the committee had under consideration a remit in connection with the readjustment of the rates charged for electricity, and an application from a number of churches in the city requesting a reduction in the rate charged to them. After deliberation, it was decided to defer the matter for further consideration in view of the exceptionally heavy charges which, it was stated, would have to be faced in the current year for coal, etc.

Dewsbury.—The Dewsbury Electricity Committee have for some time been considering the question of reducing charges for day load of electricity, and have been collecting information from several municipalities where the system of reduced day load charges is in vogue. On Thursday week the committee paid a visit to the Grimsby electricity works, and were well impressed by what they saw of the system in vogue there. It is expected that a scale of reduced charges for the day load between sunrise and sunset will be in force ere long in Dewsbury.

Telephone Extensions.—The National Telephone Co. announces that exchanges were opened at the following places during the months of July and August. The trunk telephone service is available to and from the subscribers on the exchanges, and a continuous service is given: Bexleyheath, Saddleworth, Croston, Saltford, Bitton, Grassington, Brading, Cheadle, North Walsham, Pollokshields, Brinscall, Crewkerne, Kilbarchan, Tramore, Tyn-y-Groes, Eastergate, Willenhall, Gullane, Radcliffe, Douglas, Twyford, Lockerbie. The company's system now comprises 434,236 telephone stations.

Longitude by Wireless.—One of the scientific applications of wireless telegraphy, capable of considerable extension, is the determination of longitudes. To know one's longitude on the earth it is necessary to compare the local time with that of a standard meridian. Signals sent by wireless apparatus are capable of furnishing this information where no ordinary telegraph lines exist. A comparison of the two methods made between Potsdam and Mount Brocken showed that the wireless method was trustworthy, although the aerial signals were more sensitive to atmospheric influences than those sent by wire.

Wireless Telegraphy on the Stage.—On no few occasions have electric effects been an inherent part of a play produced on the stage, and only recently we had introduced an "electric" man who mystified audiences at a well-known London theatre. Now, apparently, we are to have "wireless telegraphy" as part of the performance in a theatre, for it is announced that in one scene of Messrs. Cecil Raleigh and Henry Hamilton's new drama, "The Sins of Society," to be produced at Drury Lane Theatre on Thursday, Sept. 12, Mr. Arthur Collins will introduce this system of telegraphy "with a most dramatic effect."

Winnipeg.—The Board of Control of the city of Winnipeg has decided to abandon the city's electric lighting plant, and to purchase the current required from the street railway company. It is claimed that the purchase of the power from the street railway company will mean a saving of close upon 50 per cent. on the cost of generating it. At the present time the city is generating current for the direct-current lamps used for street-lighting. These lamps number about 200. The city also supplies the power necessary for the wells except for the fire booster at well No. 2, which is supplied by the street railway company.—*Canadian Electrical News.*

Proper Lightning Protectors.—In an address to the Royal Engineers at Chatham, Mr. Alfred Hands said that too much import-

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ance is attached to the form and composition of lightning conductors, and not enough to the fact that the efficiency depends almost entirely on the way the apparatus is attached, and little on what it is made of. Lightning conductors in the hand of experts, he said, may be likened to drugs in the hands of doctors—they must be suited to the particular case. As to the relative value of iron and copper for conductors, there is but a trifling difference, except that for conductors expected to last long iron is too perishable.

Whitehead (Antrim).—At a meeting of the ratepayers' association on the 23rd inst., Mr. George Allen, M.A., presiding, estimates for the lighting of this improving seaside place were considered. Four schemes of lighting — electricity, gas, acetylene gas, and petrolite—were submitted. The estimate for electrical lighting varied from £2,200 to £2,166; gas, £2,640 (with a capital expenditure of £3,000); acetylene, £1,326 to £1,441; and petrolite, 40 lamps at £493, with an upkeep of £75 per lamp. After considerable discussion, the schemes and estimates were referred back to the Lighting Committee for further report. Whitehead is a rising watering place on Belfast Lough.

York.—In the report of the Electricity Committee to be submitted to the next meeting of the City Council it is stated that during the month of July 78,487 units of electricity were generated, of which 63,234 were sold and 8,636 unaccounted for. The total income was estimated at £675. 18s. 1d. In consequence of the use of steam from the destructor, the cost of which for the month is put at £52. 5s. 11d., the expenditure on coal last month was only £43. 11s. 7d., as compared with £86. 5s. 1d. in July, 1906. The costs for the month totalled £411. 7s. 11d., as against £384. 19s. 10d. in the corresponding month last year, but as a greater quantity of electricity was generated this year there is really a decrease in the cost of production of ·35d. per unit.

Dorking.—The Board of Trade have written to the Council stating that they would be prepared to approve the deed of transfer under the new agreement with Messrs. Edmundson's Electricity Corporation for the transfer to the latter of the Dorking electric light order and undertaking. The seal of the Council has accordingly been affixed to the agreement for the transfer. The Council have also authorised the clerk to apply to the Local Government Board for sanction to the borrowing for the purposes of the electric light undertaking the sum of £12 000 or such lesser amount as might be actually required to pay off the outstanding debt of £11,523. 19s. 8d. due to Messrs. Edmundsons.

Huddersfield.—At the last meeting of the Council the Electricity Committee recommended the acceptance of the tender of Mr. Mark Brook for the construction of the foundation of a new turbine plant. The engineer reported that in August the number of consumers was 2,543, an increase of 10 on last month, and the number of lamps connected 185,300, an increase of 1,161. The tenders of Messrs. W. C. Holmes for exhaust-steam valves, and Mr. J. Winterbottom for painting, etc., the electricity supply station, and of Messrs. James Russell and Sons, Wednesbury, for steam-pipes, were recommended for acceptance. Mr. Hilton Walker was promoted engineer-in-charge. It was decided to apply for the Board of Trade's approval for three-phase supply at 6,600 volts transformed to 400 volts upon power users' premises. The report was adopted.

West Hartlepool.—Messrs. Furness, Withy, and Co., of West Hartlepool, have just made an important addition to their fleet in the form of a twin-screw steamer, 127ft. in length, specially designed for salving and towing purposes. The vessel has been specially strengthened for the heaviest class of work, and is fitted with a most complete set of diving plant, fitted with electric light and telephone arrangements. The vessel has also a powerful electric light installation, with searchlight, and a number of portable electric tools. The vessel's equipment also comprises four powerful centrifugal pumps, and a large quantity of other necessary gear. On her trial trip the vessel attained a mean speed of 11½ knots. She afterwards proceeded on active work in salving and removing the wreck of the s.s. "Clavering" and the s.s. "Carlo" at the mouth of the Tees, and also the s.s. "Enterprise" near Whitby.

Electricity at Durham Pits.—Three power stations have been completed at Messrs. Bolckow, Vaughan, and Co.'s Binchester, Auckland Park, and Newfield Collieries in South Durham. Each group of pits has its own central generating station, at which steam at 150lb. pressure is obtained from boilers fired with coke-oven gas. The Binchester Colliery station chiefly supplies power for use on haulage gears, whilst also a small winder and electrically-driven fans are here at work. The Auckland Park Colliery generating station supplies power for haulages, and also the pumping plant at the Shildon Lodge Colliery, some 3,000 yards distant, whilst a considerable amount of power is also used for driving fans and motors in connection with screening plant, and the station supplies power for the Black Boy Colliery. The power from the Newfield Colliery station is almost entirely utilised for pumping.

Lancaster.—At the meeting of the Electric Lighting Committee on Aug. 2, the engineer produced his statement of the cost of diverting the electric cables from under the Moss-lane level crossings over the Euston-grove Bridge, and for which the Midland Railway Co. had agreed to bear one-half the cost of such diversion. It was resolved that an account of one-half the cost be forwarded by the town clerk to the railway company. With reference to the application of Messrs T. W. Ward, Limited, for a supply of electric current for power purposes at their works on the Morecambe Harbour, it was reported correspondence had passed between Messrs. Ward and the borough electrical engineer upon the subject, and instructions were given to the engineer thereon. It was resolved that the chairman of this committee and Councillor Ashton be authorised to agree to terms for a contract for the supply of coal for the electricity works for six or twelve months, after receiving the reports of the engineer upon his tests of the coal.

A New Use for Warships.—According to the second annual report of the Meteorological Committee, issued on the 26th, a new use has been found for the ships-of-war which guard our coasts. The report says: "Further important progress has been made in the development of the daily weather service through the courtesy of the Lords Commissioners of the Admiralty, who have issued a circular letter directing the officers commanding such of his Majesty's ships and vessels as are provided with wireless telegraphic apparatus to send meteorological reports whenever they are in appropriate positions for communicating with certain of the wireless signal stations. The desirability of arranging for reports by wireless telegraphy from the sea on the north and west of our islands has been pointed out on many occasions, and notably by Sir Herbert Maxwell's Committee. The expense of such messages from Atlantic liners is prohibitive, and the committee are, therefore, specially obliged to their lordships for allowing them to make use of the facilities belonging to the navy."

The "Lusitania's" Telephone System.—In no ship has the question of intercommunication been so comprehensively dealt with as in the "Lusitania." The system adopted is that of the telephone, and so thoroughly has it been carried out that no hotel has a completer system of telephonic communication. When the vessel is alongside the stage or wharf at Liverpool, the telephonic system of the ship is connected with the central exchange, thus enabling the passenger from his own cabin to talk with London, Paris, etc. In the ship herself the central battery method of working is employed. As our readers are aware, in this system only one battery is required, and there is, of course, a central exchange controlled by an expert operator. The central battery supplies the current for signalling and speaking for all the instruments in the ship. To call the exchange it is only necessary to lift the receiver and place it to the ear. The act of lifting the receiver lights a little electric lamp on the telephone switchboard. Immediately under the lamp is placed the answering jack or switch, and when the operator inserts one of the plugs to answer the call the lamp is extinguished.

Slaby-Arco Wireless Telegraphy.—A consular report published by the Washington Bureau of Manufacture states that the Slaby-Arco system of wireless telegraphy, which is the official German system, is making rapid progress not only within but outside the empire. The number of stations equipped with apparatus of this system is now 641, or 41 per cent. of the entire list of wireless telegraphic stations, numbering 1,550. These have all been installed by one Berlin company, which controls a variety of patents in the leading countries on machines and accessories. These 641 stations are scattered over the territory or vessels of 31 different countries, and 174 are located on land. They usually command a radius of 125 miles, but in several cases this is extended to 310, 435, or even greater distances. Germany's own quota is 36, mostly located on the coasts of the Baltic and the North Sea, and it includes the great experimental station at Nauen, which commands a radius of 1,860 miles. The United States has 20 stations, Russia 17, Austria-Hungary 10, Denmark and Spain each 7, Holland 6, Norway and Sweden each 5, etc. In non-European lands the system has four stations in Argentine, six in Brazil, five in Cuba, six in Mexico, two in the Philippines, one in the Sandwich Islands. The majority of these land stations are Government property, and under the control of the postal, naval, or lighthouse services. Most of the installations are on ocean vessels. Of these, 22 are on Dutch and German steamers, while 389 are on warships. In France, Great Britain, and Italy the German system is evidently unable to meet the competition of the strongly intrenched systems under local control. In the United States, despite the active competition of the De Forest, Fessenden, Stone, and other systems, it is apparently able to secure a fair share of the installations.

TRACTION.

Llandudno.—The first trial car of the new Llandudno electric tramway last Friday made a satisfactory run.

Birstall.—The local Council are protesting against the increase in tram fares adopted by the Yorkshire (Woollen District) Tramway Co. on the road between Batley and Birstall.

Maidstone.—It is probable that the extension of the Maidstone tramway system to Tovil will be proceeded with at once, as a saving of some £2,000 on the contract will be effected if this is done.

Louth.—Consent has been given by the Lindsey Highways Committee for the construction of a tramway passing across the highway in Fotherby, from the chalk and lime company's works there.

London Tube Extension.—It is stated in the report of the Great Northern, Piccadilly, and Brompton Railway that the directors hope to open the Holborn-to-Strand section of their tube next December.

West Indies.—The Belgian consul at Batavia states that the West Indian Government are about to grant a concession for the construction of an electric tramway from Menado to Tindano, for which offers are invited.

Lucan Electric Railway Co.—The report of the directors of the Lucan Electric Railway Co. shows an available balance of £1,035, a slight increase over last year's revenue. A dividend of 5 per cent. on the preference shares has been declared.

Rochester.—The Kent County Council have agreed to contribute towards the cost of paving with wood the margins between the tramway and the kerb in connection with the proposed additional tramways on the main roads in the city of Rochester.

Aberdeen.—The Tramway and Cleansing Committees have been considering matters in connection with the cleansing of the streets by means of electric traction, and have agreed to recommend to run a car for a year, at the rate of 7d. per car mile, as an experiment.

Liverpool.—A deputation recently waited on the Finance and Traffic Sub-Committee of the Liverpool Tramways Committee to urge

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the desirability of running certain of the cars along Manchester-street and St. John's-lane. The matter is to receive consideration.

Eastbourne.—The Town Council have been memorialised against the running of motor omnibuses on the sea-front. The traffic is declared to depreciate the letting value of the property. The whole matter will probably be considered at the ensuing meeting of the Council.

The Electrobus.—It is said that the "electrobus" which has been running in London during the past six weeks has proved very successful, and that the number of these cars in use will soon be increased to 40, the first instalment towards the 300 which are promised.

Portsmouth.—The Portsmouth Tramways Committee have handed over £5,000 from the year's profits to the relief of the local rates, and the Electric Light Committee make a contribution of £3,500, or £8,500 in all. The Tramways Committee carried a total of 20,668,825 passengers during the year.

Live-Rail Accidents.—The Board of Trade has promised to prepare a return of the total number of persons injured by the "live rail" on railways in the years 1904, 1905, 1906, and the first eight months of 1907, defining in the return the number of fatal accidents and on what railway they took place.

Birmingham.—The new section of the Digbeth tramway between Rea-street and High-street is now under construction, and will probably be opened early in October. The greater part of the permanent way has been laid, but the paving has still to be done. It is proposed to run a number of the Coventry-road cars through to Saltley.

Sicily.—The Municipal Council of Palermo has granted to a Milan syndicate, composed of MM. Ugo Casalis, Ing. Andrea Laporto, and Antonio Carissimo, the concession of about 40 km. of electric tramway in the interior of the city and the suburbs. The same syndicate has obtained a concession to construct and work tramways in the popular seaside resort of Mondello.

Accrington Tramways Arbitration.—As a result of the arbitration between Haslingden and Rawtenstall Corporations and the Accrington Steam Tramways Co., Haslingden pays £12,203 for so much of the undertaking as belonged to their borough, which includes the depôt and its land. From Rawtenstall the company get £4,252. The matter is referred to in another column.

Ayr.—Messrs. Keyden, Strang, and Co. propose to proceed with the Largs and district tramway scheme in the coming session of Parliament. Last year the promoters were unable to come to any arrangement with the Ayr Road Board, and the matter was allowed to drop. They are now asking the Board to take such steps as might be necessary to have the matter proceeded with at once.

Austria.—The postal authorities at Vienna propose to experiment with electrically-driven tricycles, to be used by the postmen on their deliveries. The tricycles will not be unlike the ordinary machines except that the double wheels will be to the fore instead of at the back. The accumulators will be beneath the case in which the letters are held, and the motor, driven through belt shafting, will be fixed between this case and the wheel.

Musselburgh.—A conference was held in Musselburgh on Tuesday between the management of the Corporation tramways and the strikers on the invitation of Mr. Mackie Bryce, the official of the Board of Trade who has been investigating the dispute on behalf of the Board of Trade. The conference lasted two hours, but no settlement was come to. As a result it has been gathered the agitation will be renewed vigorously by the strikers and their friends.

Bradford.—Lieut.-Colonel Druitt, the Board of Trade inspector, paid a further visit to Bradford on Tuesday in connection with the tramway accident which occurred at the foot of Church Bank on July 31, when a number of passengers were injured. The inspector took the evidence of the driver and conductor, who at the time of his first visit were suffering too much to make their statements. His report on the accident will be made in due course.

Dresden.—For years ago the City Council of Dresden offered prizes for the most effective form of "pedestrian catcher," a device to prevent accidents from swiftly-moving tramcars in crowded streets. Over 400 specimens have been tested, and one of them, invented by a Dresden merchant, has received the first prize. It is easily attached to cars, does not get out of order, and picks up and carries along life-size leathern mannikins, living dogs, and even bottles filled with liquid.

Bury (Lancs.).—The Corporation tramway receipts from April 1 to Aug. 21 totalled £22,420, as compared with £20,390 last year, an increase of £2,030. The increase owing to the extension of the Bolton-road and Black-lane sections was £2,075. The three months during which the arrangement between Bury and Bolton for the through running of the cars was to be in operation have expired, and the respective tramway managers are now going into the matter. Instructions have been issued for the wiring of the extension of the Bury car depôt.

Spain.—The *Gaceta* of Aug. 13 contains a copy of a decree granting a concession to the Nueva Sociedad de las minas del Horcajo for the construction of a private railway for the conveyance of ore, etc., between Conquista (Córdova) and the Horcajo mines (Ciudad Real). The *Gaceta* of Aug. 15 contains a copy of a decree granting the concession for the construction of an electric tramway in San Sebastián to the Compañia del Tranvia de San Sebastián. The *Gacetas* may be seen at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, E.C.

Brighton.—The Corporation Tramway Committee have been considering suggestions from the engineer and manager (Mr. W. Marsh) with a view to effecting economies during the winter. One of the results will, it is expected, be a considerable curtailment in the number of tramcars running on the Old Steine extension route. It is rumoured that in consequence of the persistent falling off in the traffic, which last week showed a decrease of £196, and the serious financial outlook consequent upon impending renewals of the lines, the Tramway Committee are contemplating disposing of the undertaking to the British Electric Traction Co.

Canada.—The Sydney and Glace Bay Railway Co., operating the interurban railway between Sydney and Glace Bay and around the various colliery towns of the Dominion Coal Co., have decided to locate their central power station and car-barns in Glace Bay. The announcement is made that work on the new electric railway from New Westminster to Eburne is to be commenced immediately, the contract having been awarded to Mr. J. B. Bright. This road is being built by the Canadian Pacific Railway for the use of the British Columbia Electric Railway Co., and will run for nearly 10 miles along the banks of the north arm and within a short distance of the river road.

Dublin.—A dispute has arisen between the employés and the directors of the Dublin Tramways Co. The men have formulated their demands in amalgamation with the General Warehousemen, Drivers', Shopworkers', and kindred trade unions, and forwarded them to the board of directors. The latter replied declining the interference of any outsiders in the management of the company's business. The employés held a midnight meeting on Tuesday, and demanded the right to have their grievances stated to their employers by the representatives of other trade unions, and if the company would not meet their wishes they threatened to strike work yesterday (Thursday).

Puebla Tramway, Light, and Power Co.—The control of the company has been acquired by a London syndicate, headed by Sir Weetman Pearson, of S. Pearson and Son. The transaction involves the consolidation of the interests of the Anglo-Mexican Electric Co. with those of the Puebla Tramway, Light, and Power Co., all the properties of the former company, including its developed water-power plant near the city of Puebla, having been conveyed to the latter company. Under the terms of the consolidation, all the capital necessary for the extension and development of the company's undertaking is provided. Sir Weetman Pearson has been elected president, and Dr. F. S. Pearson will remain on the Board for some time.

Tramway Men's Benevolent Fund.—With regard to the proposal of Mr. McElroy, general manager of the Manchester Corporation tramways, for the establishment of a sick and benefit society for the employés of the Tramways Committee, the Manchester and Salford United Friendly Societies' Council have resolved to protest against any sick and benefit society being established on the lines suggested by the report of Mr. McElroy, as they believe that to subsidise such society from the revenues of the tramways would be unfair to the many friendly societies at work in the city. The Tramways Committee have been requested to receive a deputation from the council with reference to this matter before they arrive at a decision upon it.

Dundee.—The tramway men who were successful at their annual sports were last week presented with their prizes. The Lord Provost made a short speech at the presentation ceremony, complimenting the tramway men. He said the growth and progress of their city were due to the tramways, and he hoped they would have their manager, Mr. Fisher, at the head of them for a very long time to come. His lordship then presented the prizes to the successful competitors, while, in handing over the Speed Cup (presented by Councillor Speed, convener of the Tramway Committee) to Mr. John Fisher as being the best athlete at the games, Lord Provost Longair also presented Mr. Fisher with a gold badge.

Motor-Omnibus Losses.—The publication of the report of the London General Omnibus Co. shows a very heavy loss in working, which is attributed to bad weather and keen competition. Of course, the old excuse, competition from London County Council tramways and the electric railways, is trotted out again on this occasion. Perhaps one of the chief causes is that mentioned by the engineer of another motor-omnibus company—*i.e.*, the class of vehicles at present in use is unsuited for the work—and anyone who watches one of these 'buses rattling through the streets cannot fail to believe that the machinery is somewhere defective. The London General Omnibus Co. are opening up new and untapped routes, one of which was recently opened, and is said to be paying well.

Milan-Genoa.—The line projected to connect these towns is of a length of 136 km., and passes through 19 tunnels, one of which is 20 km. in length. The central station, comprising 24,000 kw., will be served by a waterfall. The construction will be double track, entailing a cost of 11½ million pounds. Each train, made up of three carriages, each seating 50 passengers, will weigh 150 tons, and will be drawn by a double-bogie locomotive, each furnished with four motors of 220 kw., and weighing 45 tons. The maximum speed of the trains will be 128 km. per hour and 86 km. on the inclines. Twenty passenger trains will be run each day, and every two hours there will be an express train. For the transport of goods and merchandise, from 70 to 100 trains, each having a capacity of 700 tons and comprising 30 wagons, will be run each day at a speed of 32 km. to 35 km. per hour.

The District Railway.—It is stated that a change, which will probably mean some reduction in expenses, is being contemplated on the District Railway. At present there are from two to four conductors on each train. It is proposed to reduce the number to one, and leave the passengers who desire to alight to open the gates themselves. Sliding gates will be provided, and they will be closed by porters at the various stations. An experimental train was recently run to Wimbledon at the busiest time of the evening, and the plan was found to work fairly satisfactorily. It has not yet been decided to adopt the proposed method on all the trains, but should the management do so it would mean a reduction in the number of conductors. On the other hand, the staff of porters at many stations would have to be increased. Green paint is to be used in the future for all the trains on the District Railway, this colour being cheaper and more serviceable.

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Tramway Traffics.—Auckland Electric (for 28 days ended Aug. 16), £10,063; increase, £505. Aggregate from Jan. 1, £83,769; increase, £3,473. Calcutta Tramways (week ended Aug. 26), Rs.45,322. Hong-Kong Tramways (week ended Aug. 24). 8,538dol.; increase, 1,114dol. Aggregate, 262,332dol.; increase. 36,060dol. Rio de Janeiro Tramway. Light, and Power (month of July), 548.998dol. Aggregate, 3,472,984dol. [Office note: "We are advised by cable that power from the first unit of the water-power installation at Rio das Lages will be delivered in the city of Rio de Janeiro about Oct. 15, and that two further units will be available very shortly afterwards."] Sao Paulo Tramway, Light, and Power (month of July), 160,712dol.; decrease, 2,288dol. Aggregate, 1,188,184dol.; increase, 38,257dol. Singapore Electric (week ended Aug. 21), £9,432dol.; increase, 2,090dol.

West Ham.—The Corporation tramways manager, Mr. H. E. Blain, in his third annual report says the total gross receipts were £122,881. 18s. 2d., and the working expenses £72,418. 15s. 6d., leaving a gross profit of £50,463. 2s. 8d. Out of this balance, interest and sinking fund contributions absorb £28,750. 17s. 6d., bringing the profit down to £21,712. 5s. 2d., which is the net surplus on the year's working, and which is £3,031. 14s. 7d. more than the profit for the previous year. The Corporation has placed £7,722. 8s. 10s. to the reserve fund, has carried forward £4,321. 16s. 4d., and has contributed the remainder—£9,668—in aid of the rates. During the three years the tramways have been in operation they have made a net profit of £50,485, out of which the rates have benefited to the extent of £24,668. The number of passengers carried during the past year was 35,502,836, an increase of just over four millions over the previous year.

Wakefield.—The Wakefield City Tradesmen's Association are strongly opposed to the action of the Wakefield and District Light Railways Co. in abandoning on the one hand and delaying on the other the construction of certain sections of their system in the city and district. The association have consequently sent a communication to the Board of Trade, in which they strongly object to the abandonment of the Ardsley section, referred to in the Wakefield and District Light Railway Extension Order of 1902. They also protest against the delay in carrying out the Alverthorpe section and the portion connecting Wakefield with Normanton *via* Stanley. The association say they feel that it is unfair that some of the most desirable portions of the scheme should be abandoned to the disadvantage of the Corporation, the ratepayers, the city, and neighbourhood, and regret that through an oversight this objection has not been delivered to the Board before the date mentioned in the notice. The reason for this, they say, is that the notice of the application received by them was of the most meagre kind.

Leeds.—At the Leeds Police Court last week Arthur Blundell, a tramcar driver employed by the Leeds Corporation, was charged with causing grievous bodily harm by neglect to a boy named Cartwright. The case was a sequel to an accident which occurred in Harehills-road on the evening of July 11, when a car crashed into a cart on which was Cartwright and a youth named Coldwell. A bone in one of Cartwright's toes was fractured, and the toe had to be amputated. The boy stated that about half-past five in the evening in question he was driving a horse attached to a flat cart along Harehills-road, and was going to Ashton-street. Before he crossed the road he noticed a car about 70 or 80 yards away, and coming towards him. It seemed to be "slowing down," and he thought the driver was going to stop at a stopping place. As he was crossing the road the car increased in speed, and travelled towards the cart at a furious rate. The car caught the body of the cart, and the boy was thrown out. An eye-witness of the accident was called, and gave it as his opinion that if the boy had used a little more discretion the accident would not have occurred. The defendant was committed to take his trial at the next quarter sessions, on bail.

Berlin.—Special attention is at the present time being given to the conversion of the street railway systems of Berlin and the suburbs to electric traction. The *Times Engineering Supplement* states that the State railway authorities are seriously about to apply themselves to the realisation of this long-delayed project. The first portion of the scheme will, in terms of the order promulgated, deal only with the city and circle railways and the inner suburban lines, the electrification of which will, it is expected, be completed during the next six years. The power station would, according to present plans, be located in the suburbs, and, in addition to supplying current for traction purposes, would also supply light and power over a wide industrial area. The second portion of the scheme now outlined provides for the electrification of the suburban lines of Bernau, Oranienburg, and Tegal, and other outlying routes, and it is hoped that the work of converting the whole of the lines to electric traction will be completed by the year 1920. With the increase of traffic which would accompany the improved service which electric traction would afford, track additions within the city are not improbable, but whether these would take the form of shallow underground routes or that of elevated railways is not decided. The cost of the electrification of the large mileage represented in the scheme is estimated at £9,000,000.

Keighley.—The third annual report of the Corporation tramways states that the total revenue from the undertaking for the year ended on June 30 last was £8,270, as compared with £7,659 for the previous year, representing 7·73d. per car mile, as against 6·92d. The number of passengers carried was 1,935,098, an increase of 163,124 on the year before, the number representing 46 times the population of the borough. There had been a steady increase in traffic revenue, and workmen's cars run at noon and evening had proved a great success. The number of accidents during the year was only 22, as against 49 for the previous year, and most of them had been very slight. The amount paid in compensation was £32. 10s., and the compensation fund at the end of the year was £224. 15s. 4d. The working expenses for the year totalled to £5,222. 12s., and the gross profit on the year's working was £3,048. 5s. In addition to this, £89. 15s. 11d. was received in bank interest, leaving a sum of £3,138. 1s. out of which to meet interest on loans and sinking fund charges. After meeting these charges there was still a balance of £252. 19s. At the commencement of the year the Council made a grant-in-aid from the rates of £880 to meet any loss which might accrue on the undertaking for the year. There had been no need to draw on this, but if the committee now propose to take it and the net profit on the year and transfer them to the reserve or renewals fund, which would thus be increased to £1,640. 18s.

North London.—There is some talk of considerably altering the roadway facing King's Cross Station in consequence of the extension and development of the electrification of the London County Council's northern tramway system. The *Telegraph* states that the Highways Committee of the London County Council have given some attention to a scheme which would wipe out of existence that portion of the Metropolitan Railway Station at King's Cross which is at present a stumbling block not only to tramway development, but also to rapid vehicular transit. This station occupies practically the base of an angle formed by the junction of Gray's-inn-road and Pentonville-road. Two schemes are mooted. The first is to make an entirely new junction between the Pentonville-road and the Gray's-inn-road, by making a direct cut across at that point which is at present occupied by the Metropolitan Station. This would involve bridging over the station in such a manner as to give light and air to the railway as well as adequate and convenient means of ingress and egress. From an engineering point of view, this could not present any considerable difficulties, but it would involve the formation of an island just in the place where an island was not wanted. The other scheme is to make the curve from Pentonville-road into Gray's-inn-road somewhere about the point where the Caledonian-road terminates. The County Council meets in October, but we doubt whether the matter to which our contemporary draws attention will be taken up by the Highways Committee for some time. In the meantime, we understand that the electrification of the northern portion of the Gray's-inn-road will be completed within the next six months.

Plymouth.—Mr. C. R. Everson, general manager of the Plymouth Corporation tramways, has presented his annual report for the last financial year. The number of car miles run was 695,250 by the electric cars and 25,865 by the horse cars compared with 699,235 electric and 30,429 horse cars in the previous year. The average consumption of units per car per day was 112 in 1907 and 118 in 1906, and the number of units consumed in 1907 was 938,006, and in the previous year 937,180. The average units per car mile were the same in both years—1·34. The miles run per car per annum last year was 30,224, and in the previous year 31,783. The average mileage per car per day last year was 90 on weekdays and 51½ on Sundays, and in the previous year 93½ on weekdays and 51 on Sundays. The total number of passengers carried in the year was 7,324,347, or 61½ times the population of Plymouth. The traffic revenue amounted to £31,265, and the total revenue £33,753. Including power cost and the repair of the permanent way, the working expenses totalled £23,049. The average traffic revenue was 11 05 per car mile. The number of cars in stock was 42. The average working expenses of the electric cars per car mile, excluding power cost and permanent-way repair, was 4·29d.; including power cost, 6·67d.; and including power cost and permanent way, 7·74d. The net revenue account, including the gross profit of £9,404 and £1,182 received from the Plymouth, Stonehouse and Devonport Tramway Co., showed an income of £10,703. The expenditure in dividends, interest, and stock redemption charges amounted to £3,351, leaving a net profit of £1,352. The borough treasurer's statement of capital account embodied in the return showed a capital outlay of £153,764, and assets and liabilities £199,442. The traffic returns for the five weeks ended Aug. 17 show a decided improvement. In the period covered by the return the total receipts were £3,654, compared with £3,488 in the corresponding period of last year, an increase of £166.

London County Council.—The local authorities of Leyton and West Ham are endeavouring to stir up opposition to the proposal of the London County Council to electrify the Aldgate-to-Bow tramways by means of the surface-contact system, which has been instituted with satisfactory results at Lincoln and other places in the provinces. The authority directly concerned is that of Stepney, and at the meeting of the County Council a few weeks back, when the scheme submitted by the Highways Committee was approved, subject to the necessary consent of the Board of Trade, it was stated that the proposal had been favourably received by the Stepney Borough Council. The new system, as we pointed out last week, is objected to by Leyton and West Ham, on the ground that it will be impossible for them to run their cars through to Aldgate, and, consequently, passengers will be compelled to change, as they do at present, at Bow Bridge. Pressure is being brought to bear upon the Stepney Council to accept the overhead system, as is in vogue at Leyton and West Ham so that there can be continuity of running from the Romford-road Forest Gate, to Aldgate, and from Chingford and Leyton to Aldgate. It rests entirely with Stepney, however, to place an official objection with the Board of Trade if the Borough Council desires to do so, but this is not thought likely. That authority has, all along, strongly opposed the institution of the overhead system, for the reason that it would disfigure the thoroughfares through which it would pass. The contention of the Leyton and West Ham Councils, that the cost of converting their cars to enable them to run over the surface-contact system is prohibitive, is not taken seriously at Spring-gardens. A member of Highways Committee said that, considering the great convenience to the public, the cost of fitting the cars with the necessary apparatus would be a comparatively small one, and there was no reason why the County Council should cancel its decision. Nothing further, however, can be done in the matter until the Council again meets in October after the summer recess

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Manchester.—The Manchester Tramways Committee have adopted certain recommendations of a sub-committee appointed to consider the general question of fares and stages for presentation to the City Council. Mr. M'Elroy, the general manager, in a long report to the sub-committee, states that the ordinary 1d. fare in Manchester is very low, being less than ½d. per mile; the 2d. and 3d. fares, though low as compared with the fares charged in a large number of other towns, are considerably greater per mile than the ordinary 1d. fare, and exceed the workmen's statutory limit of ½d. per mile; the number of passengers who pay fares of 2d. and upwards is only 12 per cent. of the total; the 1d. stage on the workmen's cars in the mornings is equal to ·292d. per mile, or 40 per cent. less than the statutory fare, and 90 per cent. of these passengers pay only 1d. fares. He suggested that the committee should first of all consider the ordinary 2d., 3d., and 4d. stages with a view to seeing whether it was possible to alter them, so as to bring them nearer the average rate per mile of the 1d. fares. If they determined to do anything in this direction, it was desirable that an experiment should be tried on one or two routes to ascertain the financial results before any wholesale alteration in fares was made. The sub-committee report that they consider it desirable slightly to reduce the long-distance fares, and suggest that an experiment should be tried, mentioning the Middleton route as suitable, where the present through fare of 3½d. could be reduced to 3d., and the intermediate fares over and above the first 1d. stage reduced accordingly. If this experiment proves satisfactory, through fares on the other main routes should be reduced by ½d. and proportionately on other stages after the first 1d. In the matter of workmen's cars the committee recommend that the return-ticket system should be adopted, enabling those who travel before seven o'clock in the morning to return at any time during the day of issue.

New York.—The *Times* correspondent at New York makes known some serious charges of corruption with regard to the New York tramways. He says there is every indication that the first inquiry conducted by the new Public Service Commission, formed as a result of the passage of the Public Utilities Act at the recent session of the Legislature of New York State, will lead to disclosures far worse than those of the insurance investigation. The commission is investigating the merger of traction lines in this city. Hitherto, he says, the newspapers have not been paying a great deal of attention to the subject, probably on account of its extraordinary complicated character. To understand the maze of figures involved an accountant would have to be very expert indeed, and before now men who are regarded as among the most accomplished in their profession have thrown up their hands after attempting to get to the bottom of the devices by means of which the present financial situation of the street railways of New York has been brought about. He continues: "It requires no expert, however, to understand some of the accusations which are being made. It is asserted that the cost of the electrification of one short tramway line was inflated to 6,000,000dol. (£1,200,000) a mile, and that the cost of construction of another line on which horses are still used was inflated to 2,000,000dol. (£400,000) a mile. One does not have to be an expert accountant to know that there must be rather strange bookkeeping when the salary of the president of the Inter-Borough Co. is charged to 'subway equipment,' as the investigation has shown, and when his contribution to the Civic Federation is charged to the same account. It is asserted that the books of the old Metropolitan Co. have been burned, and the assertion is not denied by counsel for the merger, while Mr. Ivins, who is examining witnesses before the Public Service Commission, declares that he has been denied access to the books of the Inter-Borough Co." If we may credit the latest reports, the matter is, indeed, more serious than expected. According to the *World*, the "water" in the New York street railway stocks amounts to 400,000,000dol. (£80,000,000). The *World* says that every step in local traction extortion has been due to corrupt control and corrupt use of political power.

PROVISIONAL PATENTS, 1907.

AUG. 19.

18670. Improvements in a method of transmitting positions of needles to a distance by means of alternate currents. Carl Meyer, 68, Alterwall, Hamburg, Germany. (Date applied for under Patents Act, 1901, Oct. 25, 1906, being date of application in Germany.) (Complete specification.)

18681. Improvements in or relating to electric arc lamps, chiefly for use in searchlight projectors. Siemens Bros. Dynamo Works, Limited, and Ernest Akehurst Holmes, 139, Queen Victoria-street, London.

18688. Improvements in incandescent electric lamps. Tom Wiseman Lowden, Westinghouse Building, Norfolk-street, London.

AUG. 20.

18742. Improvements in arc lamps. William George Heys, 51, Deansgate-arcade, Manchester. (The Scott Electrical Company, United States.) (Complete specification.)

18747. Improvements in and relating to electric ignition apparatus for internal-explosion engines. Walter Joseph Charles and Alfred Watson, Edward-street Works, Parade, Birmingham.

18778. Improvements relating to electric transformers for electromagnetic instruments. Robert Grisson, 7, Southampton-buildings, London. (Complete specification.)

18782. Improvements in or relating to surface-contact electric traction systems. Edward Albert Mitchell, 46, Lincoln's-inn-fields, London.

18788. Improvements in electrical resistance devices for the control of electrical energy. Harold Sheen Martin, 6, Lord-street, Liverpool.

18790. Improvements in and relating to electric time switches. William Henry Laird, 6, Lord-street, Liverpool. (Complete specification.)

18793. Improvements relating to double-wire overhead trolley systems. Kalman von Kando, Westinghouse Building, Norfolk-street, Strand, London. (Complete specification.)

AUG. 21.

18833. Improvements in or relating to motor controllers. Siemens Bros. Dynamo Works, Limited, 139, Queen Victoria-street, London. (Siemens-Schuckertwerke, G. m. b. H., Germany.) (Complete specification.)

18834. Improvements in or relating to friction clutches. Siemens Bros. Dynamo Works, Limited, 139, Queen Victoria-street, London. (Siemens-Schuckertwerke, G. m. b. H., Germany.) (Complete specification.)

18842. Means for receiving intelligence communicated by electric waves. Greenleaf Whittier Pickard, 65, Chancery-lane, London. (Date applied for under Patents Act, 1901, Aug. 30, 1906, being date of application in United States.) (Complete specification.)

18843. New or improved electrical switch or commutator applicable to railway signalling. Richard William Gudgeon, 60, Doughty-street, London. (Complete specification.)

18849. Improvements in and relating to the laying of underground electric cables and conductors. Albert Ernest Horatio Dussek and Angelo Sebastian Dussek, 53, Chancery-lane, London.

18868. Improvements in electric magnetic make-and-break ignition devices for explosion engines. Jean Kwapil and Otto Bihn, 6, Lord-street, Liverpool. (Complete specification.)

18881. Improvements in and relating to dynamo-electric machines. The British Thomson-Houston Company, Limited, and William Francis Dawson, 83, Cannon-street, London.

AUG. 22.

18898. Improvements in apparatus for electrodeposition of metals. Bertram Morley Bailey, Carlton-buildings, Paradise-street, Birmingham.

18900. Improvements in apparatus for producing voltaic high-current arcs. Harry Pauling, 79, Augsburgerstrasse, Berlin, Germany. (Complete specification.)

18901. Improvements in apparatus for producing voltaic high-current arcs. Harry Pauling, 79, Augsburgerstrasse, Berlin, Germany. (Complete specification.)

18921. Improvements in electric telegraph apparatus. British Insulated and Helsby Cables, Limited, and Harry Hughes Harrison, Prescot, Lancashire. (Complete specification.)

18922. Improvements relating to the production of tungsten dioxide. The Westinghouse Metal-Filament Lamp Company, Limited, Westinghouse Building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Nov. 23, 1906, being date of application in Germany.) (Complete specification.)

18923. Improvements relating to electric incandescent lamps. The Westinghouse Metal-Filament Lamp Company, Limited, Westinghouse Building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Nov. 23, 1906, being date of application in Germany.) (Complete specification.)

18924. Improvements in current-collecting devices for electrically-propelled locomotives and vehicles. Kalman von Kando, Westinghouse Building, Norfolk-street, Strand, London.

18952. Improvements in secondary or storage batteries. Sherard Osborn Cowper-Coles, 4, South-street, Finsbury London.

18955. Improvements relating to transmitters for electromagnetic waves. Alessandro Artom, 7, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Feb. 2, 1907, being date of application in Italy.) (Complete specification.)

18956. Improvements relating to the control of induction motors. Rhodes Motors, Limited, and Septimus Henry Fielden, 322, High Holborn, London.

18961. Improved method of telegraphing with currents which are weak when they arrive at the receiver. Anton Pollak, 6, Lord-street, Liverpool.

AUG. 23.

18984. Improvements in electric heating apparatus. Herbert John Dowsing, 24, Bridge-road, London.

19010. Improvements in current-collecting devices for dynamo-electric machines. Miles Walker, Westinghouse Building, Norfolk-street, Strand, London.

19027. Improved electrolytic process for the preparation of indigo dyes. Henri Chaumat, 7, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Aug. 28, 1906, being date of application in France.) (Complete specification.)

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AUG. 24.

19065. Producing electric alternating currents of high periodicity. Reinhold Rüdenberg, 224, Friedrichstrasse, Berlin, Germany. (Complete specification.)

19073. Improvements in guide and holder devices for wire in electric lighting plants. Karl Füsser, 224, Friedrichstrasse, Berlin, Germany.

19077. Improved apparatus for use in connection with electric wave telegraphy. Reginald Richard Osman, 47, Angell-road, Brixton, London. (Complete specification.)

19085. Improvements in tremblers for electric sparking apparatus. Marconi's Wireless Telegraph Company, Limited, and Clifford Mitchell, 24, Southampton-buildings, London.

19101. Electrical water heater. Delia Beauregard Rawson and Eli Edward Sager, 322, High Holborn, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Sept. 12.)

1906.

11853. Means for compensating load variations in electrical installations. Johnson. (Felten und Guilleaume-Lahmeyerwerke Act.-Ges.)

18488. Filaments for use in electric lamps, furnaces, or other apparatus. British Thomson-Houston Company. (General Electric Company.)

18489. Methods of purifying metallic compounds. British Thomson-Houston Company. (General Electric Company.)

18666. Prepayment attachments for electricity meters. Peacock.

18748. Conductive filaments for use in electric lamps or other apparatus. British Thomson-Houston Company. (General Electric Company.)

18812. Supports for metallic filaments for electric incandescent lamps. Lederer.

18817. Alternating-current dynamo-electric machinery. Scherbius.

18875. Electric incandescent lamps. Lederer.

18886. Electrodes and separators for secondary batteries. Joel.

19037. Electric ignition for explosion engines. Boult. (De Loma.)

19461. Systems of electrical distribution in which vapour electric devices are employed. Thomas. (Date applied for under International Convention, Sept. 1, 1905.)

21167. Junction boxes for electric cables. W. T. Henley's Telegraph Works Company and Nichols.

21511. Manufacture of electric conductors of refractory metal. British Thomson-Houston Company. (General Electric Company.)

21654. Manufacture of filaments for incandescence electric lamps. Johnson. (Dr. Hollefreund and Co.)

22716. Electric warming devices. Laffoon.

22717. Electrical connectors, more especially of the type used for bonding rails. British Thomson-Houston Company. (General Electric Company.)

23445. Devices for automatically stopping railway trains and the like. British Thomson-Houston Company. (General Electric Company.)

26131. Electrostatic voltmeters. Murphy, and Kelvin and James White, Limited.

27317. Device for eliminating interference between telephonic and telegraphic or low-frequency currents transmitted simultaneously over the same line. Duo.

27728. Points or switches for electric tramways working upon the slot conduit system. Spicknall and J. G. White and Co.

29050. Electrical ignition devices for internal-combustion engines. Bellamy.

1907.

327. Means of working and control of petrol-electric and electric cars. Stevens.

1100. Dynamo-electric machines. Noeggerath. (Date applied for under International Convention, Jan. 16, 1906.)

1548. Telautographic systems. Korn.

4809. Signalling in wireless telegraphy. Poulsen.

4828. Prepayment electric meters. Berland. (Date applied for under International Convention, July 10, 1906.)

5507. Connection system for alternating-current commutator type motors. Lamme. (Date applied for under International Convention, Aug. 2, 1906.)

8611. Device for connecting wires to telephone receivers. Brunnschweiler.

10230. Methods of and apparatus for refining tin electrolytically, particularly for extracting pure tin from alloys, wastages, residues, and the like, with the extraction of the foreign metals. Steiner. (Date applied for under International Convention, Feb. 1, 1907.)

14847. Electrodes for searchlights. Geb. Siemens und Co. (Date applied for under International Convention, Sept. 26, 1906.)

COMPANIES' STOCK AND SHARE LIST.

Name	Amount paid.		Last price
Commercial and Industrial.	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	—	¼-⅝
—— Ord., 1 125,000	1	..	⅛-¼
Anglo Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	5/32-9/32
British Aluminium Co., Ordinary, 2,001-40,000	5	..	4½-5¼
—— 7 per cent. Cum. Pref., 1-40,000	5	..	5-5½
—— "A" 6 per cent. Cum. Pref., 1-20,000	5	..	4¾-5¼
—— 4 per cent. Funding Certificates, 1-20,000	5	..	3¾-4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	100-103
—— 5½ per cent. Loch Leven Deb (Reg.), Red., 1-3,000	100	..	96-99
British Insulated and Helsby Cables, Ord., 1-100,000	5	—	6¾ 7¼
—— 5 per cent. Cum. Pref., 1-100,000	5	—	5⅞-6¼
—— 4½ per cent. Mortgage Debentures	100	—	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	—	87 91
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	3	—	1-1¼
—— 4 per cent. Mortgage Debenture Stock	100	—	59 64
Brush Electrical Engineering, Ordinary, Nos. 1-106,751	2	..	¼-⅜
—— Non. Cum., 6 per cent. Pref.	2	..	⅛-1¼
—— 4½ per cent. 1st Debenture Stock	100	..	88-91
—— 4½ per cent. 2nd Debenture Stock	100	—	7 -74
Callender's Cable, Debentures	100	—	105-107½
—— Ordinary	5	—	9½-10⅜
—— 5 per cent. Pref.	5	..	5¼-5⅜
Consolidated Electrical Co., Ordinary, 1-110,000	1	..	⅜-½
Crompton and Co.	3	..	1¼-2⅛ xd
—— 5 per cent. Debentures	100	—	93½-96½
Dick, Kerr, and Co., Ordinary, 1 260,000	1	..	1⅜-1⅝
—— 6 per cent. Cum. Pref., 1-305,000	1	..	1-1¼
—— 4½ per cent. Debenture Stock, Red.	100	..	101-104
Edison and Swan United, "A" Shares, 1-99,261	5	—	1¼-1⅜
—— "A" Shares, 01-017,139	5	—	2¼-2⅜
—— 5 per cent. Debentures	100	—	83-92
—— 4 per cent. Deb. Stock, Red.	100	..	83 85
Electric Construction, Nos. 1 to 112,100	2	..	5/16-7/16
—— 7 per cent. Cumulative Pref.	2	..	1¼ 1⅝
—— 4 per cent. Perp. 1st Mort Deb.	100	—	77-81
Electrolytic Alkali Co., Ordinary, 1-202,218	1	..	¼-⅜
Ferranti Limited, 6 per cent. 1st Mort. Deb. Stock, Red.	100	..	—
General Electric Company (1900), 5 per cent. Cum. Pref.	10	—	8 8½
—— 4 per cent. 1st Mort. Deb. Stock	100	—	92 96
W. T. Henley's Telegraph Works, Ordinary	5	—	11½-12½
—— 4½ per cent. Preference	5	—	5-5½
—— 4½ per cent. Debentures	100	—	105½ 107½
India Rubber, Gutta Percha, and Telegraph Works	10	—	14½ 15½
—— 4 per cent. Debentures	100	—	97-99
National Electric Construction Co., 1-170,000	1	..	27/32-31/32
Parker, Thos., Limited, Ordinary	10	—	10-10¼
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5	—	3¼-4
Telegraph Construction and Maintenance	12	—	31-33
—— 5 per cent. Bonds	100	—	99½ 02½
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	..	9½-9⅝

Electric Lighting and Supply.—

Name.	Amount paid.		Last price
	£		£
Adelaide Electric Supply Co., 6 p. c. Cum. Pref., 1-10,000	5	..	4¾-5¼
Bournemouth and Poole, Ordinary	10	—	9¾ 10¾ xd
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	—	9¾ 10¼ xd
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	—	10 .0¼ xd
—— 4½ per cent. Debenture Stock, Red.	100	—	99 1⁰2 xd
Bromley (Kent) Electric Light and Power Co.	5	—	4¾ 5¼
—— 4½ per cent. 1st Debenture Stock, Red.	100	—	98 100
Brompton and Kensington, Ordinary	5	—	7½ 8¼ xd
—— 7 per cent. Preference	5	—	7⅝ 8⅛ xd
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	—	6¾ 7¾
—— Nos. 80,001-100,000	4	—	6¼ 7¼
Cambridge Electric Supply Company, £10 Ord.	8	—	12½-13½
Canadian General Electric Co., Common Shares	$100	..	115-119
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	—	99 ·2
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	—	3¾ 3¼ xd
—— 4½ per cent. Cum. Pref., 1-80,000	5	—	2⅝ 4¼ xd
—— 4 per cent. Debenture Stock, Red.	100	—	95 98
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	—	3¼ 3¾
—— ditto (1903) 40,001-80,000	5	—	3¼-4¼
Chelsea Electricity Supply	5	—	3¼-4¼
—— 4½ per cent. Debentures	100	—	101-104
Chicago Edison Co, 1st Mt. 5 p. c. 30-yr. Gld. Bds, Red., 1-1,200	$1000	..	98-101
City of London, Ordinary	10	—	9- 0
—— 6 per cent. Cumulative Pref.	10	—	10¾- 1⅜
—— 5 per cent. Debenture Stock	100	—	121-124
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	—	96-99
City of Wellington Electric Light and Power Co, 5 per cent. Registered 1st Debs., Red., 1-1,650	50	—	50-53
Cordoba Light and Power Co., 1st Mt Stl. 5 per cent. Bds., Red., 1-1,000	100	..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5	..	4¼-5
—— 5 per cent. Preference, 1-50,000	5	..	4¼-5
County of London Electric Supply, Ordinary	10	—	7-8
—— 6 per cent. Cum. Pref.	10	—	10¼-11¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	—	105-109
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	—	94-97
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5	—	½-1
—— 6 per cent. Cum. Pref.	5	—	1½-2
—— 4½ per cent. First Mort. Deb	100	—	76 81
Electrical Development Co of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, 0,751-15,750	—	..	77-79 p.c.
Electric Lt & Traction Co of Aust., 6 p c Cm Pf, 1 30,000	5	—	2¼ 2⅝
5 per cent Debenture Stock Red	100	—	85¼ 89½
Electric Supply Co of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red	100	—	94½ 96½
Folkestone Electric Supply, Ord. Nos. 1-10,000	5	—	4¾-5¼
—— 4½ per cent First Deb. Stock, Red.	100	—	96-99
Hove Electric Lighting, Ord., 1-13,000	5	—	6¾-7¼
Indian Electric Supply and Traction Co, 6 per cent. Construction Deb. Stock, Red.	100	..	103-106
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Deb. Stk. Red.	100	—	94-97
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	—	—
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5	—	8¼-8½
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	—	94-97
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9⅜-10⅛
London Electric, Ordinary	2	—	1⅜ 1⅝
—— 6 per cent. Pref.	5	—	4¼-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	92-95

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Name.	Amount paid. £		Last price £
Madras Electric Supply Corporation, 5 per cent. Construction Deb. Stock., Red. (Prov. Certs.), all paid	100	..	94-97
Metropolitan Ordinary, 100,001-300,000	5	—	5¼ 6¼
—— 4½ per cent. First Mortgage Debenture Stock	100	—	105-107
—— 4½ per cent. Cum. Pref.	5	—	4⅞ 5¼
—— 3½ per cent. Mortgage Debenture, Red.	100	—	87 89
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds., 1935, C 1-1,000 ($100), D 1-2,000 ($500), M 1-4,400 ($1,000)	—	..	73·75 p.c.
Mexican Light and Power Co., Capital Stock	$100	..	4¾-5¼
—— 5 per cent 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14,000 ($1,000)	—	..	80-82
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	—	95-98
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,000	5	—	6¼ 7
—— do., 57,001-75,000	5	—	6¼-7
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid)	5	—	6½ 7
—— 5 per cent. Pref., 1-57,000	5	—	5 5½
—— do., 75,001-87,500 (issued at 10s. prem., 4s. paid)	5	..	5-5¼
Notting Hill Electric Lighting	10	—	11 12
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	—	96 99
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	—	5¼ 6⅜
—— 4 per cent. Debenture Stock	100	—	95 97
River Plate Electricity Co., Ord., 1-119,687 & 120,501-120,507	1	..	⅞-¾
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	..	⅝-1
—— 4 per cent. Debenture Stock, Red.	100	..	95-98
Rosario Electric Co., 6 per cent. Cum. Pref., 1-20,000	5	..	5-5¼
—— 6 per cent. Cum. 2nd Pref., 1-15,000	5	..	5-5¼
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	—	96 98
Shawinigan Water and Power Co., 5 p c. Cons. 1st Mt. Bds.	—	..	99 101 p.c.
Smithfield Markets Electric Supply, Ord. 1-12,000	5	—	½-1½
—— 4 per cent. Debenture Stock	100	—	71-75
South London, Ordinary	5	—	2-2½
South Metropolitan Electric Light and Power, Ord.	1	—	⅝ ¾
—— 7 per cent. Cum. Pref.	1	—	1 1/16-1 5/16
—— 4½ per cent. 1st Mort. Deb.	100	—	100-103
St. James's and Pall Mall, Ordinary, 101-20,080	5	—	7⅜ 8⅜
—— 7 per cent. Pref.	5	—	6⅜ 7⅜
—— 3½ per cent. Deb.	100	—	86 91
Urban Electric Supply Co., Ordinary, 8-30-007	5	—	1½ 2¼
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	—	2-3
Westminster, Ordinary	5	—	8¼ 9½ xd
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	—	5-5⅛

Electric Tramways.—

Name.	Amount paid. £		Last price. £
Anglo-Argentine, 5½ per cent. Cum. Pref., 1-260,007	5	—	6-6¼
—— Ord.	5	—	8 8¼
—— Permanent 6 per cent. Debenture Stock, 1888	100	—	131-134
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	—	102-106
Barcelona Tramways, Ord., 1-20,000	10	—	—
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	—	—
—— 5 per cent. Deb., Red., 1-600	100	—	—
—— 4½ per cent. Red. Deb. Stock	100	—	—
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1	—	¾ ⅞
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	—	13/16-15/16
Birmingham and Midland Trams., 4½ p c. 1st Db. Stk., Red.	100	..	94-97
Blackpool and Fleetwood Tramroad	10	—	13⅜-13⅝
Bombay Elec. Supply & Trams. Co., 6 per cent. Cum. Pref.	8	..	7⅜-8⅛
—— 4½ per cent. Deb Stock, Red.	100	..	94-96
Brisbane Tramway Invest., Ord., 1-75,000	5	—	3 3/16 3 7/16
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	—	4¼-5⅛
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	—	96-100
British Columbia Electric Railway Co., Ord. Def.	100	—	127-128
—— Ord. Pref.	100	—	110-114
—— 5 per cent. Cum. Perpetual Pref. Stock	100	—	103-106
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each	40	—	100-103
—— 4½ per cent. Vancouver Power Deb.	100	—	100-102
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	—	2¼ 2⅜
—— 6 per cent. Cm. Pf., 30,001-60,000	10	—	6¼-7 xd
—— 5 per cent. Perpetual Debenture Stock	100	—	100-103
—— 4½ per cent. 2nd Deb. Stock	100	—	78-81
Buenos Ayres and Belgrano Trams.	5	—	4⅛-4⅜
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	—	4⅜-4½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	4⅜-4½
—— 5 per cent. Deb. Stock, Red.	100	—	106-110
—— Prov. Cert., all paid	100	—	100-103
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100	—	92-97
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb. Bonds, Red., 1-1,500	100	..	99-103
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	..	100-105
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	93-96
Calcutta Tramways, 1-105,000	5	—	7½ 8
—— 105,001-137,610	5	—	5¼ 5⅝
—— 4½ per cent. 1st Deb. Stock, Red.	100	—	102 106
Cape Electric Tramways, Nos. 1-480,000	1	—	5/16 7/16
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	—	4¾ 5
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100	—	98 101
City of Buenos Ayres Trams. Co. (1904) 1-248,000	5	..	5¼-5⅜ xd
—— 4 per cent. Deb. Stock, Red. 1985	100	..	97-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	00	—	94 98
Cork Electric Tramway and Lighting Co., Ordinary	10	—	13¼-13½
—— 6 per cent. Cum. Pref.	10	—	13-14
—— 4 per cent. Debentures	100	—	98-101
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	—	12⅜-13⅜
—— 6 per cent. Pref., Nos. within 1-60,000	10	—	12⅜-13⅜
—— 3½ per cent. Mort. Debs., 1-3,000 Red.	100	—	93-97
Hastings and Dist Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100	..	98-101
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6,957	$1,000	—	82 87
Imperial Tramways, Ordinary	all	—	18-19
—— 6 per cent. Cum. Pref.	all	—	14-14¼
—— 4½ per cent. Deb. Stock	100	—	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5	—	1 1¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	—	66 71
Kalgoorlie Electric Tramways, 1-250,000	1	..	5/32-5/32
—— 5 per cent. "A" Deb. Stock	100	..	89-93
—— 6 per cent. "B" Deb. Stock	100	..	78-82
Kidderminster and District Lighting and Traction, Pref.	5	—	8-8½
Lancashire United Tramways Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	—	94-97
—— £296,500 2nd Mort. Deb Stock	—	—	—
—— £83,330 Deferred Deb. Stock (all fully paid)	—	—	—
Lisbon Electric Tramways Limited, Ord., Nos. 1-594,188	1	..	1 1/16-1 5/16
—— 6 per cent. Cum. Pref., Nos. 1-425,553	1	..	1 1/16-1 3/16
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100	..	95-98
London United Trys. (1901), 5 per cent. Cum. Pref.	10	—	7⅜-8⅜
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	—	84-88
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Rd.	100	—	96-99
Manila Elec. R.R. and Lghtg. Corp., 5 p.c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000	..	90-92 xd
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 23,436-25,000	5	..	4⅜-5¼
—— 4½ per cent. 1st Mort Deb. Stock, Red.	100	..	97-100
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	—	3/32 5/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	—	27,32-31/32
—— 4½ per cent. Deb. Stock, Red.	100	—	84-87
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	—	..	81-83 p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	—	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 601-2,000 (1922)	100	—	101-103
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	—	⅜-1⅜
Oldham, Ashton, and Hyde Tramway, Ordinary	10	—	12
—— 5 per cent. Cum. Pref.	10	—	8⅜-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100	—	100-104
Potteries Electric Traction, Ordinary, 1-245,000	1	—	5/16-9/16
—— 5 per cent. Cum. Pref., 300,001-545,000	1	—	⅛ ⅜ xd
—— 4½ per cent. Debenture Stock	100	—	95 98
Provincial Tramways Co., Ordinary, 1-24,912	10	..	4½-5
—— 6 per cent Cum. Pref., 1-10,000	10	..	10¼-11¼
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-30,000	5	..	5¼-5⅝
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	97-99
Sao Paulo Tramway, Light, and Power Co.	$100	..	113-118
—— 5 per cent. 1st Mort. Deb., Red. 1929, 1-11,000	$500	..	92-94 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent. Cum. Pref., 19,671-169,570, Prov. Certs.	1	..	⅛-1
—— 4 per cent. Deb. Stock, Red. 1940	100	..	80-84
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs, Red., 1-1,600	100	..	84-88
Yorkshire (West Riding) Elec. Tram Co., Ord., 70,001-110,000	5	..	1-1½
—— 6 per cent. Cum. Pref., 1-46,261	5	..	3¼-3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	87-90

Electric Railways.—

Name	Amount paid. £		Last price £
Central London, Ordinary	100	—	71-73 xd
—— 4 per cent. Pref.	100	—	83-91 xd
—— " " deferred	100	—	53-56
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	—	102-106
City and South London, Consolidated Ordinary	100	...	44-46 xd
—— 4 per cent. Debenture Stock	100		102-105
—— 5 per cent. Pref. Stock '91	100	—	117-121
—— " " " '95	100	—	115-118
—— " " " '01	100	—	110-113
Liverpool Overhead, 5 per cent. Pref.	10	—	10-10¼
—— Ordinary, 1-50,000	10	—	3⅜-4¼
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	—	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	...	64-67

Telegraphs and Telephones.—

Name.	Amount paid. £		Last price. £
Amazon Telegraph Co., 1-25,000	10	..	3-3¼
—— 5 per cent. Debs., Red., within 1-1,069	100	..	85-88
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000	$1,000	..	90-92
Anglo-American Telegraph Co., Ordinary	100	..	60-63
—— 6 per cent Preferred Ordinary	100	...	105-106
—— Deferred Ordinary	100	...	16¼-17⅛
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort Deb. Stock, Red.	100	...	101-104
Chili Telephone Co., 1-44,000	5	...	6-7¼
Commercial Cable Co., Ster. 500-year 4 p.c. Deb Stk., Red.	100	...	92-94
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	...	7-8
—— 10 per cent. Preference, 1-6,000	10	...	15⅜-16⅜
Direct Spanish Telegraph Co., Ordinary	5	...	3⅛-3⅜
—— 10 per cent. Cum. Preference	5	...	9-9¼
—— 4½ per cent. Debs., 1-600	50	...	98-101
Direct United States Cable Co.	20	...	14⅜-15½
Direct West India Cable Co., 4½ per cent. Debs., Reg. within 1-1,200, Red.	100	...	99½-101½
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1959	100	...	97½-100½
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8,000, 1913	£5	...	98½-100½
Eastern Extension, Australasia and China, 1-300,000	10	...	12⅜-13½
—— 4 per cent. Mort. Deb. Stock, Perp.	100	...	102-104
Eastern Telegraph Co., Ordinary Stock	100	...	132-137
—— 3½ per cent. Preference Stock	100	...	86-88
—— 4 per cent. Mortgage Debenture Stock	100	...	103-105
Great Northern Telegraph Co. (of Copenhagen)	10	...	34-36
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1,200, Red.	100	...	99½-101½
Indo-European Telegraph Co.	25	...	56-58
Marconi's Wireless Telegraph Co., 1-256,127	1	...	⅛-¼
—— 256,128-384,190	1	...	⅛-¼
Monte Video Telephone Co., Ordinary, 1-72,680	1	..	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492		...	¾-1
National Telephone, Preferred	100	...	106-108
—— Deferred Stock	100	—	106-107
—— 6 per cent. Cum. First Pref.	10	—	11-13
—— 6 per cent. Cum. Second Pref.	10	—	10-12
—— 5 per cent. Non. Cum. Third Pref.	5	—	5¼-5½
—— 3½ per cent. Deb. Stock, Red.	100	—	96-98
—— 4 per cent. Deb. Stock, Red.	100	—	101-103
Oriental Telephone and Electric Company	1	..	1¼-1⅜
—— 6 per cent. Cum. Pref.	1	..	1 3/16 1 5/16
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100	...	97-100
United River Plate Tele. Co., Ordinary, 1-100,000	5	...	6⅜-7¼
—— 5 per cent. Cum. Pref., 1-40,000	5	...	5-5½
—— 5 per cent. Debenture Stock, Red.	100	...	—
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	...	98-101
West African Telegraph Co.	10	...	10-10¼
West Coast of America, 1-30,000 and 53,001-53,008	2½	...	1¼-1⅜
—— 4 p.c. Debs., 1-1,500, Gua. by Western Telegraph	100	...	97-100
West India and Panama Telegraph Co., Ordinary	10	...	7/16 9/16
—— 6 per cent. Cum. 1st Preference	10	...	7¼-7½
—— 6 per cent. Cum. 2nd Preference	10	...	6¼-7¼
—— 5 per cent. Debs., Red., 1-800	100	...	99-102
Western Telegraph Co., 1-207,930	10	...	13-13⅛
—— 4 per cent. Debenture Stock, Red.	100	...	100-103

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1907.	1906.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pass'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Aug 31	1,639	1,673	− 33	— h	25½	25	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	,, 24	420	405	+ 15	—	8	8	,, 15	14,388	3,316,380	353,945	1	9·71	1,830	5·16
Baker Street and Waterloo Ry.	,, 24	2,070	1,155	+ 915	+ 8,183	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 25	1,058	1,118	− 60	− 440	23·53	3·53	March 31	55,025	11,145,531	1,309,903	1·18	10·08	2,338b	6·03
Birmingham Corporation	,, 24	6,093	—	—	—	56½	—	,, 31	17,133	4,709,788	256,526	·86	14·5	8,866	—
Blackburn Corporation	,, 21	1,170	1,076	+ 94	+ 1,097	24	24	,, 25	48,875	8,661,729	986,953	1·35	11·69	2,036	7·44
Blackpool Corporation	,, 23	3,721	3,235	− 212	− 1,902	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	,, 24	2,183	2,242	− 59	− 984	16½	16½	Dec. 31	31,846	2,325,677	57d,264	3·28	13 19	—	7·27
Bolton Corporation	,, 25	2,360	2,388	− 28	+ 2,677	42	40	March 31	95,766	20,205,196	2,161,130	1·13	10·63	2,394	6·14
Bournemouth Corporation	,, 21	3,672	2,539	+ 163	+ 1,179	17·41	16·82	,, 31	55,276	10,058,288	1,121,623	1·32	11·83	3,226	7·19
Bradford Corporation	,, 24	4,995	4,783	+ 213	+ 508	95	95	,, 31	230,085	47,108,000	5,053,392	1·172	10·927	2,395	—
Brighton Corporation	,, 25	1,241	1,388	− 147	− 2,421	9½	9½	,, 31	50,339	11,321,160	1,152,828	1·06	10·48	2,914·8	8·0·4
Bristol Tramway Company	,, 23	5,275	5,404	− 129	—	51½	51½	Dec. 31	259,799	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	,, 21	1,305	1,220	+ 85	—	40	40	March 31	57,932	11,092,704	1,197,772	1·31	11 61	5,388	8·17
Burton Corporation	,, 25	330	318	+ 12	—	8½	8½	,, 31	17 950	3,878,269	454,082	1·07	9·21	2,068	6·76
Cardiff Corporation	—	—	—	—	—	32 62	†32·26	,, 31	112,209	24,134,363	2,770,049	1·12	9·72	3,782	9·44
Carlisle Tramways Company	,, 24	187	208	− 21	− 434	8·5	8·5	Dec 31	10 713	2,935 002	359,756	—	7·14	—	5 18
Central London Railway	,, 24	4,305	4,979	− 674	− 3,940	6	6	,, 31	347,588	4,875,547	1,261,214	1 86	65·10	57,931	35·80
Charing X, Euston, & Hamp. Ry.	,, 24	2,270	2,320	− 50	—	8	—	—	—	—	—	—	—	—	
City and South London Railway.	,, 25	3,064	2,285	+ 779	+ 5,260	6½	6½	,, 31	—	—	—	—	—	—	—
Colchester Corporation	May 8	195	195	—	—	8	8	March 31	10,588	2,457,553	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	Aug. 22	511	544	− 33	—	15½	15½	Dec 31	24,895	5,814,376	882,256	1 01	6·64	—	4 69
Darwen Corporation	,, 23	253	280	− 17	− 27	7 23	7·23	March 31	—	—	—	—	—	—	
Dover Corporation	,, 24	306	356	− 60	− 784	4½	4½	,, 31	11,250	2 853,200	284,343	·94	9·49	2,500	
Dublin and Lucan Electric Ry.	,, 24	170	153	+ 17	+ 73h	6½	6½	Dec 31	6,358	402,611	113,738	3·79	13·78	942	7·33
Dublin U.T.	,, 23	7,627	5,713	+1,914	+14,227	48½	48½	,, 31	267,489	50,050,949	7,077,372	1·18	9·07	691	5·55
Dundee City Tramways	,, 21	1,155	1,102	+ 53	+ 408	22	22	May 15	50,154	13 086 396	1,005 911	·906	11·96	2,180	7·42
East Ham Corporation	,, 24	924	980	+ 56	+ 411	14	14	March 31	56,652	3,689,658	863,816	·64	10 18	2,934	6 79
Glasgow Corporation	,, 21	17,200	17,002	+ 198	— h	79½	79½	May 31	756 490	195,767,519	17,946,595	—	10 12		—
Gloucester Corporation	July 10	278	304	− 26	—	15	15	March 31	15,465	3,902,077	563,595	·60	6·58	959	5·32
G.N., Piccadilly, and Brompton	Aug. 24	3,5.0	—	—	—	9	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	37	37	,, 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 21	1,672	1,518	+ 114	+ 1,444	35	35	,, 31	63,938	12 838,150	1 665,262	1·24	9·71	1,923	—
Hull Corporation	,, 24	2,405	2,282	+ 123	+ 2,502	26	26	,, 31	112,651	27,104,921	2,910,698	1	9 29	—	—
Ilford Corporation	—	—	—	—	—	10½	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 21	147	143	+ 4	+ 170	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	11,586	3,626,656	419,800	·737	6 62	1,480	5 22
Lancashire United Tramways	,, 21	1,555	1,309	+ 246	+10,812	38½	28	—	—	—	—	—	—	—	—
Leeds Corporation	,, 26	4,595	4,522	+ 73	+ 2,243	89½	89½	March 25	298,233	64,223 666	7,121,038	1 10	10·02	351	—
Leicester Corporation	,, 24	2,121	2,232	− 111	—	42	42	Dec. 31	26,011	12 039,252	1,229,507	1	9·79	—	4 82
Liverpool Corporation	,, 17	11,153	10,842	+ 311	+ 7,353	104	104	,, 31	547 625	115,642 663	12 166 419	—	—	—	—
Liverpool Overhead Railway	,, 25	1,573	1,537	+ 36	+ 1,007h	6·65	6 65	June 30	81,302	11,171,865	1,024,275	—	—	—	—
London County Council	,, 17	31,257	24,519	+6,748	—	98	98	—	—	—	—	—	—	—	—
Lowestoft Corporation	—	—	—	—	—	6	6	Sept. 30	14,511	3,128 857	359,435	1 08	9·68	2,630	6 48
Maidstone Corporation	—	—	—	—	—	2	2	March 31	4,740	850 121	112,227	1·33	10 13	2,370	
Manchester Corporation	,, 24	15,272	14 783	+ 489	+23,936	149	149	,, 31	631,956	126,800,875	14,123,124	1·19	10·73	4,299	6 99
Metropolitan District Railway	,, 25	6,106	6,463	+ 143	+ 470	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 25	13,793	13,426	+ 367	+ 3,796	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 21	154	149	+ 5	+ 61	2½	2½	,, 31	6.159	1,992,647	206,358	·82	7 14	2,239	—
Newcastle-on-Tyne Corporation	,, 24	3,955	4,000	− 45	+ 491	50	50	,, 31	197,849	43,061,934	4,326,152	1 07	.0·98	3,957	7·0
Newport (Mon.) Corporation	June 29	639	628	+ 11	+ 1,397	15½	15½	,, 31	30.356	7,252,535	783 435	—	9 29	—	6·4
Oldham Corporation	—	—	—	—	—	34	34	,, 25	65 563	15,466,245	1,504,740	1 16	10·45	1,886	—
Portsmouth Corporation	May 21	2,330	1 578	+ 752	+ 632	28½	28½	,, 31	95,702	19,625,329	197,499	1·17	11 63	—	—
Reading Corporation	Aug. 22	691	690	+ 1	+ 580	33½	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	11·29	21·29	,, 31	14,881	2,837,110	386,547	1·24	9·24	1,102	7 82
Rotherham Corporation	—	—	—	—	—	9½	9½	,, 31	23,563	5 251,472	593,054	1 07	9·53	2,612	7·49
Salford Corporation	,, 19	4,900	4,512	+ 358	+ 2,170	70½	70½	,, 31	214,111	39,213 560	4,894,590	1·28	10 29	—	—
Scarborough Tramways Co.	—	—	—	—	—	4½	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 25	5,653	5,639	+ 19	+ 5,264	35½	35½	,, 25	210,515	63 952,283	,049,899	·903	9 543	3,653	6·477
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,365	9 294,771	1,108,369	1·27	11·02	—	7·83
Southend-on-Sea Corporation	,, 21	735	740	− 5	− 367	9	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	,, 31	39,550	6,766,031	1,027,730	—	9 23	—	4·75
Sunderland Corporation	,, 4	1,560	1,692	− 131	− 272	21	20	,, 31	64,858	15,364 463	1 495,785	1·004	10·36	—	6·37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	4,937	1,315,757	102,751	0·87	11 53	1,371	—
Torquay Tramways	Aug 15	356	—	—	—	5 16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 24	947	994	− 47	—	13 68	12·43	,, 31	43,607	7,995,451	862,123	9·27	12·14	3,132	7·50
Warrington Corporation	—	—	—	—	—	9	9	,, 31	17,0.7	4,418 225	403 363	—	9 85	—	6·33
West Ham Corporation	,, 22	2,212	2,308	− 95	+ 1,222	14·7	14 7	,, 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	,, 21	920	917	+ 3	—	20	20	,, 31	41,905	8,847,066	960,338	—	10·583	2,062	6·15

† And 98 miles of interlacing track. a Train mile. b Per mile of single track. h Half-year's figures. k Double track

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NOTES.

Electrification of the Rand.—Sir Charles Metcalfe, Bart., of Sir Douglas Fox and Partners, consulting engineer to the Rhodesia Railways, arrived at Southampton on Saturday last, from South Africa, on the Union Castle liner "Armadale Castle." Interviewed on his arrival, Sir Charles Metcalfe stated that during the visit which he has just paid to South Africa, he has been most largely engaged with a personal survey of the railway routes into Rhodesia from the east and west coasts. He has also visited Johannesburg on two occasions with regard to the project for the electrification of the Rand. Sir Charles stated that great progress had been made with the scheme. The Victoria Falls Power Company, of which he was one of the consulting engineers, had not only secured further valuable contracts since the flotation of the company, but they had also been of considerable service to the Johannesburg municipality in the difficulties they had encountered with regard to the municipal electrical scheme. As a result of the goodwill thus obtained and the new contracts, the prospects of the company were of the brightest.

Electro-Chemistry.—A concrete example of the value of a high load factor to electric generating stations is afforded by the announcement made in the *Manchester Guardian* that the British Carbide Factories, Limited, are about to build a carbide factory close to the power station at Thornhill of the Yorkshire Electric Power Company. The Carbide Company will obtain electric power from the Power Company, but will only take the surplus power, the station load being kept at or near some predetermined value. Ordinary customers will take their supply as they need it, and the surplus will be sold to the Carbide Company at, we may be sure, a very low price. Unless the carbide process is allowed to follow the fluctuations of load on the power station, the factory will require a good deal of spare plant. In any case a continuous electro-chemical process is the ideal condition for economical home generation of current, and the price for purchased current must be remarkably low if it is to compete. If the chemical process is allowed to fluctuate in order to accommodate the power station, it is difficult to see how the final cost of production can be as small as it would be with continuous production using current from a works generating station.

The Quebec Bridge Disaster.—The news of the collapse of the superstructure of the southern section of the mammoth bridge under construction across the River St. Lawrence, nine miles above Quebec, evoked deep regret in every section of the engineering community, and served to bring vividly home the great task of the engineer who is engaged in the practical applications of science. Various theories have been put forward as to the probable cause of the disaster, but remembering how misleading and wide of the mark have been the theories hazarded on occasions of previous disasters, we prefer to await the official report which will in due course be issued by a commission of experts to be appointed to investigate the matter. From the numerous accounts of the constructional work in connection with the bridge which have been published within the past few days, it will be gathered that the structure was designed to be one of the largest of its type in the world. The bridge is 2,800ft. long between the anchorages, and is to have a total width of 82ft. When completed it is to carry two electric car tracks as well as two railroad tracks and two highways. The entire work of erecting the bridge is being performed by electric power. The work is being conducted from the shore ends without the use of any false work. Two steel travellers are doing the work of placing the bridge members in place. One traveller rests upon the bridge deck and extends over the end of the cantilever, being moved forward as fast as the parts it handles are put into place. The other traveller is suspended between the bridge deck, with its upright parts rising more than 300ft. above the ground, so as to pass on either side and above the tops of the towers above the bridge, each of which is 300ft. high. Each of the two electric hoists with which the traveller is equipped has drums 40in. in diameter and 50in. on the face, and capable of lifting 20,000lb. on a single line. They have handled single bridge parts weighing 100 tons.

Electricity in Coal Mines.—A new danger in coal mines was brought to public notice at Houghton-le-Spring police court, county Durham, last week, when a miner was summoned for a breach of the special rules enforced under the provisions of the Mines Regulation Act by the Dorothea Pit, Philadelphia, owned by the Lambton Coal Company. The firm owns 11 large collieries, and have recently installed electric power on a large scale to drive their machinery. Defendant had charge of an electric coal-cutter in the workings, and while he was operating it the current failed. In order to ascertain the cause, and contrary to the regulations, he opened a switchbox, removed a portion of the mechanism, and introduced a piece of wire. The result was a blinding flash, which destroyed the terminals and illuminated the whole pit. The manager of the colliery stated that a serious explosion might have resulted, as they had been troubled with fire-damp of late, and had had to withdraw workmen from this portion of the mine in consequence. Defendant pleaded ignorance, but he was very smartly punished by the magistrates, who inflicted a fine of 20s. and costs. We hope this penalty will act as a deterrent to others who through careless handling of apparatus entrusted to their charge endanger many lives and property.

Wireless Telegraphy in the Navy.—The Admiralty announce that they have approved the establishment of a separate branch for conducting wireless telegraphy in his Majesty's fleet. This branch will be exclusively for wire less telegraphy duties, and will be quite distinct from the visual signalling branch. It will work under the torpedo officer in the wireless room, and with the electrical party when not required in the wireless room. The ratings composing the wireless branch will be of the seaman class their titles and pay per diem being as follows: boy telegraphist, 7d.; ordinary telegraphist, 1s. 3d.; telegraphist, 1s. 11d.; leading telegraphist, 2s. 1d.; petty officer, 3s., and after six years 3s. 6d.; chief petty officer, 3s. 10d, and after three years 4s. 2d., and after six years 4s. 6d. Ultimately a limited number of warrant officers, commissioned warrant officers, and lieutenants will be promoted from the telegraphists' ratings. As a consequence of the separation of wireless operators from the ordinary signal ratings the complement of the latter is to be reduced in all ships. Four telegraphists are to be allowed to all cruisers, scouts, and flagships, and three to all battleships other than flagships. One petty officer telegraphist is to be allowed to every destroyer fitted with wireless apparatus except the "Swift," which will carry a telegraphist as well as the petty officer. It is ultimately intended to allow one warrant officer for wireless telegraphy duties to the senior flagship of the Channel, Atlantic, Mediterranean, and China fleets. All other flagships will carry one chief petty officer telegraphist A *pro rata* reduction will be made in the signal ratings of these ships. Changes in complement are to be effected gradually as men become available. In order to place the telegraphist branch on a proper footing, 192 yeomen and leading signalmen are to be allowed to turn over to it as volunteers, as also are about 100 able

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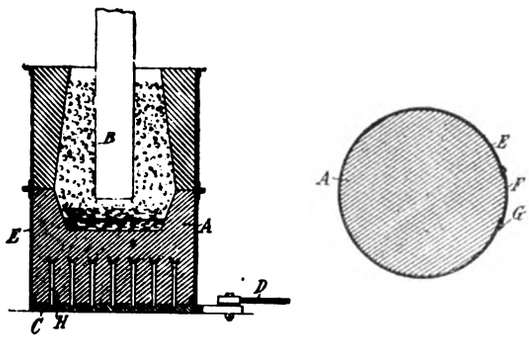
seamen and marines. It is intended ultimately to fill the telegraph branch wholly from boys entered in the training ships in the ordinary way. The new regulations affecting the wireless telegraphy branch take effect from Oct. 1 next.

Electro-Metallurgy.—*Electrochemical and Metallurgical Industry* gives an account of an electric furnace designed and patented by Mr. Paul L. T. Héroult Details of construction show that this furnace has one carbon electrode, the other terminal being formed by the carbon crucible itself. The construction is shown in vertical and horizontal cross-section in the illustration. The body, A, of the furnace is of carbon and bound by a surrounding jacket or rings of iron, steel, or like. The current passes from the electrode, B, through the charge and then through the cast-iron piece, C, to the cable, D. Ordinarily the jacket is made of iron or steel, forming a continuous ring of magnetic material, so that a magnetic flux is set up within this ring. In order to eliminate it, the iron portion, E, of the jacket is not continuous around the periphery, but is broken at one or more points, the edges being connected by a strip, F, of copper or other non-magnetic material.



This reduces very largely the impedance of the furnace when operated with alternating current. A more perfect contact than usual between the body of the furnace and the cast-iron base is secured by providing long forked pins, H, which extend from the base upward into the carbon block, and the lower ends of which are cast into the base-plate, C, so as to make perfect contact therewith. For making a good connection between the cable, D, and the plate, C, a special contact block, J, of copper is provided, about which the plate, C, is so cast as to effect an intimate welded union.

The Wireless Convention.—*The Times* prints a lengthy letter from Mr. John T. Macpherson, M.P., setting forth the reasons why the writer, as a member of the commission appointed to inquire into the Radio-Telegraphic Convention, refused to sign the report. Mr. Macpherson explains how surprised he was to find that Mr. Buxton, who had to all intents and purposes prejudged the position, and Mr. Lambert, another member of the Government, were on the committee, and he confesses that a suspicion crossed his mind "as to whether the committee had a *bona fide* object in view, or whether it was simply appointed for the purpose of supporting the conclusions arrived at by our delegates at the Berlin Conference." He then enters into details as to why he opposed the ratification of the convention. He says: "I was mystified between the different experts. At first it seemed as if the whole desire of one expert was to confute the statements made by some other expert at previous meetings of the committee; and I confess that I had really got no practical guidance until Mr. Marconi was examined by the committee. His evidence, to my mind, was clear and definite. While attending ostensibly as a witness on behalf of the Marconi Company, it appeared to me that he ever endeavoured to keep his science apart from the company; and when he stated that 'it was his desire for the Post Office to license any system of wireless telegraphy in this country and to permit stations to be erected in all parts of the country, so that the best system would come to the top,' he without doubt supported his conclusions in such a manner as no other witness even approached. What was his conclusion, might be asked. Simply this—that in the present state of wireless telegraphy it would be absolute folly to place it within the confines of rules and regulations of an international character, as by so doing progress would be stayed, further invention would be hindered, and our newest science would practically be crippled at its birth." The foregoing represents Mr. Macpherson's main reasons for the position he took; the rest of his letter attempts to show that, as a free-trader, he feels no qualms of conscience with respect to the vote he gave on this matter. No doubt the honourable gentleman anticipates the stern rebuke of his political friends for his lapse into heterodoxy.

A Lecture-Table Method of Demonstrating Phase Displacement.—None of the existing methods of indicating phase difference—such as the use of two oscillographs or two Braun tubes or the determination by means of voltmeter, ammeter, and wattmeter measurements—actually shows the angular displacement involved. This difficulty is overcome by the following stroboscopic method described by H. Starke in a recent number of the *Physikalische Zeitschrift*. A small black cardboard disc is attached to the alternator or, more conveniently, to a small synchronous motor driven by the alternator under test, and on to this disc a narrow radial strip of white paper is fixed. When the disc is running and is illuminated by a steady source of light, it appears a uniform dull white, but if the illumination occurs in periodic flashes of the same frequency as that of the alternator, the white strip will appear stationary. Such an illumination may be readily produced by the discharge of Leyden jars charged by an induction coil connected to the alternator. Since in this case the discharges occur twice in every period, the white strip will appear to form a stationary diameter across the black disc. The position of this diameter varies according to the phase of the discharge. If the illumination is produced by two independent induction coils two diametral lines will appear, and they will be at an angle to one another equal to the angle of phase difference between the currents supplying the two coils. This angle can be read off on a degree scale placed around the disc, or by means of a transparent scale placed in front of it. As an example of the use of this apparatus the demonstration of the difference in the effect of resistance and self-induction in a circuit may be taken. A switch is arranged in the primary circuit of the induction coil by means of which either resistance or inductance can be inserted. With the resistance in circuit the white diameter takes up a certain position on the degree scale, whilst when the choking coil is inserted the line jumps round approximately 90deg., and this movement takes place in the direction of rotation, showing that the inductance has delayed the spark. If the resistance in series with the choking coil is gradually increased, the white line is seen to move gradually back towards its original non-inductive position. A large number of other lecture-table experiments can be readily carried out with this arrangement.

Electro-Chemical Industry in France.—The annual report from the British consul at Lyons states that the electro-chemical and metal industries have continued to make progress in 1906, which has seen an addition of some 5,000 h.p. for the production of aluminium and the same increase for carbide of calcium. These increases have been obtained by the completion of existing hydraulic

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works, but the present year (1907) will see the harnessing of further falls in the service of these industries not only in the Alps, but also in the Pyrenees. The use of what is fantastically called "white coal" has attained a remarkable development in South-Eastern France within the last few years. The production of aluminium, he reports, has made rapid strides of late, having risen from 1,647 metric tons in 1904 to 1,905 metric tons in 1905, and though the actual figures of actual production for 1906 are not yet accessible, the export alone increased by over 50 per cent. as compared with the previous year; so that it is certain that the rate of progression in production was at least maintained. The extraction of bauxite, the raw material of aluminium, has also risen from 75,000 metric tons in 1905 to 103,000 metric tons in 1906. A large part, however, of the quarried bauxite is of no use for the manufacture of aluminium, and is employed for making fireproof ware. The water power used for the various chemical industries in 1906 amounted in the aggregate to 100,000 h.p., which may be distributed as follows:

	Horse-power.
Aluminium	35,000
Carbide of calcium	25,000
Chlorate of potassium or sodium	15,000
Metallurgic products (steel)	22,000
Soda (chlorine) / Hypochlorates	1,000
Various	2,000
Total	100,000

The success of the Société Grenobloise de Force et Lumière in bringing water power 112 miles from Moutiers to Lyons has given birth to a scheme for bringing many thousands of horse-power from Bellegarde (Ain), on the Rhone, to Paris. It is of interest to note that a factory is being established in the district of Tarentaise for the manufacture of cyanimide in the temperature of an electric furnace. Considering that France is such a large importer of nitrites, electrolytic production should have a good future before it, providing, of course, the cost can be kept low.

Studies in the Properties of Carborundum.—It has already been shown that a crystalline mass of carborundum when supplied with electrodes acts as a receiver for electric waves. This interesting property of carborundum has given rise to various investigations with a view to further knowledge of it being obtained, and Mr. George W. Pierce has contributed to the July issue of the American *Physical Review* a lengthy communication on the subject. Mr. Pierce's investigations were extended to include many other crystalline substances, but for the present it is only possible to confine attention to carborundum, and even then, owing to lack of space, we can do no more than indicate briefly some of the chief results arrived at. One of the chief properties shown in carborundum is that of unilateral conductivity. With one specimen under 10 volts, the current in one direction is 100 times the current in the opposite direction. With another specimen platinised on one side, the current at 34·5 volts is 527 times as great as the current in the opposite direction under the same voltage. In another case at 30 volts, the current in one direction is 4,000 times the current in the opposite direction under the same voltage. As the current increases the efficiency of rectification decreases. A specimen platinised on both sides has a smaller efficiency of rectification and a much lower resistance than a piece not platinised. Though the efficiency of rectification is less with the platinised specimen, the excess of one current over the other for a given voltage is much greater with the platinised specimen on account of its low resistance. A method is shown of employing crystal rectifiers in the construction of alternating-current measuring instruments. These instruments are applicable to the measurement of telephone currents, and may be used in experiments on resonance in telephone circuits. A determination of the temperature coefficient of conductivity of carborundum is given, which shows this coefficient to be in the neighbourhood of weak electrolytes. No theory is given as to the cause of the unilateral conductivity of carborundum. The question whether or not the action of carborundum when used as a detector for electric waves is a heat effect, goes back to the question whether the unilateral conductivity of the substance is of thermal origin. Mr. Pierce is of opinion, however, that heat is practically a negligible factor in the process. No doubt, when data regarding other substances having the same properties have been accumulated, some explanation will be possible.

Electrical Progress in Sweden.—If additional evidence were required to testify to developments in the applications of electricity to Swedish industries and communications, it could be obtained from the large contracts for the electrical work and goods that are from time to time announced in the columns of this journal. Indeed, elsewhere in this issue will be found an announcement calling for tenders for the supply of the electrical equipment for the Government power station at Trollhättan, and it will be seen that the prospective work is of no small nature. The enlargement of the Trollhättan Canal will greatly increase the traffic over this waterway, and make the district one of the most important centres of transport in the country. The utilisation of the great water power of Trollhättan will produce a rich supply of power at far less expense than under present circumstances. On these grounds according to all probability, both at Trollhättan as well as throughout the district between that place and Gothenburg, and within the town itself, a considerable industry will arise, taking its requirements from abroad and exporting its productions *vid* Gothenburg. A consular report from Gothenburg gives an account of some important works to be undertaken by the Town Council. One of the most important resolutions by the Town Council in the course of the past year may be mentioned the erection of powerful electrical works with connections, at a cost of about £320,000. By this resolution the distribution, within the territory of the city, of lighting and power will become almost a municipal monopoly, and the electricity works will be in the same position as the gas-works, tramway lines, and waterworks. The electricity works will also undertake the distribution of the electric current from the electrical works building at Trollhättan, transformed to suitable tension for different purposes, and to serve as a reserve when interruptions of the current from Trollhättan take place. A company has been granted a concession for 25 years for the supply of electricity for lighting and other purposes in the town of Warberg at moderate rates, the power being obtained from the Yngeredsfors waterfall, situated about 22 miles east of Warberg; a steam-power reserve being also erected to secure the supply in case of breakdown or shortness in the water supply. At Halmstad, too, the Electric Installation Company is well under way, and tenders are now being called for. This class of enterprise will react favourably upon the industries of the country, and the consul points out that "on the whole the employment of electric power for industrial purposes will raise the industry of the country to a standpoint far above the present."

Illuminating Engineering.—It is impossible not to sympathise with the movement which is on foot and is slowly gaining ground in this country for arousing interest

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in the matter of illumination, and for impressing engineers, architects, and the public generally with the fact that artificial illumination should be based on scientific principles. The moment for encouraging specialisation in illuminating engineering is singularly appropriate, for with the advent of the newer forms of incandescent lamps, for which such high efficiencies are claimed, the disposal of light sources is a matter which must undergo some change, and it is essential that if the full economy is to be obtained from the use of the new electric incandescent lamps, the problem which their disposal involves should be left to an illuminating engineer who makes that branch of engineering his particular department of work. Specialisation in artificial illumination has reached such a high pitch in the States that an Illuminating Engineering Society was founded, and although its birth does not date back further than January, 1906, it now numbers over 1,000 members, with five branches. The progress which the movement has made was emphasised in the holding last month of a convention at Boston, where a large gathering assembled to discuss a good programme of papers. Dr. Clayton H. Sharp opened the proceedings with an interesting presidential address containing suggestions tending to simplify the calculations made by illuminating engineers. He advocated the use of the word "lumen" for "luminous flux." The unit of luminous flux is the "lumen," which is the flux of light emitted by a 1-c.p. course through a unit solid angle. The use of such a unit, he said, eliminates the awkward and inappropriate term "foot-candles," which does not represent the product of the feet by the candles; it renders unnecessary the use of the corresponding misleading term, the "metre candle," known as the "lux." He suggested that, instead of the gross efficacy of an installation being expressed in "foot-candles per watt per square foot," it should be denoted by the "lumens per watt." True specific consumption would then be measured by "watts per lumen." It is noteworthy that the society is open to electrical engineers and to gas engineers, and at the recent convention papers dealing with both branches of illumination were discussed. This association between exponents of rival methods of illumination forms a marked contrast with this country. It is too early to estimate whether the *entente* will be strong enough to withstand the controversies of successive conventions, but it can at least be said that the first convention passed off in a very friendly way. There is much to be said in favour of this association, which may lead to the promotion of knowledge on problems of illumination.

Educational Notes. — The department of applied science and technology in University College, London, is intended to provide for students wishing to devote themselves to engineering a systematic training in the application of scientific principles to industrial purposes. The electrical engineering department is completely equipped with all the necessary apparatus for teaching this subject. It contains a dynamo room, having in it dynamos and motors of the latest type, such as continuous and alternating current dynamos, single and polyphase, and the means of testing and working dynamo machines and motors of various construction. There are three storage batteries and two boosters for providing electric current for experimental purposes. Adjacent to the dynamo room are the two large rooms forming the principal teaching electrical laboratory. The electrical laboratory is equipped with electrical measuring instruments of all kinds for effecting practical electrical measurements. These rooms contain a large photometric gallery for testing arc and incandescent lamps, and are fitted for this purpose with all the necessary instruments and appliances. The photometric equipment is particularly complete, and includes an intergrating photometer. The course of instruction in electrical engineering is arranged to provide efficient practical instruction in the scientific principles of electrical engineering, and has been also laid down with regard to the requirements of students who intend taking the intermediate and final examination in engineering in the University of London. This instruction is given by lectures, experimental demonstrations, and individual laboratory work. Students in the engineering department of the faculty of science who intend to adopt electrical engineering as a profession are thereby enabled to supplement the general scientific education to be obtained at University College by a further course of practical instruction in laboratory work and electrical measurements which is as complete as possible. The general or junior course covers the elementary principles of electrical engineering and the applications of electrical and magnetic facts in dynamo and motor construction and electric lighting. It covers the greater part of the syllabus for group A, electrical technology, in the B.Sc. degree in engineering in the final examination of the University of London. The course comprises about 30 lectures, extending over the three terms of the college session. At the end of each term a written examination is held and an inspection of the students' lecture note-books. The advanced or senior course comprises about 20 to 25 lectures given during the first and second terms, and during the third term the professor indicates to students a suitable course of reading in final preparation for the above degree. Exercise classes (junior or senior) are intended to afford students the opportunity of training in electrical calculations. The instruction in the electrical laboratory is given by a series of graduated practical exercises in which the student is taught to make the chief measurements required in electrical technology, beginning with easy exercises and advancing to more difficult ones. The students are taught to record their observations systematically. A record is kept of their progress in the laboratory register, and at the end of each term an inspection of laboratory note-books takes place. At the end of each session the laboratory forms have to be bound up and presented for final examination.

Mexico.—It is scarcely necessary to draw special attention to the progress which this country has achieved, for it is now a recognised fact that Mexico has taken her place among the nations of the world. As a factor in the industrial development of the country, the generation and transmission from considerable distances of electrical power in large units has been not the least important. There is yet, however, a vast opening for electrical enterprise in the country. But it does not seem that British manufacturers are participating to a very large extent in the openings for the supply of electrical material in Mexico, and there is ample evidence to show that American competition, which is being waged with vigour, intelligence, and commercial perspicacity, is ousting the British article. In the latest consular report from Mexico attention is drawn to the development of electricity in Mexico. Our consul states: "In my report for 1899 I indicated the demand for electrical appliances—electric lamps, incandescent or arc lights, high and low tension cables for transmission lines, dynamos and motors, either steam or water driven, in fact all kinds—and I can only repeat this. Many of the tramway systems are being altered from animal power to electric power, and it should be borne in mind that there is hardly a town of any importance in the country that has not got a tramway system. Factories,

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too, are largely using motors with direct connection, instead of the overhead system pulleys and belting for power transmission to machine tools." One will be naturally anxious to know the share of British manufacturers in this development. While only meagre particulars are given by the consul, the position is summed up in the following significant sentence in his report: "I have," he says, "up to the present not seen a single British-made motor or dynamo in Mexico, and only a few of German manufacture; nearly all the electrical appliances used up to the present in this country are American." Allowing for the advantage over its competitors which the United States enjoys from its proximity to Mexico, there is no reason, apart from the apathy and pusilanimity of its competitors, why the latter should be so out-distanced. Long distance transmission is a feature in the industrial development of the country, the policy of which is to manufacture in Mexico as much as possible what Mexicans require. In mining, too, high-pressure power has been largely adopted. The new harbour works at Coatzacoalcos are to have electric crane. Twelve are already in operation, and more are under construction. At Colima there are two cotton mills, both operated by water power, but equipped with antiquated machinery. An ice plant and a mill for grinding corn, both in the same city, are driven by electricity, and it seems probable that the conversion of the cotton mills will follow. It is said that now the electric power company is in operation other manufactories will spring up, as hitherto lack of power has been the great drawback, fuel being scarce, costly, and unsatisfactory. On Dec. 1, 1906, the Colima Electric Light and Power Company was formally opened by the governor of the State. The company develops its power by a waterfall at El Remate, some 20 miles north of Colima, with a distributing station in Colima. With a full plant of machinery the company can develop some 900 h.p., but at the present moment is only generating some 300 h.p. to 400 h.p. The cost of the entire plant was about 360,000dol. It was built and is owned by local capital. The machinery, turbines, etc., came from Germany. There are horses and mule tramways running from the main plaza to the railroad station, the cemetery, and the Villa de Alvarez, a very flourishing suburb of Colima distant about 2½ miles. These will be changed to electricity by the end of 1907, and an extension built to Comala, a distance of five miles, the second largest town in the State. The docks at Tehuantepic are equipped with the most modern electrical apparatus for handling cargoes rapidly. On the whole, the development of electricity in Mexico shows no signs of abating; on the contrary, the possibility of obtaining a supply of power is a strong inducement to the establishment of other industries.

City of London Engineer's Report.—Mr. Sumner's annual report to the Corporation touches, as usual, upon several matters of electrical interest, the principal of which we give below. With regard to electric lighting, he states that the lighting of most of the main thoroughfares of the City by arc lamps was continued throughout the year. The number of electric lamps in lighting at the end of the year was 449, being a reduction of 16 on the previous year. The cost of each is £26 per annum. The number of defective electric lamps observed during the year was 178. The returns of these defects are made daily to the engineer by the police; and the City of London Electric Lighting Company is fined for each failure. During the year, in the month of July, the City of London Electric Lighting Company, Limited, waived their refusal to take down their arc lamps in Queen Victoria-street and Fleet-street, which had been lighted by incandescent gas lamps, also the extinguishing of the arc lamps in their eastern district—viz, Lower Thames-street, Monument-street, and Arthur-street East—which had been lighted by high-pressure gas, and proceeded with the extinguishing of the lamps and the removal of the columns and brackets. From a tabulated statement showing the length of the various mains, conduits, etc., in the City subways, we gather that the total length of mains owned by the City of London Electric Lighting Company is 1 mile 1,481 yards; the Charing Cross, West End, and City Electricity Supply Company, Limited, 1 mile 1,721 yards; pneumatic tubes (General Post Office), 1 mile 1,353 yards; telegraphs and telephones (General Post Office), 2 miles 1,145 yards. The scale of fees agreed to was: with the General Post Office, £25; the City of London Electric Lighting Company, Limited, £21. 13s 1d.; Charing Cross, West End, and City Electricity Company, Limited, £16. 10s. 10d. Since the year 1899, when the Corporation took in hand the work of the supervision of the overhead wires, a total of 24½ miles of derelict wires have been removed. All owners of overhead wires are required to identify them by having a perforated zinc label of approved pattern attached. This system has proved of great advantage, and is the means of immediately locating the owners of wires in the event of the same requiring repair. During 1906 there were 48 derelict and unidentified wires removed, of a total length of 2,193 yards, together with their insulators and attachments, and the facts relating thereto were duly reported to the Streets Committee. The overhead wires in the City continue to increase, and during 1906 the number of private owners of lines increased to 133, and the number of companies to 21. Both have considerably added to their number of spans during the last 12 months, and these now total about 731,500 spans crossing public thoroughfares, as compared with 699,300 spans last year and 260,000 spans in 1899. There has been a net increase of about 1,526 miles of National Telephone Company's wires. The number of owners of overhead wires during 1906 was: companies, 21; private owners, 133. The periodical statutory returns of all work done overhead have been regularly sent to the Corporation, and the marked plans of routes of all wires in the City kept up to date. Although the exchange telephone systems of the Telephone Company and the Post Office have been greatly extended, there is a continued addition in the number of private "direct" lines. The necessity of an immediate connection for business purposes is one cause of this increase, and there is nothing to prevent such lines being erected. The following table shows the notifications given by the Corporation in 1,854 cases of broken wires and other contraventions of the by-laws during 1906, as compared with 1,508 the previous year:

	Defective materials.	Broken wires.	Other contraventions.
National Telephone Company, Limited	1,400	112	54
Private companies and owners	43	5	67
District Messenger Company..	43	4	38
The Standard Time Company, Limited	22	0	23
The Exchange Telegraph Company	23	5	13
The Postmaster-General	0	0	2
Totals	1,531	126	197

In every case these notifications have been complied with. Mr. Sumner again calls attention to the fact that, owing to the smoky City atmosphere, the corrosion of exposed metal proceeds far more rapidly than is generally supposed, and he adds that the galvanising applied as a protection to pole stays and cable suspending wires does not last long.

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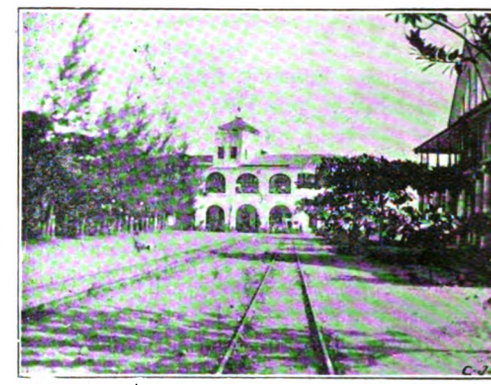
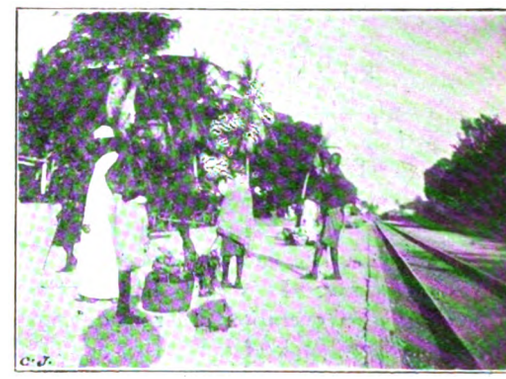
A TRAM WAY.

FIG. 1.



Looking towards Grand Hotel.



Natives.

Killindini Road.

Treasury Building, Mombasa.

Grand Hotel, as coming from the Town.

Trams with rails, but humans to propel, are fairly well known in East Africa, showing that with the advent of European control trade follows. The accompanying photographs are of "rails" at Mombasa. It will be remembered

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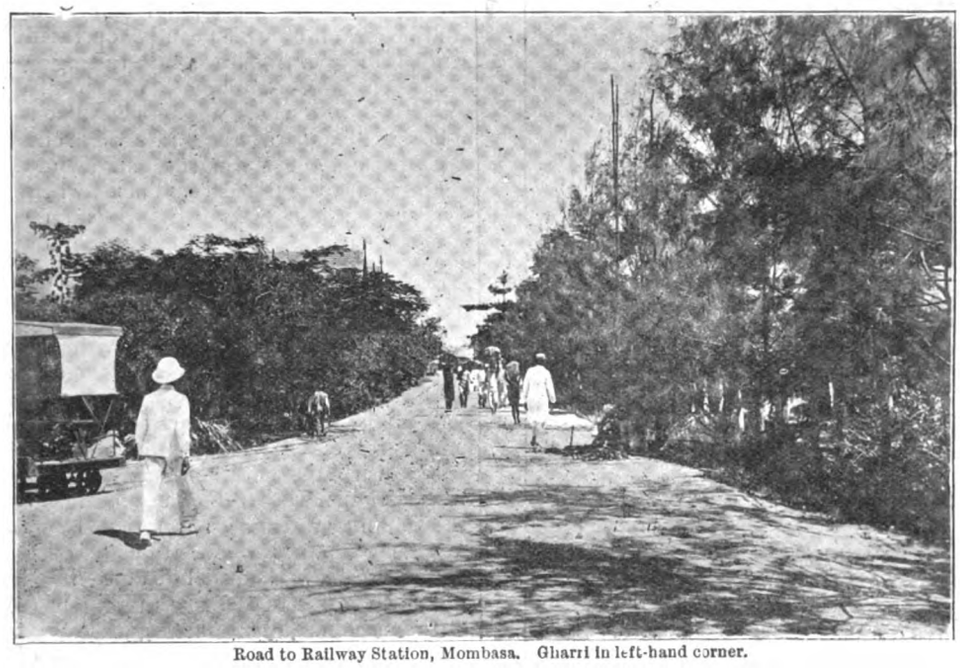
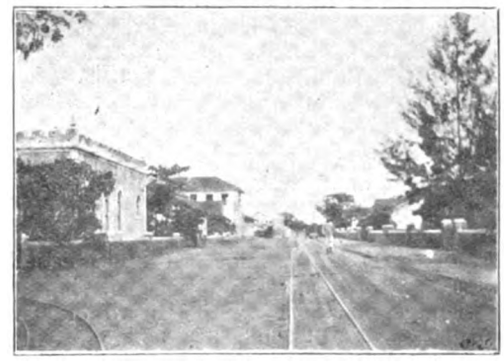
that millions were spent to prepare materials for a railway from Suakin to get to the Sudan, but the railway was never built. The rails have come in handy at Mombasa, for they have been utilised to form tramways for the gharri traffic. We understand that every official is provided with a gharri, or travelling car, that rails are laid through the principal streets, and that the propelling power used is that of a couple of "boys," euphemistic for "men." Fig. 1 shows an official with his wife going to the tennis-court. The remaining photographs are of various street scenes, showing how the rails are placed. Our point is this: although for the moment there is nothing electrical in this work, it is certain that with the development of this or any other colony there will and must arise a demand

From the Killindini Road towards Mombasa.



Road to Railway Station, Mombasa. Gharri in left-hand corner.

Mosque in Mombasa.



Road to Killindini.

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for iron and steel work, and apparatus of all kinds. It is well known that one of the first demands in a colony is for roads, railroads, telegraphs—not forgetting cables. We may be almost certain that if mining of any kind is developed there will be large demands for electrical apparatus. In this case the work commenced with these gharri roads. Probably with the advent of Mr. Winston Churchill we shall hear a good deal in the near future of Mombasa, Nairoba, etc.

AN ELECTRICALLY-CONTROLLED TESTING MACHINE.

In a paper read at the Aberdeen meeting of the Institution of Mechanical Engineers last month, Mr. Charles E. Larard (member) described a testing machine recently added to the equipment in the mechanical engineering department at the Northampton Polytechnic Institute, London. This machine represents the latest of Mr. J. Hartley Wicksteed's testing machines, as supplied by Messrs J. Buckton and Co., of Leeds, and has given very satisfactory results, due primarily to its great precision of

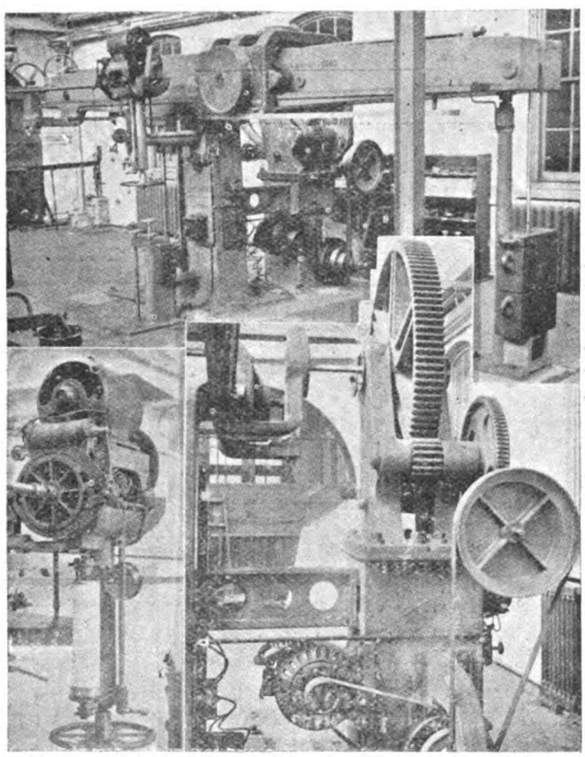

FIG. 1.—Three Views of Testing Machine with Electric Control.

control with respect to the time rate of straining and loading, either slowly or very quickly, over a large range.

The remarkable control obtained for torsion, as well as the more usual tests of tension, compression, and bending, as will be seen presently, is due to the use of two electric motors with wide speed ranges, the high range in the rate of straining by hydraulic pressure, and the fact that the handle and other adjustments are controlled from one position. These and other special features, together with an efficient chronograph for indicating the time intervals during straining and loading, will, the author believes, enable fresh investigations on the strength and properties of material to be carried out. As will be seen from the illustration (Fig. 1), the machine is of the vertical single-lever type, with a low lever ratio, satisfying in every respect the requirements of the Board of Trade. A maximum stress of 150,000lb. can be impressed on the specimen for tension, compression, and bending, while torsion tests can be made on short specimens up to a moment of 400,000 inch-pounds. The poise weight, which can be given two values, is under electrical control in either direction, or hand-driven when required. The straining for tension, compression, and bending is, as usual with these large machines, effected by hydraulic pressure, while for torsion the twist is put on by means of an electric motor.

The power for straining in tension, compression, and bending is applied through an inverted hydraulic cylinder with an enlarged end on the ram, forming a piston moving in the cylinder under hydraulic pressure. The diameter of the piston is 17in., and of the ram 16½in. There is, therefore, an annulus of ¼in. on the underside of the piston. The bottom end of the ram is carried by a cross-head, which is connected by three vertical rods to the sliding cross-head moving on the vertical guide on the main standard of the machine. To the sliding cross-head are attached the dies and blocks for the bottom ends of the tension specimen or the compression plattens, and pressure feet for the compression and bending tests. The straining, therefore, is effected by the water pressure acting upon the top of the piston, the intensity of which depends upon the stress actually on the specimen at any given instant The total resultant pressure on the top of the piston can be increased up to 150,000lb. The return stroke of the straining ram is effected by the water pressure, in the annular space between the piston and the trunk of the ram, lifting the ram and forcing the water in the top of the cylinder through the exhaust, the exhaust valve being open. A combined valve box with three valves is provided to regulate the admission of water to the machine, so as to control the velocity of the ram during the test and the exhaust of the water during the upstroke after the straining has taken place. The hand-wheels for working these valves are close together, and alongside the other handles and levers, all of which can be operated from one position, a point of great importance in testing.

The rate of straining can be controlled over a wide range by means of the supply valve and the test valve. The maximum straining rate is about 30in. per minute with very light specimens and about 12in. to 15in. per minute with the largest specimens when testing to the full capacity of the machine; this is an exceptionally wide range as compared with that usually obtained from many other testing machines. For example, a well-known screw testing machine gives a maximum straining rate of 2in. and a minimum of $\frac{1}{10}$in. per minute, or a total range of 20 to 1 as against 150 to 1 with the present machine when testing the heavy specimens and a range of 300 to 1 with the lightest specimens. The method of applying the load is by means of a double-armed steelyard of cast iron and a travelling poise weight, which may be given two values, with the addition for heavy testing of suspended weights upon the end of the beam. Special features of the loading system are: (1) that by means of a fulcrum distance of 4in. an exceptionally open scale reading is obtained (3in. is the usual distance for the Wicksteed testing machines up to 100 tons capacity); (2) the adaptability of the machine to both light and heavy testing is secured by means of the special combination of (*a*) the 1,000lb. poise weight; (*b*) the two 500lb. side weights which, when secured to the poise, give to it its higher value of 2,000lb.; (*c*) the suspended weights of 1,250lb., which may be imposed at the end of the beam.

For lighter testing the poise weight of 1,000lb. is moved along the lever, giving a maximum load of 50,000lb. on the specimen when the poise is in its extreme position on the positive arm of the steelyard, the suspended weights and side weights being out of action. For testing up to 100,000lb. load on the specimen, the two side weights (which when not in use are attached to the projecting brackets from the main lever) are screwed on to the sides of the poise, thus giving the poise its higher value of 2,000lb. The poise weight thus augmented, when carried to the end of the lever, records on the scale a load of 100,000lb. on the specimen, the scale unit being one half of what it is for the 1,000lb. poise. The heaviest testing, between 100,000lb. and 150,000lb. (the full capacity of the machine), is obtained by running the 2,000lb. poise to the extreme position on the lever, and as soon as the end of the lever is close to or rests on the bottom stop, the suspended weights, consisting of 1,250lb. gross load, are attached to the suspension rod. This is effected by means of a sleeve on the suspension rod, which is lifted up underneath the lowermost weight and turned round through a right angle,

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so as to rest upon a cotter through the suspension rod. In making a test where the load on the specimen is over 100,000lb., the poise weight is run along the lever to its extreme position as indicated by the scale, the end weights are then attached to the suspension rod, and the poise weight is then run back to about the 50,000lb. graduation on the scale, until the lever rises, lifting with it the suspended weights. The specimen then supports a load of 50,000lb. imposed by the suspended weights, and 50,000lb. due to the position of the poise weight along

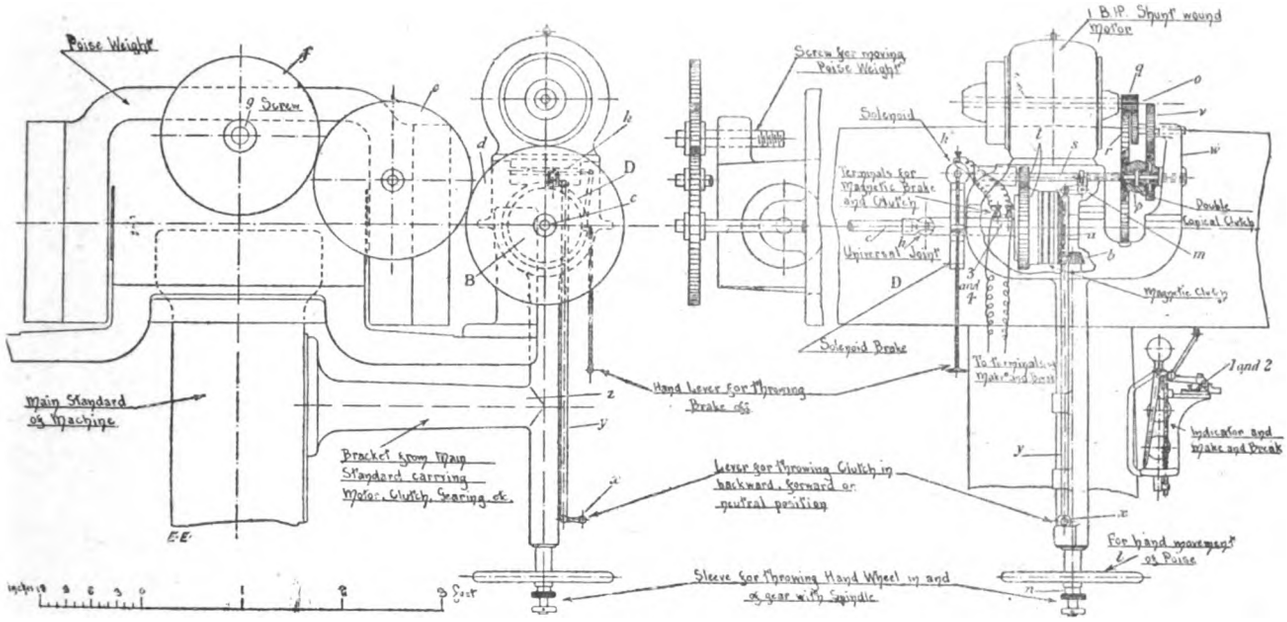
Poise Weight
Screw
Main Standard of Machine
Bracket from Main Standard carrying Motor, Clutch, Gearing &c.
Hand Lever for Throwing Brake off
Lever for Throwing Clutch in backward, forward or neutral position
Sleeve for Throwing Hand Wheel in and of gear with Spindle
1 B.H.P. Shunt wound Motor
Screw for moving Poise Weight
Solenoid
Terminals for Magnetic Brake and Clutch
Universal Joint
Solenoid Brake
Double Conical Clutch
Magnetic Clutch
1 and 2
Indicator and Make and Break
For hand movement of Poise

FIG. 2.—Electrical Drive for Poise, showing Clutch, Gearing, Brake and Hand Control.

the steelyard. Any additional load above 100,000lb. up to 150,000lb. is obtained by running the poise weight along in the positive direction.

The movement of the poise in both directions is effected either by hand or by means of an electric motor, which can be thrown in and out of operation at pleasure. Fig. 2 represents these two methods of actuating the poise. The usual method of running on the poise by hand needs little

The hand-wheel, *l*, can be put in and out of gear with the vertical spindle by means of a sleeve, *n*, sliding on the end of the spindle underneath the handle, this arrangement being convenient when it is required to drive the poise weight by means of the electric motor. The shunt-wound electric motor, which is on the top of the gear box, carried by a bracket from the main standard of the machine, develops 1 h.p. at 1,200 r.p.m, and has a variable speed down to 600 r.p.m. The speed variation is obtained by means of a variable adjustment consisting of a 12-point resistance frame in the shunt field of the motor. It is thus possible to obtain a speed variation of 2 to 1, and a step-by-step variation of speeds between these limits either on the forward (or loading motion of the poise weight) or on the return of the poise; but by means of the gear, *o*, and double conical clutch, *p*, shown in the right-hand view (Fig. 2), a quick return at double the speed of the forward motion can be obtained, so that the two ranges of speed of

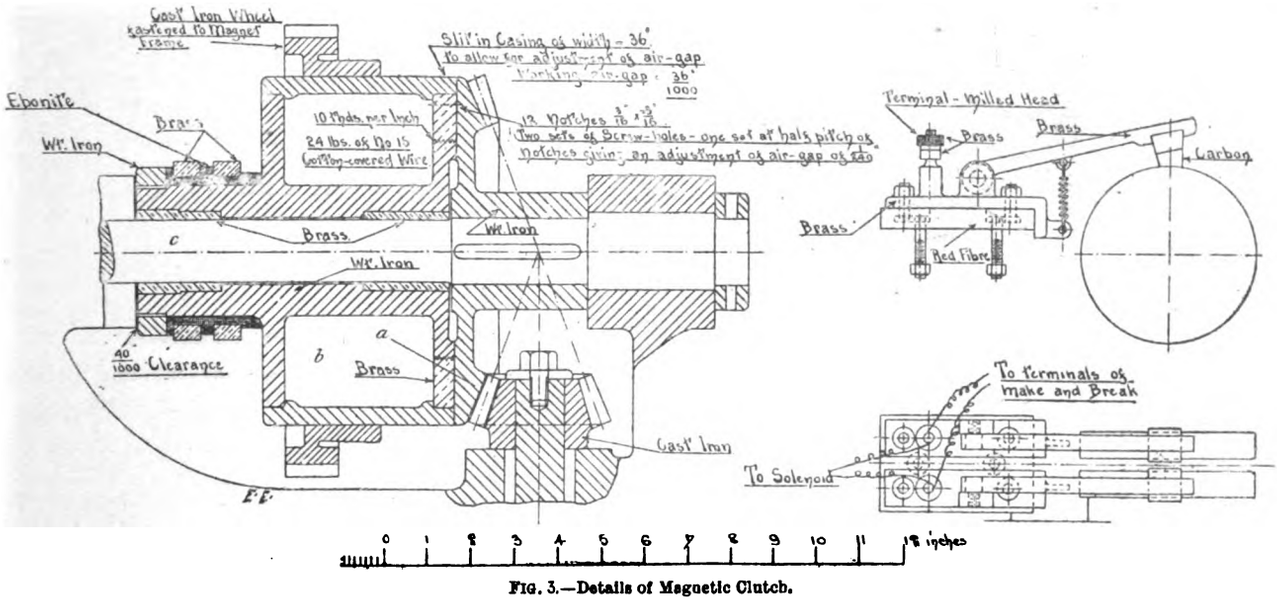
Cast Iron Wheel keyed to Magnet Frame
Ebonite
Brass
Wr. Iron
10 Rods per Inch
24 lbs. of No 15 Cotton-covered Wire
Slit in Casing of width = 36"/1000 to allow for adjustment of air-gap
Working air-gap = 36"/1000
12 Notches 3/16" x 3/16"
Two sets of Screw-holes - one set at half pitch of Notches giving an adjustment of air-gap of 1/2000
Brass
Wr. Iron
Wr. Iron
40/1000 Clearance
Brass
Cast Iron
Terminal - Milled Head
Brass
Brass
Carbon
Brass
Red Fibre
To terminals of Make and Break
To Solenoid
0 1 2 3 4 5 6 7 8 9 10 11 12 inches

FIG. 3.—Details of Magnetic Clutch.

description, being so well known to those who are acquainted with the Wicksteed testing machine. By reference to the illustration it will be noticed that the handle transmission from the vertical spindle is through a pair of bevel wheels, *a* and *b*, to the motion shaft, *c*, which is geared by three equal spur wheels, *d*, *e*, and *f*, to the screw, *g*, driving the poise weight. The double Hooke or flexible joint, *h*, between the horizontal shaft and the first gear wheel, *d*, carried by the movable beam is shown on the right-hand view to the left of the solenoid brake, *k*, to which reference will be made presently.

the poise weight as between the slowest motion forward and the quickest motion backwards is as 1 to 4.

With respect to the maximum speed at which it is advisable to arrange for the poise weight to be moved along the beam, the author is of opinion that it would add to the interest of the discussion and value of the paper if on this point as well as on the time rate of straining the results of experience were given. In the machine here described the maximum velocity of the poise is equivalent to 0/0in. and the minimum 0/0in. per minute. By referring to Fig. 2 it will be seen that a small pinion, *q*, on the motor

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spindle gears with a wheel, *r*, eight times its diameter on an intermediate shaft, *s*, and that this motion is transmitted through another train of wheels, *t*, to the shaft, *c*, connected to the first gear wheel, *d*, on the steelyard. For the reverse motion of the poise the clutch is thrown over to the extreme right, so as to engage with one of two equal toothed wheels on the intermediate shaft, *s*, the other wheel, *v*, being attached to the bracket, *w*, carrying a spindle from which a 2 to 1 transmission by the motor is effected. A convenient handle control, *x*, for throwing the clutch in and out of gear is supplied just above the ordinary handle control for the poise. A vertical spindle, *y*, passing up the supporting bracket, *z*, and connected at its upper end with a bell-crank lever, *m*, and small worm and nut enables the clutch to be readily connected with either the forward or backward drive. The handle regulator referred to has, therefore, three distinct positions: (1) the neutral position, when the clutch is out of gear with both the forward and backward driving wheels; (2) the position to the extreme right, which brings the clutch into gear with the forward driving wheels; and (3) the position to the extreme left, which brings the clutch into gear with the backward driving wheels.

For continuous and steady testing, the movements of the poise should be effected automatically, and in this machine considerable ingenuity has been shown in arranging for an automatic control of the poise weight. In addition, it is of

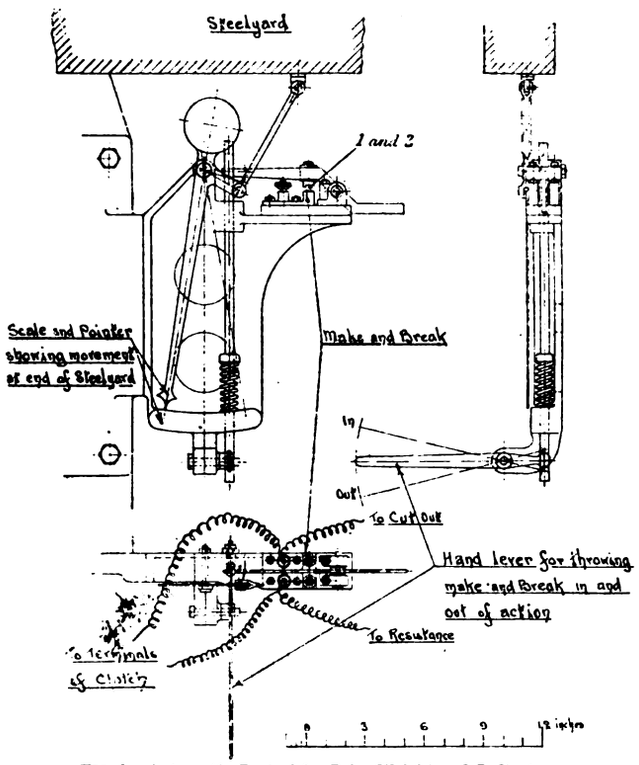
Steelyard
1 and 2
Scale and Pointer showing movement of end of Steelyard
Make and Break
To Cut Out
Hand lever for throwing make and break in and out of action
To Resistance
To terminals of Clutch
0 3 6 9 12 inches

FIG 4.—Automatic Control for Poise-Weight and Indicator.

the highest importance that during the process of testing the poise weight shall instantly be brought to rest when the positive end of the steelyard approaches the bottom stop—that is, the poise weight must not overrun its correct position on the scale. Both of these difficulties have been successfully overcome; the first by means of a magnetic clutch and an automatic make-and-break controlled by the rising and falling of the steelyard, and the second by means of a solenoid or magnetic brake. The details of the magnetic clutch are shown in Fig. 3. The clutch is arranged in connection with the larger bevel wheel, *a*, shown in Figs. 2 and 3, fixed on to the horizontal shaft, *c*, transmitting motion to the poise. When the steelyard is floating the electrical circuit round the windings, *b*, of the clutch is closed, making the clutch a powerful electromagnet firmly gripping the large bevel wheel, *a*, and transmitting motion from the motor through the gear wheels to the screw actuating the poise; but when the steelyard approaches the bottom stop (as when falling) the clutch circuit is broken by short circuiting across the terminals, 1 and 2 (Figs. 2 and 4) of the make-and-break connected with the beam, the current being then run entirely through the resistance (Fig. 4). As soon as the lever again rises or approximates to the horizontal, the clutch circuit is closed and the motor again drives the poise forward or backward as the case may be. It will be observed that by means of the magnetic clutch, the make-and-break, and the resistance, the motor is kept constantly running throughout the test, and, indeed, it is important that this should be the case. The solenoid brake, D (Fig. 2), comes into action when the clutch circuit is broken. Fig. 2 shows the wiring to the solenoid, *k*, from the terminals 3 and 4 of the clutch circuit. The solenoid brake consists of a pulley, B, mounted on the horizontal spindle, *c*, which transmits the motion to the poise, and round which is fitted a special form of strap, D, operated by the solenoid, *k*, at the top. As soon as the clutch circuit is broken (and with it the solenoid circuit), the soft-iron core which is attached to the strap is released, and in the act of release puts the brake on the wheel, thus ensuring that the poise weight is stopped dead at the instant the beam falls below its proper position. The brake is automatically released on the lifting of the beam and completion of the clutch circuit. The special function of the solenoid brake is to prevent the poise weight over-running its true position at any stage during the loading or at the sudden fracture of the specimen. While the clutch is in operation the speed of the motor can be varied, as already pointed out, from 1,200 r.p.m. to 600 r p.m., so that with the wide range of variation in the time rates of straining and loading the machine has greatly increased value as an instrument either for research work or rapid commercial testing.

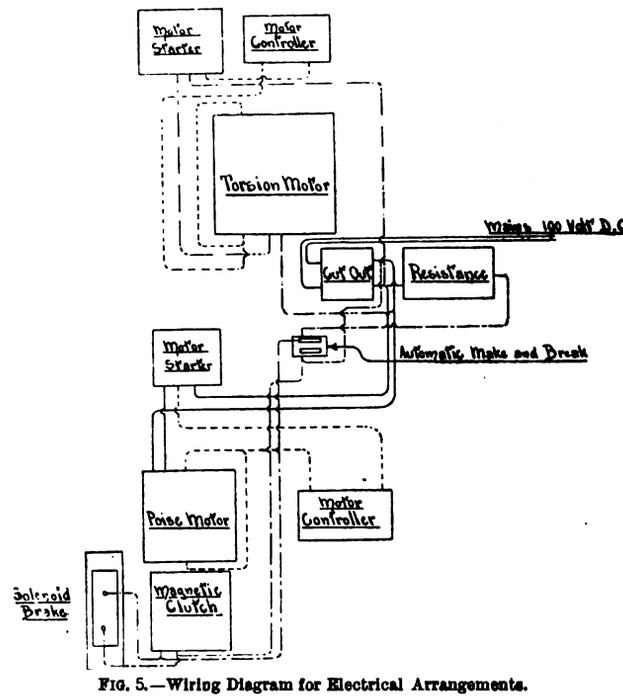

FIG. 5.—Wiring Diagram for Electrical Arrangements.

Fig. 4 represents the arrangement for scale and pointer, showing the magnification of the movement at the end of the steelyard. It will be noticed by reference to Fig. 2 that this pointer is directly in front of the operator controlling the handle movements, so that it is not necessary to watch the movements at the end of the beam. The length of the scale is 200in., and this, with a 4in. fulcrum distance registers 50,000lb. load on the specimen, with a scale unit of 4in. to 1,000lb. The vernier scale reads in conjunction with the main scale to 2½lb. When the poise weight is 2,000lb., the scale unit is one half of this, and the total length of the scale gives a reading of 100,000lb., with a vernier reading of 5lb. The addition of the suspended weights does not alter the second scale reading, but as soon as these are imposed at 160in. from the main fulcrum $\frac{160 \times 1,250}{4}$ or 50,000lb. additional load is given on the specimen through the second knife-edge 4in. away from the main fulcrum. The 4in. fulcrum distance was introduced so as to obtain a more open scale reading, and at the same time satisfy the Board of Trade requirements

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The low lever ratio of 50–1 for loads up to 100,000lb., with a 1,250lb. weight suspended at a leverage of 40–1 for the remaining 50,000lb. facilitates the floating of the lever, so that a given load can be held on the specimen long enough for taking exact observation. To enable the distance between the two main knife-edges to be tested and adjusted, and also to enable the weight of the poise to be verified from time to time, two additional knife-edges are provided in the steelyard, fixed at 80in. on either side of the main fulcrum or knife-edge carrying the beam.

Fig. 5 represents the electrical connections for the machine. The current is in the first instance supplied to the main switch of the machine from the 100-volt continuous-current circuit of the laboratory. This switch is of the double-pole cut-out type. The feeders from the main switch to the motors are represented by full thick lines. Reference to the diagram will show the complete circuit from the pole of the cut-out to the starting rheostat, and from thence to one terminal of the motor. From the other pole of the cut-out the connection is taken direct to the second terminal of the motor, the circuit being thus completed through the windings of the motor itself. The variable speed of the motor is obtained by means of a controller consisting of a 12-stop variable resistance in series with the shunt winding of the motor. The wiring is represented by chain-dotted lines from the starter to the controller, and from the controller to the shunt winding. The circuit between the cut-out, resistance, make-and-break, and the magnetic clutch is shown thus —·—·—·—. This circuit runs from the cut-out through the resistance to one terminal on the make-and-break, and from thence to one terminal on the magnetic clutch, the return or completion of the circuit being through the windings of the clutch to the other terminal and back to the second terminal on the make-and-break, and thence to the other pole on the cut-out. The wiring to the solenoid brake is taken through the terminals of the magnetic clutch, and when this clutch circuit is broken the solenoid circuit is broken too. No less than a dozen handles, controllers, or levers can be operated from one position. This, the author claims, is a very remarkable achievement in itself. Thus, suppose a tension, compression, or bending test is being made, the parts under control from one position are as follows: (*a*) the hydraulic pressure supply valve; (*b*) the test valve; (*c*) the exhaust valve; (*d*) hand regulation of poise; (*e*) the main double-pole switch for electric current to motor; (*f*) the starter; (*g*) the controller or regulating resistance; (*h*) the sleeve for throwing the hand-wheel for the poise in and out of gear with the vertical spindle; (*i*) the handle controlling the clutch with its three positions corresponding to the forward and backward movements of the poise, and the neutral position for out of gear; (*j*) the handle controlling the automatic make-and-break; (*k*) the handle to throw off the solenoid brake; (*l*) the extensometer or strain indicator.

In the construction of the autographic recorder, special care has been taken to minimise any inaccuracies likely to arise in transmission between the indicator and poise weight. The gearing is machine cut with very great care, and in the design of the instrument it is arranged that any slight backlash between the hand-wheel and the indicator barrel is in proportion to that in the gear wheels between the hand-wheel and the poise weight. The machine is arranged for testing specimens in torsion up to a twisting moment of 400,000 inch-pounds. This is considerably in excess of anything that has previously been done in connection with machines of a similar size. A 3½in. specimen of mild steel up to 15in. long can readily be tested to destruction. Fig. 1 illustrates the means of attaching the specimen to the lever of the testing machine at one end, and to the sliding socket and die in the boss of the large spur wheel at the other end. With this arrangement it is not necessary to remove any bracket or connections (except the dies) from the steelyard when the machine is in use for testing in tension, compression, etc., as with some machines of this type. The poise weight can readily pass along the steelyard quite clear of the torsion bracket, as will be seen by reference to the views (Fig. 1). For taking torsion specimens of different sizes, several pairs of driving collars or dies are available. These fit easily and truly into the sleeve of the spur wheel and in the sleeve of the bracket on the steelyard. The torque on the specimen is given by the product of the scale reading indicating the position of the poise on the steelyard, into the 4in. distance between the main knife-edge of the machine and the knife-edge carrying the direct straining mechanism for tension and compression. The large spur wheel through which the torque is applied is graduated over the full circle to indicate its angular motion, and this motion can be conveyed through two wheels and a small pulley geared up to the outer socket to the autographic recorder; this recorder is positively geared to the poise on the steelyard, so that both the torque and twist are registered autographically as the test proceeds. Special instruments are provided for attachment to the specimen for the measurement of the elastic strains. The chronograph with the autographic recorder gives the intervals of time, torque, and twist rates at which the angular movement takes place.

An electric motor of 1½ b.h.p. is used for driving the

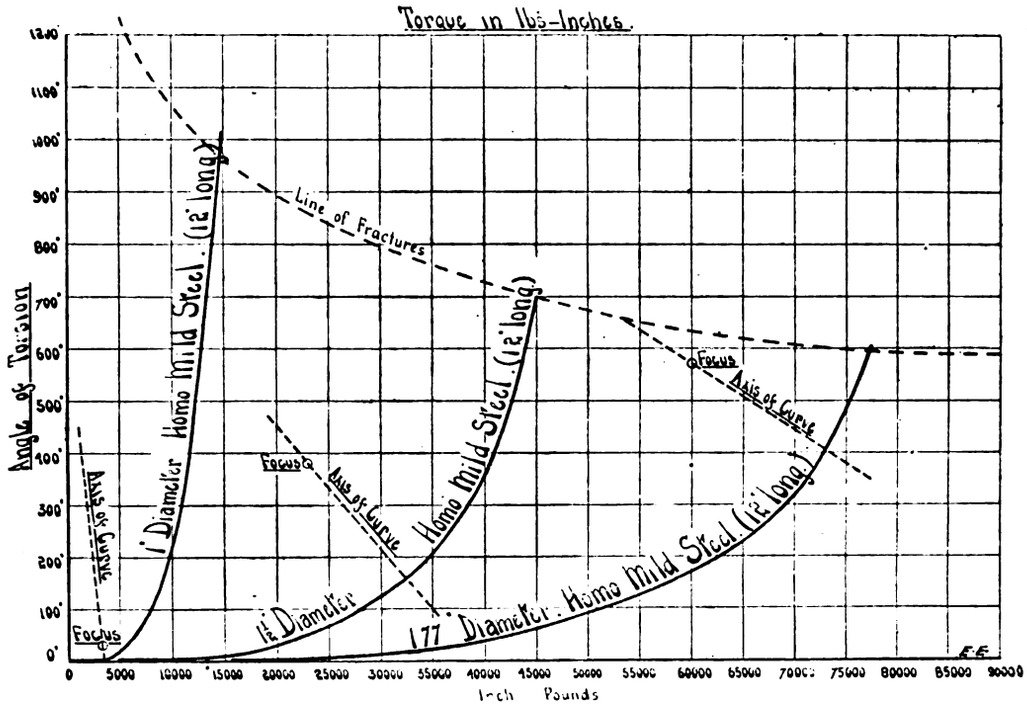
Torque in lbs-Inches.
Angle of Torsion
Line of Fractures
Axis of Curve
Focus
½" Diameter Homo Mild Steel (12" long)
¾" Diameter Homo Mild Steel (12" long)
1·77" Diameter Homo Mild Steel (12" long)
Inch Pounds

FIG. 6.—Comparison of Torsion Curves, showing Line of Fractures.

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gearing by means of which the twist is applied. This motor, which is worked from the continuous-current 100-volt circuit, has a speed variation of 800 r.p.m. to 1,500 r.p.m., and is controlled through a 12-point resistance frame. The small pulley on the motor spindle is connected by means of a belt to a larger pulley on the cone countershaft. A second belt drive is given through a pair of three-stepped speed cones to the worm spindle gearing into the worm wheel. On the same axis as the worm is a small pinion which gears into a large spur wheel fixed on the sleeve to which one end of the torsion specimen is attached (Fig. 1). The variable resistance which is applied in connection with the electric motor, together with the change of speed given by means of the stepped cones, enables the rate of straining to be altered not only to a nicety on a fine adjustment, but also quickly over a wide variation. The result is that a most efficient control is obtained on a steelyard when a test is in progress. The specimen can be twisted at any rate from one-tenth of a turn per minute to one turn per minute, thus giving a range of 10 to 1 on the time rate of twisting. Two special features stand out prominently in connection with the torsion apparatus—that is: (1) tests to destruction can be carried through in *a small fraction* of the time that would be required by the more usual methods; (2) by using the speed regulator for the poise motor in conjunction with the regulator for the torsion motor, the steelyard can be brought to and maintained in an almost stationary position during the plastic stage of a test on good ductile material. The torsion gear is also provided with square ends and winch handles for hand adjustment or twisting. These handles are, however, only used in testing the specimen up to and well clear of the elastic limit, the angular movement being comparatively small until the limit of elasticity is reached. The handles are then removed, and the straining is effected by means of the power drive.

In an appendix the author shows that he has obtained some exceedingly interesting results in testing short specimens of iron and steel with the diameters varying from ½in. to 3in., and with two different lengths, 4in. and 12in. The object of the experiments was to determine the form of the torque twist curve during the plastic stage, and these experiments were facilitated and rendered almost fascinating by the ease with which the torque and twist rates could be controlled. Fig. 6 shows three curves plotted to common scales, the line of fractures being a curve meeting the axes at infinity. It will be seen that a remarkably uniform type of curve is obtained for the different tests, and an investigation shows each of these curves to be very closely parabolic from the elastic limit to the maximum torque.

THE CONCEPTS AND TERMINOLOGY OF ILLUMINATING ENGINEERING.*

BY CLAYTON H. SHARP.

In the infancy of a science the concepts regarding it are necessarily neither very clear nor definite. The terminology of a science always lags far behind the actual state of the science itself. We must have the thing before we have a name for it—we must have the concept before we have a word to express it. An exact terminology, as contrasted with a loose one, is found to be more and more essential in proportion as its concepts develop, and as the science itself progresses in exactitude. As long as the treatment of the science is qualitative only, no particular need is felt for an exact terminology. As, however, the science becomes quantitative, and involves exact measurements of the quantities entering into it, the need for a terminology which is correspondingly precise is felt. For instance, in the earlier days of the science of mechanics no strict differentiation was made between the terms force, work, and power. At the present time, however, these concepts, and the terminology corresponding thereto, are very clearly differentiated. The inter-relations of things are not seen in the same way when a science is young as they are when it has, so to speak, reached its maturity. The simplest and most obvious relations are the ones which first are used, and it is only with advancing knowledge that the utility of the less obvious relations comes to be appreciated. This is true for an applied science as well as for a pure science. In the application of scientific principles and industrial products to the uses of everyday life it usually happens that the practitioner at first proceeds in a purely empirical way. He is likely, however, very soon to find a need for greater exactitude in his work, consequently his terminology, which at first was of the crudest description, becomes more exact and perhaps more complex. His concepts of what he is working with, which at first are inexact and hazy, necessarily become cleared with time, and he finds that the ideas on which he proceeded at first, while they may have been more or less correct, yet are not the ones which are most useful in the more extensive practice which time has brought. It may be useful to illustrate these abstract ideas by a few concrete examples.

Going back into the history of electrical science and of electrical engineering, we find that the earliest electrical conception was that of a force, or tension or pressure. The idea of such a thing as a flow of electricity did not become established until after Volta's discovery and the pioneer work of Davy, Faraday, Ohm, and others had brought this concept to light, and in Ohm's law a relation between the fundamental electrical qualities was established. It was very many years before the terminology of electricity became in any sense systematised or exact. When, however, electricity ceased to become a pure science and came to be applied to the very practical problem of artificial illumination, so that electric power was generated in large quantities and became a commercial product, the need for a terminology and for units of measurement and for measuring instruments all made themselves felt, and the terms volt, ohm, ampere, and watt came quickly into existence and into the everyday language of the science. The science of magnetism furnishes another example. The obvious thing about a magnet is its attractive force for other pieces of iron. This force is concentrated at points near the ends of the magnet, which points received the name of "poles." When investigators began to study magnets critically, the most apparent thing to do was to measure the force or strength of these poles. On measurements of pole strength the whole science of magnetism was based. The theory of magnetism, however, went on in its development, and the ideas of lines of force and of flux of magnetism were introduced. Later, when magnetic calculations became a feature in the commercial design of dynamos and motors, the old concept of pole strength was found to be too awkward and cumbersome as a basis for making such calculations and had to be abandoned in favour of the newer one of magnetic flux, doubtless to the great temporary inconvenience of those to whom the pole strength concept was a familiar one and the magnetic flux concept an unfamiliar one, acquaintance with which was to be gained only at the expense of considerable mental effort and inconvenience

We are led now to ask what is the state or condition of the science of illuminating engineering in regard to its terminology and its concepts? This science is founded on the ancient science of optics. All the optical principles which apply to illuminating engineering have been known for many years. Optics is, in many respects, an exact science. The laws of reflection, refraction, diffraction, and polarisation have been studied with minute care. The measurement of wave-lengths and angles of rotatory polarisation, as well as the computation of lenses, mirrors, and other optical apparatus, have been carried to an extraordinary degree of precision. In spite of all this, however, the science of optics has remained in a rudimentary condition in so far as its terminology and concepts relating to light as an output, used for purposes of illumination, are concerned. Just as in the case of magnetism, where the elementary notion of pole strength was long regarded as the fundamental point of departure for calculations, so the strength or intensity of light sources has been the principal concept in dealing with light as a product. Until touched by the quickening hand of practical application, until illuminating engineering began

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to take its place as a quantitative science, measurements of the candle-power of luminous sources were all that were required, and by candle-power was usually meant the candle-power in a given direction. At the present time there are many signs that this branch of optical science is following the same course of progress which magnetism has taken before. Within a very few years the term "mean spherical candle-power" has come into use among engineers. This marks a distinct advance in the practical application of illuminating engineering, since it implies a recognition of the difference between a candle-power in a given direction and the average candle-power in all directions in space. The notion of intensity of illumination, as distinct from intensity of a luminous source, has become a familiar one, and an awkwardly named unit for it has been used. These are sure indications of the practical progress of illuminating engineering.

What should be, or are likely to be, the lines of further development? These may be determined, in some directions, largely by action which our Committee on Nomenclature and Standards may take. In other directions this committee will be impotent, since it cannot enforce the adoption of its recommendations in practice. The practitioner must feel the need of some novel term or idea before he will adopt such term or idea. Such a need is sometimes unfelt because the practical value of novel terms and concepts is not clearly enough recognised by those to whom they would be useful. Having this in mind, I desire to bring to your closer attention the bearing of some terms and concepts which have not, I believe, established themselves in the practice of illuminating engineering to the extent to which their practical convenience and utility entitle them.

At the present time, in his quantitative work, the illuminating engineer deals chiefly with candle-power in its various aspects and with intensity of illumination. He does not, as a rule, employ any term which expresses directly the quantity of light which is being emitted by the source with which he is dealing. This is surprising, for the quantity of light which he had at his command is of vital importance to him. The distribution of this light he can arrange according to his own wishes by the use of various devices. Now the proper term for the quantity of light is easily found by a consideration of the physical nature of light itself. Light consists in ether waves propagated with a velocity of 300,000 km. per second. A source of light is simply a wave-maker. It agitates the ether continually and sends out a constant stream or flow of such waves in all unobstructed directions. If we take any transparent plane on one side of which is a source of light, we may think of a continual flow of wave-trains in the ether across this plane. If we surround our source of light by a closed, transparent surface, say an imaginary sphere, the total flow of ether-trains through this surface measures the luminous output of the source. For the sake of uniformity with the usages of other branches of physics, etc., the wave-flow is referred to by using the Latin name for flow—namely, "flux." We should form a concept, then, of all sources of light, whether primary or secondary, as the starting points of a luminous flux, and of all spaces surrounding such sources of light as traversed by this luminous flux. Having formed the concept of luminous flux, the following definitions and relations are a direct consequence. The output of any lamp is measured by the total luminous flux which it emits; the brightness of a diffusely reflecting or transmitting surface is proportional to the luminous flux which it emits per unit of area; the reflecting or transmitting power of such a surface is the ratio of the luminous flux which it emits to that which it receives; the intensity of illumination on any surface is the flux which it receives per unit of area. All the above quantities are of vital importance in illuminating engineering, in view of which fact it would be surprising if the concept of luminous flux should not prove itself to be very useful in the everyday work of the illuminating engineer.

It is necessary first to define a unit in terms of which luminous flux is to be measured and to establish its relation to the unit of luminous intensity, the candle-power. This is done in a way analogous to that employed in magnetism and electrostatics—that is, unit flux is defined as the flux emitted by a light of unit intensity, or 1 c.p., in a unit solid angle. A unit solid angle is the solid angle subtended at the centre of a sphere by a portion of the surface of the sphere bounded by four lines, each equal in length to the radius of the sphere. There are 4π or 12·57 such solid angles in the entire sphere. This being the case, we have approximately the relation that a unit solid angle is the one subtended at a point by a surface 1ft. square 1ft. distant from that point, or by a surface 1m. square 1m. distant from the point, or a surface one yard square one yard distant from the point, etc. If at the apex of such a solid angle a light source of 1 c.p. be placed, a unit luminous flux will pass through any transverse plane through the solid angle, no matter what the inclination of the plane or its distance from the light. In terms of this unit luminous flux is measured. The relation between the total luminous flux of a source of light and the mean spherical candle-power of that source is at once seen. If we consider a source of light having an intensity of 1 c.p. in all directions, its mean spherical candle-power would be one; and since there are 4π solid angles in a sphere surrounding that source, the total flux from it will be 4π unit of flux. If the mean spherical candle-power of a source is I_s, its total flux will be equal to $4\pi I_s$, or ϕ equals $4\pi I_s$, where ϕ represents the total flux and I_s the mean spherical intensity. Thus the total flux is numerically equal to 12·57 times the mean spherical candle-power of the source.

We have next to consider the relations existing between flux of light and intensity of illumination. As we have seen, the flux falling on a plane surface 1ft. square placed 1ft. distant from a light of 1 c.p. is approximately a unit flux. But the illumination on that surface is unit illumination if we measure in English units. If the same plane surface is removed to a distance of 2ft. from the light, only one-fourth of the total flux falls on it and the illumination is one-fourth as intense. In other words, the intensity of illumination on any surface is measured by the luminous flux per unit of that surface or by the flux density. This relation may be expressed thus: $E = \frac{\phi}{8}$. From this relation the familiar inverse square law may at once be deduced. The above equation becomes of practical importance in computing average illumination results. If, for instance, we know that from a given source or sources of light a certain flux falls upon the plane of reference, we can determine at once the average illumination on this plane by dividing the flux by the area of the plane. Thus the average illumination is determined without direct reference to the candle-power of the sources. Conversely, measurements of illumination on a given plane enable us to determine the flux of light falling on that plane. This is a quantity of great importance, since it leads us to a value for what we may term the net efficiency of the installation, or the efficiency of utilisation of the light. By the net efficiency of the installation or the efficiency of utilisation would then be meant the ratio of flux which falls upon the horizontal plane of reference to the total luminous flux emitted by the lamps in the room.

In order to make the use of the notion of luminous flux a convenient one in practical work of the computation of illumination, it is necessary to use it also with reference to the sources of light employed. In other words, when we wish to arrive at average values for illumination rather than exact illumination curves, we may ignore the candle-power and the distribution of the luminous intensity of the lamp, and may start out from a value for the flux of light which the lamp, together with its reflector or globe, sends in the direction of the plane of reference. Multiplying this flux by the number of lamps, and dividing it by the area of the plane, we have approximately the illumination on the plane, neglecting reflections from walls and other objects. The effect on the flux of multiple reflections by the walls of the room can be found according to the usual procedure—that is, the flux must be multiplied by $\frac{1}{1-K}$ where K is the average coefficient of reflection of the walls

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and ceiling, and where this value is subject to large modifications according to the location of the lamps in the rooms. The maximum and minimum points of illumination in a given installation can usually be told at a glance, and the values of these illuminations can be computed if required. The advantage of the procedure outlined above is that it gives an average value for the illumination over the entire plane of reference without the necessity for going through the computation of the actual illumination at a large number of points in the room.

The procedure for determining the value of the luminous flux from a lamp, either its total flux or the flux within a certain solid angle, is similar to that pursued in determining the mean spherical candle-power and mean hemispherical candle-power, etc. For instance, the well-known Rousseau diagram, so generally employed for the determination of mean spherical candle-power, is really a flux diagram. If the Rousseau diagram extends over 180deg. polar distance, the total area which it encloses is proportional to the total flux of light from the lamp and the part which is enclosed between any two angles as marked on the axes of the abscissæ is proportional to the flux from the zone or from the solid angle. Consequently, any method which will yield the mean spherical, mean hemispherical, or mean zonular candle-power will give, with practically no modification, the luminous flux corresponding thereto. The Matthews integrating photometer may be calibrated so as to give directly the total luminous flux from the lamp measured by it, or other integrating devices may be employed. By the use of such devices as are at hand to-day, it would not be at all impossible to rate lamps according to their total luminous flux, rather than according to their candle-power. Thus at one stroke the difficulty would be cleared up which arises from the actual difference in performance of incandescent electric lamps, which are rated alike according to our present arbitrary method. Using one of the methods indicated above, it is a matter of no difficulty to determine what the total flux of light will be, for instance, from a lamp with a conical reflector inside the angle subtended by the sides of the cone. Imagine, then, a number of lamps with such reflectors illuminating a room, and so placed that the angles of the cones of the reflectors do not in any case fall outside the boundaries of the plane of reference. Then the total amount of light which these lamps are throwing on the plane of reference will be approximately equal to the number of lamps multiplied by the flux which is sent out inside this plane, and, as said above, the average illumination is obtained by dividing this flux by the area of such plane. This method is of such extreme simplicity that it seems that it ought to be developed in practice. It is concededly approximate, but since any method yields results which are so strongly affected by the reflections from walls and ceiling, it is a question whether an approximate method like this might not in the end yield results which are quite as reliable as those which are obtained by the more laborious calculations involved when illumination curves are computed.

Having pointed out certain reasons why the notion of luminous flux should find extensive application in illuminating engineering work, let us consider for a moment the question of terminology. We have at the present time a name for the unit of luminous intensity. We call that the candle, and we measure luminous intensities in candle-power. It is usual in this country to express illumination in terms of the candle, and of the foot as the unit of distance. We have no suitable name for this unit of illumination; by some it is called the candle-foot, by others the foot-candle. Some make the plural candle-feet, others make it foot-candles. The name is inappropriate and awkward, since ordinarily, when we place two words in conjunction like this, we mean the product of the two quantities involved, as, for example, in foot-pounds, where we mean the product of the feet by the pounds. The foot-candle, or the candle-feet, however, means candles divided by, not feet, but feet squared; consequently the term is doubly inappropriate. It would, therefore, be very desirable, if we are going to adhere to this unit of illumination, to have a suitable name for it If we use the metric system, a name for the unit of illumination is at once at hand. In this system the candle may be the unit of luminous intensity, but the metre is taken as the unit of length. The illumination produced by one candle at a distance of 1m. is called the "lux." On account of the relation existing between the foot and the metre, it happens that the lux is about 10 times the size of the foot-candle. To be more exact, it is $\frac{39{\cdot}37^2}{12^2}$, or 10·8. The use of the lux, however, involves the use of an unaccustomed unit of length, and it is, consequently, found awkward. This is all a matter with which the Committee on Nomenclature and Standards will undoubtedly deal. When it comes to the unit of flux of light, as we have seen, the unit of length does not enter. The unit of flux depends only upon the chosen unit for luminous intensity, and, consequently, we may adopt the name which has already been suggested and used for this purpose—namely, the "lumen." By the lumen we mean the flux of light emitted by a source of 1 c.p. through a unit solid angle, and, as we have seen, the number of lumens falling on a surface, divided by the area of the surface in square feet, will give the illumination in foot-candles, or the number of lumens falling upon a surface divided by the area of that surface in square metres will give the illumination on that surface in lux. It would, therefore, seem to be an obvious thing to do to adopt the lumen as the name for the unit of luminous flux.

A point in terminology which it may not be out of the way to bring up at the present time, relates to the use of the term "efficiency" in illumination work. We have in this kind of work at least three kinds of efficiency to consider. We have, first, the efficiency of the illuminant as such; second, the efficiency of the illumination installation irrespective of the lamp—this may be called net efficiency of the installation, or the efficiency of utilisation of the light; and, third, the efficiency of the installation including the lamp—this may be called the gross efficiency of the installation. The efficiency of the lamp, if it be an electric lamp, would properly be determined by its lumens per watt. This term has not come into use, but deserves to do so. Instead of lumens per watt, we speak of watts per candle. Watts per candle measures for a given type of lamp—the specific consumption of that lamp. True specific consumption would be measured by watts per lumen. The term watts per candle, while a very convenient one from the lampmaker's point of view, is not so good a term for the use of the illuminating engineer. It is to be hoped, therefore, that in time lamps will be designated by their efficiencies, and the efficiencies will be expressed in terms of lumens per watt. What we ordinarily at the present day call a 16-c.p. 3·1-watts-per-candle lamp would, under that system, have a rating of 163 lumens and an efficiency of 3·3 lumens per watt. In the case of gas lamps the efficiency could be expressed in terms of lumens per cubic foot per hour.

Going next to the net efficiency of the installation, irrespective of the lamp. This is the efficiency which it is the especial province of the illuminating engineer to attend to. Given any illuminants whatever, there is some best way to equip and to arrange them so as to produce a maximum result in illumination This efficiency may be expressed in terms of the lumens received on the horizontal plane of reference, divided by total lumens emitted by the lamps. The gross efficiency includes the efficiency of the lamps themselves. This is the efficiency with which the user of the installation, the man who pays the bills, is most interested. The efficiency can be expressed in terms of lumens on the plane of reference per watt, or per cubic foot per hour expended in feeding the lamps. In the *Transactions* of this society it has appeared that the need is felt for an expression of the gross efficiency of an installation, since the term foot-candles per watt per square foot has been used for this purpose. Those who have used this term have recognised its awkwardness as well as its usefulness, and it has even been proposed to give a name to this unit. If we stop, however, to analyse this expression, we see that foot-candles per watt per square foot is equivalent to foot-candles multiplied by square feet and divided by watts. But, as we have seen, the foot candles multiplied by the square feet gives the luminou flux in lumens, consequently the expression foot-candles

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per watt per square foot is equivalent numerically to lumens per watt, so that here again the introduction of the notion of luminous flux, and of the term lumen, justifies itself by reducing an expression of unusual complexity to one of very great simplicity.

This address as a treatise on the concepts and terminology of illuminating engineering is necessarily indefinite and incomplete. Its purpose is to point out the utility of certain ideas and names which should prove useful in the pursuit of the theory and practice of illuminating engineering. What the ultimate developments will be in concepts and terminology of the science cannot be foretold; the most obvious steps in advance are those outlined above.

THE GENERATION, TRANSFORMATION, DISTRIBUTION, AND USE OF ELECTRIC ENERGY.

Under the above title a set of draft regulations in pursuance of Section 79 of the Factory and Workshop Act, 1901, has been sent out for examination by suppliers and users of electrical energy, and their detailed consideration is required with the object of securing a complete code of regulations under the Factory Act in regard to works where electric energy is used. As stated in our issue of the 30th ult. (p. 309), any objections of substance made by employers, workpeople, or other persons affected will be fully considered by the Secretary of State, and will, if necessary, be the subject of full inquiry made by a competent person appointed by him. If the objection is considered to be of sufficient weight, those concerned will be entitled to a full hearing at the inquiry, and the report of the person holding it will be considered by the Secretary of State before the regulations are finally made. Any objections should be sent in at once, and it is, therefore, necessary to very carefully examine the regulations as they now stand in draft.

The first point that would appear to be worthy of being considered is that given under the section of "Duties." The draft states "that it shall be the duty of the occupier to comply with these regulations, and it shall be the duty of the assistants and workmen employed to conduct their work in accordance with these regulations." Now this introduces a principle of responsibility of persons in employment in connection with this Act which appears to somewhat militate against the sole authority of the employer in respect to the work done by his staff. It is quite conceivable that an employé, considering himself in some way responsible to the State, should set up his opinion in opposition to that of his employer, and, arguing on the basis that the employer is reasonably supposed to know more about the correctness or otherwise of the operations under his control than the employé, who has only a partial view of the work done, it seems reasonable to conclude that once the employer has had his attention drawn to any act of omission or commission against the regulations he should be solely responsible for such irregularities. Otherwise there will be an opportunity for any "sea-lawyer" among the employés to render himself obnoxious and to unduly impede the progress of work for which he is paid.

Passing on to "Exemptions," it will be noted that nothing in the regulations shall apply to any system the normal working pressure of which does not exceed 130 volts continuous or 65 volts alternating. This is presumably on account of the greater damage due to shock receivable by alternating-current than is the case with continuous-current contact, although it is the opinion of many engineers that the burning effect of continuous current is greater than that of alternating current. An important point to be noted is that the standard pressure of battleship wiring is under the continuous-current limit given; but this is not the case in merchant vessels, where pressures of 240 volts are sometimes to be found. In this connection a curious question arises as to whether a ship having once left the building yard is a factory within the meaning of the Act. It certainly is during the course of construction. There is, however, a saving clause in the exemptions which in reality provides a very wide loophole for escape if the regulations are to be interpreted in a tolerant spirit, this clause reading: "If the occupier can show with regard to any requirements of these regulations that the special conditions of his premises are such as to prevent danger not less adequately than if the said requirements where observed, that requirement shall be deemed to be satisfied." It is, however, probable that this exemption will tend to open up a considerable amount of appeal from onerous conditions.

With regard to the actual regulations, the first clause which appears to be doubtful is No. 12: "Every electric motor shall be controlled by an efficient switch or switches for starting and stopping, so placed as to be easily worked by the person in charge of the motor." In many factories the person at present in charge of the motor for group driving is one of the machine operators, and the question arises as to whether it will be necessary to place the switch or switches near the actual machine which is being operated, or whether the clause simply means that the apparatus can be reached by the workman without the necessity of climbing ladders or other gymnastics. The second part of the clause is a little formidable: "Every electric motor rated at more than $\frac{1}{3}$ h.p. shall be further protected by a release that will automatically break the circuit if the current is interrupted, unless the motor is capable of restarting automatically on the current being restored." It would surely appear that the limit of $\frac{1}{3}$ h.p. is extremely small, as it will be found for machines of such small size that the cost of the motor will be less than that of the starter. The third paragraph of this clause is still more alarming, as "for every piece of machinery which is being driven by any electric motor there shall be means at hand for quickly stopping the motor." It will be interesting to know whether this involves the application of brakes to all running machinery driven by motors; if this is so, the amount of expense involved in workshops and factories under this clause will be enormous.

In Paragraph 13 the condition is made that "every portable apparatus and its flexible cable shall be independently controlled by a switch conveniently placed." Much depends on the interpretation of the word "switch" in this instance, and unfortunately there is no definition of the term in the draft regulations. If the simple two-prong plug, for example, can be taken as a switch in this connection, then the connecting device by which the flexible cable is plugged on to the system will suit the requirements. If, however, the switch is to be a definite and separate piece of apparatus, it will be seen at once that there will be a considerable increase in installation expense in many shops where flexibles are used, inasmuch as the switch on the portable apparatus itself will not control the flexible cable. Moreover, a limitation will be placed on the means of wiring, inasmuch as the switch must be conveniently placed for the operator, making long runs of flexible cable from wall or ceiling rather impossible.

In Clause 15 it is exhibited that "every switchboard having conductors so exposed that they may be touched shall be located in an area or areas set apart for the purpose thereof and suitably fenced or enclosed." Now it should be remembered that no voltage limits are placed on these conditions, except that of 130 volts continuous or 65 volts alternating. If this rule is interpreted rigorously, it means that every low-tension switchboard used throughout an electric supply system will have to be caged or fenced unless the area mentioned covers the whole of a sub-station. But this does not appear to be contemplated, because in Clause 32 the draft regulations provide that "every sub-station shall be under the control of an authorised person, and none but an authorised person or a person acting under his immediate supervision shall enter any part thereof where there shall be danger." The phrase "entering a part" indicates that there shall be some partition in the sub-station, which is probably the fencing or enclosure referred to in Clause 15. This view is confirmed by the second paragraph in Clause 15—namely, "no person excepting an authorised person or a person acting under his immediate supervision shall have access to any part of such area."

In Clause 17 it is stated that "at the working platform of any switchboard or switchboard passage-way, if there be bare conductors exposed, or arranged to be exposed when

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alive so that they may be touched, there shall be a clear and unobstructed passage of ample width and height with a firm and even floor. For low pressure and medium pressure the clear height shall not be less than 7ft. and the clear width not less than 3ft., and for high pressure and extra high pressure 8ft. and 4ft. respectively." These conditions assume that safety may be expressed in terms of feet and inches, which is a wholly fallacious basis. Some exposed conductors are safe at a few inches distance, others are dangerous at a distance of several feet, everything depending on the design and workmanship of the switchboard. If this clause is to be retrospective, the amount of alteration, redesign, and confusion that will result in central stations throughout the kingdom, more especially in congested areas such as are found in the Metropolis, will be something too awful to contemplate. If the designer bows to the inevitable, and spreads out his switchboard and passage-ways over valuable ground so that he gets his 8ft. and 4ft. in order that he may have bare conductors exposed or arranged to be exposed when alive, then he comes up against Section (*a*) of Clause 18, which states "that every conductor within any working platform or in any switch passage-way shall be so placed or protected as to prevent danger." In other words, he first constructs his board according to the views of the authorities as to safety (which may not coincide with his own), wasting considerable space over it, and then, having gone so far, he must provide further protective devices.

Section (*c*) in Clause 18 states "that all metal switches, handles, and the metal rods connecting them with the switches shall be earthed." This provision seems to be absurd in the case of, for example, metal switch handles which operate by means of wooden links the actual switchgear encased in earthed tanks, which design is found in one of the most modern central stations in the kingdom. The metal handles, being on a section of the switchboard quite away from the high-tension part, would be obviously incapable of receiving any high-voltage charge, nevertheless, according to the regulations, they must be earthed. It would seem that in view of Clause 21, which reads, "adequate precautions shall be taken to prevent any metal other than the conductors from becoming electrically charged, and such metal shall be earthed where necessary to prevent danger," that Clause 18 (*c*) is adequately covered, and could be left out.

In Clause 21 it is stated "that every sub-station shall be made of ample dimensions and substantially constructed of fire-resisting material." This is a very hard hit at some of the fearfully and wonderfully ornate arrangements found in highly capitalised undertakings, and the question arises as to whether such combustible material as wooden hand-rails for switchboard protection, etc, are admissible, and whether wood of a nature which is not highly combustible shall be entirely excluded.

With the exception of the clauses mentioned above, which it is suggested might be capable of a little amendment, the draft regulations are decidedly good, and mark a distinct step towards reasonable regulation of industrial conditions. The great point to be insisted upon is that nearly everything depends upon the way in which the regulations are to be administered. A drastic method means the imposition of great difficulties upon the occupier of works using electric power, while a mild and generous interpretation of the rules undoubtedly induces the suppression of those danger traps which are, as evidenced in Mr. Scott Ram's recent report, only too prevalent in our electric supply systems.

RADIO-TELEGRAPHIC CONVENTION.

Report of the Select Committee.

This report, together with the minutes of the evidence heard, has now been published by the Government, and contains a great deal of most valuable information. As an historical record of what has been accomplished it surpasses any previous publication. Although there is much difference of opinion as to the effects of the convention, this record of progress must be pleasing to all. The following extracts from the report will be of general interest.

1. The committee have held 13 meetings and examined 18 witnesses whose official or commercial experience and scientific attainments qualified them to give evidence on the subject referred to the committee. The terms of reference were as follows: "That a Select Committee be appointed to consider the Radio-telegraphic Convention, signed at Berlin on Nov. 3, 1906, and to report what, from the point of view of national and public interests, would in their opinion be the effect of the adhesion or non-adhesion of this country to the convention."

2. Among the witnesses whose evidence the committee have taken were several of the delegates appointed by Great Britain to attend the Berlin conferences of 1903 and 1906, referred to later; Government representatives of the Admiralty, War Office, Post Office, and Colonial Office; a witness from Lloyd's and one from a steamship company, representing the shipping interests; scientific and other witnesses to explain various system of radio-telegraphy other than that known as the Marconi system; representatives of the Marconi companies, and Mr. Marconi himself. Although the committee had not the advantage of hearing evidence from any member of the Committee of Defence, they have been assured on the highest authority that there was no difference of opinion among the members of that committee as to the satisfactory nature of the convention from the point of view of the interests of the country.

3. The committee have been furnished by several witnesses with a general review of the past history and development of the art of wireless telegraphy—termed also radio-telegraphy, the name officially adopted by the convention—since it has been in practical operation on practical lines in Great Britain. This history may best be briefly reviewed by an account of (1) the invention and development of wireless telegraphy from a scientific discovery to an applied art; (2) its political history and international recognition.

4. Wireless telegraphy or radio-telegraphy means the transmission of signals by electrical energy between two points which are not connected by a wire or other metallic conductor. The term is specially used—and exclusively used in the convention—in connection with instruments employing the Hertzian waves, so called from their discoverer, Heinrich Hertz. Before the discovery of the Hertzian wave other methods were used experimentally for sending messages across space without conjunction other than the earth: (1) by earth induction, using two parallel or nearly parallel wires erected, for example, on either side of a stream, each end being fitted with telegraphic apparatus; (2) by electric magnetic induction; and (3) by a combination of the two former. This means was taken up by Sir (then Mr.) W. Preece in 1885 (then electrician to the Post Office), and a system was set up of telegraphic communication without direct connecting wires between places not more than six or seven mile apart. A wireless telephone service has been established by Mr. Gavey on this basis between Holyhead and the Skerries, and recently telephonic speech has been exchanged between the two stations with the greatest ease.

5. These induction systems are not, however, suitable for communication over a long distance, nor for communication with ships, and the methods now used for that purpose are all based on the employment of the Hertzian waves. The means employed in transmitting messages across space without physical connection consists broadly of two stations, a transmitting station and a receiving station. At each of these stations a wire or wires must be erected in the air by means of a mast, tower, balloon, kite, etc. This structure of wires is known as the antenna or aerial. Speaking generally, the greater the range intended to be covered the higher or more extensive must be the antenna or aerial. The energy is generated by a battery or generator worked by a steam, gas, oil, or other power engine, and is communicated to the aerial by the transmitting apparatus proper.

6. The receiving apparatus is also connected with the aerial. There are many forms of receiving apparatus in use, and it may be said that one of the principal differences between the several systems of wireless telegraphy consists in the various forms of receiving apparatus. In some the apparatus automatically records the dots and dashes of the Morse alphabet, but in most forms a telephone is attached, and the operator hears the dots and dashes, and this permits of more rapid working than any recording instrument yet devised.

7. With the most powerful stations very great distances have been covered, and signals have actually been transmitted across the Atlantic, but in the present condition of radio-telegraphy communication has not been effectively maintained with regularity over so great a distance, especially by day. The maximum effective range for regular communication by day or night may be put, possibly, at 1,000 or 1,500 miles, but this state of affairs is changing almost month by month. Wireless messages are frequently sent from Poldhu to Gibraltar and Malta. As regards the ordinary ship and shore stations, the effective range may be said to vary between 50 and 300 miles, possibly rather more, according to the power of the station.

8. The signals are usually sent out with equal energy in all directions. A message sent out, for instance, from the high,

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power station at Poldhu, Cornwall, and intended for ships in mid-Atlantic, has been equally received at Nauen, near Berlin, and at the Dutch station at Scheveningen, or at Gibraltar. Attempts have been made to devise methods of directing the waves, or, at least, of sending them with the greatest energy in one particular direction, but so far only with moderate success. The Admiralty are able to determine the direction in which a wireless message is coming under certain conditions.

9. The main defect which was first found in the working of wireless telegraphy, resulted in part from this inability to control direction. As every receiving station within range of a transmitting centre could read all the messages sent from that centre, it was not possible for more than two stations in a given area to interchange signals at a given time without mutual interference. It was impossible, of course, for the ether within a wide radius thus to be monopolised by two persons if the invention was to be of real practical value. It was also obvious that if two sets of apparatus could be so accurately adjusted the one to the other as to ensure reciprocal radiation, whilst other apparatus not so adjusted would not be affected, the practical problem would be solved. It is in the direction of "syntony" or the "tuning" of apparatus so as to induce "selectivity" between them that recent scientific research and experiment have been chiefly concentrated; and, as will appear later, the more or less complete manner in which this has been achieved between different systems constitutes one of the difficulties placed before the committee.

10. The committee do not wish to express any opinion on controversial questions of priority and patent right, but it appears to be generally admitted that the Hertzian waves were first experimentally applied for practical telegraphic purposes in 1895-6 by Mr. Marconi. Many inventions and improvements by Mr. Marconi and others have appeared since at a rapid pace, and there are now several "systems" or "methods" in existence, whilst the number of patents is very great.

11. The principal systems in use are: Marconi—The first practical system in the field. The first Marconi British patent was applied for on June 2, 1896, and accepted on July 2, 1897. De Forest—American in origin; acquired in Great Britain, and it is said for all parts of the world except North America, by a British company (the Amalgamated Radio-Telegraph Company). Fessenden — American. Lodge-Muirhead — British, both as regards invention and ownership; first patent applied for May 10, 1897, accepted Aug. 10, 1898. Telefunken ("far-sparking")—German, an amalgamation of the systems of several different inventors (Slaby, Arco, Braun, Siemens). Rochfort—French. Branly-Popp—French. Poulsen—Danish, of recent invention, the rights in which for all parts of the world have also been acquired by the Amalgamated Radio-Telegraph Company. Shoemaker—American. Massie—American.

12. The use of radio-telegraphy is rapidly increasing. A large number of instruments are already in operation in various parts of the world. Conflicting evidence was given as to the exact number in commercial use, but this is partly explicable by the fact that conditions are rapidly changing, and that there are in existence a number of experimental stations and other stations not open for commercial work. A relatively small proportion of the existing stations are on British territory. The greatest number are in the United States. There are also a considerable number in Italy and Germany, a few in Holland, Belgium, Spain, and France, and several for non-commercial purposes in Russia. According to the most recent returns, it would appear that there are 186 commercial stations throughout the world, of which some 63 are Marconi and 123 are other than Marconi. There is a preponderating number of Marconi stations in Great Britain, Italy, and Canada, but in all other parts of the world, with few exceptions, the stations are on other systems. The most important stations are those situated on the south coast of the United Kingdom, which is, owing to its geographical situation and the predominant part it plays in the maritime business of the world, the chief focus of ocean commerce.

13. The principal uses of radio-telegraphy may be placed under two main heads: (1) naval and military purposes; (2) commercial and mercantile purposes. Reserving the former for discussion in a later part of this report, the latter may be again divided into three classes: (*a*) shore-to-shore communication; (*b*) ship-to-ship communication; (*c*) ship-and-shore communication. The committee have been informed that shore-to-shore use of radio-telegraphy has not at present reached a point where international regulation has become indispensable; and, therefore, stations intended for the purpose of shore-to-shore communication exclusively were left outside the convention, except in relation to the application of Articles 8 and 9, which will be referred to later.

14. It will be convenient here, however, to define exactly what is meant by shore-to-shore communication. The expression includes communication from one shore station to another shore station, irrespective of whether they are in the same or in different countries, or whether the sea is crossed in such communication. Thus a shore-to-shore communication would be one from (1) Dover to Brest, or (2) London to Paris—that is, from one territory to another across the sea—or from (3) Paris to Berlin (similarly but not crossing sea), or (4) from London to York (within the same territory). It embraces, in point of fact, such communication as would take the place of telegraphy by land wires or submarine cables, or supplies communication where the ordinary methods would be inapplicable, either on financial or physical grounds. Thus, the Lodge-Muirhead communication between Burma and the Andaman Islands, where the traffic is not enough to pay for a cable, is an instance of wireless telegraphy of this category. It should also be specially noted that shore-to-shore communication includes communication with lightships, or other ships permanently moored, lighthouses, and outlying islands. A number of installations of this kind have already been established on the British coasts and elsewhere.

15. The expression ship-to-ship communication is self-explanatory. The question of the application of the convention to such communication will be dealt with hereafter.

16. The expression ship and shore communication means communication between a coast station and a ship at sea. "Coast station" is defined as any radio-telegraph station which is established on land or on board a ship permanently moored, and which is used for the exchange of correspondence with ships at sea. The coast station may be actually on the coast, as at Poldhu, or miles inland. Thus communication from Nauen, near Berlin, to a vessel up Channel would fall within this definition.

17. In the absence of other invention, there is at present small likelihood of wireless telegraphy competing commercially with ordinary telegraphy overland wires, or superseding the use of cables. But if transmarine radio-telegraphy could be effected with certainty and reasonable speed, there would be an extensive field for its employment as a subsidiary method to cable communication. For military and naval purposes, the importance of the invention cannot be over-estimated, especially to Great Britain in time of war, when the cables might be cut.

18. The principal application of wireless telegraphy has been in the provision of an entirely new facility for communicating between shore and ship, and *vice versâ*. It is the rapid development of this kind of radio-telegraphy which has rendered international regulation desirable. Ship and shore communication may be divided into two classes or three different categories: (1) maritime intelligence; (2) sea telegraphy, (*a*) news messages, (*b*) private and commercial messages.

19. Under the first heading would fall messages relating to the service or safety of the ship, such as reports of a ship's position, time of arrival in port, directions for berthing and docking, or as to cargo, etc.; information regarding navigation, such as icebergs, derelicts, approaching storms; and in the case of a stranding or collision, fire, or other casualty, the summoning of assistance. It would include messages from a port where there is infectious disease to warn off an approaching steamer, thus avoiding the necessity of her remaining in quarantine at the next port of call. This class of message may not be numerous, but is of the greatest importance. When the utility of wireless telegraphy as a protection against maritime disasters is more realised, a larger number of vessels will, doubtless, carry wireless apparatus.

20. Sea telegraphy embraces (*a*) news services, such as the regular service of news sent out from a high-power station such as Poldhu for the benefit of ships crossing the Atlantic. But the most important are (*b*) private messages from or to persons on board ships, especially the large Transatlantic liners. The greater part of this traffic is from ship to shore, about 20 telegrams passing in this way to one from shore to ship. A service which provides for this development has the best chance of being remunerative. It is mainly on board the large liners carrying a considerable number of passengers that wireless telegraphy has so far been installed, apart from naval use.

(To be continued.)

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RADIO-TELEGRAPHY.

As soon as any scientific invention enters into the domain of business it becomes of interest to the general public, and speculation as to its ultimate development commences. This has been clearly shown by the history of radio-telegraphy as disclosed in the report of the Select Committee of the House of Commons on the Radio-telegraphic Convention. With the business side of the question we do not propose to deal at the present time, beyond expressing the opinion that the pioneering work of Mr. Marconi deserves more recompense than is awarded to it under the terms of the convention. The report, with the evidence of those experts who have made the transmission of messages by Hertzian waves their special study, is most valuable as giving definite statements as to what has been accomplished up to the present. Of course, with so many experts who have worked on different systems and in opposition to each other there is bound to be some difference of opinion, and the committee have had to leave some important questions without definite answers. Take, for instance, the vexed question of intercommunication between arc and spark systems. "It was generally admitted that all existing spark systems intercommunicate readily, the fact being that the so-called systems are really different methods of one system. A considerable doubt arises, however, in regard to the present possibility of commanding intercommunication between the arc (or continuous wave) and the spark systems. The doubt is due to the fact that no arc systems are in operation as commercial stations, and, therefore, it has been difficult to prove or disprove the possibility of intercommunication in actual practice. Mr. Maskelyne stated that he believes it can be done, but (as he describes it) only by elevating the inferior spark system to the standard of the arc system, or by degrading the arc system apparatus to the level of the spark system. This he deprecates, contending that the superiority of the former will at no distant date make it the prevalent system throughout the world. Sir Oliver Lodge stated that by a careful system of syntonisation — by the superior perfection to which he has brought the tuning of his method—all difficulties in the way of intercommunication can be removed. Mr. Marconi and Prof. Fleming, however, question whether, for practical purposes, it can be done at all. Sir William Preece, on the contrary, asserted that there would be no difficulty in securing non-interference by syntonisation. Commander Payne, the Admiralty wireless expert, speaking from actual experience, claimed that he can show there is no physical difficulty in making an undamped wave system, which produces greater selectivity, intercommunicate with a moderately damped spark system, and that, as apparatus could easily be tuned, without suffering depreciation, to make the damped and partially damped wave work together satisfactorily, so it might equally be anticipated that the partially damped wave may be made to work with the undamped wave." After this variety of evidence the committee did not feel themselves competent to draw any deductions from the conflicting views of such distinguished scientists. They, however, point out that the convention clearly provides by Article 4 of the final protocol for the introduction of new systems, even if they cannot intercommunicate with existing systems. "In regard to the general question of the development of wireless telegraphy, the convention is intended to oppose no obstacle to the experimental and practical development of all new inventions, and if the continuous wave system is proved to be superior to any of the spark systems, it will inevitably displace the latter and become universal. In

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the meantime the convention provides for present intercommunication without intended prejudice or detriment to the development of the arc system or any other that may be devised. Indeed, such systems will enjoy the advantages and protection of the convention." A full extract from the first part of this report will be found elsewhere in this issue, and we hope to refer to the business side of the question in a subsequent issue.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

LIVE-STEAM HEATER.

SIR,—I note in your last issue a letter over the *nom-de-plume* of "Cephas" in which, while classifying himself as amongst the elect of steam experts, he attempts to critcise my work, and characterises my claims as absurd and nonsensical. It is obvious that "Cephas" has not carefully read the discussion on my paper before the Municipal Electrical Association in 1906, or he would have discovered that my reply fully dealt with the points raised during the discussion by Mr. Stromeyer, and showed that gentleman had taken in error the temperature of the gases leaving the boiler flues to the economiser as the temperature of the gas at the base of chimney—hence the absurdity of his deductions.

It would be easy for me to deal effectively with all the points raised, but as a preliminary I invite "Cephas" to reveal his identity, as I do not care to deal with a person who has not the courage and good taste to sign his name to his letter. Judging from the last sentence thereof, I conclude that "Cephas" is considerably interested in some other form of feed heater, and possibly this may be the reason why he prefers to try to "stab me in the dark."—Yours, etc., GEO. WILKINSON.

Beech Mount, Harrogate, Sept. 2, 1907.

THE TELEPHONE QUESTION.

SIR,—It is as the result of tests—and of much more searching tests than would be made by a non-technical jury—that the solid-back transmitter has been found to be the most efficient type of telephone transmitter. Practical telephone men do not differ on this point, but Mr. Bennett differs with all practical telephone men on almost all practical telephone points—which is the cause of all this correspondence.—Yours, etc.,

HERBERT LAWS WEBB.

35, Old Queen-street, Westminster, London, S.W.,
Aug. 31, 1907.

FIRE PREVENTION.

SIR,—I read with interest the letter on the prevention of fires in factories in your issue of Aug. 30, and note the means of extinguishing the several outbreaks was varied. Would any of your correspondents give their opinion through your columns as to what is the best means to have at hand to cope with an outbreak of fire in a large factory pending the arrival of the fire brigade.—Yours, etc.,

W. H. T.

A NOTE ON SUB-STATION CABLE ARRANGEMENT.

BY W. PLEASANCE.

Now and again various problems crop up in the equipment of sub-stations for electricity supply, upon the solution in detail of which the safety and efficiency, quite apart from the appearance of the sub-station, depend very largely. When an engineer enters a sub-station to which he is a stranger, nothing is more likely to create a bad impression in his mind and confuse him in his work than to see a tangled collection of leads and cables strung across the roof, the cables entering on all sides and taken to the switchboards by the easiest way. Although it is true that where the connections and leads are distinctly labelled, and the switch and fuses marked, there should be no trouble or great confusion, nevertheless, connections have sometimes to be altered, perhaps, by a new man or careless jointer; and, whatever may be said to the contrary, it is not always possible for the mains superintendent to be everywhere at once. Mistakes can more easily occur in an untidy sub-station than in one where care is taken to make each board, as far as possible, its own diagram outlined on clean lime-washed walls by red and black painted leads.

In order to secure a neat sub-station, one of the first considerations is the method of bringing in the cables. This, of course, depends on the position and the number of the cables to be brought in, and it will be found very often that in the case of a sub-station put down to feed into an existing system, it may be a rather awkward matter to arrange to bring all the cables in and out on one side of the sub-station. It will, however, be found not only to be the neater method if the cables are brought in and out together, but also the cheaper as regards provision for rendering the ducts watertight. It is an easy thing where the cables are armoured and laid direct into the ground to bring them out into the required position with relation to the sub-station, and in the case of a cable passing through, if this is cut so as to leave one end long enough to reach the switchboard, only one joint will be necessary in order to tap the continuation on to it. The problem of the draw-in system is a little more difficult. It will be found better either to utilise an existing box or to build a fresh one close to the sub-station, from which box the cables are brought to and from the sub-station chamber.

The next consideration is the prevention of water entering the sub-station, especially when this is underground. It is usually found that if there is any surface water about, especially in a clay soil, it seems to have a preference for a cable trench or duct, and follows along the pipes or trenches into the sub-station chamber. The method of getting away from this risk in the case of armoured cables laid direct into the soil is to bring them through the pipes usually built into the wall of the sub-station, and then close up the inside end of each pipe with cotton waste and fill up the aperture from the outside with pitch. The spare pipes can be plugged with tapered wooden spigots, which must have been well dried and steeped in very hot pitch for some hours previous to insertion. If this is not done, there is a chance of the plug swelling and splitting the duct. In the case of the solid system, the bitumen carrying troughs can be carried right up to the chamber, and if the work is properly carried out, there should be no trouble. In the case of the draw-in system, the best way is to build a separate surface box adjoining the sub-station chamber, and the pipes leading from the surface box into the sub-station should be plugged with cotton waste and pitch as described above. The surface box itself, should, if possible, be thoroughly well drained.

It will be seen from the above notes that it is quite possible to secure the regular arrangement of cables inside the sub-station so as to avoid the confusion to anyone working therein, and at the same time to avoid an undue waste of cable and expense in special fitting, and get rid of that very dangerous trouble, percolation of water into the sub-station.

MACHINE FOR WEIGHING THE FORCES ON A CUTTING TOOL.*

BY JOHN F. BROOKS.

The object of the machine is to measure the three component forces (at right angles to each other) which result in the formation and separation of a chip of metal in a lathe. The forces are designated as follows: The *vertical* force is called X; the *horizontal* force (at right angles to the lathe axis), Y; the *horizontal* force (parallel to lathe axis), Z. These forces are balanced by weights, P, Q, and R, applied at a greater distance from the fulcrum. Fig. 1 is a sketch of the essential features. The tool, secured in a holder, is carried by a diaphragm of steel; for very small displacements only the device forms a universal frictionless pivot. Exact location of the long arm is

* Paper read before Section G of the British Association at Leicester.

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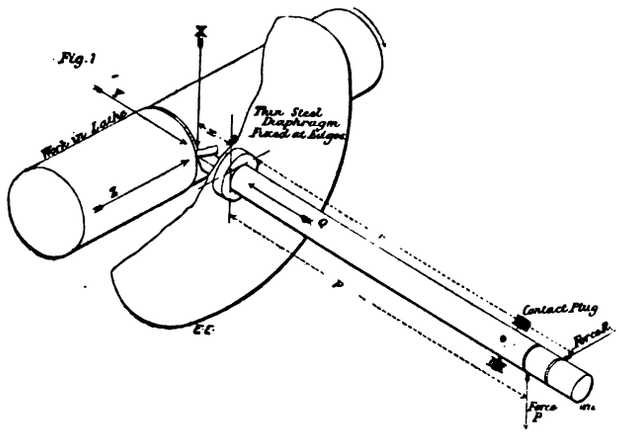
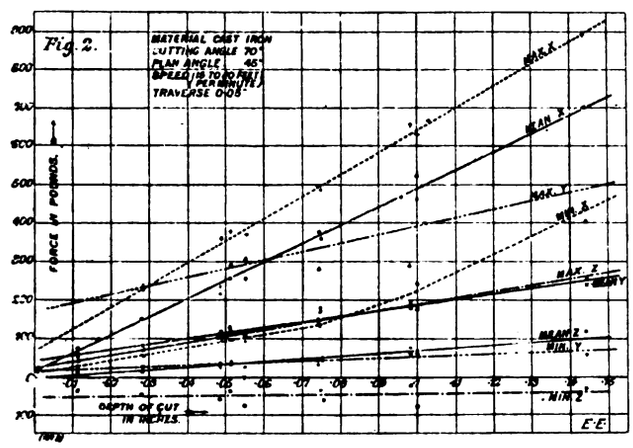
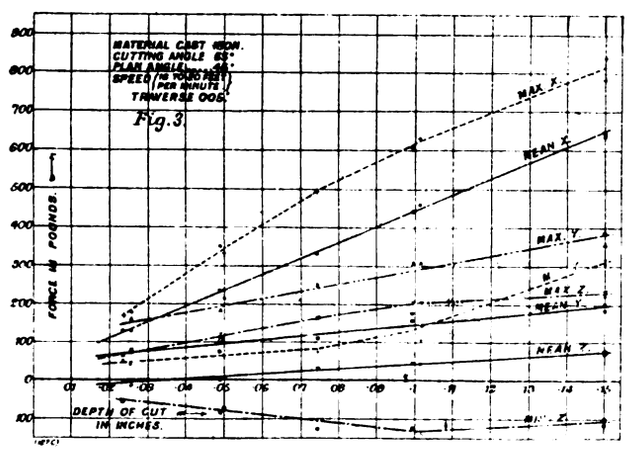
effected by means of hardened steel contacts, one of each pair being insulated from the general body. A telephone received in circuit with each pair of contacts enables the operator to make an observation. The force Y is balanced in the same manner through a bell crank lever not shown.



An experiment is made as follows: The lathe is run at a given speed, depth of cut and traverse arranged for, and the tool fed up to the work. As soon as possible the forces are balanced and brought to a working mean—that is, contact is made at regular intervals at all the stops. Each force is then separately balanced for its *maximum* and



minimum values. Friction on the stops is thus avoided. Before the force itself can be measured by a single experiment it is necessary to know the *centre of pressure*—that is, the point at which all the small forces in action may be assumed to act. This may be situated anywhere within the body of the shaving; and while for very small depths



of cut, its position may practically coincide with the centre of depth, with deep cuts and a short length of tool the divergence may be noticeable. In any case it is an advantage to have this information. It may be found, together with the real value of the forces, in the following way.

Referring again to Fig. 1. Let x be the distance from the fulcrum to the *centre of pressure*. Let p be the distance from the fulcrum to weight P. Then, by taking moments about the fulcrum, we get

$$X\,x = P\,p \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

If we now change the length of tool and balance under the same conditions as to cut, speed, etc., we get

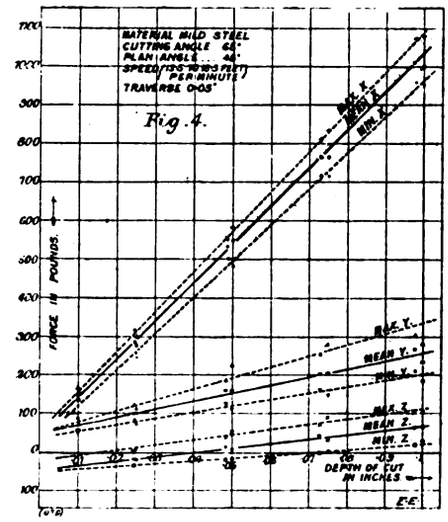
$$X\,(x + \delta x) = (P + \delta P)\,p \quad . \quad . \quad . \quad (2)$$

Subtracting (1) from (2)

$$X\,\delta x = \delta P\,p \text{ or } X = \frac{\delta P\,p}{\delta x}.$$

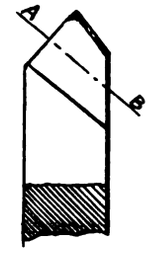
NOTE.—This is the real value of the force X, and by inserting in equation (1) we get x, the distance required.

Direct method: $\dfrac{X\,x}{X\,(x + \delta x)} = \dfrac{P\,p}{(P + \delta P)\,p}$ $\therefore x = \dfrac{P\,\delta x}{\delta P}$.



In working out the final values of the forces, calibration curves are used. The curves show the relation between the experimental forces and the actual moment on the opposite side of the system.

In no experiment I have made are the forces constant in value, and the exact nature of the fluctuation is not accurately known. Dr. Nicolson, of Manchester, has shown this fluctuation by measuring the forces at small intervals with a very slow cutting speed. The author has also published some photographs illustrating the formation of a chip. The capabilities of the machine, however, are such that when the *maximum* and *minimum* are well defined, they can be measured with accuracy. The tools used were of simple shape, with diamond points slightly flattened. In plan the cutting edge makes an angle of 45deg. with the axis of the work. The cutting angle is measured on the plane A B, and was accurately formed on a machine



grinder. Clearance in all cases is 7·5deg. Material operated on is as follows:

Cast iron, average crushing resistance	25	tons per square inch.
Mild steel, average crushing resistance	43	,, ,,
Mild steel, tenacity—nominal	34·5	,, ,,
,, ,, real.....	58·5	,, ,,
With an elongation on 2in. of.....	32	per cent.
Reduction of area	50·8	,,
Elastic limit	17·85	tons.

Cast iron: *Composition.*	Per cent.
Combined carbon.....	0·315
Graphite	3·26
Silicon	2·193
Sulphur.....	0·039
Phosphorus	0·991
Manganese	0·781

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No.	Speed — Revolutions	Speed — Feet per minute	Diameter — Before	Diameter — After.	Depth of cut.	Traverse per revolution	X.	Y.	Z.
			in.	in.	in.	in.			
135	—	—	4·794	—	—	—	361	215	114*
	16·25	19·9	—	4·697	—	0 05	235	104	35†
	—	—	—	—	0·0485	—	93	28	- 55‡
	—	—	4 697	—	—	—	659	292	193
136	16	19 9	—	4 501	—	0 05	481	182	72
	—	—	—	—	0·098	—	194	58	- 19
	—	—	4·501	—	—	—	498	284	143
137	16	18·5	—	4·353	—	0·05	378	150	42
	—	—	—	—	0·074	—	135	33	- 36
	—	—	4·353	—	—	—	227	235	70
138	16·27	18 4	—	4·297	—	0·05	149	80	13
	—	—	—	—	0·028	—	51	25	- 50
	—	—	4·297	—	—	—	130	54	42
139	16·27	18·25	—	4 275	—	0·05	75	56	10
	—	—	—	—	0·011	—	25	—	36
	—	—	4·275	—	—	—	898	403	257
140	16	17·3	—	3·987	—	0·05	705	243	119
	—	—	—	—	0·144	—	434	58	- 30
	—	—	3·987	—	—	—	370	305	118
141	16	16·5	—	3·877	—	0·05	257	103	25
	—	—	—	—	0·055	—	93	—	- 65
	—	—	3 877	—	—	—	379	292	120
142	16·27	16·3	—	3·775	—	0·05	256	130	31
	—	—	—	—	0·051	—	97	32	- 36
	—	—	3·775	—	—	—	489	450	171
143	16·13	15 6	—	3·626	—	0·05	360	182	51
	—	—	—	—	0·0745	—	134	42	- 55
	—	—	3·626	—	—	—	636	529	181
144	16 13	14·9	—	3 426	—	0·05	464	243	68
	—	—	—	—	0·1	—	244	58	- 76§
	—	—	4 774	—	—	—	170	242 ?	64*
145	16·55	20	—	4·727	—	0·05	128	53	- 7‖
	—	—	—	—	0·0235	—	50	—	- 55‡
	—	—	4·727	—	—	—	350	182	118
146	16·4	20	—	4·629	—	0·05	234	73	0
	—	—	—	—	0·049	—	76	—	- 88
	—	—	4·629	—	—	—	497	242	163
147	16·4	19·6	—	4·480	—	0·05	331	112	28
	—	—	—	—	0·0745	—	76	—	- 128
	—	—	4·48	—	—	—	631	305	202
148	14·65	16·8	—	4·277	—	0·05	455	143	42
	—	—	—	—	0·1015	—	106	—	- 140

No.	Speed — Revolutions	Speed — Feet per minute	Diameter — Before	Diameter — After.	Depth of cut.	Traverse per revolution	X.	Y.	Z.
			in.	in.	in.	in.			
149	—	—	4·277	—	—	—	840	354	232
	16·15	17·5	—	3·977	—	0·05	647	196	77
	—	—	—	—	0·150	—	315	—	- 103
	—	—	4·483	—	—	—	610	305	203
150	16·27	18·7	—	4·283	—	0·05	441	150	47
	—	—	—	—	·0995	—	172	—	- 124
	—	—	4·289	—	—	—	784	382	228
151	16·27	17 6	—	3·989	—	0 05	638	181	78
	—	—	—	—	0·150	—	305	—	- 115
	—	—	3·989	—	—	—	332	214	107
152	16·55	17	—	3·889	—	0·05	237	102	6
	—	—	—	—	0·05	—	67	—	- 77
	—	—	3·889	—	—	—	179	158	75
153	15·6	15·7	—	3 838	—	0·05	129	70	- 12
	—	—	—	—	0·0255	—	44	—	- 107 ?§
	—	—	4·295	—	—	—	319	123	6·9¶
154	16·55	18·5	—	4·2455	—	0·05	288	102	- 16‖
	—	—	—	—	0·0247	—	260	82	- 32‡
	—	—	4·2455	—	—	—	557	187	44
155	16·55	18·1	—	4·148	—	0 05	532	162	19
	—	—	—	—	0·0487	—	501	127	- 16
	—	—	4·148	—	—	—	813	255	75
156	16	17·5	—	4 002	—	0 05	766	205	44
	—	—	—	—	0 073	—	716	162	0
	—	—	4 002	—	—	—	1080	283	106
157	13	13·3	—	3 802	—	0·05	1002	235	68
	—	—	—	—	0·1	—	953	187	24
	—	—	3 802	—	—	—	303	114	10
158	16·55	15·9	—	3·752	—	0 05	282	102	10
	—	—	—	—	0 025	—	247	75	- 15
	—	—	3 752	—	—	—	582	227	53
159	16·55	15·65	—	3·652	—	0·05	545	162	10
	—	—	—	—	0·05	—	488	116	- 15
	—	—	3·652	—	—	—	833	283	91
160	16·3	15·3	—	3·502	—	0·05	765	205	35
	—	—	—	—	0·075	—	716	150	3
	—	—	3·502	—	—	—	1072	305	108
161	16·3	14·5	—	3·306	—	0 05	1015	267	65
	—	—	—	—	0 098	—	956	213	22
	—	—	4	—	—	—	154	92	1
163	16	16·7	—	3 98	—	0 05	140	54	— ?
	—	—	—	—	0·01	—	124	55	- 2 ? §

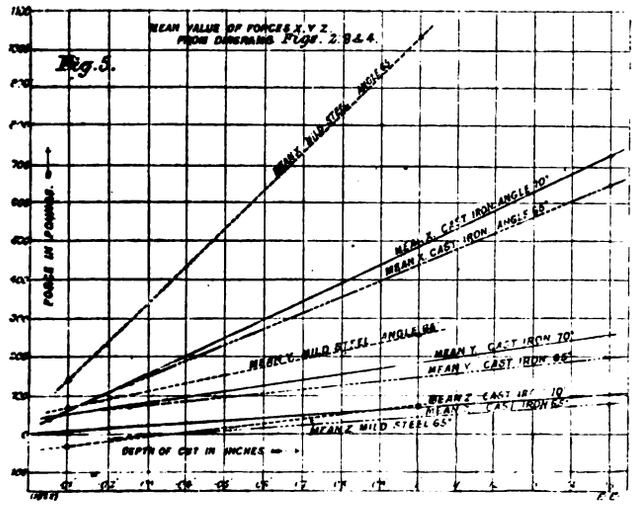
* Material, cast iron. † Cutting angle, 70deg. ‡ Tool, high-speed Mushet. § Tool in good order. ‖ Cutting angle, 65deg.
¶ Material, mild steel.

Mild steel (acid Bessemer):

Carbon	0·22
Manganese	0·936
Silicon	0·047

Results.

Tables of data showing three sets of experiments, together with curves illustrating same, are appended. Straight lines have been drawn on the diagrams as indicating the probable relations between the forces and the


MEAN VALUE OF FORCES X, Y, Z FROM DIAGRAMS Figs. 2, 3 & 4.
Fig. 5.
MEAN X MILD STEEL ANGLE 65°
MEAN X CAST IRON ANGLE 70°
MEAN X CAST IRON ANGLE 65°
FORCE IN POUNDS.
MEAN Y MILD STEEL ANGLE 65°
MEAN Y CAST IRON 70°
MEAN Y CAST IRON 65°
MEAN Z CAST IRON 70°
MEAN Z CAST IRON 65°
MEAN Z MILD STEEL 65°
DEPTH OF CUT IN INCHES.

depths of cut. In the experiments on mild steel these are very near the truth, and represent many separate experiments performed at different times. With cast iron the results are not so good, and represent one of its chief characteristics—that is, heterogeneous and open structure. The actual machine was on exhibition in the meeting-room.

THE BRITISH ASSOCIATION.

Address to the Chemical Section.

BY PROF. A. SMITHELLS, B.SC, F.R.S., PRESIDENT OF THE SECTION.

(Concluded from page 309.)

The admirable researches carried out in the University of Manchester by Prof. Bone and his collaborators have afforded most valuable information as to the oxidation of hydrocarbons at temperatures extending from those of incipient oxidation up to the highest ones that prevail in a flame. According to Prof. Bone, the oxidation of a hydrocarbon involves nothing in the nature of a selective or preferential oxidation of the carbon or the hydrogen, but it occurs in several well-defined stages, during which oxygen enters into and is incorporated with the hydrocarbon molecule, forming oxygenated intermediate products, among which are alcohols and aldehydes. The reaction, just referred to, between ethylene and an equal volume of oxygen is, according to Prof. Bone, to be represented by the scheme :

$$\begin{array}{ccccccc} CH_2 & & CH.OH & & CH.OH & & H_2C:O & & H_2+CO \\ \| & \rightarrow & | & \rightarrow & | & \rightarrow & \| & \rightarrow & \\ CH_2 & & CH_2 & & CH.OH & & H_2C:O & & H_2+CO \end{array}$$

There can be no question about the facts on which this scheme is based, and they are a new and important addition to knowledge. It is a great aid to the study of chemical changes, when we can resolve them into stages, whether or not these stages be realisable under certain experimental conditions. In this way we can get a clear view of the relationship between the action under one set of circumstances to the action under another set; and in this way also we can often establish rational links between reactions which at first sight seem quite disconnected. Intermediate reactions are much used to elucidate cases of contact action, and in the processes of organic chemistry they are almost universally assumed.

I am far from wishing to disparage these practices, but I think it important that we should realise how far we are dealing with convenient devices and how far with ascertained facts.

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The isolation of an immediate product under one set of circumstances is in itself no proof that this product is transitorily formed when the reaction is proceeding under another set of circumstances; and if we were to assume generally that because we can represent a chemical transaction as if it were due to a successive construction and destruction of a series of molecular edifices it actually does take such a course, we should, I think, be making the same kind of mistake as to suppose that in the application of two differently directed forces to a body at rest, the body will move successively in the direction of each force instead of moving immediately in the direction of their resultant. I know that I may be considered hypercritical, and perhaps obstinate, in this matter; but I wished to state the reasons that prevent me from accepting entirely the interpretation which Prof. Bone has given to his experimental results, and to draw attention to a question of general importance that has not, I think, received the attention it deserves.

The mode of burning of carbon, whether in the free state or as a constituent of a compound, is not at all easy to determine; and, notwithstanding many investigations, among which must be specially mentioned those of Prof. H. B. Dixon and his collaborators, so simple-looking a question as whether carbon forms carbon monoxide by directly uniting with oxygen, or only by reducing carbon dioxide, is still a matter of uncertainty. Our knowledge concerning the question of flame temperatures has been much improved in recent times, thanks mainly to the admirable work of M. Le Chatelier. The well-known memoir of Mallard and Le Chatelier on the explosion of gases supplied the data which first permitted of a moderately exact calculation of flame temperatures, and the perfection of the thermo-couple by M. Le Chatelier gave us the first instrument that could be used directly for making a satisfactory measurement. The uncertainty connected with this subject may be well illustrated by quoting the temperatures that have at different times been ascribed to the flame of coal gas when burnt in a Bunsen burner, where we have had values varying from 1,230deg. to 2,350deg. C. The question of calculating the temperature attained during combustion by reference to calorimetric values, specific heat, dissociation, and other considerations is to form the subject of a joint discussion with Section G during the present meeting, so that I shall not here enlarge upon it.

With regard to the use of thermo-couples, I may remark that the practical difficulties have been successfully met. The chief difficulty is, of course, to secure that the thermo-junction attains as nearly as possible the temperature of the region in which it is immersed. As ordinary flames consist of thin shells of burning gases, on either side of which there is a very rapid fall of temperature, it is necessary to use thin wires, and to dispose them so that there is no appreciable drain of heat from the junction. By using wires of different gauge for the couples it is possible by extrapolation to arrive at a temperature for a couple of infinitely small cross-section, and it is also possible to make a correction for the superior radiating power of the couple as compared with the flame gases. Without this last correction a maximum temperature of 1,777deg. was obtained for the Bunsen flame by Waggener in Germany, and 1,780deg. by White and Traver in America. Correcting for radiation, Berkenbusch found 1,830deg. as the maximum temperature. M. Féry, by an ingenious application of his beautiful optical pyrometer to a flame containing sodium, gives 1,871deg. as the highest temperature of the flame of a Bunsen burner burning coal gas. The consideration of flame temperatures has become of increasing importance in the arts owing to the use of the Welsbach mantle as a means of deriving light from coal gas. The great improvements which have been made in the efficiency of atmospheric burners depend primarily on the fact that the smaller the external surface we can give to a flame consuming gas at a fixed rate the higher must be the average temperature; and since the emission of light from a mantle is proportional to a high power of the absolute temperature, a small increase of temperature is of great effect on luminosity. The acetylene-oxygen flame, in which a temperature of about 2,500deg. prevails, not very different from that of the electric arc, is the hottest of the hydrocarbon flames, and finds some important practical uses.

I have already said something about the luminosity of flames so far as relates to the separation and glow of solid carbon. But there remains the more general question of the luminosity of flames containing nothing but gases. The older explanation of the emission of light from combining gases said no more than that the energy liberated during the reaction and appearing as heat raised the product to incandescence—that is to say, so increased the velocity of its molecules and the violence of their collisions that vibrations were set up whose wave-lengths lay within the limits of visible radiation. This explanation has long been questioned, and there is now, I think, a very general agreement that it will not suffice. The average temperature, in fact, prevailing in a flame, if attained in the product of combustion by the supply of heat from outside, does not suffice to make that substance luminous. We are therefore thrown back upon the conclusion that the generation of light in a flame is not a consequence, though it is an accompaniment, of the elevation of temperature. The question now is, Can we go any further? To do this we are led to consider individual molecular transactions instead of statistical averages, and the view presents itself that the combining atoms may, in losing their chemical energy, form directly systems of independent vibration where the radiation is such as to fall within the limits of visibility. If we picture such vibrating systems momentarily formed, it is easy to see that by their collision one with another they may acquire in a secondary way increased translational motion, and so lead to a state of things where the greater part of their energy is degraded in the form of heat. The high temperature of a flame would then be a consequence rather than a cause of its light.

This subject of the mechanism of luminosity, however, like so many others, has now become involved with the theory of electrons, and a chemist may be excused if he hesitates to pursue the subject further. Some years ago I called attention to the scantiness of our knowledge of the chemical changes that take place when metallic salts are used in flames for the production of spectra. Though there was general agreement that, for example, the yellow flame produced by common salt was due to the liberation and glow of metallic sodium, there was no agreement as to how the sodium was set free. Arrhenius, pursuing the analogy which exists between the laws governing matter in the gaseous state and in the state of dilute solution, had previously been led to the view that the electrical conductivity of flames containing salt-vapours was due to ionisation of the salt throughout the volume of the flame. It appeared possible, therefore, that the luminosity might be ascribed likewise to the metal separated in the ionic state. Experimental investigation undertaken with a view to elicit information on this subject seemed to favour the view that the metal was reduced by chemical processes, and that it glowed in the un-ionised condition. Evidence seemed to point to the conclusion that, for example, when common salt is introduced into the flame of coal gas the sodium chloride yields sodium by the conjoint action of steam and reducing gases; when liberation of the metal was prevented by adding a large quantity of hydrochloric acid to the flame the glow disappeared, but the conductivity was not always diminished. The fact that sodium salts, including the chloride, impart their characteristic glow to the flame of cyanogen and to other flames in which water is absent leads to same difficulty in finding a chemical explanation, and it must be admitted that a direct thermal dissociation of an alkaline halide or oxide is not out of the question. The interval of detachment of the metallic atom may be exceedingly brief, but it must be remembered that even so short a time as the interval between the molecular encounters in a gas at a high temperature is still sufficient for the emission of thousands of undisturbed characteristic vibrations. The experiments to which I have alluded have been followed up with great industry and success by Prof. H. A. Wilson, who has added much to our knowledge of the electrical condition of the flames containing vaporised salts, but the question of the condition of the luminous gas is still far from being settled. Very interesting and important investigations have been carried out by Lenard, who has shown that the stream of luminous vapour produced from a sodium salt in a Bunsen flame is deflected in an electric field in such a way as to indicate that the vapour is positively charged, but he gives reason for believing that the charged condition is intermittent with the neutral condition. The lines in the spectrum of an alkali metal are divisible, as is well known, into distinct groups or series, in each of which the oscillation frequencies corresponding with the lines are in a definite mathematical relationship. The principal series, which include the lines seen individually as such in ordinary flame spectra, are, according to Lenard, due to the electrically neutral atoms. In a salted spirit flame, and in other flames of low temperature where only lines of the principal series are represented, the stream of luminous gas does not behave in an electric field as if it were charged. In the flame of coal gas burnt in a Bunsen burner the salt-vapour gives, in addition to the distinct lines of the principal series, diffuse bands of luminosity on the dark background, which, according to Lenard, represent the undeveloped subordinate series, and it is the atoms emitting these series that are deflected in the electric field. It is inferred, therefore, that the light in a salted Bunsen flame comes from different groups of centres of emission—the principal series from the neutral atom, and the lines of the first, second, and third subordinate series from atoms which have lost respectively one, two, and three electrons. Lenard goes further, and shows that the salt-vapour in a Bunsen flame, as in the flame of the electric arc, emits these different kinds of radiation from different structural regions; thus the vapour at the edge of the flame is electrically neutral and gives only the lines of a principal series.

The negative electricity in a salted flame would, according to Lenard, be disembodied, and recent experiments by Gold confirm the view that the negative carrier in flames is a free electron. In connection with this subject I ought to allude to

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an investigation by Tufts, which seems to throw some doubt on the conclusions which were drawn from the experiments made by Prof. Wilson, Dr. Dawson, and myself; and I must also mention an important contribution to the subject recently made by Prof. Hartley, in which considerable light is thrown upon the chemical changes undergone by compounds of the alkaline earth metals when they are introduced into flames, and upon the relation of these changes to the various spectral features. I am afraid, however, that it would be wearisome if I were to prolong this summary, and I must be content to leave it without doing justice to those who are engaged upon the work. The subject is obviously one of fundamental importance in relation to spectrum analysis, and my own slight connection with it has only strengthened my opinion that there is still a great deal connected with the genesis of spectra that requires the attention of the chemist even more than that of the physicist. Spectrum analysis arose under the joint influence of Bunsen and Kirchhoff, and I think its problems still call for more combined work on the part of chemist and physicist than has latterly been the custom.

Having given a short summary of the present state of knowledge on one particular chemical topic, I may, perhaps, be permitted to conclude my address with a few general observations relating to the science as a whole. The contemplation of such a life as that of Berthelot makes us realise in a vivid way the progress of chemical science. He was a chemist without limitation, his activity extending over the whole range of the science—physical, inorganic, and organic. Whilst we must not forget his exceptional powers, we cannot help feeling how different in its extent was our science when he entered upon his labours from what it was when they ceased, and we cannot help feeling how vain it now is for anyone to hope for so imperial a sway. Yet it is difficult to believe that the state of chemistry can ever have been more interesting than it is at the present moment, or that anyone who sighs for the good old times can do so from anything but the love of a quieter life. We need not go back more than 20 years to find a sharp contrast. At that time there was, indeed, no want of activity, but it was that of a band of travellers who had left their frontier adventures far behind, and were marching steadily over a wide and almost uninterrupted plain. To-day we are among the mountains, with new peaks and prospects appearing on every side. Truly a steady head is required, and well may we ask, Whither are we going and where is the path of progress and of safety? I rejoice to live in such times, but I feel no competence to describe them, still less can I pretend to have vision keen and comprehensive enough to let me figure as a guide.

One of the penalties of devotion to a progressive science is the constant feeling of being left behind, and the knowledge that, while we are attending to our personal task, things are happening, near or far, that may, for all we know, be affecting the simplest facts, and the most elementary principles on which we have been accustomed to reply. This is a feeling that may well prevail at the present day. At the same time I do not think there is any occasion for panic, and I cannot help regretting the somewhat sensational language that has been used, even within our own circles, in regard to recent discoveries. The revelations attendant upon the investigation of radioactivity do, indeed, mark a distinct epoch in the history of chemical discovery, but that they entail anything like an unsettlement of our scientific articles of faith is not to be admitted for a moment. They make us realise in, perhaps, a not unprofitable way that scientific knowledge and scientific theories are necessarily proximate, never ultimate, and that ideas which may have been entertained for a long time without modification, and so have begun to seem perpetual, are, after all, only provisional.

There is certainly some embarrassment on finding that a substance like radium, which, according to the conventions would be called a chemical element, breaks up so as to give substances which, according to the same conventions, are likewise called elements. But the confusion is one of terminology and not of ideas. I think it likely that few chemists of my own generation have been in the habit of regarding the conventional elements as the ultimate compositional units of matter. We know that in our own country distinguished men of science like Sir William Crookes and Sir Norman Lockyer have always insisted on the complex nature of the elements, and I suspect there are many among us who might own to having made sober, if unsuccessful, attempts at the resolution of elements before the days of radium. The perplexities of chemists at the present day do not come, I think, from the novelty of the ideas that are being presented to them, but from the great rapidity with which the whole science is growing, from the invasion of chemistry by mathematics and, in particular, from the sudden appearance of the subject of radioactivity with its new methods, new instruments, and especially with its accompaniment of speculative philosophy. There is an uneasy feeling that developments of great importance to the chemist are being made by experiments on quantities of matter of almost inconceivable minuteness. Spectrum analysis, of course, took chemistry beyond the limits of the balance, but the new materials which it disclosed could at least be accumulated in palpable quantity. With radioactivity we seem, in relation to the ponderable, almost to be creating a chemistry of phantoms, and this reduction in the amount of experimental materials, associated as it is with an exuberance of mathematical speculation of the most bewildering kind concerning the nature, or, perhaps, I should say the want of nature, of matter, is calculated to perturb a stolid and earthy philosopher whose business has been hitherto confined to comparatively gross quantities of materials and to a restricted number of crude mechanical ideas. He is tempted to think of Falstaff's reckoning and to exclaim with Prince Henry, "Oh, monstrous! but one halfpennyworth of bread to this intolerable deal of sack!" Experimental science has latterly been spun to greater and greater fineness, until in the region of the N-rays the objective element seems to have disappeared altogether. I should, however, gravely abuse the position in which I am allowed to speak for the moment as a representative of chemists if I failed to express profound admiration for the masterly work which has been accomplished by the pioneers of the science of radioactivity. All that I wish to say beyond that is in explanation of a certain awe or trepidation which chemists of the older school may feel in the presence of such bold explorers; and I am the more tempted to say something on the subject, because in recent times, before the advent of radium, a good deal has happened which has given chemists occasion to ask themselves whether chemistry was not beginning, as it were, to drift away from them.

The most conspicuous development of the science during the past 20 years has been, of course, on the physical side, and abundant have been its fruits; but it has seemed to demand from chemists habits and endowments which they did not normally possess, and which they could not easily acquire. I was much struck by a remark made to me a few years ago by a distinguished chemist, who is, I think, the most perfect manipulator I have ever seen at work, to the effect that he felt himself submerged and perishing in the great tide of physical chemistry which was rolling up into our laboratories. Now, it is precisely such men that must be preserved to chemistry. Though chemistry and physics meet and blend, there is, I believe, an essential difference between the genius of the chemist and the genius of the physicist, and I venture to think that some insistence on the primary functions of a chemist is not untimely. The chemist's first qualification is that he shall be master of a peculiar craft; his greatest merit that he is a consummate workman; his distinctive power a nicety of discrimination in questions affecting the composition and quantity of materials. He is not given to elaborate theories, and is usually averse to speculation; nor has he usually an aptitude for mathematics. Such the normal chemist is or was, and such I hope he always may be—naked, perhaps, in some respects, but unashamed.

There seems to be a solicitude in some quarters to make a chemist something more than a chemist, a solicitude which, if gratified, will, I believe, make him something less than one. We are told, for example, that a chemist should be a mathematician. I do not admit it for a moment. Some mathematics he must of necessity have—that has always been admitted—but in proportion as chemistry develops on the mathematical side does it become important, not that our chemists should be trained in mathematics, but that they should be more than ever carefully trained in the art of exact experiment; that their methods of work, their powers of observation, and, if possible, their experimental conscience, if I may use the expression, should acquire a finer edge. There is never more cause for anxiety than when we see a mathematical theory awaiting the delivery of the confirmatory facts, and there is nothing more important for chemistry than the continual recruiting of that old guard which will be ever ready to stand to arms on the appearance of an eager theorist. I do not for a moment wish to disparage the adventurous spirits within or outside our science, still less do I wish to arrange myself with those who meet new ideas with mere objurgation or raillery. We must be content to see new alliances and new activities on the frontiers that separate us from other sciences; content to see many new kinds of chemistry arise in which we cannot all effectually participate. Chemistry is becoming bewildering in its extent, and it would be a great misfortune if this led to the notion that every chemist must try to enlarge his ambit to its confines and fit himself for every variety of work. Those of us who have responsibilities as teachers cannot, I think, be too careful, lest in the attempt to secure breadth we may encourage shallowness, and fail to give our students that peculiar and time-honoured discipline in exactitude of work in chemistry proper which has characterised the chemists of the past, and which is infinitely more important than superficial dealings with a great variety of processes and appliances. I confess that I have frequent misgivings as to whether our modern courses of instruction may not tend to turn out chemists more learned in the science and less perfect in the

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art than was the case under the ancient *régime*. There was, after all, great virtue in the system which often detained a student day after day, or perhaps week after week, on a single problem of chemical composition such as is involved in the exact analysis of fahl-ore. It is not easy to meet all requirements, but I think we shall all agree that, whatever is left undone, we must make a chemist a good craftsman. It is of the utmost importance that those whom we send out to work in the newer fields shall take with them the resources that have proved most serviceable in the old, and I think it is by supplying such men for special service, rather than by attempting to shift the centre of gravity of the whole system of chemical education, that we can best serve the newer interests.

Another perturbation within the chemical camp in recent times has come from the region of philosophy. Even before the days of radium we have been accused of clinging too fondly to our atomic theory and of stating our knowledge too exclusively in terms of that theory. We are said to have drifted into a dogmatism as real as any we ourselves have had to attack, and to shut our eyes to the light which will enable us to orient ourselves truly in the wide realm of thought. The answer that most of us would give would be, that we value our hypotheses according to their productiveness in new knowledge, and that it is, on the whole, perhaps better to over-exalt an hypothesis that is fertile than from high considerations of philosophy to allow our ideas to become so fluid that they can afford no rigid framework for thought. I think that the attempts to view chemical phenomena apart from the atomic hypothesis, interesting as they undoubtedly are, have not made us feel that this hypothesis has either misled us in any matter of fact or obscured any pathway that we might have followed with greater profit. The value of the thermo-dynamical treatment of chemical problems is attested by its fruitfulness in promoting fresh discoveries, and here we may welcome a valuable adjunct to the atomic hypothesis. But I do not think we are called upon to acclaim a new method of treating old questions unless it promises some more tangible result than an alleged improvement of our intellectual morals.

If, as I have ventured to hint, mathematics brings with it an element of danger into chemistry, I think that the intrusion of metaphysics would give far greater cause for apprehension. Philosophy always stands with open arms desiring a closer embrace of all the sciences, of which she declares herself to be the fond mother, whilst Science, as we understand the term, has stood reluctant, suggesting, as someone has wittily remarked, that she regards Philosophy rather as a mother-in-law. It may, perhaps, be desirable, especially in the present state of things, that scientific men should allow themselves to become a little more interested in deep questions affecting all knowledge, and should at least examine with some care the gifts that Philosophy is so anxious to bestow upon us. I have a fear that otherwise in the elaboration of scientific theory we may find ourselves embroiled in an unequal contest with what I cannot but regard as the traditional enemy—I mean the unmitigated metaphysician—and the suggestion that I make is, to tell the truth, not so much from the hope of gain as from the desire for self-defence and the safe preservation of the methods that have served us so well in the past. I think the accusation that we delude ourselves into the belief that our hypotheses are final truth is not true of any thoughtful chemist. The great men of science have surely possessed that quality of mind which philosophy would most approve. If, as has often been remarked, Faraday was mathematically minded, though untrained in mathematics, it seems not less true that he stood in the same relation to philosophy. When, for example, he was asked to express his opinions on the atomic theory, he wrote as follows: "I do not know that I am unorthodox as respects the atomic hypothesis. I believe in matter and its atoms as freely as most people—at least I think so. As to the little solid particles, which are by some supposed to exist independent of the forces of matter, and which in different substances are imagined to have different amounts of these forces associated with or conferred upon them (and which even in the same substance, when in the solid, liquid, and gaseous state, are supposed to have like different proportions of these powers), as I cannot form any idea of them apart from the forces, so I neither admit nor deny them. They do not afford me the least help in my endeavour to form an idea of a particle of matter. On the contrary, they greatly embarrass me; for after taking account of all the properties of matter, and allowing in my consideration for them, then these nuclei remain on the mind, and I cannot tell what to do with them. The notion of a solid nucleus without properties is a natural figure or stepping stone to the mind at its first entrance on the consideration of natural phenomena, but when it has become instructed, the like notion of a solid nucleus, apart from the repulsion, which gives our only notion of solidity, or the gravity, which gives our notion of weight, is to me too difficult for comprehension; and so the notion becomes to me hypothetical, and, what is more, a very clumsy hypothesis. At that point, then, I reserve my mind as I feel bound to do in hundreds of other cases in natural knowledge." This is the attitude of mind, I think, of all thoughtful chemists; if they do not exhibit it ostentatiously, it is only because it is as disturbing to the proper work of a chemist for him to be constantly dwelling on the inward nature of his hypotheses as it is distracting in ordinary life to have men always talking about their emotions.

Few, I think, will deny that the atomic theory stands to-day as an indispensable instrument for productive chemical work; it has neither had its day nor ceased to be. Physicists have never been quite satisfied with the hard indivisible ball of specific substance and definite mass which has served chemistry so well. They have given it bells, have made a vortex ring of it, and have, indeed, done much that few chemists can understand to make it meet the exacting requirements of their science. But to us it has always been the same; what we have done to it has been external; we have given it, vaguely perhaps, a charge of electricity, a store of energy; we have attached the hooks or rods of valency, but we have not meddled with its interior. We are now called upon by chemical considerations of change of composition, as well as by other considerations more recondite, to subdivide our atom, to credit it with an unsuspected store of energy, to consider it a congeries of unsubstantial electrons. We should wish, of course, to know that the evidence is good enough, but otherwise there can be no possible objection from our side; it will undo nothing that has been done, and we may have good hopes that it will lead to the doing of many new things in chemistry. The newer theories are in consonance with the old in one most vital point: they afford those mental pictures of phenomena which most of us find indispensable for fruitful work. They do not belong to what Prof. Schuster has characterised as "the evasive school of philosophy." "Those," he says, "who believe in the possibility of a mechanical conception of the universe, and are not willing to abandon the methods which from the time of Galileo and Newton have uniformly and exclusively led to success, must look with the gravest concern on a growing school of scientific thought which rests content with equations correctly representing numerical relationships between different phenomena, even though no precise meaning can be attached to the symbols used." Most of us, I think, will take comfort in this pronouncement and rejoice that if our conception of the atom is to be transformed it may still be represented as having some kinship with what Sir Henry Roscoe's famous examinee described as the "square blocks of wood invented by Dr. Dalton."

COVENTRY ELECTRICITY UNDERTAKING.

Extensions of Area.

The Corporation of Coventry have succeeded in obtaining an additional area over which to supply electricity by a somewhat novel procedure, which has practically saved a year. The following report of the Electric Light Committee explains how this was done:

Your committee beg to report the result of their efforts to obtain parliamentary powers recommended by the committee in their report adopted by the Council on March 12 last to be sought in connection with the Corporation Water Bill then before Parliament. As the Council are aware, it was at that time too late to comply with the Standing Orders of Parliament, inasmuch as those orders require proceedings in connection with the promotion of a Bill to be commenced by petition deposited on Dec. 17. The procedure adopted for obtaining the desired powers was by way of additional provisions to the Water Bill; and to enable the procedure to be effective it has been necessary to satisfy the examiner on Standing Orders in both Houses that there were sufficient grounds to warrant a suspension of those orders, which your committee are glad to report has been successfully accomplished. The powers sought were: (1) additional borrowing power for purposes of the undertaking; (2) extension of the area of supply; (3) right to make a charge for a supply (known as a stand-by supply) to premises having a separate supply. The extension of area sought by the Bill, and consented to by the various district councils concerned, comprises the parishes of St. Michael and Holy Trinity Without, the parish of Stivichall, and the parishes of Stoke, Foleshill, and Exhall. The Meriden Rural District Council would not consent to the inclusion of Coundon and Allesley, and those places, accordingly, had to be omitted. A petition was presented by the Leicestershire and Warwickshire Electric Power Company against the Bill in regard to the proposed extension of area of supply. That company had, by an Act of 1902, obtained parliamentary power to construct generating stations and works and to supply electricity in districts and places in the counties of Leicester and Warwick, but beyond erecting a small generating station at Hinckley had done nothing towards giving a supply.

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The Bill originated in the House of Lords, and, after being read a second time, was referred to a Select Committee, which sat on May 3 and 6 last. The case for the Corporation was presented by counsel, and supported in evidence by the chairman of your committee, the electricity manager, and three other witnesses representing firms requiring a supply of energy in the proposed extended area. The Leicestershire and Warwickshire Electric Power Company were represented before the committee by counsel and witnesses. The Select Committee, after exhaustive inquiry, found the preamble of the Bill proved, which included the additional provisions relating to the electric light undertaking. The Leicestershire and Warwickshire Electric Power Company did not offer any further opposition in the Second House. The Bill was in due course read a third time, and afterwards received the Royal assent.

The Bill extends the area of supply as applied for, and contains a provision for the acquisition by local authorities within whose jurisdiction a supply is being given, after the expiration of 42 years from the passing of the Act, of so much of the undertaking as is within their jurisdiction. The Board of Trade required a clause for compulsorily laying down distributing mains, for the purposes of general supply, within two years after the passing of the Act, and a clause was accordingly inserted, under which distributing mains are to be laid as follows: Bedworth-road from the city boundary to the boundary of Foleshill and Exhall parishes; Binley-road from Stoke Vicarage to Stoke-hill; Folly-lane from the city boundary to Pinley House Lodge; London-road from the city boundary to Whitley pumping station. The Bill contains a provision that a person shall not be entitled to demand a supply or the continuance of a supply of energy for premises having a separate supply, unless he shall have previously agreed to pay to the Corporation such minimum annual sum as will give them a reasonable return on capital expenditure and will cover other standing charges incurred by them to meet the possible maximum demand for those premises.

With regard to borrowing powers, the Bill provides for the borrowing, with the consent of the Local Government Board, of such further money as may be necessary for the purpose of the electric light undertaking and for repayment within such period as the Board may sanction. It also provides that in calculating the amount which the Corporation may borrow under the Public Health Act, 1875, any sum which they have borrowed or which they may hereafter borrow for the purposes of the electric light undertaking shall not be reckoned. The Council will remember that at present the capital expenditure on the electric light undertaking (irrespective of the £27,000 extension now in hand) amounts to £185,744, and that that amount is included in calculating the amount which the Council may borrow under the Public Health Act, which is well nigh exhausted. The effect of the provision in the Bill is to free the borrowing power under the Public Health Act to the extent of the present capital expenditure on the electric light undertaking—viz., £185,744—and so make that amount available as an unexhausted borrowing power for the general purposes of the Corporation. Your committee regard this as a valuable acquisition, as had the Council desired to carry through any scheme requiring a large expenditure, in all probability it could not have done so on account of the insufficiency of borrowing power. Additional borrowing power could only be obtained from Parliament. The provision in the Bill will, therefore, obviate any such difficulty and avoid any possibility of an application to Parliament for additional borrowing powers for general purposes. Your committee recommend that they be authorised to take the necessary steps to bring the provisions into operation.

(Signed) CHARLES WEST, Chairman.

ELECTRIC LIGHT AND TRAMWAY LEGISLATION.

The parliamentary session which has just been brought to a close was in no way remarkable for the output of measures of electrical interest. Only three of the Bills introduced by the Government affected the electrical industry in any way. Among these was the Patents and Designs Bill, a measure for the amendment of the existing law relating to patents and designs, with a view especially to restraining the abuse of monopolies, and to strengthening the provision in regard to the revocation of British patents which are worked abroad, but which are not adequately worked in this country. Another Government Bill that has passed into law is for the amendment of the Companies' Acts, which, by affording fuller information concerning public companies, and by other provisions, will secure a greater degree of protection to creditors and shareholders. The third Bill of any importance is the Telegraph (Money) Bill.

Turning to private Bills of electrical interest, we find that 36 in all were introduced, 10 of which were either withdrawn by their promoters or failed to pass. Fifteen of these Bills affected London, but six, including the four introduced with a view to giving a bulk supply of electricity over Greater London, were withdrawn. Among the principal metropolitan Bills that have passed through Parliament and have received Royal assent are: Central London Railway; Electric Supply Corporation; Great Northern and City Railway; London and North-Western Railway; London County Council (Tramways and Improvements); London United Tramways; North-East London Railway; North Metropolitan Electric Power Supply; Watford and Edgware Railway.

Of the remaining Bills affecting different parts of the country the most important that have now been entered upon the statute book are: Aberdeen Corporation Electricity; Brighouse Corporation; Coventry Corporation; Folkestone, Sandgate, and Hythe; Glasgow Corporation; King's Norton and Northfield Urban District Council; Kingston-upon-Hull Corporation; Manchester Corporation Tramways; Middlesbrough Corporation; Middlesbrough, Stockton-on-Tees, and Thornaby Tramways; Oxford and District Tramways; Rawtenstall Corporation; Richmond (Surrey) Electricity Supply; Sheffield Corporation; Sunderland Corporation; West Riding Tramways; West Yorkshire Tramways.

The electric lighting provisional orders that have been granted by the Board of Trade are in most cases for extensions to and amendments of orders previously granted. Chief among the new orders are the Cork (Rural); Arbroath; Minehead and Dunster; Rhymney Valley; St. Albans and District. Tramway provisional orders granted and confirmed by Parliament include Audenshaw Urban District Council; Huddersfield Corporation; Leeds; Taunton Electric Traction Company; West Ham Corporation.

PERSONAL.

Mr. H. R. Kemp has been appointed electrician-in-chief to the General Post Office.

It is reported from America that Mr. Thos. Edison is suffering from serious nervous collapse.

We are asked to state that the address of the Newcastle branch of the Electrical Co. is now Printing Court-buildings, Akenside-hill, Newcastle-on-Tyne.

Mr. E. F. Kent, of the Croydon Corporation electricity works, has been appointed technical assistant in the test-room of the Sunderland Corporation electricity department at a salary of £156 per annum.

Mr. Launcelot P. Marshall, M.I.C.E., M.I.Mech.E., at present holding an appointment on the engineering staff of the London County Council, has been appointed chief engineer to the Rangoon Municipality, Burma. This appointment carries with it a salary of £1,200, rising to £1,500 per annum.

Mr. J. A. McLay, assistant turbine sales manager of the British Westinghouse Electric and Manufacturing Co., has been appointed agent in Great Britain of the Société Anonyme Westinghouse, Le Havre, for the Leblanc condensing apparatus. He will take up his new duties at once at his London address, 2, Norfolk-street, Strand, W.C.

The Monmouth Town Council have accepted the resignation of their electrical engineer, Mr. A. W. Wilkins, who, as we intimated last week, is taking up a business in Dublin. The Monmouth Council have decided to engage Mr. Blake, Swansea, to visit Monmouth and superintend the working of the electric installation, pending the appointment of another engineer.

A cricket match was played on the Mansfield town ground between teams representing Mansfield electricity works *v.* Chesterfield electricity works. The former came out victorious, scoring 156 runs against the latter's 48. The match was noticeable for the fine batting display of C. B. Grace, who knocked up 101 runs, and the bowling of Chaplin and Grace, who each took five wickets for 24 runs.

On Saturday, Aug. 17, Messrs. Reyrolle's held their annual beanfeast at the Spa Gardens, Shotley Bridge. About 300 members of the staff and other employés attended, and various sports, including a football match, were thoroughly enjoyed. At the dinner Mr. Shepherd proposed a toast to the firm, reminding his fellow-workers of the extensions and progress which had been made at Hebburn. Mr. Reyrolle, replying from the chair, expressed his approval of the good fellowship which existed amongst the employés, and he acknowledged that much of the success of the firm depended upon the continuance of this *entente cordiale*. This year they had nearly 400 hands, but he recalled the time, not many years ago, when there were only about six. He looked to everyone to do their best for the firm, and then he hoped that they would increase and be in a position to employ more hands. A dance on the green finished the programme for the day.

FORTHCOMING EVENTS.

Junior Institution of Engineers.—Saturday, Sept. 7, at 3 p.m., visit to the works of the Metropolitan Water Board at Hampton-on-Thames.

Iron and Steel Institute.—Sept. 23, 24, and 25, Vienna meeting.

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LEGAL INTELLIGENCE.

ANDREWS v. STACEY.

At the Bournemouth County Court on Friday last the case of H. G. Andrews, electrical engineer, Boscombe, *v.* Walter Stacey, builder and decorator, The Triangle, in which £11. 17s. 7d. was claimed for work done, was tried before his Honour Judge Philbrick, K.C.

The case for the plaintiff was to the effect that defendant entered into a contract with a Mrs. South to do certain work for her at a house known as Haslemere, and engaged plaintiff to do the electrical fittings for bells, lights, etc. After the work was done he sent in his bill in the usual way to the defendant, who some time afterwards saw plaintiff and told him he could not get any money out of Mrs. South, and asked Mr. Andrews to see if he could succeed. Mrs South, however, as plaintiff expected, ignored him entirely, and said she had given the work to Stacey, to whom she was responsible.

For the defendant, it was submitted that the plaintiff was given an introduction to Mrs. South, who gave him the orders direct for the work.

His Honour, however, upheld the claim and gave a verdict for the plaintiff.

COMPANIES' MEETINGS AND REPORTS.

GREAT NORTHERN, PICCADILLY, AND BROMPTON RAILWAY.

The half-yearly general meeting of the Great Northern, Piccadilly, and Brompton Railway Co. was held on Wednesday, Sir George Gibb (the chairman) presiding.

The CHAIRMAN, in moving the adoption of the report, said that the amount of capital expended during the half-year was £165,462. The total capital expenditure up to June 30 amounted to £6,747,715. The balance still to be credited to the contractors, the Underground Electric Railways Co., on the share capital amounted to £592,400. The only construction work remaining to be done was the completion of the Holborn-to-Strand section, and it was expected that this section would be opened for traffic in December next. They had now had the experience of a full half-year's working of the railway, and he was glad to say that they had found the whole of the construction work and equipment to be most satisfactory. They had carried 11,953,795 passengers, including season-ticket holders. The passenger receipts had been £102,836, and the gross revenue, including miscellaneous receipts, £106,570, which worked out at £461 per mile per week. The average receipt per passenger carried had been 2d. The working expenses, including £6,063 for rates and taxes, amounted to £75,794. Out of this total £30,152 was spent on train working. This was equivalent to 2·47d. per car mile. Traffic expenses amounted to £18,135, which was 23·9 per cent. of the gross revenue. Lift expenses amounted to £9,252, which was 12·2 per cent. of the gross revenue. These figures, he thought, all tended to show that the working of the railway during the half-year had been economical, and he believed it would be generally admitted that it had been efficient. Their experience of the working fortunately confirmed their expectation that it would be possible to maintain a thoroughly good service on the railway at a moderate working cost, notwithstanding the burden of lift expenses, which were a heavy item peculiar to tube working. The total working expenses represented £328 per mile per week, and he thought they would all be very well satisfied if they were able to maintain that figure, and still more pleased if they could reduce it. The working cost averaged 1·51d. per passenger carried. The net result of the half-year's working, after payment of the interest on all the debenture stock actually issued and sold to the public, showed a deficit of £5,270, which the Underground Co. were by their guarantee agreement bound to pay, and had paid. He thought they would have to wait some time before they could get the full development of which the line was capable. They looked forward, however, to getting a valuable through traffic in connection with the Hampstead Tube, as it opened up Hampstead, Highgate, and all the district north of Euston-road.

Lord FARRER seconded the motion, which was carried unanimously.

BAKER STREET AND WATERLOO RAILWAY.

The half-yearly general meeting of the Baker-street and Waterloo Railway Co. was held on Wednesday at Hamilton House, Victoria-embankment, E.C., Sir George Gibb presiding.

In moving the adoption of the report the CHAIRMAN explained that the capital expenditure during the half-year was £54,865, and the total capital expenditure up to June 30 amounted to £2,960,891. During the half-year two new stations had been opened, the Great Central Station and the Edgware-road Station. The number of passengers carried, including season-ticket holders, was 9,935,995. The passenger receipts amounted to £61,501, which worked out at an average of 1·49d. per passenger. That, he said, was a very low receipt, but the railway is only 4¼ miles long. The gross revenue was £63,451, which was an increase of £18,871 as compared with the revenue for the half-year ended Dec. 31, 1906. The gross revenue per mile per week had increased from £469 in 1906 to £631 in 1907, which he thought was quite satisfactory. The working expenses, including £3,574 for rates and taxes, had amounted to £42,128. Out of this total £16,191 had been spent on train working, which worked out at an average of 2·67d. per car mile. The traffic expenses had been £10,296, or 16·2 per cent. of gross revenue, while the lift expenses amounted to £4,125, or 6·5 per cent. of gross revenue. The total working expenses worked out at £495 per mile per week, which, considering the very full and frequent service run, was quite a low figure. The net result of the half-year's working was a credit balance of £6,744, which had been carried forward to the next half-year's account, and would be available, together with whatever net profits might then be earned, towards paying a dividend at the rate of 4 per cent. per annum on the preference shares. He said the directors had given a good deal of consideration to the question of constructing the Paddington extension, but there was no immediate necessity for deciding that question, as they had come to the conclusion that it would be wiser at present to defer commencing it. It would benefit the Great Western Railway more than the Baker-street and Waterloo, and he hoped that when they were ready to put it forward it would also be considered by the Great Western Railway. The time for extending the line did not expire till 1911, and it was proposed in an agreement with the Underground Electric Railways Co., which would be submitted to the meeting, that the commencement of the construction should be postponed till after Sept. 30, 1908.

Sir ALGERNON WEST seconded the resolution, which was carried unanimously.

CHARING CROSS, EUSTON, AND HAMPSTEAD RAILWAY.

The half-yearly meeting of the Charing Cross, Euston, and Hampstead Railway Co. was held on Wednesday.

Sir GEORGE S. GIBB presided, and, in moving the adoption of the report, stated that the capital expenditure during the half-year amounted to £547,860, and the total capital expenditure up to the end of the half-year amounted to £5,539,446. They might now practically regard the work of construction as finished. The railway had been most admirably constructed and equipped with an evident determination to let the public have the best possible railway, whatever it cost, relying that the public would sooner or later take advantage of the superior facilities which were provided for their travelling needs. The whole of the work and the services afforded on the lines received universal praise and appreciation. The service being run was so frequent that it ought to attract by making travel easy and quick. They had not as yet carried a large traffic, but, of course, this line was built to develop a new route, although part of it passed under streets where there was already a large movement of people, and from these he was glad to notice an increasing traffic Still, the main object was to open out the suburbs of Hampstead, Highgate, Golder's Green, and beyond, which were, perhaps, the most attractive districts for residents that now remained within a short distance of London, and it was to the development of these districts that they must look for their success.

Lord GEORGE HAMILTON seconded the motion, which was unanimously agreed to.

MERSEY RAILWAY.

Mr. James Falconer presided on Friday last at the half-yearly ordinary general meeting of the Mersey Railway Co., held at Worcester House, Walbrook, London.

In moving the adoption of the report, the CHAIRMAN said the results of the half-year showed that the progress of the traffic of the Company had again been well maintained. There had been a substantial increase in all classes of traffic. During the last half-year the number of passengers carried, including season-ticket holders, estimated on the same basis, was 6,686,000, showing an increase during the period of electrical working of a little over 99 per cent. Practically the number of passengers carried had doubled itself during five years. As regarded the total revenue from all sources the amount in December, 1902, the last year of steam working, was £29,470, while the amount last half-year, now ended, was £49,892, an increase of a little over 69 per cent. He thought these figures showed to a very striking extent that the increased facilities which the Company continued to give to the public were being appreciated and were having the effect.

Mr. ROBERT COOPER seconded the adoption of the report, which was agreed to.

YORKSHIRE ELECTRIC POWER.

The report of the Yorkshire Electric Power Co. for the half-year ended June 30 last, to be submitted at the meeting at Leeds on Oct. 1, states that the progress of the Company has been uniform, and shows a satisfactory reduction in working expenses, whilst the sale of electrical energy is approximately double that of the corresponding half-year in 1906. During the past half-year agreements have been made for 600 kw. (800 h.p.), making a total of 3,122 kw. (4,163 h.p.) to June 30 last. An important agreement has been made with Electricity Distribution of Yorkshire to take a bulk supply of energy in all districts for which the Distribution Co. shall hold electric lighting provisional orders within the area of the Power Co. A supply is already being given to the company in the urban district of Gomersal, and it is expected that a supply will be given in other districts at an early date. An agreement for a short period has also been made to utilise the staff of the Power Co. to manage and develop the Distribution Co., which will assist in rapidly building up an increasing demand upon the Power Co. for electrical energy. The directors desire to commend to all shareholders an investment in the Distribution Co., which they believe will at an early date be profitable in itself and of great assistance to the business of the Power Co.

NEW COMPANIES REGISTERED.

Doncaster Electrical Co., Limited. — Registered Aug. 28. Capital, £500 in £5 shares (50 preference). Objects: to carry on the business of electricians, engineers, workers, and suppliers of electricity, motive power and light, etc. No initial public issue.

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Nortons (Tividale), Limited.—Registered Aug. 27. Capital, £5,000 in £1 shares. Objects: to carry on the business of bridge and pier builders, contractors, ironfounders, mechanical, hydraulic, electrical, water supply, mining and colliery engineers, toolmakers, brassfounders, boilermakers, etc. No initial public issue. Registered office: Hecla Works, Tividale, Staffs.

Magnetic Clutches, Limited.—Registered in Edinburgh Aug. 24. Capital, £20,000 in £1 shares. Objects: to acquire from H. W. Ravenshaw, V. G. Middleton, and W. E. Townsend certain patents for the manufacture of magnetic clutches and change-speed gears, and to carry on the business of manufacturers, proprietors, agents, and brokers of and dealers in motorcars, vans, motor lorries, motor boats, and other public or private conveyances, etc.

McKenzie, Holland, and Westinghouse Power Signal Co.—Registered Aug. 29. Capital, £20,000 in £1 shares. Objects: as title. No initial public issue. 9,996 of the original shares are to be allotted to McKenzie and Holland, 9,996 to the Westinghouse Brake Co., and the remaining eight to nominees of the said two companies, each of which may nominate two of its directors or their permitted assigns as directors of this company.

Lighting and Heating Trust Co., Limited.—Registered Aug. 23. Capital, £10,000 in £1 shares. Objects: to carry on, assist in, and promote lighting, heating, and other industries and undertakings; to act as trustees for the holders of debentures, bonds, or debenture stock, and as attorneys for the investment, loan, payment, transmission, and collection of money; to subscribe for, underwrite, issue, hold, deal in, and convert stocks, shares, and securities, etc. No initial public issue.

Rubber Concessions, Limited.—Registered Aug. 21. Capital, £5,000 in £1 shares. Objects: to acquire an option for the purchase of a concession for the collection of rubber and other purposes in the Republic of Ecuador granted at Riobamba by the Government of Ecuador to Francisco I. Salazar in September, 1903, and with a view thereto to adopt an agreement with C. A. V. Conybeare and G. Gall. No initial public issue. Registered without articles of association. Registered office: 46, Leadenhall-street, E.C.

Liens Registered.

Britannia Engineering Co., Limited (Colchester).—Issue on Aug. 16 of £1,000 6 per cent. second mortgage debentures, part of series created July 20, 1907, to secure £15,000. Charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £10,400.

F. and C. Osler, Limited.—A charge dated Aug. 21, 1907 (supplemental to a trust deed of June 26, 1907, securing £50,000 debentures), has been registered. Property charged: Freehold land and buildings in Old Court House-street, Calcutta. Trustees: A. G. Mathews, 7, Eaton House, Belsize Park-gardens, W.; O. F. Dowson, of same address; and A. E. M. Long, 5, Waterloo-street, Birmingham.

Conduit and Insulation Co., Limited (London).—Issue on Aug. 22 of a 5 per cent. debenture for £250, part of series created same date to secure £500, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. A debenture of even date securing £500 and ranking *pari passu* with the above as a charge on the same property has also been registered. Trustees (or holders?): A. Holland, East India-avenue, E.C., and W. R. Comings, Wharncliffe, Wimbledon Park, Surrey. No previous issue of same series.

Rhondda Tramways Electric Supply Co., Limited.—A trust deed, dated Aug. 8, to secure £44,000 debentures, created by resolution of Aug. 7, 1907, has been registered. Property charged: (1) underlease (when granted under next-mentioned agreement) of land at Ystradyfodwg, Glamorgan, with generating station to be erected thereon, and all fixed plant, etc., appertaining thereto; (2) agreement with the Rhondda Tramways Co.; (3) agreement with the National Electric Construction Co.; (4) sinking fund policy or policies to be effected for securing redemption of debentures on Aug. 1, 1949; and (5) the company's undertaking and property, present and future, including uncalled capital. Trustees: C. A. Scott-Murray, 63, Threadneedle-street, E.C.; and L. B. Schlesinger, 21, Cornhill, E.C.

OPENINGS FOR CONTRACTORS.

ABERDEEN—Dwelling-house in Victoria-road—builder, Mr. Alexander Young; four dwelling-houses in Gray-street for Mr. C. A. Bodie; two dwelling-houses in Deeswood-place—architect, Mr. Harvey Menzie; alterations and additions to premises, 9, Golden-square—architects, Messrs. Cameron and Watt.

ALTON (HANTS)—Petty sessional court. County surveyor, Mr. W. J. Taylor, The Castle, Winchester.

ASTLEY (LANCS.)—New mines to be sunk for the Astley and Tyldesley Coal Co.

BINGLEY—Shed at Britannia Mills, Bingley, for D. and R. England, Limited.

BIRMINGHAM—School at Edgbaston. Architect, Mr. H. T. Sandy, 22, Greengate, Stafford.

BODMIN—Extension of Dunmere Mills. Architect, Mr. M. Oliver, Bodmin.

BRISTOL—Electricity works extensions (£34,600).

CLYDEBANK—Transporter for the handling of ore cargoes at Rothesay Dock, Clydebank, for the Clyde Trustees.

COATBRIDGE—Higher-grade school in Albert-street (£15,230).

COVENTRY—Buildings for the Gas Committee, including electric power-house. Mr. Fletcher W. Stevenson, engineer and general manager, Gasworks, Coventry.

CREWE—Secondary school in Ruskin-road (£17,526). Contractors, Messrs. T. Wilson and Sons, Mirfield.

CRIEICIETH—New buildings and public lighting proposed for the Town Council.

CROYDON—School for 260 children. Architect, Mr. H. Carter Pegg, Thornton Heath.

DALKEITH—New municipal buildings (£2,000). The Electric Supply Corporation to be asked to submit terms for lighting by electricity.

DARLINGTON—Extension of parcels office for the N.E.R. Mr. Wm. Bell, the company's architect, York.

DENNY (N.B.)—School to be built at Dennyloanhead (£4,000). Architect, Mr. Strang, Falkirk.

DUNDEE—School to accommodate 1,200 pupils for the School Board.

DUNDEE—Workshop in Milnbank-street for Mr. Alexander Scott; extension of works for Messrs. James Scott and Sons.

EXETER—Lace-mending rooms, offices, etc., for J. Heathcote and Co., Tiverton. Particulars from Messrs. Huckey's Banking Co., High-street, Exeter.

FRODINGHAM—Extension of the Redbourn Hill Ironworks, recently acquired by the Cwmfelin Steel and Tinplate Co., of Swansea, is proposed.

GAINSBOROUGH—The Urban District Council have passed plans for the construction of a destructor building (£6,906).

GOTHENBURG (SWEDEN)—New spinning mill and weaving mills proposed.

GUILDFORD (SURREY)—Technical institute for Surrey Education Committee. Architects, Messrs. Jarvis and Richards, 36, Victoria-street, Westminster, London, S.W.

HADDINGTONSHIRE—Reconstruction and extension of hospital for the County Council (£2,000).

HAMILTON—Baptist church and hall in Kemp-street (£5,000).

HEYSHAM HARBOUR—Sawmill. Architects, Messrs. Harrison, Hall, and Moore, 73, Church-street, Lancaster.

HOUNSLOW—New schools for the Heston and Isleworth Education Committee. Architect, Mr. A. Lancelot Lang, Council House, Hounslow.

HUDDERSFIELD—Warehouse in Lord-street. Architects, Messrs. J. Kirk and Sons, John William-street, Huddersfield.

HYDE (CHESHIRE)—Extension to mills for Gibraltar Spinning Co.

JAPAN—New sugar factory for the Ensuiko Sugar Co. being built at Formosa by the Harvey Engineering Co., of Glasgow.

KEADY—Signalling apparatus for the Castleblayney, Keady, and Armagh Railway. Mr. W. H. Mills, engineer-in-chief, G.N.R. Co. (Ireland), Amiens-street Terminus, Dublin.

KIRKCALDY—New factory for Fife Linoleum Co. Architects, Messrs. J. D. Swanston and Syme, Kirkcaldy.

LEIGH (YORKS)—New spinning mill to be erected at the Bedford end of Leigh by the Butts Spinning Co.

LONDON—Workshop at Royal Mint. Commissioners of H.M. Works and Public Buildings, Storey's-gate, London, S.W.

LONDON—Moravian Church at Priory-road, Hornsey, N. Particulars from the Moravian Church, Fetter-lane, London, E.C.

LONDON, S.E.—Well-sinking and pumping plant at the Public Baths, Manor-place, Walworth-road.

LONDON, S.E.—Extensions to St. George's Workhouse, Mint-street, S.E. Architect, Mr. A. J. Wade, 104, Harvist-road, Kilburn, N.W.

LONDON, W.C.—Offices for the Government for the State of Victoria on the Aldwych site. Architect, Mr. Alfred Burr, London.

LONDONDERRY—Boot factory, warehouse, and shops for Mr. H. McKeown. Architect, Mr. P. H. Elliott, Exchange-buildings, Castle-street, Londonderry.

MANCHESTER—Central premises for Co-operative Union (£10,000).

MANCHESTER—Packing warehouse for James Robinson, Limited. Architect, Mr. J. R. E. Birket, Manchester.

MANCHESTER—Extensions to Home for Little Sisters of the Poor at at Clayton Bridge (£10,000). Architect, Mr. O. H. Hill, Manchester.

MIDDLESBROUGH—Extensions to furnaces and ovens for Bolckow, Vaughan, and Co., and building of 150 cottages.

MIDDLESBROUGH—Extensions and alterations to Hugh Bell Schools. Architects, Messrs. J. M. Bottomley, Son, and Wellburn, 28, Albert-road, Middlesbrough.

MONAGHAN—Post office, etc. Surveyors, Messrs. W. H. Stevens and Sons, 13, Donegall-square, N., Belfast.

NEWBURY—Public elementary school (£2,510).

NEWCASTLE-ON-TYNE—School in Bowlem-street (£17,160); school for defective children (£2,421).

OLDHAM—Ring spinning mill for the Viaduct Mill Co.

OLD MONKLAND—Higher-grade school for the Old Monkland School Board (£15,230). Architect, Mr. Barclay, Glasgow.

PICKERING—Two semi-detached villas in Middleton-road. Architect, Mr. Fentress.

PLYMOUTH—Public library, museum, and art gallery. Messrs. Thornley and Rooke, 11, The Crescent, Plymouth.

PORT GLASGOW—Steamer to be built by Messrs. D. G. Dunlop and Co. for the Elder-Dempster Co., Liverpool.

RANGOON—Pumping plant for the municipality. Messrs. Ogilvy, Gillanders, and Co., Sun-court, 67, Cornhill, London, E.C.

RHONDDA—Generating station to be built at Ystradyfodwg, Glamorgan for the National Electric Construction Co.

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ROCHDALE—New baths for the Corporation (£25,000).

ROMFORD—New ward at the infirmary for the Board of Guardians.

SCUNTHORPE—School and pupil teachers' centre for Lindsey County Council Education Committee. Architects, Messrs. Scorer and Gamble, Bank-street-chambers, Lincoln.

SMETHWICK—Hospital in Holly-lane (£20,000).

SOUTHEND—Pier alterations, including provision of refreshment and other rooms, shops, etc. (£5,200). Borough Engineer.

SWALWELL—Erection of shop, warehouses, etc., in Market-lane, and alterations to existing premises for the Co-operative Society, Swalwell.

WALES—New plant for Pyle and Blaina Works Co. (£10,000); new engine-house for the Moss Bay Iron and Steel Co. (£10,000).

WARWICK—Laundry, boiler-house, mortuary, etc., to be built for the Coventry and Warwickshire Hospital Committee. Architects, Mr. A. Hessel Tiltman, F.R.I.B.A., 1, Raymond-buildings, Gray's-inn, London, W.C., and Mr. Herbert W. Chattaway, Trinity-churchyard, Coventry.

WATFORD—School for 960 children for Herts County Council Education Committee.

WEDNESBURY—Extensions in connection with electric undertaking (£10,000).

WHITCHURCH (GLAM.)—Police station. Mr. J. Mansel Franklen, clerk, Glamorgan County Council, Westgate-street, Cardiff.

WORKSOP—Plant and mains extensions at Corporation Electricity Works (£1,700).

YORK—Secondary school and pupil teachers' centre. Architect, Mr. Brierley.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Leghorn.—The Municipality invite tenders for electric lighting. Tenders by Sept. 21.

Paris.—Electric cables required for the Post and Telegraph Department, 103, Rue de Grenelle, Paris. Tenders by Sept. 30.

Dublin.—High and low pressure cables. Particulars from City Electrical Engineer. Tenders by Sept. 9.

Beaufays.—The Mayor calls for tenders for an electrically-driven pump in connection with cement reservoir. Tenders by Sept. 14.

Madrid.—The Public Works Department invite tenders for the construction of three electric tramways in Barcelona. Tenders by Sept. 13.

Rio de Janeiro.—The Estrada do Ferro Central do Brazil invite tenders for machines and apparatus for railway workshops. Tenders by Sept. 14.

Melbourne.—One 500-kw. turbo-alternator, boilers, and other appliances are required for the State Railway of Victoria. Tenders by Sept. 23.

Brisbane.—The Postmaster-General invites tenders for telephones, cells, resistance coils, battery pole changers, operators' sets, etc. Tenders by Sept. 30.

New South Wales.—The Postmaster-General invites tenders for copper wire, binding tape, porcelain insulators, etc. Tenders to the Postmaster-General's Department, Sydney, by Sept. 24.

Aldershot.—The Urban District Council invite tenders for electric light mains, bitumen, and troughing. Particulars from the Electrical Engineer, Laburnum-road, Aldershot. Tenders by Sept. 18.

Melbourne.—The Postmaster-General's Department invite tenders for 11 sets and a common-battery switchboard, and 3,000 subscribers telephones, etc., for the Windsor exchange. Tenders by Jan. 7.

London.—The London County Council invite tenders for three electrically-driven boiler feed pumps, each of 9,000 gallons per hour capacity, for the Greenwich tramway station. Tenders by Oct. 8.

Paris.—Pumping plant and electric dynamos and motors for the Municipal Waterworks Department. Estimate, £36,000. Particulars from the Canals and Waterways Department, Hotel de Ville, Paris. Tenders by Oct. 24.

Londonderry.—The District Lunatic Asylum require a 22-kw. steam set and dynamo, with switchboard, connections, etc., for the Gransha Asylum. Specification, £1. 1s. Particulars from Mr. R. V. Macrory, Londonderry. Tenders by Sept. 20.

New South Wales.—Tenders will be received at the office of the Deputy Postmaster-General, Sydney, up to 2.30 p.m. on Oct. 23 for supply of 500 wall telephones to specification No. 183, and 100 party-line telephones to specification No. 171.

Dover.—The Corporation Electricity Committee invite tenders for Welsh smokeless steam coal for the period from Oct. 1, 1907, to July 31, 1908. Particulars from Mr. L. W. Woodman, borough electrical engineer, Park-street, Dover. Tenders by Sept. 9.

Finchley.—The Urban District Council invite tenders for the supply of feeders, distributing mains, and other cables, network boxes, joint-boxes, etc. Particulars from Mr. E. Calvert Electricity Works, Squire's-lane, Finchley, London, N. Tenders by Sept. 16.

Adelaide.—The Deputy Postmaster-General for Queensland invites tenders for a common battery switchboard and 3,000 subscribers' telephones. Specification No. 166. Particulars may be obtained from the Commonwealth Offices, 72, Victoria-street, London, S.W. Tenders by Jan. 8, 1908.

Rangoon.—For pumping plant for Rangoon Municipality. Particulars, etc., of Messrs. Ogilvy, Gillanders, and Co., London agents to the Rangoon Municipality, Suncourt, 67, Cornhill, London, E.C., accompanied by a remittance of 10s., which will not be returned. Tenders to the Agents by Oct. 31.

London, E.C.—Tenders are invited for creosoting red fir telegraph poles, for the General Post Office. Forms of tender, containing all particulars, may be obtained on application to Mr. S. C. Hooley, controller of stores, Stores Department, G.P.O., 17-19, Bedford-street, London, W.C. Tenders by Sept. 9.

Victoria.—The Deputy Postmaster-General at Melbourne invites tenders for the supply and delivery at Melbourne of 11 sections of a common-battery switchboard and 3,000 subscribers' telephones and other apparatus for telephone exchange, Windsor, in accordance with Victorian specification No. 148. Tenders by Jan. 7.

Cardiff.—The Guardians invite tenders for provision of telephones, necessary wiring, switchboard, etc., and alteration of present telephone service, at their Cardiff and Ely Workhouses. Particulars, etc of Mr. Arthur J. Harris, clerk, Union Offices, Queen's-chamber Cardiff, to be returned with specification attached by Sept. 14.

Hull.—The North-Eastern Railway Co. invite tenders for the erection of an accumulator house and clock tower at Albert Dock, Hull. Particulars from Mr. William Bell, the company's architect, at York. Duplicate plans may also be seen at the Stationmaster's Office, Paragon Station, Hull. Tenders to the Secretary, at York, by Sept. 18.

Dublin.—For signalling (about 14 working levers) of the new station at Keady, for the Castleblaney, Keady, and Armagh Railway Co. Plan and specification may be seen at the office of Mr. W. H. Mills, engineer-in-chief, Great Northern Railway Co. (Ireland), Amiens-street Terminus, Dublin. Tenders to Mr. T. Morrison, secretary, Amiens-street Terminus, Dublin, by Sept. 16.

Halifax.—The Tramways and Electricity Committee invite tenders for the supply and delivery of 14,000 tons of pea slack coal during 12 months ending Sept. 30, 1908, or alternatively for 7,000 tons during six months ending March 31, 1908. Particulars from Mr. W. M. Rogerson, borough electrical engineer, Foundry-street, Halifax. Tenders to Mr. Keighley Walton, town clerk, by Sept. 7.

Rochdale.—The Gas and Electricity Committee invite tenders for the supply of about 1,000 tons of oil suitable for the manufacture of carburetted water gas, to be delivered as required at the Milnrow-road sidings of the Lancashire and Yorkshire Railway Co. during 12 months from Oct. 1. Information may be obtained of Mr. T. Banbury Ball, the manager at the gasworks. Tenders by Sept. 10.

Alexandria.—Tenders are invited for the following electrical equipment for the port of Alexandria: five large and seven small transshipping engines, six cranes of four tons, 36 cranes of two tons, 25 windlasses, various small plant and necessary accessories, and the construction and installation of a central power station. Particulars from M. le Directeur des Ports et Phares, Alexandria. Tenders by Nov. 1.

New South Wales.—With reference to an announcement inviting tenders for the supply and construction complete of a pneumatic tube service to the General Post Office, Sydney, from the Pacific Cable Board's Office, Royal and Stock Exchanges, etc., the Postmaster-General for New South Wales give notice that the date for the receipt of such tenders has been extended from July 10 to 2.30 p.m. on Wednesday, Oct. 16 next.

Birmingham.—The Commissioners of H.M. Works and Public Buildings invite tenders for the erection of new telegraph stores at Birmingham. Drawings, specification, etc., may be seen on application to the Postmaster at Birmingham. Bills of quantities and forms of tender may be obtained at H.M. Office of Works, etc., Storey's-gate, S.W., on payment of £1. 1s. Tenders to the Secretary, H.M. Office of Works, etc., by Sept. 10.

Croydon.—Tenders are invited for the supply of trolley wire and other overhead material for the Croydon Corporation tramways. Specification and form of tender may be obtained on application to the Tramways Manager, Tramways Depôt, Thornton Heath, Surrey upon deposit of £1. 1s., which will be returned on receipt of a *bona fide* tender. Tenders to be sent to Mr. F. C. Lloyd, town clerk, Town Hall, Croydon, by 11 a.m. on Sept. 9.

Glasnevin (Ireland).—Tenders are invited for the complete electrical installation at the new residence, Glasnevin, including gas-engines, producers, battery, wiring, etc., for the Commissioners of National Education. Plans, etc., can be seen and forms of tender can be had at the office of the engineers, Messrs. Tomlinson and Mills, 39 Fleet-street, Dublin. Tenders to the Secretaries, Office of National Education, Marlborough-street, Dublin, by 5 p.m. on Sept. 13.

Hastings.—The Corporation invite tenders for the supply during six months from Nov. 1, 1907, of the following coal for their electricity works: Nixon's Navigation colliery screened, Nixon's Navigation washed nuts, Glasbrook Merthyr best Welsh smokeless unscreened large, Bwllfa No. 1 large smokeless. Forms of tender from the Borough Electrical Engineer, Electric Light Works, Hastings. Tenders to Mr. Ben. F. Meadows, town clerk, Town Hall, Hastings, by Sept. 17.

New South Wales.—Tenders will be received at the office of the Deputy Postmaster-General, Sydney, until 2.30 on Oct. 23 for supply and delivery of the following material at the Departmental Stores, Sydney: 11 tons galvanised iron wire, 400lb. per mile, as per specification No. 164; 1,600 large best white porcelain insulators, as per specification N.S.W. No. 17. and sealed pattern N.S.W. No. 5. Specifications, general conditions, and sealed patterns may be seen and tender forms obtained at the General Post Office, Sydney, Melbourne, Brisbane, and Adelaide.

Mersey Railway.—The Directors of the Mersey Railway Co invite tenders for the supply of stores, including: asbestos packings, indiarubber, and guttapercha; boiler suits; bolts, nuts, screws, nails, etc.; brake gear; car fittings; collector shoes and brackets and brake blocks, etc.; cotton waste, etc.; electrical sundries; fog signals; gauge glasses; glass; incandescent lamps and fittings; oils, greases,

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etc.; paints, varnish, etc.; signal gear; signal wire. Forms of tender may be had on application to the secretary, Mr. G. H. Langham, Worcester House, Walbrook, London, E.C.

Maidstone.—Tenders are invited for four electrical motors and centrifugal pumps, each capable of delivering 150 cubic feet of sewage, and three electrical motors and centrifugal pumps at 225 cubic feet per minute, together with two motor-driven air injectors, two travelling cranes, switchboard, starting switches, workshop fittings, and other appliances and connections, including a complete electric light installation, for the sewage-disposal works. Plans, etc., and form of tender from Mr. G. R. Strachan, 9, Victoria-street, Westminster, London, on and after Sept. 3. Tenders by Oct. 1. See advertisement in last issue.

Gothenburg.—The Commercial Intelligence Branch of the Board of Trade are notified by his Majesty's Consul at Gothenburg that tenders are invited for supply of the electrical equipment for the Government power station at Trollhattan, comprising three electric generators for direct current, each of 350 kw.; one accumulator battery of 4,800 ampere-hours capacity; four three-phase generators, each of a maximum of 11,000 kilovolt-amperes; 12 transmitters, each of a maximum of 3,670 kilovolt-amperes; connections; regulators; and control tables. Sealed tenders, marked "Anbud a elektrisk utrustning for Statens kraftverk," should be sent to the Managing Director of the Royal Trollhattan Canal and Waterworks, Trollhattan, Sweden, by noon on Oct. 1 next. Tenders are binding until Jan. 1, 1908. Delivery is to be completed by Sept. 1, 1909. Further information may be obtained from the Managing Director, from whom a copy of the programme can be had against a deposit of 50 kronor, which will be returned on receipt of a tender in accordance with the programme.

RESULTS OF TENDERS.

Gainsborough.—The tender of Meldrum Bros. for a refuse destructor installation for £2,196 for the Urban District Council has been accepted.

Paddington.—The Guardians have accepted the tender of the Bell Telephone and Electric Co., at £115, for the installation of electric fire alarms at the workhouse.

Barnes.—The tender of the Lahmeyer Electrical Co., New Oxford-street, London, W.C., for the supply of feeder and distributor cables has been accepted by the Urban District Council.

Newcastle-on-Tyne.—The Corporation have accepted the tender of E. Allen and Co. for the construction of a tramway junction at Pilgrim-street and Market-street extension for £2,142. 10s.

Maidstone.—The Council have accepted the tender of Messrs. Phillips and Co., Leicester, for the supply of coal, ¼in. slack, at 12s. 3d. per ton, required at their electricity works for the ensuing 12 months.

Dundee.—The tenders of the Brush Electrical Engineering Co. for car bodies and top covers and of Dick, Kerr, and Co. for trucks and equipment have been accepted by the Dundee Tramways Committee.

Ravensthorpe.—The Electric Lighting Committee have accepted the tenders of W. Bradbury for the erection of a sub-station, the British Thomson-Houston Co. for meters, the General Electric Co. for cut-outs, and W. T. Garnett for cables.

Colchester.—The contract for the supply of Hucknall hard steam coal for the Corporation electricity works for the ensuing year has been let to Thomas Moy, Limited, whose price was £1 per ton. It has also been agreed to purchase for £1,017 six mechanical stokers.

Liverpool.—The Tramways and Electric Power and Lighting Committee recommend (1) that the tender of Messrs. John Griffiths and Son, 203, Great Howard-street, Liverpool, for the supply of slack to the Pumpfields electric power station, and the removal of ashes therefrom, during 12 months commencing on Oct. 1, 1907, be accepted; (2) that the tender of Messrs. J. and G. Chappell, 174 to 176, County-road, Walton, for the erection and completion of shed adjoining the new tramway offices, Hatton-garden, for £2,836, be accepted.

BUSINESS NOTES.

TRACTION.

Liversedge.—The Liversedge Urban Council are protesting against the increase in fares of which the local tramway company have given notice.

Brisbane.—The traffic receipts of the Brisbane tramways for the month of August amounted to £15,225; corresponding period last year, £14,186—increase, £1,039.

Dartford.—The Board of Trade have confirmed the Dartford District Light Railways (Amendment and Extension of Time) Order, 1907, amending the Dartford District Light Railways Order, 1903.

London County Council.—The electrification of the tramway system from South-street, Greenwich, to the obelisk at Lewisham was commenced last Monday, and it is anticipated that the work will take about three months.

Collision.—The Dover-to-Folkestone coach "Active" collided last Friday with an electric tramcar at Kingston, Surrey. The coach was overturned and practically wrecked, and the passengers, numbering seven, were badly hurt.

Austria.—A new electrically-worked narrow-gauge mountain railway is to be constructed on the Gross Glockner, and Redlich and Berger, Vienna, have been instructed by the Minister for State Railways in Austria to make the necessary surveys.

Belfast.—At the monthly meeting of the Corporation on Monday it was reported that 47 electric cars had been maliciously injured during the recent riots, and that the estimated cost of repairing the injuries was £122. 8s. A decrease in the tramway receipts was also reported.

Brighton.—It is now authoritatively stated that the rumours circulated in the town last week to the effect that the Tramways Committee of the Corporation were contemplating disposing of the undertaking to the British Electric Traction Co. are without foundation.

Dumbarton.—The Board of Trade have now sanctioned the by-laws which were framed for the conducting of the local tramways. The sanction is given without any amendment having taken place on the text of the by-laws as previously advertised and considered by the Town Council.

Erdington (Birmingham).—The Board of Trade have granted the request of the local authority for an extension of time for the making of the tramways at present unlaid in Erdington, and authorised to be made by the Erdington Tramways Act, 1902, until July 23, 1909. A tramway shelter is to be erected at Salford Bridge.

South Shields.—On the recommendation of the Tramways Committee the Council have agreed to pay the borough electrical engineer's out-of-pocket expenses, amounting to £75, incurred in consequence of injuries which he sustained on Jan. 4, 1906, while carrying out his duties in connection with the construction of the tramways.

India.—An electric power installation has been established by the Kalka-Simla Railway at the Tara Devi Station (just outside Simla) for working the water-hoisting pump. The general and larger question of the electrification of the line for electric traction appears, according to *Indian Engineering*, to have been dropped for the present.

United States.—It is reported from Indianapolis that a goods tram on the electric trolley track at Mattoon, Illinois, overtook and crashed into the rear of a crowded tramcar last Friday, tearing down the protection guard and wrecking the platform on which many people were standing. Seventeen are said to have been killed and many injured.

Bradford.—The suggestions made by a joint sub-committee of the Watch and Tramways Committees of the Bradford City Council for the better regulation of tramway traffic in the centre of the city have been referred by the Tramways Committee to the manager (Mr. C. J. Spencer) and the city surveyor (Mr. J. H. Cox), who will report as to their feasibility.

Woolwich.—A public meeting was held last week under the auspices of the Bostall Estate Protection Association, when a resolution was unanimously passed calling the attention of the London County Council to the need for tramways in the district, and urging them to extend the present line from Wickham lane to the county boundary at Knee Hill.

Madras.—The Madras Electric Tramways (1904) announce that the traffic receipts for the fortnight ended Aug. 31, 1907, was Rs.18,728 compared with Rs.14,544 in 1906, an increase of 28·7 per cent. Gross receipts from Jan. 1, 1907, amounted to Rs.274,600 compared with 228,209 for the corresponding period of the previous year, an increase of 20·3 per cent.

Dublin.—The conductors and motormen in the employment of the Dublin United Tramways Co. have decided not to strike. The company announce that in consequence of extra work in connection with the International Exhibition a bonus of a week's wages will at once be given to all employés having three months' service, and not, as intended, at the close of the exhibition.

Accrington.—The Accrington Town Council have approved of an arrangement whereby the Council shall pay the tramways company £2,227—each side to pay its own costs and half the arbitrator's charges—for the steam-engines, tramcars, and machinery which the company transferred to the Corporation on the expiration of a 21 years' lease which the company had of the Corporation's lines.

Manchester and Salford.—The sub-committees of the Manchester and Salford Tramways Committees met on Monday in the Salford Town Hall to consider the question of inter-running of the cars of the two authorities. Progress was made in the negotiations, and, although no definite decision was reached, it is anticipated that an agreement will be drawn up at an early date to run at least over an experimental route.

Newcastle-on-Tyne.—The city engineer has submitted to the Tramways Committee new plans for a temporary tramway in North-terrace for passenger traffic to the Royal Show next year. The estimated cost for making such a line was £550. The members of the committee, however, think it unnecessary to spend the money, as they propose to make special arrangements for carrying passengers to the show by way of Spital Tongues and the North-road routes.

Dalkeith.—Mr. James F. Whyte, solicitor to the promoters of the electric tramway scheme, has informed the Town Council that arrangements for financing the undertaking are still under consideration. He assures the Council that no effort has been wanting on the part of the promoters, but that the delay is solely attributable to the extreme stringency of the money market. He hopes, however, to be able to give the Council some definite information towards the end of October.

Glasgow.—The Glasgow Corporation tramway cars ran 395,214 miles last week, as compared with 382,609 in the corresponding week of last year; carried 4,276,068 passengers, as against 4,321,087; and drew £17,428. 2s., in comparison with £17,519. 7s. 9d. Since the beginning of the financial year on June 1 the number of passengers carried has been 55,787,672, as compared with 55,368,454; while the receipts have been £227,124. 17s. 9d., an improvement of £2,812. 12s. 3d.

Leeds.—The Leeds City Council have before them a notice of motion from Mr. R. Armitage, M.P., to the effect that the Tramways

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Committee be instructed to proceed with the tramway along Whitehall-road to the city boundary authorised in 1902. There is also another motion that the Tramways Committee consider the advisability of obtaining powers to construct a tramway from the terminus at Upper Wortley by way of Swallow-hill and Tong-road to the junction of Butt-lane with Tong-road.

Dundee.—At a meeting of the Dundee Tramway Men's Union it was stated that a great many conductors continually leave the service to find employment in other towns. Complaint was also made about the practice of posting the names of conductors in the depôts every day along with the shortages in their drawings. Shortages were kept off their wages, but the men, it was stated, had not only to make good the loss, but had to endure the ridicule cast upon them by having their names and their shortages placarded before the eyes of their fellow-workmen.

Darwen.—At a recent meeting of the Tramways Committee the town clerk reported that the Johnson-Lundell Electric Traction Co. had issued a writ against the Corporation alleging that the Corporation had infringed the patents of the company in using the new demi-cars. A letter was also read from the solicitors for the Raworth Traction Patents, Limited, that no infringement had taken place, and that they had been instructed to defend the action at the expense of their clients, and asking the town clerk to forward the writ. The town clerk has been instructed to defend the action through Messrs. Raworth's solicitors.

Acton.—For the past week there has been a cessation of work among the excavators in connection with the laying of the light railway by the Middlesex County Council to connect Willesden with Acton. The men went out in a body on Tuesday of last week, and since then over a mile of broken road and road widening has been left unfinished and in abeyance. The contractors, Messrs. Robert W. Blackwell and Co., of Westminster, were paying some of the men 6d. per hour and others 7d., and the men struck for 7d. all round. This the contractors agreed to on Wednesday, and work will be resumed on Monday.

Keighley.—The Council, on the recommendation of the Tramways Committee, have accepted the tender of Messrs. H. Lotery and Co., of London, for the supply of overcoats and uniforms for the tramways employés at the following prices: overcoats for motormen and conductors 24s. 3d., and for inspectors 33s. 6d.; and tunics and trousers for motormen, conductors, and inspectors, 29s. 6d. each. The annual report of the Tramways Committee, showing a gross profit on the year's working of £3,048 and a net profit of £252 (an abstract of which appeared in these columns last week), was passed by the Council at their last meeting.

York.—The agreement between the York Corporation and the City of York Tramways Co. for the sale to the former of the tramway undertaking owned by the company was completed on March 25, and it now remains to be seen what steps the Corporation propose to take and when they propose to acquire the concern. In the meantime the city is being served by the antiquated system of horse-drawn cars. The last half-year's working of the trams shows that the gross receipts for the half-year amounted to £1,540, and the working and general expenses to £1,544, showing a debit balance of £4. The number of passengers carried during the half-year was 349,355.

Tees-side Tramway Men's Outing.—Sir Clifton and Lady Robinson entertained the wives and children of the employés of the Middlesbrough and Stockton tramways to a garden party on Stockton Racecourse on the afternoon of the 29th ult. There were about 450 present. In the evening the men, to the number of about 300, were entertained to a banquet. Sir Clifton congratulated the employés upon the excellent record that had been made in connection with the Tees-side tramway system during the past year, and attributed the success due largely to the happy relations which existed between the management and the employés. He also congratulated Mr. F. Freshwater upon his appointment as superintendent engineer.

Birmingham.—The tramlines in Station-street are now being reconstructed with the object of bring them nearer the footpath. In ordering this improvement the Tramway Committee have acted on a suggestion made by the chief constable, who pointed out that intending passengers ran considerable risk by waiting in the horse road. When the alteration of the lines is completed the cars will run close to the kerb, so that passengers may mount direct from the pavement. In Navigation-street the cars are now stopped some distance from the shelter which marks the terminus of the King's Heath, Cannon-hill, and Ladywood lines. This is a temporary arrangement, due to the fact that the bridge which carries the roadway at this point is under repair, and new girders are being placed in position.

Germany.—According to a report issued by the United States Department of Commerce, accumulator cars have been running since February on three German railway lines. The arrangements have been made by the Prussian Railway Department, which also by special agreement controls the Hessian Railway. The new cars run four or six times a day, and the maximum speed is 28 miles an hour. The carriages are three-axle cars built for this purpose. The batteries consist of 180 cells of about 200 ampere-hours capacity, each weighing 121lb., and containing four positive and five negative electrodes, a car battery weighing about 10 tons, and yielding 68·5 kilowatt-hours—that is, seven watt-hours per kilo (2½lb.) of all weight complete. Each car travels about 37 miles a day. The full car weighs 38 tons.

Highgate-hill Tramways.—The running powers for the above line having recently expired, and application for renewal being made, the Board of Trade appointed Colonel Yorke to make the necessary inquiry as to the condition of the line. The inspection took place in the presence of representatives of the London County Council and the Islington, St. Pancras, and Hornsey Borough Councils, none of whom, it was stated, raised any objection to the renewal of the order. Under these circumstances, and Colonel Yorke's report being favourable to the company, the Board of Trade has renewed the licence for a term of three years. It is understood that the line will be remade and equipped with a service of electric cars by the London County Council, or others, long before the expiration of the licence. The London County Council will, it is intimated, deal with the matter after the holidays.

Wimbledon.—Negotiations are at present being carried on with the view to an improvement being made in the tramways system which links up Tooting with Hampton Court. It consists of the laying of a single line of tramways to connect the west track of the system in Hill-road with the south track in Worple-road. On behalf of the Town Council Mr. A. Steele Sheldon (town clerk) and C. H. Cooper (borough engineer) are conferring with Sir J. Clifton Robinson, the managing director and engineer of the London United Tramways, regarding the matter. Should an amicable arrangement be arrived at, the improvement would permit the existing service of tramcars between Hampton Court and Tooting to be operated without running round the loop in St. George's-road and Francis-grove. It would also do away with the alleged annoyance the tramcars occasion the residents in these two quiet thoroughfares.

Light Railways.—The Board of Trade have recently confirmed the undermentioned orders made by the Light Railway Commissioners: Callington Light Railway (Amendment and Transfer) Order, 1907, authorising the transfer to the Great Western Railway Co. of the powers conferred on the Callington Light Railway Co. by the Callington Light Railway Order, 1900, as amended by the Callington Light Railway (Extension of Time) Order, 1903, and reviving the powers granted and extending the period limited by the said orders for the compulsory purchase of lands, and extending the period limited by the said orders for the completion of the railway and works thereby authorised. Derwent Valley Light Railway (Transfer, etc.) Order, 1907, transferring to a company the powers conferred upon the Rural Districts Councils of Escrick and of Riccall by the Derwent Valley Light Railway Order, 1902, and amending that order.

The Simplon Tunnel.—The *Moniteur Industriel* gives some particulars of the traffic on the Simplon Tunnel line, which was opened on June 1, 1906. The import of goods into Italy amounted to 27,400 tons, and the export of goods from Italy for Switzerland amounted to 29,400. Thus the traffic in merchandise totalled 56,800 tons. The tariff rate, which only came into force on Jan. 1 of this year, has not been very popular, probably on account of its not being sufficiently known, or because it does not give the Simplon sufficient advantage, the rate being the same as the rate for transport through the Mont-Cenis. In any case, the volume of Italo-Swiss traffic passing over the Simplon has been somewhat disappointing, for the annual traffic was estimated to be 100,000 tons. It is expected, however, that the latter figure will be reached during the second year's working of the line. The number of passengers transported during the past year cannot yet be ascertained, but it is calculated to fall not far short of 430,000 for the whole year. It has been decided to go on with the construction of the second tunnel.

Liverpool.—The agenda for this week's Council meeting contains notice of the following resolution: "That a motor-'bus service be established on the Edge-lane route as an experiment for six months, and that for this purpose the Tramways and Electric Power and Lighting Committee be instructed to purchase six motor 'buses (or a less number if sufficient for the maintenance of any service that may be instituted) at a cost of about £850 each." The following resolution, of which notice was also given, is not without interest: "That, in view of the large increase in the price of coal, it is desirable that steps should be taken towards the breaking down of the ring or monopoly in the coal trade, and hereby instructs the town clerk to take the necessary steps towards securing the co-operation of other municipalities in Lancashire, Cheshire, and Yorkshire in considering the best means to be adopted, either in regard to joint action being taken in the purchase of coal mines, or in bringing combined pressure to bear upon his Majesty's Government in the direction of the nationalisation of the coal mines, the distribution of the commodity being undertaken by the Corporation."

LIGHTING AND GENERAL.

Reigate and Redhill.—The Corporation intend to substitute electricity for gas for the lighting of the main streets.

Cirencester.—The Urban District Council have passed plans for the erection of an electric power station at Cirencester House for Earl Bathurst.

Rochdale.—The Electricity Committee are recommending the Town Council to apply for sanction to a loan of £22,175 for the purposes of electric lighting.

Worksop.—A Local Government Board inquiry is to be held on Sept. 12 into the Council's application for permission to borrow £1,700 for electric lighting.

Newcastle and District Electric Lighting Co.—The directors of the Newcastle and District Electric Lighting Co. announce the payment of an interim dividend of 2 per cent.

Wednesbury.—The Local Government Board will hold an inquiry on Sept. 11 into the Council's application for permission to borrow £10,000 for the electricity undertaking.

Bristol.—The Local Government Board will hold an inquiry on Sept. 9 into the application of the Corporation for sanction to borrow £34,600 for the electricity undertaking.

Northampton Electric Light and Power Co.—The directors of the Northampton Electric Light and Power Co. announce the payment of an interim dividend of 2 per cent. on the ordinary "B" shares.

Llanelly.—Mr. Eccles, who is one of the directors of the Llanelly Steel Co., has offered to install a complete electrical equipment at the

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operating theatre of the hospital, as he has done for the Swansea Hospital.

British Insulated and Helsby Cables.—The directors of the British Insulated and Helsby Cables announce an interim dividend for the half-year ended June 30 last at the rate of 8 per cent. per annum, ess income tax.

Chelsea Electricity Supply Co.—The directors of the Chelsea Electricity Supply Co. have declared an interim dividend on the ordinary shares for the half-year to June 30 last at the rate of 4 per cent. per annum.

Educational Note.—It will be seen from an announcement in our advertisement columns that particulars of the renowned correspondence, etc., classes carried on by Prof. Jamieson at Kelvinside, Glasgow, are now ready.

Newport.—The Electricity Committee have instructed the borough engineer to experiment during the coming winter with 49 cheap incandescent lights to replace the present old burners in the neighbourhood of Victoria-crescent.

Warrington.—The Local Government Board has held an inquiry into the application of the Council for sanction to the borrowing of £3,071, the sum required in connection with the proposed boiler plant extensions at the electricity works.

Notice of Dividend.—The *London Gazette* announces that a supplemental dividend of 1s. 2d. in the £ has been declared in the estate of A. Blackburn and J. Walker, electrical and mechanical engineers, Upper-lane Mills, Cleckheaton, Yorkshire.

Wireless Telegraphy for Destroyers. — The Admiralty have given orders that all destroyers are to be installed with wireless telegraphy, and at least 80 boats are to be taken in hand at the dockyards. Destroyers building are to be equipped with the wireless system.

Notice of Removal.—The headquarters of the publicity department of Messrs. Bruce Peebles and Co. have been transferred from London to their Edinburgh office, East Pilton Works, Edinburgh, and all communications should now be forwarded to that address.

Stock Exchange.—The Stock Exchange Committee have appointed Sept. 18 special settling day in United River Plate Telephone Co.'s £183,632 4½ per cent. debenture stock, and provisional certificates (partly paid) for £116,368 4½ per cent. debenture stock, and have ordered the same to be quoted in the official list.

United Electric Car Co.—The directors of the United Electric Car Co., in respect of the year ended June 30 last, have decided to pay a dividend of 5 per cent. on the ordinary shares, less income tax, to carry £2,000 to general reserve fund, to write off £6,106 for depreciation (including reserve), and to carry forward £5,095.

Haddington.—At the last meeting of the County Council intimation was made by the Electric Works Development Co. of their intention to apply for a Board of Trade electric lighting provisional order for the burgh of Cockenzie, parish of Tranent, and county of Haddington. The matter was delegated to the Western District Committee.

Nonington.—The Postmaster-General having obtained the consent of the body having the control of the public road between the park entrance to St. Alban's Court and the post office, Nonington, Dover, intends to place a telegraph over and along the public road, and to erect and maintain posts in and upon the road under the Telegraph Acts.

Leatherhead.—In spite of the energetic opposition of the local gas company the Leatherhead and District Electricity Co., who supply the whole area between Epsom and Dorking, are making good progress. With the aid of metallic-filament lamps many consumers have been weaned from the cult of the gas mantle. Messrs. Mould and Sons, High-street, have opened a contracting branch. Accessories manufacturers please note.

Hinckley.—A formal notice has been served on the Council of the intention of certain gentlemen to apply to the Board of Trade this autumn for a provisional order under the Electric Lighting Acts to supply electric light in Hinckley and other districts. The matter has received the careful attention of the committee, and the engineer in connection with the scheme has been interviewed, with the result that at the proper time opposition will be made to the application.

Ontario (Canada).—The Hydro-Electric Commission's engineers, says the *Canadian Engineer*, are looking into the plan of a complete circuit, such as from the Falls to Hamilton, thence to Brantford, Woodstock, Ingersoll, and London, then turning northward to St. Marys, Stratford, Berlin, Guelph, and back to Hamilton. Such a circuit would, it is thought, have advantages similar to those of a waterworks system from which dead-ends have been eliminated, as well as giving a continuity of service.

Bexley.—At the last meeting of the Urban District Council the clerk to the Crayford Parish Council wrote stating he was directed to say that the Council had decided to bear the cost of two 32 c.p. electric lamps, as suggested, at the cost of £4. 16s. per lamp per annum, and to ask that the necessary arrangements be made without delay. The letter was referred to the Electric Lighting and Traction Committee to carry out the matter as quickly as possible, the clerk in the meantime to prepare an agreement to be signed by the Crayford Council.

An Electric Plant.—A plant has been discovered in Nicaragua which appears to be charged with electricity. If one of its branches is touched with the naked hand, a distinct shock is felt similar to that produced by a battery. Its influence upon a magnetic needle is noticeable at a distance of half a dozen yards, and as one gets nearer the plant this influence increases; while, if the instrument is placed in the centre of the bush, it will assume a deadly circular movement. The intensity of the phenomenon seems to depend entirely upon the time of day.

Quebec (Canada).—The Saraguay Electric Light and Power Co., of Montreal, are erecting a three-phase 11,500-volt transmission line to Notre Dame de Grace, about nine miles. Porcelain insulators mounted on steel pins with porcelain bases will be used. Mr. C. E. Brandeis, C.E., of Montreal, is engineer for the company. Mr. Brandeis also is preparing the plans for the electric equipment of the new Provincial jail, to be erected at Bordeaux, near Montreal, from the plans of Marchand and Haskell, architects.

Dunnet Head.—The wireless telegraph station for the reception and transmission of messages by the Marconi system is now completed at Dunnet Head, Caithness-shire. The mast which carries the electrical apparatus, and which consists of two very tall spars of Oregon pine, is erected in the vicinity of Dunnet Head Lighthouse and the coastguard station. This mast is secured in position by eight steel rope stays fixed in rings which are weighted by several tons of concrete. The contractors for the pole are Messrs. Andrew Campbell and Co., boatbuilders and engineers, Glasgow.

Japan.—The import of gas-engines into this country during 1906 amounted to £19,414 in value. The import of telephones amounted to £11,713. Of the total import of electric motors of £143,765 last year, only about 25 per cent. (£33,270) was from the United Kingdom; considerably more than half comes from the United States. The past year has witnessed a large increase in the number of private and joint-stock companies formed in Japan. For the manufacture of electric lamps, companies with an aggregate capital of £1,410,000 were formed. A great deal of capital was also to be devoted to electrical enterprises.

Liverpool.—As evidence of the determination of the city authorities to put down the smoke nuisance, it may be mentioned that the Health Committee have recommended the appointment of an inspector of nuisances, who shall have power to take proceedings under the Liverpool Sanitary Acts in respect of nuisances arising from the emission of smoke. He is to be authorised to serve notices, issue summonses, and to take all such further legal or other proceedings as may be necessary for the abatement and discontinuance and the prevention of the recurrence of and the recovery of penalties in respect of such nuisances. He will receive a salary of £120 per annum, increasing £5 per annum to £130 per annum, with uniform.

Hawkshead.—Telephonic communication is being installed and will shortly be in operation between Hawkshead Post Office and Satterthwaite Post Office. The wires are being affixed to the police telephone poles between Hawkshead and Ulverston, owned by the National Telephone Co. Up to the present telegrams for Grizedale and Satterthwaite have been sent over the moor from Hawkshead by messenger, and as Satterthwaite lies beyond the three-mile limit it did not come within the free delivery. Under the new arrangement telegrams for both places will be transmitted by telephone from Hawkshead and delivered from Satterthwaite. Grizedale is about three miles from Hawkshead, and Satterthwaite a mile further on.

Lowestoft.—Owing to the breakage of a feeder cable of the London-road section of the public electric lighting system at Lowestoft, a portion of the main thoroughfare was in darkness for two or three hours on Monday night. The breakage occurred about 8 p.m., and it was some time before it could be located. The tram service was not affected, and private consumers had current as usual, with the exception of a small section. As it was a wet evening, however, and not the usual crowds about, the inconvenience to the public was not serious, and the manager of the works (Mr. G. A. Bruce) had the light on again about 11 p.m. This was the first prolonged absence of light which has occurred since the works opened, five or more years ago.

Gas-Engine Combination.—Negotiations have been proceeding for the amalgamation of the Ashton-under-Lyne National Gas-Engine Co. with Crossley Bros., Otto Gas-Engine Works, Openshaw, Manchester, and the *Financial Times* yesterday stated that the fusion is now practically completed. The National Gas-Engine Co., which was registered in 1900, has an authorised share capital of £200,000 in £1 shares, half being 5½ per cent. cumulative preference shares and half ordinary, and the whole amount had been subscribed and called up. The authorised capital of Crossley Bros. was £973,700 in shares of £10, £403,390 being 5 per cent. cumulative preference, having also a priority as to capital, with a premium of 10s. per share, and £570,310 being ordinary. The entire capital of Crossley's had been subscribed and called up.

Brighton.—The final accounts of the Corporation telephone undertaking, which has now passed into the hands of the Post Office, show a surplus available as the result of the sale of £2,509. 6s. 10d. Deducting the £1,878 drawn from the rates during the early stages of the undertaking, a net profit is yielded of £631. At the time of the sale to the Post Office the outstanding loans and debts amounted to £50,448. 4s. 1d. The purchase money paid by the Post Office was £49,000. This, it will be seen, failed to reach the liabilities by £1,448. 4s. 1d. The stock for the redemption of the outstanding loans was, however, purchased at a discount of £2,793—leaving that amount to the good on the transaction. In addition there was a profit balance of £900. 4s. 8d. already referred to, and a sum of £264. 3s. 3d. interest on bank deposit.

Bispham.—The Bispham urban councillors have held a statutory meeting to consider the matter of applying for an electric lighting provisional order, to allow the Council to supply electric light in its district. The Chairman observed that he thought it very expedient that they should have the order, whether they generated the electricity themselves or obtained supplies. Councillor Beaumont said it was essential they should secure the right to light their own district with electricity. Councillor Foster also agreed that the order was wanted, and he proposed, Councillor Beaumont seconding, a resolution authorising the clerk to make the application. Another resolution followed, authorising the retention of Messrs. Baker and Co., of London, as

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parliamentary agents in connection with the application for the order. Both motions were carried unanimously.

British Columbia.—According to the *Canadian Engineer*, the British Columbia Power and Electric Co., of Vancouver, is contemplating developing water power on the Cheakamus River at the head of Howe Sound. Three development schemes are outlined in this report, one by means of which 100,000 h.p. can be secured under a head of 565ft.; another, which will give 75,000 h.p. at a head of 400ft.; and a third, whereby 20,000 h.p. at a head of 115ft. can be secured. The report shows that the power plant will be located 16 miles from tidewater, and two routes are open for the transmission line to Vancouver, one along the eastern shore of Howe Sound and northern shore of English Bay and the inlet to the Second Narrows; and the other *via* the valley of Seymour Creek to the Second Narrows. The distances are 61 and 47 miles respectively. It is proposed to transmit at 50,000 volts.

Greenock.—The Electricity Committee of Greenock Corporation visited the new refuse destructor in Dellingburn-street on the 29th ult., when an interesting and somewhat remarkable ceremony took place. A chimney stalk, 150ft. in height and 9ft. 3in. in diameter at the top, has been erected in connection with the works, and the last brick of the structure was laid by Provost Denholm. For this purpose the provost was hoisted up the exterior of the chimney by means of a wooden cage, suspended by a wire rope, and worked by a builder's winch from the ground. On reaching the top, accompanied by a representative of the contractors and Mr. Robertson, the burgh electrical engineer, Provost Denholm placed in a cavity a large jar containing copies of various newspapers, and thereafter put the last brick in position, using a silver trowel presented to him by the builders. When the party descended they were greeted with loud cheers by the company present.

Dundee.—Messrs. Gourlay Bros. and Co. have again opened up communication with the electricity department of the Corporation with the view of procuring a supply of power for shipyard purposes, and the Electricity Committee have resolved to offer to supply Messrs. Gourlay with electrical energy in bulk for a period of not less than five years at the rate of 1d. per unit, metered by the Corporation meters, subject to the following conditions—viz.: (1) that energy shall be used or paid for by them at the above-mentioned rate up to a minimum amount of £200 per annum; (2) that for every increase of 3d. per ton in the average price of coal which the electricity department has to pay above the assumed standard of 10s. per ton for Scotch steam singles, the above rate per unit shall be increased by ·01d.; and (3) if any reduction be made generally to consumers of their class, and working under similar conditions, a proportionate reduction will be allowed them.

Alresford.—On Aug. 24 the electricians in the London and South-Western Railway's Eastleigh works held their annual outing. A large number left by the 12.51 train for Winchester, whence they drove in a brake through the Worthys to Avington Park, where a visit was paid to the old church. From there they went through the Itchen Valley to Tichborne Park, and on to Cheriton, where refreshments were provided. Journeying *via* Bramdean Common to Alresford, a sumptuous meat tea was provided by Mr. Gifford, of the Sun Hotel, and was greatly appreciated. After tea a visit was made to the bowling green, and various other games were played. In the evening a smoking concert was held, Mr. Searle presiding, supported by Mr. Hutchinson. Songs were sung, and Mr. H. King excelled himself on the concertina. During the evening the health of Mr. Walker (foreman) was drunk with musical honours. The time passed rapidly and pleasantly, and at 10.30 the party left by train for home, everyone thoroughly enjoying the outing.

Bradninch.—Bradninch is contemplating adopting the electric light. A report has been presented by a committee appointed to consider the subject, and has been considered by a meeting presided over by Mr. T. Hepburn, who explained that there was already sufficient motive power for generating purposes at Kensham, and the premises, which belonged to the Duchy of Cornwall, could be obtained at a fair rental for a term of 25 years. Capital of £1,500 would be needed, but the contractors were willing to take up half the shares. In order to make the scheme pay, 500 lamps of 8 c.p. would have to be used. During the day the current could, it was estimated, be sold at less than 6d. per unit for motive power. Dr. Muir said if properly used the electric light would be no more costly than oil lamps. If largely used by the public, the light would cost probably 5d. per unit. Mr. J. J. Norman promised to help the scheme financially. Mr. P. Warren, jun., said Dulverton, which possessed facilities inferior to those at Bradninch, had adopted the electric light with success. Dr. Muir advised that steps should be taken to ascertain to what extent the parishioners were likely to use the light.

Trowbridge.—At a meeting of the Electricity Committee a letter was read from Messrs. Seymour, Williams, and Co., on behalf of the Western Electric Distributing Corporation, in reply to communications sent to them, stating that the Council must recognise the practical impossibility of floating electrical concerns at the present moment, with Consols at 80, except under conditions which would seriously hamper them and add to the cost of running. The committee recommended the Council, as the Corporation had neglected to carry out the terms of the agreement between them and the Council, to call their attention to the fact that the provisional order for the supply of energy within the district had lapsed under Clause 15 of the agreement between the parties. Mr. W. N. Haden, in moving that the recommendation be confirmed, said since the laying of the cable the Corporation had done nothing. The time was really up in August last year, but the Council extended it to Feb. 6 last, and it was now six months after that. It was for the Corporation to find the money; that Council had nothing to do with the state of the money market. Mr. Lister seconded and the recommendation was agreed to.

Italy.—A consular report from South Italy states that the Italian Government has decided to take over the telephones, subject to coming to an arrangement with the various companies, of which the Societa Generale Italiana di telefoni ed applicazioni elettriche is the principal. Naples can now communicate with Rome, Castellamare, and some other neighbouring towns, but it is hoped that when the Government have taken the wires over that there will be a great expansion of the system. The Elettrica Baresa (Bari), although the price is very low (40c., or 4d. per kilowatt), is going to distribute 4 per cent. to shareholders at first. As the result of a compromise in a lawsuit with the Tuscan Gas Co. the municipality of Bari have discontinued the service of public lighting, which will be continued by the gas company with the modification that in some of the principal streets and squares electric light will take the place of gas. The Marconi station at San Cataldo has continued service with Antivari, the number of messages received and dispatched being on an average 30 per month, and the charge for Montenegro 9d. (1d.) per word.

Bridgend.—Mr. R. C. Griffiths, chairman of the Bridgend District Council, made a long statement at the meeting of that authority on the question of the proposed sale to them of the South Wales Power Co.'s local generating station. The Council were facing a position which he did not believe had ever met the members of a similarly situated District Council, but they could not pay £14,000 for the station, which was the price asked. They had considered various schemes, including a reversion to gas for street-lighting purposes, but they were advised that the best scheme was the purchase of the company's undertaking in Bridgend. The Council's investigations revealed the fact that the company had invested no less than £38,700 in the erection and equipment of the station. The present position was, shortly, this: the company agreed to sell and the Council to purchase the undertaking for £5,000, and a loan of £6,500 had been applied for, to cover the cost of purchase, the provision of stock-in-trade, and the obtaining of the provisional order for the supply to the Glamorgan county asylums—which were outside the Bridgend area—and the extended urban district area, for which no powers had been obtained. He did not think any serious difficulties would arise in the way of obtaining the order, and the Penybont Council would not object. Concluding, the chairman said the question had received the anxious consideration of the Council for two years past, and they were now nearing solution. He did not think any town had made a better bargain. Mr. George Bevan thought the time had come when figures showing the estimated receipts and expenditure should be given to the public, but after some discussion the question was adjourned.

Worthing.—The Electricity Committee of the Town Council have had under consideration the question of the desirability or otherwise of effecting a reduction in the price now charged to private consumers for electricity supplied for lighting purposes, and in connection therewith had before them certain particulars and memoranda prepared by the resident engineer relating to the matter. The Council are reminded that the committee have in previous reports made to them (which have been approved by the Council) recorded their opinion that at the earliest practicable date the price to private consumers should be reduced, the last occasion in which the matter was reported on being the Council meeting on June 4 last. The committee having carefully considered the question, and being of opinion that the time has now arrived when a reduction of the nature indicated should be effected, have resolved that the Council be recommended to rescind so much of the resolution adopted by the committee on Dec. 17, 1900, and approved by the Council on Jan. 1, 1901, as prescribes that the charge for current supplied for lighting purposes to private consumers be at the rate of 6d. per unit, and in substitution therefor to direct that from and after Oct. 1, 1907, the charge for current supplied to private consumers for lighting purposes be at the rate of 5d. per unit, with the present scale of discounts, to shops, dwellings, offices, banks, workshops, and schools, hospitals, homes, and religious institutions; and at the rate of 4½d. per unit, without discounts, to places of public worship, hotels and licensed houses, restaurants and clubs, boarding-houses, with minimum installation of equivalent to 45 lamps of 32 watts each, and public halls, public libraries, and fire stations. Councillor Chignell has given notice that he will move at the next Council meeting that the resolutions previously passed with reference to the charge for electricity for public lighting be rescinded, and that in future the price per unit shall be the same as that charged for lighting the Worthing Theatre (3d. per unit).

Brighouse.—At a meeting of the General Purposes Committee of the Brighouse Town Council on Aug. 28, the sub-committee appointed to negotiate with the Yorkshire Electric Power Co. to supply in bulk the electricity required for the borough presented a report as to the best terms they could obtain as follows: "(1) The company are prepared to give a supply of direct current for tramways and lighting at a charge of £6 per annum per kilowatt of maximum demand plus ¼d. for all units consumed, the maximum demand to be determined by adding the maximum indicated on the tramway and lighting meters. (2) The charge made on this scale shall not for the whole supply exceed 1·25d. per unit. (3) The period shall be fixed for 14 years, with a revision of price at the end of seven years, the 1·25d. per unit being the maximum price to be charged per unit. (4) The company require that there should be a guarantee of minimum annual payment in the first instance of 30,000 units per annum for lighting, and that when the tramways take their load they should also be covered by an agreed further minimum quantity, as the Corporation will no doubt be so covered. Note.—As it is impossible at the present time to say when the tramways will require a load, the company are not to be required before September, 1908, to give a supply of current either for lighting or power unless the tramways come along. In that case the company are prepared to give the supply of energy to the trams, the minimum not to exceed in any case for lighting and power together the sum of £1,000 per annum. (5) The Corporation to provide the land and build the transforming sub-station, and also

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provide switchboard and balancer. (6) The company to put down all transforming plant and apparatus, supply all labour in the sub-station, and bear all loss of transforming, except the loss in the balancer." The adoption of the report was moved by the Mayor and seconded by Alderman Healey. Councillor Hardaker moved an amendment, which was seconded by Councillor Taylor, to the effect that the Corporation put down an electrical generating station in conjunction with a refuse destructor, but the amendment was rejected, and the report was approved by a majority of the members present.

Aberdeen.—The accounts of the Aberdeen Corporation's electricity department for the year ending July 31 show that in the revenue and expenditure account of the electricity department the total revenue amounted to £42,247, made up as follows: sale of current by meter, £27,627; public lighting, £2,358; Corporation traction (less £741, difference between amount charged and actual cost), £8,819; Suburban traction, £1,397; rents and feu duties, £243; hire of motors, £1,148; attendance on harbour and other arc lamps, £559; tramway department for services of engineer and staff, £1. 13s.; sale of lamps, £91. The expenditure under this account amounted to £18,571, leaving a balance of £23,675 to be carried to the net revenue account. The principal items of expenditure were: fuel, £5,343; wages at generating station, £1,845; repairs on buildings and plant, £284; main and service repairs, £1,054; wages of meter inspectors, £100; rents, feu duties and taxes, £5.174; proportion of engineer's salary, £560, etc. The balance of £23,675 carried to net revenue account was disposed of as follows: interest on mortgage and other loans, £8,217; depreciation, £7.960; sinking fund, £5,448; and surplus carried to reserve fund, £2,049. The amount of the reserve fund at July 31 was £19,624. The amount expended on the works in the general balance account was £283,937, less depreciation written off, £47,414—£236,522. The total assets amount to £280,788. The amount borrowed on mortgage was £205,130, of which £32,443 has been redeemed by the sinking fund. During the year the quantity of electricity generated was 5,540,120 Board of Trade units, as compared with 4,945,198 units last year. The total amount sold was 4,794,507 units, compared with 4,280,248 last year. Of the total quantity sold, 1,922,388 units went for Corporation traction, 149,062 units for Suburban traction, 2,453,866 for private consumers by meter, and 269,191 units were consumed for public lighting. The quantity used in the works and subway was 405,179, the total quantity thus accounted for being 5,199,686 units. The quantity lost in distribution or otherwise not accounted for was 340,434 units, a percentage of 6·14, compared with 6·29 last year. The total number of public arc lamps was 202, the number in the previous year being 192. The prices per Board of Trade unit were 5½d. and 1½d., 2½d. and 1d., and 2½d. and 1·1011d.

Manufacturers' Lists.—We have received from Major and Co., Elland-road, Leeds, a number of cards on which plotted curves show the insulating properties of Major's insulating varnishes. Tests made for moisture absorption show slightly over 0·25 per cent. of moisture over a period of five weeks for Major's varnish compared with 0·5 for black varnish, and 1·25 per cent. for yellow varnish. Other tests show that Major's varnish does not become brittle even after 300 hours at a temperature of 250deg. F., and in another case of 7,700 volts alternating current the varnish did not puncture.—We have received from the General Electric Co. a reprint of an article on the "Osram" lamp comparing the efficiency of the metallic-filament lamp with other types of electric incandescent lamps. With the advent of the "Osram" lamp electric lighting is made available at a lower price than gas lighting. Full particulars of this lamp have already appeared in the columns of this journal.—The Sheffield Engineers, Sheffield, send us particulars of their wood-split pulley. The "Hercules" wood-split pulley, as it is called, can be used on the heaviest as well as the lightest drive. It is as light as possible consistent with strength, and has a rigid hub, separated to pass the air instead of fanning it as with some other pulleys.—From the Silvertown Storage Co., Temple Bar House, London, E.C., we have received a catalogue of the British transformer and switch oils manufactured by this company. A diagram illustrating the dielectric strength of various oils for insulating purposes has also been sent to us, and the spark-gap tests show exceedingly good results.—A list of special slow-speed protected type motors (single, two, and three phase) has been sent to us by Messrs. Wright and Wood, Halifax.—Mr. Lancelot W. Wild sends us descriptive particulars of the Wild flicker photometer, which consists of an adaptation of the principle of the Bunsen disc. A notable feature of this instrument is that the disc is driven by a small electric motor. This is much more convenient than a clockwork motor, which requires continual rewinding, and generally at a critical moment. An electric motor has the further advantage of maintaining its speed more constant, and can be regulated to a nicety by means of a resistance. In addition to this advantage the photometer gives perfect freedom from angularity errors, has perfect shielding from stray light, is screen proof against damage, and can be used with coloured lights.—From Messrs. O. C. Hawkes, 69 and 70, Aldersgate-street, we have received a catalogue of electric signs. We would like to point out that this firm specialises in electric signs, and their enterprise in this class of business is especially gratifying. Central-station engineers will be specially attracted to the interchangeable standardised letter system and the method of efficient sign building shown in the catalogue. With regard to illuminated wood letters, the engineer can estimate for a complete sign of any size and calculate current consumption and running cost from data given in the catalogue.—G. Braulik, of Upper Thames-street, London, E.C., sends us a copy of his latest catalogue of electric light fittings and glassware (Section F), which should be filed for reference by every buyer.—The British Aluminium Co., of 109, Queen Victoria-street, London, E.C., have sent us a number of leaflets, etc., giving particulars of aluminium 'bus bars and cable, both stranded and solid, which they have recently been supplying in increasing quantities to many first-class firms.

PROVISIONAL PATENTS, 1907.

AUG. 26.

19113. Improvements in conduits applicable for electric wiring, water, gas, air, or other purposes. Harry Pendlebury, Arthur Pendlebury, and Henry Pendlebury, 6, Bank-street, Manchester.

19135. Improved signal transmitter. George Henry Oatway, 82, Milton-park, Highgate, London.

19157. Method of manufacturing filaments for electric lamps. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, London. (Glühlampen - Fabrik "Union," G. m. b. H., Germany.)

19174. Improvements in or connected with dynamo-electric machines. John Wesley Burleigh, Norfolk House, Norfolk-street, London.

AUG. 27.

19222. Improvements in tramway rails. John Steel Hunting, 65, Chancery-lane, London.

19234. Cluster lamp sockets. Wallace Fairweather, 65, Chancery-lane, London. (Benjamin Electric Manufacturing Company, United States.) (Complete specification.)

19241. Improvements in circuit breakers. Jules Lecoche, 28, Mexfield-road, East Putney, London.

19274. Improvements relating to receivers for wireless telegraphy and telephony. Simon Eisenstein, 7, Southampton-buildings, London. (Complete specification.)

19281. Improvements in wave power apparatus. William Phillips Thompson, 322, High Holborn, London. (Alva Leeman Reynolds and George Albert Reynolds, United States.) (Complete specification.)

19282. Improvements in apparatus for strengthening weak current impulses, alternating currents, and variations in current strengths. Anton Pollak, 6, Lord-street, Liverpool.

19293. Improvements in trolley cars for wire rope or suspension railways. Max Adolf Bleichert and Paul Max Bleichert, 31, Bedford-street, Strand, London. (Complete specification.)

AUG. 28.

19305. Improvements in signalling apparatus for tramcars. John Mason, 6, Bank-street, Manchester.

19340. Improvements relating to signalling telegraphs. Siemens und Halske Akt.-Ges., Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Dec. 17, 1906, being date of application in Germany.) (Complete specification.)

19348. Improvements in the manufacture of iron or steel by the open-hearth process or in electrical furnaces. Josy Flohr, 55, Chancery-lane, London.

AUG. 29.

19365. Improvements in the fixing of tramcar seats and the like. Peter Kavanagh, 9, Tempest Hey, Liverpool.

19368. New and improved sanitary mouthpiece for telephones, speaking instruments, and the like. Thomas Justin, 92, Shakespeare-street, Nottingham.

19378. Improved sanding apparatus for use with tramcars. Alfred Whittaker, 60, Newhall-street, Birmingham.

19403. Improvements in electrical signalling systems. Walter Victor Turner, Westinghouse Building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Feb. 23, 1907, being date of application in United States.) (Complete specification.)

19417. Improvements in carbon brushes for dynamos and electric motors. J. Stone and Co., Limited, and Edwin Mumford Preston, 77, Chancery-lane, London.

19424. Improvements in or relating to the electrical propulsion of marine vessels. Henry Alexander Mavor and John Harvard Biles, 46, Lincoln's-inn-fields, London.

19428. Electrical elevated railway. Albera Carlo, 110, Strand, London.

AUG. 30.

19432. Improvement in electric tram and other cars, omnibuses, carriages, vehicles, and the like. Henry Clayton Wood, 5, Bromfield-terrace, Tadcastle, Yorks.

19447. Single falling-rod electric automatic illuminator and extinguisher. Edmund William Moore, 31, Manbey-grove, Stratford, London.

19462. Improvements relating to portable searchlights, signalling lamps, and the like. Henry John Scott Stobart and William Henry Robson, 18, Southampton-buildings, London. (Complete specification.)

19466. Improvements in and relating to spark arresters. Richard Francis Lamb, 615, F.-street, N.W. Washington, D.C., United States. (Complete specification.)

19468. Improvements in electric sparking coils with special reference to internal-combustion engines. Thomas Linforth Jones, 13, Greek-street, London.

19492. Improvements in combined semaphores and in indicators for railway signalling. Siemens Bros. and Co., Limited, and Luiz de Moraes Gomes Ferreira, Birkbeck Bank-chambers, Southampton-buildings, London. (Complete specification.)

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19491. Improvements in electro-capillary apparatus. Thomas Maughan Riddell, 22, Southampton-buildings, London.

19493. Improvements relating to interlocking signal and points levers on railways. Siemens Bros. and Co., Limited, and Luiz de Moraes Gomes Ferreira, Birkbeck Bank-chambers, Southampton-buildings, London. (Complete specification.)

AUG. 31.

19527. Improvements in or relating to electric incandescent lamps. Alfred Wood Somers and Richard Joseph Crowley, Spring Bank, Bradford, Yorks.

19546. Improvements in the armatures of magneto machines. Mortimer Arthur Codd, 27, Addington-square, Camberwell, London.

19558. Improvement in electrical locking apparatus for railway signalling. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, London. (Siemens und Halske Akt.-Ges., Germany.) (Complete specification.)

19562. Improvements connected with electric incandescence lamps having holders or suspenders for the filaments. Deutsche Gasglühlicht Akt.-Ges. (Auergcs), 55, Chancery-lane, London. (Date applied for under Patents Act, 1901, April 15, 1907, being date of application in Germany.) (Complete specification.)

19570. Improvements in electricity control relays. Charles Cornfield Garrard, and Ferranti Limited, 18, Scuthampton-buildings, London.

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Sept. 19.)

1906.

16602. Electric switches. British Thomson-Houston Company. (General Electric Company.)

17077. Arc lamps. Myers.

18956. Alternating electric current motors and systems of operating and controlling same. British Thomson-Houston Company. (General Electric Company.)

18976. Electric automobiles. Mackenzie. (United States Motor Vehicle Company.)

19235. Circuit-protecting devices. British Thomson - Houston Company. (General Electric Company.)

19623. Electric batteries. Sandy and Middleton.

19951. Primary batteries. Sefton-Jones. (Decker Electrical Manufacturing Company.)

19951c. Galvanic batteries. Sefton-Jones. (Decker Electrical Manufacturing Company.) (Date applied for under Rule 5, Patents Rules, 1905, Sept. 7, 1906.)

21059. Automatically-operating telegraphic mechanism for transmitting predetermined messages, particularly applicable for fire-alarm apparatus. Smith.

21506. Joints between electric conductors, specially applicable to joints for electric incandescent lamp conductors. British Thomson-Houston Company. (General Electric Company.)

23289. Process for electrically welding the longitudinal joints of tubular objects, such as boiler shells, tubes, pipes, and the like. Bier.

23931. Wheels of tramcars and the like. Ward and Codham.

24203. Controllers or cut-outs for electrical circuits. Garrard, and Ferranti Limited.

24337. Electric transformers. British Thomson-Houston Company. (General Electric Company.)

24576. Flame arc lamps. Gilbert.

26226. Gear generating machine. Wallwork and Wallwork.

26678. Conduit fittings for electric wires and cables. Oldbury Steel Conduits, Limited, and Hackett.

26867. Electric furnaces. British Thomson-Houston Company. (General Electric Company.)

27205. Electric motors. Parker. (Date applied for under International Convention, Dec. 4, 1905.)

1907.

3380. Wireless telegraphy. De Forest. (Date applied for under International Convention, Feb. 14, 1906.)

5532. Wireless transmission of sonorous vibrations. Feeny. (McCarty Wireless Telephone Company.)

6715. Dynamo-electric machines and means for controlling the same. Siemens Bros. Dynamo Works, Limited, (Siemens-Schuckertwerke Ges.)

6895. Brush-holders for dynamo-electric machines. Tingley. (Date applied for under International Convention, April 4, 1906.)

7336. Pole-pieces of electrical machines. Unione Elettrotecnica Italiana. (Date applied for under International Convention, March 28, 1906.)

9017. Reflectors for electric and other lamps. Tartsch. (Date applied for under International Convention, April 20, 1906.)

11528. Holders for electric lamps and shades. Gosling.

12584. Trolley cars for wire rope or suspension railways. Bleichert and Bleichert.

COMPANIES' STOCK AND SHARE LIST.

Name	Amount paid.		Last price
Commercial and Industrial.	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	—	⅛-⅝
—— Ord., 1 125,000	1	..	¼-½
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	5/32 9/32
British Aluminium Co., Ordinary, 2,001-40,000	5	—	4½-5½
—— 7 per cent. Cum. Pref., 1-40 000	5	..	5-5½
—— "A" 6 per cent. Cum. Pref., 1-20 000	5	..	4⅞-5½
—— 4 per cent. Funding Certificates, 1-20,000	5	..	3⅞ 4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	100-103
—— 5½ per cent. Loch Leven Deb (Reg.), Red., 1-3,000	100	..	96-99
British Insulated and Helsby Cables, Ord., 1-100,000	5	—	6¾ 7¼
—— 6 per cent. Cum. Pref., 1-100,000	5	—	5⅞-6⅛
—— 4½ per cent. Mortgage Debentures	100	—	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	—	85 87 xd
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	3	—	1-1½
—— 4 per cent. Mortgage Debenture Stock	100	—	59 64
Brush Electrical Engineering, Ordinary, Nos. 1-105,751	2	—	⅛-¼
—— Non. Cum., 6 per cent. Pref.	2	—	⅝-1⅛
—— 4½ per cent. 1st Debenture Stock	100	—	86 89 xd
—— 4½ per cent. 2nd Debenture Stock	100	—	7 -74
Callender's Cable, Debentures	100	—	1051-107½
—— Ordinary	5	—	9½-10½
—— 5 per cent. Pref.	5	—	5¼-5½
Consolidated Electrical Co., Ordinary, 1-110,000	1	..	⅜-½
Crompton and Co.	5	..	1⅞-2⅛
—— 5 per cent. Debentures	100	—	85 88
Dick, Kerr, and Co., Ordinary, 1 250,000	1	..	1⅜-1⅝
—— 6 per cent. Cum. Pref., 1-305,000	1	..	1-1⅛
—— 4½ per cent. Debenture Stock, Red.	100	..	101-104
Edison and Swan United, "A" Shares, 1-99,261	5	—	1⅛-1⅜
—— "A" Shares, 01-017,139	5	—	2⅛-2⅜
—— 5 per cent. Debentures	100	—	81-82
—— 4 per cent. Deb. Stock, Red.	100	—	83 85
Electric Construction, Nos. 1 to 112,100	2	—	⅛-⅜
—— 7 per cent. Cumulative Pref.	2	—	1⅛ 1⅜
—— 4 per cent. Perp. 1st Mort Deb.	100	—	77-81
Electrolytic Alkali Co., Ordinary, 1-202,218	1	..	⅛-⅜
Ferranti Limited, 6 per cent. 1st Mort. Deb. Stock, Red.	100	—	—
General Electric Company (1900), 5 per cent. Cum. Pref.	10	—	8 8½
—— 4 per cent. 1st Mort. Deb. Stock	100	—	82-86
W. T. Henley's Telegraph Works, Ordinary	5	—	11½-12½ xd
—— 4½ per cent. Preference	5	—	5-5½ xd
—— 4½ per cent. Debentures	100	—	105½ 107½
India Rubber, Gutta Percha, and Telegraph Works	10	—	13½ 14½
—— 4 per cent. Debentures	100	—	97-99
National Electric Construction Co., 1-170,000	1	..	27/32-31/32
Parker, Thos., Limited, Ordinary	10	—	10-10½
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5	..	3½-4
Telegraph Construction and Maintenance	12	—	31-33
—— 5 per cent. Bonds	100	—	99½ 102½
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	..	9½-9¾

Electric Lighting and Supply.—

Name.	Amount paid.		Last price
	£		£
Adelaide Electric Supply Co., 6 p. c. Cum. Pref., 1-10,000	5	..	4½-5 xd
Bournemouth and Poole, Ordinary	10	—	9¾ 10¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	—	9¾ 10¼
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	—	10 10½
—— 4½ per cent. Debenture Stock, Red.	100	—	99 101
Bromley (Kent) Electric Light and Power Co.	5	—	4¾ 5¼
—— 4½ per cent. 1st Debenture Stock, Red.	100	—	98 100
Brompton and Kensington, Ordinary	5	—	7¼ 8¼
—— 7 per cent. Preference	5	—	7¼-7½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	—	6¾ 7¾
—— Nos. 80,001-100,000	4	—	6¼ 7¼
Cambridge Electric Supply Company, £10 Ord.	8	—	14-14½
Canadian General Electric Co., Common Shares	$.00	..	118-122
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	—	99 102
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	—	3¼ 4
—— 4½ per cent. Cum. Pref., 1-80,000	5	—	3⅝ 4⅛
—— 4 per cent. Debenture Stock, Red.	100	—	95 98
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	—	3¼ 3¾
—— ditto (1903) 40,001-80,000	5	—	3¼-4¼
Chelsea Electricity Supply	5	—	3¼-4¼
—— 4½ per cent. Debentures	100	—	101-104
Chicago Edison Co, 1st Mt. 5 p. c. 30-yr. Gld. Bds., Red., 1-1,200	$1000	..	98-101
City of London, Ordinary	10	—	9-10
—— 6 per cent. Cumulative Pref.	10	—	10¾-11¾
—— 5 per cent. Debenture Stock	100	—	121-124
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	—	96-99
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1,650	50	—	50-53
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100	..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5	..	4½-5
—— 5 per cent. Preference, 1-50,000	5	..	4½-5
County of London Electric Supply, Ordinary	10	—	7-8
—— 6 per cent. Cum. Pref.	10	—	10¼-11¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Bd.	100	—	106-109
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	—	94-97
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5	—	¼-1
—— 5 per cent. Cum. Pref.	5	—	1¼-2
—— 4½ per cent. First Mort. Deb	100	—	76 81
Electrical Development Co. of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, 10,751-15,75)	—	..	75-77 p.c. xd
Electric Lt. & Traction Co of Aust., 6 p.c. Cm Pf., 1 30,000	5	—	2¼-2⅜
—— 5 per cent Debenture Stock Red	100	—	85½ 89½
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red.	100	—	94½ 96½
Folkestone Electric Supply, Ord. Nos. 1-10,000	5	—	4⅝-5½
—— 4½ per cent. First Deb. Stock, Red.	100	—	96-99
Hove Electric Lighting, Ord., 1-13,000	5	—	6¾-7¼
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100	..	103-106
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Deb. Stk. Red.	100	—	94-97
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	—	—
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5	—	2¼ 2½
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	—	94-97
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9⅜-10¼
London Electric, Ordinary	2	—	1⅜-1⅝
—— 5 per cent. Pref.	5	—	4¼-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	90-93

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Name.	Amount paid. £		Last price £
Madras Electric Supply Corporation, 5 per cent. Construction Deb. Stock., Red. (Prov. Certs.), all paid	100	..	94-97
Metropolitan Ordinary, 100,001-300,000	5	—	5-6
—— — 4½ per cent. First Mortgage Debenture Stock	100	—	103-107
—— — 4½ per cent. Cum. Pref.	5	—	4⅜ 5½
—— — 5½ per cent. Mortgage Debenture, Red.	100	—	87-92
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds., 1935, C 1-1,000 ($100), D 1-3,000 ($500), M 1-4,400 ($1,000)	—	..	73-75 p.c.
Mexican Light and Power Co., Capital Stock	$100	..	42½-44½
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14,000 ($1,000)	—	..	80-82
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	—	95-98
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009	5	—	6½ 7
—— do., 57,010-75,000	5	—	6⅝-7
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid)	5	—	6½-7
—— 5 per cent. Pref., 1-57,000	5	—	5 5½
—— do., 75,001-87,500 (issued at 10s. prem., 4s. paid)	5	..	5-5⅛
Notting Hill Electric Lighting	10	—	11 12
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	—	96 99
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	—	5⅛ 6⅜
—— 4 per cent. Debenture Stock	100	—	95 97
River Plate Electricity Co., Ord., 1-119,687 & 120,501-120,507	1	..	⅞-1
—— — 6 per cent. Non-Cum. Pref., 1-100,000	1	..	⅞-1
—— — 4 per cent. Debenture Stock, Red.	100	..	95-98
Rosario Electric Co., 6 per cent. Cum. Pref., 1-20,000	5	..	5-5⅛
—— — 6 per cent. Cum. 2nd Pref., 1-15,000	5	..	5-5⅛
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	—	96 98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	—	..	99-101 p.c.
Smithfield Markets Electric Supply, Ord. 1-12,000	5	—	⅛-1⅛
—— — 4 per cent. Debenture Stock	100	—	71-75
South London, Ordinary	5	—	2-2⅛
South Metropolitan Electric Light and Power, Ord.	1	—	⅜-⅜
—— — 7 per cent. Cum. Pref.	1	—	1 1/16-1 5/16
—— — 4½ per cent. 1st Mort. Deb.	100	—	100-103
St. James's and Pall Mall, Ordinary, 101-20,080	5	—	7⅛ 8⅜
—— — 7 per cent. Pref.	5	—	6⅞ 7⅜
—— — 3½ per cent. Deb.	100	—	86 91
Urban Electric Supply Co., Ordinary, 8-30-007	5	—	1½-2½
—— — 5 per cent. Cumulative Preference, 50,001-80,000	5	—	3 3
Westminster, Ordinary	5	—	8½ 9½
—— — 4½ per cent. Cum. Pref., 110,101-138,251	5	—	5-5½

Electric Tramways.—

Name.	Amount paid. £		Last price. £
Anglo-Argentine, 5½ per cent. Cum. Pref., 1-260,007	5	—	5 15/16-6 3/16
—— — Ord.	5	—	8 1/16-8 5/16
—— — Permanent 6 per cent. Debenture Stock, 1888	100	—	131-134
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	—	102-105
Barcelona Tramways, Ord., 1-20,000	10	—	—
—— — 5 per cent. Cum. Pref. Shares, 1-10,000	10	—	—
—— — 5 per cent. Deb., Red., 1-600	100	—	—
—— — 4½ per cent. Red. Deb. Stock	100	—	—
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1	—	⅜-½
—— — 5 per cent. Cum. Pref. Shares, 1-59,394	1	—	13/16-15/16
Birmingham and Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100	..	94-97
Blackpool and Fleetwood Tramroad	10	—	13⅜-13⅝
Bombay Elec. Supply & Trams. Co., 6 per cent. Cum. Pref.	8	..	7⅜-8⅛
—— 4½ per cent. Deb. Stock, Red.	100	..	94-96
Brisbane Tramway Invest., Ord., 1-75,000	5	—	3 3/16 3 7/16
—— — 5 per cent. Cum. Pref., Nos. 1-75,000	5	—	4⅛-5⅛
—— — 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	—	96-100
British Columbia Electric Railway Co., Ord. Def.	100	—	127-132
—— — Ord. Pref.	100	—	110-114
—— — 5 per cent. Cum. Perpetual Pref. Stock	100	—	103-106
—— — 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each	40	—	100-103
—— — 4½ per cent. Vancouver Power Deb.	100	—	100-102
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	—	2⅛-2⅜
—— — 6 per cent. Cm. Pf., 30,001-60,000	10	—	6⅜ 6⅝
—— — 5 per cent. Perpetual Debenture Stock	100	—	100-103
—— — 4½ per cent. 2nd Deb. Stock	100	—	78-81
Buenos Ayres and Belgrano Trams.	5	—	4 5 16 4 9/16
—— — "A" 6 per cent. Cm. Pf., 1-40,000	5	—	4⅜-4⅛
—— — "B" 6 per cent. Cm. Pf., 1-27,500	5	—	4⅜-4⅛
—— — 5 per cent. Deb. Stock, Red.	100	—	105-115
—— — Prov. Cert., all paid	100	—	100-103
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100	—	92-97
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb. Bonds, Red., 1-1,500	100	..	99-103
—— — 6 per cent. Deb. Bonds, Red., 1-2,275	100	..	100-105
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	91-94 xd
Calcutta Tramways, 1-105,000	5	—	7⅜-7⅝
—— 105,001-137,610	5	—	5-5⅛
—— — 4½ per cent. 1st Deb. Stock, Red.	100	—	102 106
Cape Electric Tramways, Nos. 1-480,000	1	—	5/16 7/16
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	—	4½ 5
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100	—	98 101
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	..	5⅛-5⅜
—— 4 per cent. Deb. Stock, Red. 1985	100	..	97-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	00	—	94 98
Cork Electric Tramway and Lighting Co., Ordinary	10	—	13¼-14½
—— — 6 per cent. Cum. Pref.	10	—	12⅜ 12⅝
—— — 4 per cent. Debentures	100	—	98-101
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	—	13½-14½
—— 6 per cent. Pref., Nos. within 1-60,000	10	—	12⅜-13⅜
—— — 3½ per cent. Mort. Debs., 1-3,000 Red.	100	—	93-97
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100	..	98-101
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6,957	$1,000	—	82-87
Imperial Tramways, Ordinary	all	—	18-19
—— — 6 per cent. Cum. Pref.	all	—	14-14½
—— — 4½ per cent. Deb. Stock	100	—	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5	—	1 1½
—— — 4 per cent. 1st Mt. Db. Stock, Red.	100	—	66-71
Kalgoorlie Electric Tramways, 1-250,000	1	..	5/32-5/32
—— — 5 per cent. "A" Deb. Stock	100	..	89-93
—— — 6 per cent. "B" Deb. Stock	100	..	78-82
Kidderminster and District Lighting and Traction, Pref.	5	—	3-3⅛
Lancashire United Tramways Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	—	94-97
—— — £296,500 2nd Mort. Deb. Stock	—	—	—
—— — £83,330 Deferred Deb. Stock (all fully paid)	—	—	—
Lisbon Electric Tramways Limited, Ord., Nos. 1-594,188	1	..	1 1/16-1 5/16
—— — 6 per cent. Cum. Pref., Nos. 1-425,553	1	—	1 1/16-1 3/16
—— — 5 per cent. Mort. Deb., 1-5,000 Red.	100	..	95-98
London United Trys. (1901), 5 per cent. Cum. Pref.	10	—	7⅜-8⅜
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	—	82 86
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Red.	100	—	96-99
Manila Elec. R.R. and Lghtg. Corp., 5 p.c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000	..	90-92
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 23,436-25,000	5	..	4⅜-5⅛
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	97-100
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	—	3/32 5/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	—	27 32-31/32
—— — 4½ per cent. Deb. Stock, Red.	100	—	94-97
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	—	..	79-81 p.c. xd
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	—	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 601-2,000 (1922)	100	—	101-103
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	—	⅜-1⅜
Oldham, Ashton, and Hyde Tramway, Ordinary	10	—	12
—— 5 per cent. Cum. Pref.	10	—	8⅜-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100	—	100-104
Potteries Electric Traction, Ordinary, 1-245,000	1	—	5/16-9/16
—— 5 per cent. Cum. Pref., 300,001-545,000	1	—	⅜-⅜
—— — 4½ per cent. Debenture Stock	100	—	95-98
Provincial Tramways Co., Ordinary, 1-24,912	10	..	4½-5
—— 6 per cent. Cum. Pref., 1-10,000	10	..	10½-11½
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-30,000	5	..	5⅛-5⅜
—— — 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	97-99
Sao Paulo Tramway, Light, and Power Co.	$100	..	118-123
—— 5 per cent. 1st Mort. Deb., Red. 1929, 1-11,000	$500	..	92-94 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1	..	⅞-1
—— — 4 per cent. Deb. Stock, Red. 1940	100	..	80-84
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs, Red., 1-1,600	100	..	84-88
Yorkshire (West Riding) Elec. Tram. Co., Ord., 70,001-110,000	5	..	1-1⅛
—— 6 per cent. Cum. Pref., 1-46,261	5	..	3⅛-3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	87-90

Electric Railways.—

Name	Amount paid. £		Last price £
Central London, Ordinary	100	—	71-73
—— 4 per cent. Pref.	100	—	89-91
—— " " deferred	100	—	53-56
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	—	102-105
City and South London, Consolidated Ordinary	100	...	46-48
—— 4 per cent. Debenture Stock	100	..	102-105
—— 5 per cent. Pref. Stock '91	100	..	115-118
—— " " " '96	100	—	113-116
—— " " " '01	100	—	113-116
—— " " " '03	100	..	108-111
Liverpool Overhead, 5 per cent. Pref.	10	—	10-10½
—— Ordinary, 1-50,000	10	—	3⅜-4⅛
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	—	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	...	55-58

Telegraphs and Telephones.—

Name.	Amount paid. £		Last price. £
Amazon Telegraph Co., 1-25,000	10	..	3-3½
—— 5 per cent. Debs., Red., within 1-1,069	100	—	85-88
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000	$1,000	..	90-92
Anglo-American Telegraph Co., Ordinary	100	..	60-63
—— 6 per cent Preferred Ordinary	100	...	105½-106½
—— Deferred Ordinary	100	...	17⅜-18¼
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100	...	93-102 xd
Chili Telephone Co., 1-44,000	5	...	6⅜-7⅛
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100	...	92-94
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	...	6½-7⅛
—— 10 per cent. Preference, 1-6,000	10	...	15⅜-16⅜
Direct Spanish Telegraph Co., Ordinary	5	...	3⅜-3⅝
—— 10 per cent. Cum. Preference	5	...	9-9⅛
—— 4½ per cent. Debs., 1-600	50	...	98-101
Direct United States Cable Co.	20	...	14⅜-15⅛
Direct West India Cable Co., 4½ per cent. Debs., Reg. within 1-1,200, Red.	100	...	99¼-101½
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1929	100	...	97½-100½
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8,000, 1913	£5	...	98½-100½
Eastern Extension, Australasia and China, 1-300,000	10	...	12⅜-13½
—— 4 per cent. Mort. Deb. Stock, Perp.	100	...	102-104
Eastern Telegraph Co., Ordinary Stock	100	...	132-137
—— 3½ per cent. Preference Stock	100	...	86½-88½
—— 4 per cent. Mortgage Debenture Stock	100	...	103-105
Great Northern Telegraph Co. (of Copenhagen)	10	...	34-36
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1,200, Red.	100	...	99½-101½
Indo-European Telegraph Co.	25	...	56-58
Marconi's Wireless Telegraph Co., 1-256,127	1	...	⅜-⅜
—— 256,128-384,190	1	...	⅜-⅜
Monte Video Telephone Co., Ordinary, 1-72,680	1	..	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492		...	⅞-1
National Telephone, Preferred	100	...	106-108
—— Deferred Stock	100	—	105-107
—— 6 per cent. Cum. First Pref.	10	—	11-13
—— 6 per cent. Cum. Second Pref.	10	—	10-12
—— 5 per cent. Non. Cum. Third Pref.	5	—	5⅛-5⅜
—— 3½ per cent. Deb. Stock, Red.	100	—	96-98
—— 4 per cent. Deb. Stock, Red.	100	—	101-103
Oriental Telephone and Electric Company	1	..	1⅛-1⅜
—— 6 per cent. Cum. Pref.	1	..	1 3/16 1 5/16
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100	...	97-100
United River Plate Tele. Co., Ordinary, 1-100,000	5	...	7-8
—— 5 per cent. Cum. Pref., 1-40,000	5	...	5-5⅛
—— 5 per cent. Debenture Stock, Red.	100	...	—
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	...	98-101
West African Telegraph Co.	10	...	10-10⅛
West Coast of America, 1-30,000 and 53,001-53,008	2½	...	1⅜-1⅝
—— 4 p.c. Debs., 1-1,500, Gua. by Western Telegraph	100	...	97-100
West India and Panama Telegraph Co., Ordinary	10	...	7/16 9/16
—— 6 per cent. Cum. 1st Preference	10	...	7⅛-7⅜
—— 6 per cent. Cum. 2nd Preference	10	...	6⅛-6⅜
—— 5 per cent. Debs., Red., 1-800	100	...	99-102
Western Telegraph Co., 1-207,930	10	...	13-13⅛
—— 4 per cent. Debenture Stock, Red.	100	...	100-103

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1907.	1906.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Aug 28	1,653	1,738	− 85	— h	25½	25	May 31	64,071	15,530,351	1,379,723	0 98	11·14	2,512	6·45
Ayr Corporation	,, 31	355	362	+ 3	—	8	8	,, 15	14,328	3,316,380	353,945	1	9·71	1,830	5·16
Baker Street and Waterloo Ry.	,, 31	2,005	1,363	+ 642	+ 8,825	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	Sept. 1	1,111	1,160	− 49	− 478	23 53	3·53	March 31	55,025	11,145,531	1,309,903	1·18	10·08	2,338b	6·03
Birmingham Corporation	Aug 31	6 082	—	—	—	56½	—	,, 31	17,133	4,709,788	266,526	·86	14·5	8,866	—
Blackburn Corporation	,, 28	1,169	1,039	+ 130	+ 1,231	24	24	,, 25	48,875	8,661,720	986 953	1·35	11·89	2,036	7·44
Blackpool Corporation	,, 29	2,175	2,469	− 294	− 2,253	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	,, 31	1,310	1,843	− 533	− 1,516	16½	16½	Dec. 31	31,846	2,325,677	579,264	3·28	13 19	—	7·27
Bolton Corporation	Sept. 1	2 321	2,339	− 8	+ 2,639	42	40	March 31	95 766	20,205 196	2,161,130	1·13	10 63	2,394	6·14
Bournemouth Corporation	Aug. 28	2,564	2,552	+ 12	+ 191	17·41	16·82	,, 31	55,276	10,058,288	1,121,623	1·32	11·83	3,226	7·19
Bradford Corporation	,, 31	4,735	4 851	− 115	+ 393	95	95	,, 31	230,085	47,108,000	5,053,392	1·172	10·927	2,395	—
Brighton Corporation	Sept 1	1,262	1,434	− 172	− 2,572	9½	9½	,, 31	50,339	11,321,160	1,152,828	1·06	10·48	2,914·8	8·0.4
Bristol Tramway Company	Aug. 30	5 376	5,376	—	—	51½	51½	Dec. 31	259,799	45,312,373	6 127,135	—	—	—	—
Burnley Corporation	,, 31	1,251	1 2·1	− 30	—	40	40	March 31	57,992	11,092,704	1,197,772	1·31	11 61	5,388	8·17
Burton Corporation	Sept 1	293	33	− 32	− 355	8½	8½	,, 31	17 950	3,878,269	454,082	1·07	9·21	2,018	6·76
Cardiff Corporation	—	—	—	—	—	32 62	† 32·26	,, 31	112,209	24,134,363	2,770,049	1·12	9·72	3,782	9·44
Carlisle Tramways Company	Aug. 31	198	232	− 34	− 469	8 5	8·5	Dec. 31	10 713	2,935 002	359,755	—	7 14	—	5 18
Central London Railway	,, 31	4,240	5,131	− 891	− 4,831	6	6	,, 31	347,588	4,875,547	1,261,214	1 86	65·10	57,931	35·80
Charing X, Euston, & Hamp. Ry.	,, 31	2,345	—	—	—	8	—	—	—	—	—	—	—	—	
City and South London Railway.	Sept. 1	2,848	2 351	+ 497	+ 5,757	6½	6½	,, 31	—	—	—	—	—	—	—
Colchester Corporation	May 8	195	195	—	—	8	8	March 31	10,588	2,457,553	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	Aug. 29	513	563	− 50	− 657	15¼	15¼	Dec 31	21,895	5,814,376	882,256	1 01	6·64	—	4 69
Darwen Corporation	,, 30	252	265	− 3	− 30	7 23	7·23	March 31	—	—	—	—			
Dover Corporation	,, 24	306	366	− 60	− 784	4½	4½	,, 31	11,250	2 853,200	284,343	·94	9·49	2,500	
Dublin and Lucan Electric Ry.	,, 30	163	153	+ 10	+ 84h	6½	6½	Dec 31	6,358	402,511	110,738	3·79	13·78	942	7 33
Dublin U.T.	,, 30	8,872	7,911	+ 961	+ 15,826	48½	48½	,, 31	267,489	50,050,949	7,077,372	1·48	9·07	691	5·55
Dundee City Tramways	,, 28	1,163	1 144	+ 19	+ 428	22	22	May 15	50 154	13 086 396	1,005 911	·906	11·96	2,180	7·42
East Ham Corporation	,, 31	965	978	− 13	− 423	14	14	March 31	56,652	3,689,658	863,816	·64	10 18	2,994	6 79
Glasgow Corporation	,, 31	17,423	17,519	− 81	+ 2,812h	79½	79½	May 31	756,430	195,767,519	17,946,595	—	0 12		—
Gloucester Corporation	July 10	278	304	− 26	—	15	15	March 31	15,465	3,902,077	553,595	·50	6·58	939	5·32
G.N., Piccadilly, and Brompton	Aug. 31	3,500	—	—	—	9	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	37	37	,, 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 31	1,622	1,593	+ 29	+ 1,690	35	35	,, 31	63,938	12 838,150	1 661,262	1·24	9 71	1,923	—
Hull Corporation	,, 31	2,364	2,275	+ 89	+ 2,591	26	26	,, 31	112,651	27,104,921	2,910,698	1	9 29	—	—
Ilford Corporation	—	—	—	—	—	10½	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 28	153	154	− 1	+ 169	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	11,586	3,626,656	419,800	·737	6 62	1,480	5 22
Lancashire United Tramways	,, 28	1,479	1,085	+ 394	+11,193	38½	28	—	—	—	—	—	—	—	—
Leeds Corporation	,, 26	4,595	4,522	+ 73	+ 2,243	83½	89½	March 25	298,233	64,223,666	7,121,038	1 10	10·02	351	—
Leicester Corporation	,, 31	2,164	2 316	− 152	—	42	42	Dec. 31	26,011	12 039,252	1,229,507	1	9·79	—	4 82
Liverpool Corporation	,, 24	11,027	11,124	− 97	+ 7,256	104	104	,, 31	547,625	116,642 663	12 166 419	—	—	—	—
Liverpool Overhead Railway	Sept. 1	1,533	1,498	+ 35	+ 342h	6·65	6 65	June 30	81,302	11,171,865	1,024 275	—	—	—	—
London County Council	Aug 17	31,257	24,519	+6,748	—	93	98	—	—	—	—	—	—	—	
Lowestoft Corporation	—	—	—	—	—	6	6	Sept. 30	14,511	3,128,857	359,435	1 08	9·68	2,630	6 48
Maidstone Corporation	—	—	—	—	—	2	2	March 31	4,740	850 121	112,227	1·33	10 13	2,370	
Manchester Corporation	,, 31	14,647	14,835	− 188	+ 24,089	149	149	,, 31	631,956	126,900,875	14,123,124	1·19	10·73	4,299	6 99
Metropolitan District Railway	Sept. 1	6,633	6,567	+ 66	+ 536	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 1	13,889	13 559	+ 330	+ 4,125	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	Aug 31	149	163	− 14	+ 47	2¾	2¾	,, 31	6,159	1,992,647	206,358	82	7 14	2,239	—
Newcastle-on-Tyne Corporation	,, 31	3,800	3,957	− 157	+ 335	50	50	,, 31	197,849	43,06 ,934	4,326,152	1·07	10·98	3,957	7·0
Newport (Mon) Corporation	June 29	639	628	+ 11	+ 1,797	15¼	15¼	,, 31	30,356	7,252,535	783 435	—	9 29	—	6·4
Oldham Corporation	—	—	—	—	—	34	34	,, 25	65 553	15,466,245	1,504,740	1 16	10·45	1,883	—
Portsmouth Corporation	May 25	2,330	1 578	+ 752	+ 632	23½	28½	,, 31	95,702	19,625,329	197,499	1·17	11 63	—	—
Reading Corporation	Aug. 22	691	690	+ 1	+ 5·0	33½	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	11·29	21·29	,, 31	14,881	2,837,110	386,547	1·24	9·24	1,102	7 92
Rotherham Corporation	—	—	—	—	—	9½	9½	,, 31	23,569	5 251,472	593,054	1 07	9·53	2,612	7·49
Salford Corporation	Sept. 2	4,751	4,850	− 119	+ 2,121	70¾	70¾	,, 31	214,111	39,213,560	4,894,590	1·28	10 29	—	—
Scarborough Tramways Co.	—	—	—	—	—	4½	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 1	5,554	5,522	+ 32	+ 5,296	35¾	35¾	,, 25	210,555	63 952,283	,049,899	903	9 543	3,653	6 477
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,365	9 294,771	1,108,369	1·27	11·02	—	7 83
Southend-on-Sea Corporation	Aug 23	704	703	− 4	− 371	9	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	,, 31	39,550	6,766,031	1,027,730	—	9 23	—	4 75
Sunderland Corporation	,, 25	1,471	1,592	− 121	− 279	20	20	,, 31	64,858	15,364,463	1,495,f85	1·004	10·35	—	6·37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	4,937	1,315,757	102,751	0·87	11 53	1,371	—
Torquay Tramways	Aug 29	470	—	—	—	5 16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 31	941	968	− 27	+ 349	12 68	12·43	,, 31	43,607	7,995,451	862,12	9·27	12·14	3,132	7 90
Warrington Corporation	—	—	—	—	—	9	9	,, 31	17,057	4,418 225	403 363	—	9 85	—	6·33
West Ham Corporation	,, 29	2,322	2,347	− 25	+ 1,198	14·7	14 7	,, 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	,, 28	346	814	+ 21	+ 282	20	20	,, 31	41,905	8,847,066	950,338	—	10·583	2,062	6·15

† And 98 miles of interlacing track. a Train mile. b Per mile of single track. h Half-year's figures. k Double track

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NOTES.

New Irish Wireless Station.—A Midleton telegram states that the Government, through the Irish Board of Works Department, are about to erect and equip a wireless telegraphy station at Corkbeg, just inside the mouth of Cork Harbour, 11 miles from Midleton, according to plans already prepared.

Victoria Falls Power Scheme.—The following is an amusing extract from the Pretoria *Volkstein* concerning the above scheme: "This monster has once more raised its head, and is busy showing its fangs and crushers. Its promoters are simply determined by more undeviating persistence to impose the suicidal monopoly upon us, and every device of unprincipled capitalism will be used to bring us into subjugation. Four million is to be invested in it—foreign capital—and thus we will have to pay a fair interest on four millions per annum to foreign capitalists for a foreign industry, by means of which they close down an equal amount of production within our own borders, from and with our own resources. We would thus, by accepting this suicidal imposition, assume the double burden of curtailing our local production by local workers to an annual amount equal to a fair interest on four millions of money, and we would export annually in money that amount from our earnings to keep up the production in some foreign locality. Midsummer madness would be a mild form of lunacy in comparison with such a total inversion of all economic laws and of the eternal principle of self-preservation." The four millions are yet to be found, and we shall be surprised if the company is so suicidal as to use the Victoria Falls for the supply of power in the Pretoria district. Still, the fear of their so doing is responsible for the above.

South African Business.—We gather from the *British South African Gazette* that the Pretoria Municipality, acting upon the recommendation of the manager of the electric light works, have unanimously decided to increase the generating plant. Owing to the heavy demand for light, the present machinery is working at full output, and it has long been recognised that if a breakdown of any magnitude occurred, without a reserve of machinery as a stand-by, the city would be placed in the same position as Johannesburg found itself some months ago, when its plant broke down. The engineer has already reported as to the estimated reserve of machinery that will be required, and it is probable that tenders will be invited for the same at an early date. In Johannesburg the legal proceedings between the Corporation and the contractors for the gas-engines and producers are still being pushed forward. Arbitration would, in our opinion, save much further waste of money on all sides. It is probable that the Corporation's claim will run into something like £450,000. Meanwhile the Johannesburg Corporation have decided to make an arrangement with the Victoria Falls Power Company, Limited, for the supply of 1,300-kw. three-phase current at 3,000 volts. The question of installing new plant has also been further considered, and it has been resolved to invite tenders locally for plant of 1,000 kw. capacity, tenderers to be given the opportunity of offering either one set of the full capacity or two 500-kw. sets, and alternatively steam generators or steam-turbine generators. The estimated cost of installing this plant is £17,000.

Maximum Demand in Melbourne.—The maximum demand system of charging for electricity differentiates between the long and short hour consumer, and ensures that the price paid for electricity is in proportion to the cost of supply in each case. It involves a different charge per unit to various consumers, and, in consequence, the gas company of Melbourne considered it to be illegal. The question has been well fought out, and, as was to be expected, the gas company has not succeeded in its attempt to stifle progress In this case, styled the Attorney-General on the Relation of the Metropolitan Gas Company *v.* the Mayor, etc., of the city of Melbourne, the action was brought on the ground that the City Corporation had infringed Section 39 of the Electric Light and Power Act of 1896, which forbids preferential charges to consumers, and provides for a uniform charge for electric supply. The Corporation, in supplying electricity, charged at two alternative rates, either of which might be chosen by consumers. One of the alternative rates was of such a nature that some consumers might have to pay more per unit than others. An injunction was asked for by the gas company to restrain the City Corporation from charging in that way. The case was heard before the full Court (Mr. Justice A'Beckett, Mr. Justice Hodges, and Mr. Justice Hood) in November, 1905, and the injunction asked for was granted, with costs. That decision was reversed by the High Court of Australia at the end of last year, and the gas company then carried an appeal to the Privy Council, which has been dismissed, with costs. Under the flat-rate system payment is made at 4½d. per unit, and under the maximum demand rate 7d. per unit for 45 hours and the remainder of the quantity used during the month at 2d. per unit.

Improvements in Measuring Instruments.—The recent exhibition of the Société française de Physique contained some interesting improvements in electrical measuring instruments. Messrs. Richard showed a moving-coil ammeter provided with an arrangement for greatly extending its range. The pointer has a spiral spring attached to it whose free end comes in contact with a stop after the pointer has moved over a certain prearranged portion of the scale—for instance, up to the 100-ampere point. With any further increase in current the deflecting torque is opposed by the additional force of the spring, so that the motion of the pointer for a given rise in current is greatly reduced—the instrument indicating, for instance, up to 300 amperes in the last part of the scale In the hot-wire meter of Messrs. Meylan the current to be measured does not flow directly through the hot wire, but through an insulated wire wrapped round the hot wire, the heat being transferred to the latter by conduction. The hot wire is only ·13mm. in diameter, and the insulated wire does not absorb more than 1·5 watts for the full scale deflection. The Compagnie de Compteurs have introduced a novel temperature convection into their supply meters. The aluminium disc on the moving member of the instrument varies its resistance considerably with temperature, and to compensate for this they produce a proportional but opposed variation in the magnetic field. The magnet is provided with a magnetic shunt of a steel-nickel alloy whose permeability falls rapidly with increase in temperature, the material being practically non-magnetic at 120deg C. If, therefore, the temperature of the instrument increases, the rise in the resistance of the aluminium disc is completely compensated for by the reduced amount of magnetic shunting which takes place owing to the fall in the permeability of the shunt. The foregoing particulars are taken from *Elektrotechnik und Maschinenbau.*

Earth Detection on Three-Phase Power Systems. With the growing use of electric power on private plants for industrial purposes, it is interesting to note a system of quick detection of faults to earth on such a high-tension alternating-current system which has been successfully applied to such an installation. The use of portable and semi-portable machinery, and the large amount of tem-

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porary connections that were made from time to time, together with the danger of interruption, partial or complete, due to heavy work getting entangled with such circuits, led to the recognition of the desirability of a quick means of detecting upon which phase the earth was located, inasmuch as it would be possible, in the event of a bad fault occurring during a busy time, to operate at least part of the plant on two phases only, if it was considered advisable to do so. Between each pole and earth was connected a series of incandescent lamps, or preferably a Geissler tube, placed in a dark location on the main switchboard of the installation, so as to be prominently visible to the switchboard attendant. So long as the current was flowing at proper potential in all three phases each tube glowed with a violet light, due to the difference of potential between its ends. Supposing, however, that there was an earth on one phase, the terminal volts of this tube would be at earth potential and the tube would cease to glow, indicating at once the faulty branch. Fuses would then be drawn on each end of the circuit whose ammeter indicated the heavy load, and the rest of the plant would continue in operation as before. Should it be particularly desired to run any motor on the disabled circuit, and at the same time it was found impossible to totally disconnect the faulty portion to the conductor, an attempt was made to run the machine on two phases only. This was rendered possible by the fact that the faulty phase was known by the indicator.

Power Plant for Winnipeg.—The city of Winnipeg is inviting tenders for the equipment for the Point du Bois water-power plant. The work is well subdivided, so that there is a good chance for the English contractor to obtain a share of the same. It includes the construction of the general works, and the supply and erection of the various portions of the equipment for the hydro-electric works and station at Point du Bois, transmission line between Point du Bois and Winnipeg, and a receiving transformer station in Winnipeg. Tenders are to be returned by Oct. 1, 1907. Copies of the instructions to bidders, plans, specifications, and forms of tender may be obtained at the Power Engineer's Office, Carnegie Library Building, Winnipeg. Individual tenders will be received for: (3) telephone system; (4) general works at Point du Bois; (5) five 4,000-h.p. turbines; (6) two 450-h.p. turbines; (7) five 3,000-kw. generators; (8) two 250-kw. generators; (9) one induction motor; (10) five step-up transformers; (11) switching and accessory apparatus at generating station; (12) light, heat, and power systems, ditto; (13) oil and air systems, ditto; (14) erection of transmission system (75 miles); (15) steel towers; (16) high-tension insulators; (17) electric transmission cable; (18) terminal station; (19) five step-down transformers; (20) switching and accessory apparatus at terminal station; (21) light, heat, and power systems, ditto; (22) oil and air systems, ditto; (24) testing transformers and apparatus; (25) three electric travelling cranes; (26) seven turbine governors; (27) auxiliary apparatus; (28) repair shops. An alternative lump-sum tender will be received for the entire work, including all of the above-mentioned items, together with additional work and equipment necessary to install a complete working plant. As a further alternative, tenderers may include or group together one or more of the above items, providing that they have also tendered for the individual items of such group.

Rubber Cultivation in Samoa.—The increasing demand for rubber as raw material to the electrical industry has made the necessity of further caoutchouc sources become more evident, and it is, therefore, satisfactory to know that the good prospects of rubber culture in Samoa are fully appreciated. Already a great quantity of English and American capital has been laid out in Samoa for the cultivation of caoutchouc, and now interested parties in Germany are commencing to plant large acres with rubber. Experiments made with caoutchouc are reported to show that the different species of rubber develop admirably in the country, while another fact which might be mentioned as showing the favourable prospects for rubber cultivation is that the enterprise yields good dividends to the companies engaged in it. A consular report gives the opinion of Dr. Preuss on the question, which is of interest. He says: "In my opinion the Hevea has the best prospects. However, it cannot yet be said how the caoutchouc will turn out. According to the analogy of other lands, clayey soil has produced more milk than volcanic soil. It is, therefore, possible that the tree will give a smaller yield here than it does in Malayan lands, with their splendid sandy and clayey soils. But we can always look hopefully forward towards the development of the Hevea culture. One must treat the Castilloa with more mistrust. It has a very fine growth here; in a few years it attains a marvellous size. This plant, however, is very susceptible to disease, especially limumea. It does not want shade, when it is young it wants sun; it should be planted in blocks with shade trees, leaving it when young the full benefit of the sun, but in six or seven years, when the trees are tapped, outgrowing it and so providing shade. It is not a shade tree either for coffee or cacao. It hinders the growth of the trees in its neighbourhood by developing extensive surface roots. The Kickscia must also be planted in blocks. It is a better shade tree, and could possibly be used amongst the cacao; but the same care must be taken with it as with Castilloa. Ficus elastica can be planted without misgivings. Its culture is recommended, for it yields good caoutchouc, and is an excellent wind-break. Perhaps it is best to plant it in strips, and allow it to stand as a wind-break. Ficus elastica is easily planted as a cutting. Manihot glaziovii (or Ceara) grows very quickly, but grows weaker as it ages, and gives but little milk. . . ." These expressions of expert opinion justify the enterprise which is displayed in exploiting the country for rubber.

Publications Received. — "Standard Polyphase Apparatus and Systems," by Maurice A. Oudin. (Sampson Low, Marston, and Co., 100, Southwark-street, London, S.E. 12s. 6d. net.) The first edition of this work, by an American author, was published in 1899, and at the time of its publication was one of the first to deal with the application of polyphase systems to engineering. Since then there has been a notable increase in the size of apparatus units, and in the development of appliances for their control and protection. Mr. Oudin has done well, therefore, to keep pace with these developments, and the latest edition of his work—the fifth—has been altered and amended in accord with the changed order of things. The 21 chapters into which the book is divided deal with generators, induction motors, synchronous motors, transformers, rotary converters, switchboards and station equipment, lightning protection and line construction, frequencies, etc., the most notable addition being the extended treatment of the single-phase motor. The book is set throughout with a great many clear illustrations and diagrams, as well as tables.—The latest addition to Messrs. Methuen's "Text-Books of Technology" series is "Electric Light and Power," by E. E. Brooks, B Sc. (head of the physics and electrical engineering department at the Leicester Municipal Technical School), and W. H. N. James, A.M.I.E.E., A.R.C.S. (lecturer in electrical engineering at the Municipal School of Technology, Manchester). Price 4s. 6d. This

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book, it is explained in the preface, represents a preliminary course for students, and is intended rather for the student engaged in electrical industries rather than for the ordinary student in general physics. Nevertheless, it is unlike some other text-books for "practical" students, inasmuch as it aims at broadening the view of the student, and inculcating in him the faculty of developing correct habits of thought—a feature which is likely to be deficient in the person who lacks suitable theoretical training.—"Everybody's Guide to Electricity," by E. Pierce, is published by Madgwick, Houlston, and Co., 4, Ave Maria-lane, E.C., at 6d. (cloth) and 1s. (leather). The author has set himself the task of conveying (in a very small space) a general idea of the method of working electric bells and batteries, and also of working electric light and power systems.—The American *Physical Review* for August contains the following communications: "Fatigue and Recovery of the Photo-Electric Current," by W. F. Holman; "Coefficient of Linear Expansion at Low Temperatures," by Herbert G. Dorsey; 'The Effect of Temperature upon the Discharge of Electricity from Metals Illuminated by Ultra-Violet Light," by George Winchester; "Temperature Control of the Cheltenham Magnetic Observatory, U.S. Coast, and Geodetic Survey," by J. E. Burbank; "The Effect of Frequency upon the Capacity of Absolute Condensers," by J. G. Coffin.—The August issue of the *Journal* of the Franklin Institute (Philadelphia) contains a "*Résumé* of the Literature of the N-Rays, the N_1-Rays, the Physiological Rays, and the Heavy Emission—with a bibliography," by Dr. George Flowers Stradling.

Electricity Machinery Failures. — In a recent issue of this journal there appeared an extract from the report of the British Engine, Boiler, and Electrical Insurance Company showing the causes of failure in electrical machinery. Attention was also drawn to the numerous breakdowns due to the frequent short-circuiting of commutator bars. These bars have usually been insulated from each other and from the binding washers by small flakes of mica bound together by shellac or fish-glue, and compressed into sheets by hydraulic pressure. The following is a typical case. A six-pole, shunt-wound, 15-b.h p. motor, taking current at 200 volts, broke down by fusion of several of the armature coils. The armature had to be entirely rewound. The inspector who examined it came to the conclusion that the damage was caused by short-circuits in the commutator, for the bars, especially those connected to the damaged coils, were burnt, and the insulating material between them carbonised. This material was found to be "made-up" mica. The carbonisation had probably been caused by ignition of the binding material used for cementing the flakes of mica, or of carbon or copper dust collected in the interstice between the flakes. The inspector declares that the flakes of mica are not always of equal thickness or laid close together, and that interstices are left from which the cement is not entirely expressed by the hydraulic pressure. If this cement be combustible, it is easy to understand how it becomes carbonised by sparking, and how the material becomes perforated. For insulating the segments of large commutators "made-up" mica must be used, and is used successfully, but the company's experience leads them to think that for small motors soft green mica is a better material than some of the "made-up" stuff sent out. Another case might also be mentioned—*i.e.*, a three-phase induction motor, six months old, about 30 h.p., taking 33 amperes per phase from a 500-volt supply, used for driving a coal-cutter. At the end of six months one of the usual stoppages occurred for propping the roof. On attempting to start the motor again the fuse—a No. 20 S.W.G. copper wire (70 amperes)—melted. A second fuse of the same size melted also. The company's inspector, who was then sent for, found no external evidence of damage. He, therefore, replaced the fuses and tried to start, but two of the three melted. He then put in No. 18 S.W G. copper wire (108 amperes), and got the motor into motion with a starting current of about 110 amperes, which settled down to 10 amperes as the rotor got up speed, and resistance was cut out. In starting he noticed that gas was given off from two only of the three plates in the temporary liquid starter which was in use. The motor was eventually sent to the maker's works to be dismantled for thorough examination, and the cause of the short-circuiting was then found to be overheating from overloading, which had melted the solder on some of the conductors at the slip-ring end. The melted solder had run down the conductors and short-circuited them in several places. This is said to be a not uncommon experience with motors driving coal-cutters.

Auxiliary Service.—From time to time an electricity supply station is confronted with a proposal in which the prospective consumer wishes to take electricity for the purpose of providing a stand-by only. The difficulty with regard to this form of proposition is that its acceptance renders the station liable to sustain exceedingly heavy loads at inconvenient times, there being no guarantee as to the occurrence of the extra load. In some cases, such extra current required from the generators in operation may pull down the voltage and seriously inconvenience other consumers, causing complaints of bad supply all round; at the same time it is not good policy to altogether refuse such applications from the point of view that central-station electricity supply is by this means brought into direct comparison with that of private plant, whether supplying power from an isolated dynamo, a steam-engine, a gas-engine, or any other source of power. Should interruptions occur in the course of operation by an isolated plant, and the central station be able to take up the work without undue trouble whenever required, this constitutes a very strong argument for the central-station canvasser when he is approaching the consumer for the total supply to such an installation. From this point of view, therefore, auxiliary service should not be refused. The best line upon which to tackle such a proposition is to draw out a special agreement giving the ordinary rates for the particular class of service required—that is to say, lighting or power—making the contract tenable for a year and having in it a guarantee that a payment of a minimum of, say, 10s. per month for every kilowatt connected shall be paid to the company irrespective of the current actually used. This provides a guarantee against loss of capital in putting in the service, and also compensates for the extra trouble and expense in being ready to serve at a moment's notice. In such stations, however, as give special facilities to their customers, such as the supply on hire or the trimming of arc lamps, the supply or renewal of incandescent lamps, it should be carefully pointed out to the auxiliary service consumer that these advantages do not extend to him, inasmuch as it would be obviously unfair to the supply authority if trouble and expense were imposed upon it due to causes connected with the supply of power over which they had no control. This can be carried further to an extent depending on the policy of the supply authority. For example, in cases of trouble to a consumer's installation it should be stipulated that no service would be rendered by the officials or workmen of the central station unless such trouble was directly connected with the supply authority's service; even then should the trouble be caused by any failure in the installation beyond the corporation's fuses, an account

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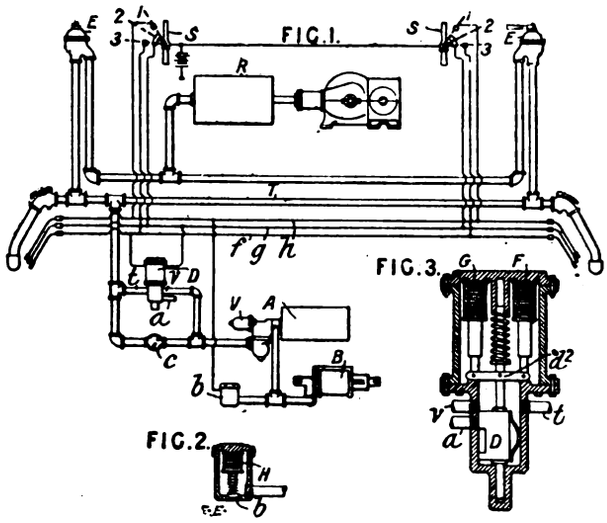
should be made against the customer for any time and material required in putting such an installation right. In other words, care should be taken to impress upon the customer a sense of the advantages which he is losing in the way of skilled supervision by not becoming a regular consumer of the authority. This policy should be combined with a periodically courteously worded letter intimating the supply authority's willingness to undertake any advisory work connected with central-station supply to consumers' premises.

Brakes.—A patent recently granted to the British Thomson-Houston Company and the General Electric Company, of New York, relates to automatic compressed-air brake systems which are fitted with electrically-operated valves adapted to connect the train-pipe side of the triple valve to atmosphere to apply the brakes, and at the same time to disconnect the triple valve from the train pipe, so that train-pipe pressure is not reduced when the brakes are applied electrically. The brake system shown comprises the usual driver's valves, E, for connecting the train pipe, T, to the main reservoir, R, or the atmosphere auxiliary reservoir, A, brake cylinder, B, and triple valve, V. An electrically-operated valve, D, is arranged in the connection between the train pipe and the triple valve. When the switches, S, are in the position shown, the electric circuit



to the valves is open; the valve D occupies the position shown in Fig. 3, in which the train-pipe passage, *t*, communicates with the triple-valve passage, *v*; the brake-cylinder exhaust valve, *b* (Fig. 2), is closed; and the brakes can be controlled pneumatically in the usual way. In the electric release position, 1, of the switch, the train wires, *g h*, are energised; the magnet G draws up its core and rocks a cross piece, d^2, about its pivotal connection to the core of the magnet F, whereby the slide valve, D, is moved to cover the triple-valve passage, *v*, and the magnet H opens the exhaust valve, *b*. In the lap position, 2, of the switch, the wire *g* only is energised, so that the exhaust valve, *b*, is closed, and the triple valve is cut off from the train pipe. In the electric application position, 3, of the switch, the wires *f g* are energised, the cores of both magnets F G are thus drawn up, and the slide valve, D, closes the triple-valve passage, *v*, to the train-pipe passage, *t*, and opens it to the exhaust passage, *a*. In case the valve D should stick while obturating the triple-valve passage, *v*, and so prevent the brakes from being applied pneumatically, there is provided around the valve D a by-pass containing a check valve, *c*, which allows air to flow from the triple valve to the train pipe, but prevents it from passing in the opposite direction. The exhaust valve, *b*, may be a normally open one adapted to close the triple-valve exhaust.

West Ham.—The annual report of the West Ham Corporation electricity undertaking gives rise to the question whether the policy of reducing rates to a very low standard in favour of a certain class of consumer is always a very good one for a central station to pursue. At any rate, West Ham's experience last year is instructive. During the year reductions in price amounting to £9,500 were made to all classes of consumers, but the increased sales of the one year did not cover the cost of the reductions. It was estimated in December, 1905, that if the sales during 1906-7 could be increased by 900,000 units for lighting and 1,000,000 for power, the increased revenue, with its smaller profit, would balance the small cost of production of the additional units. As a matter of fact, only an additional 190,000 units were sold for lighting and 700,000 odd for power. On analysing these reductions, we find that they amount in the case of private lighting, at ·61d. per unit, to £4,626; power, at ·39d. per unit, to £1,625; and tramways, at ·21d. per unit, to £3,327. Thus, while the private lighting consumer has received the largest reduction, he has been the most difficult to induce to take up the use of electricity. The net result of the year's working is an adverse balance of £1,829. The total working expenses amount to £31,953. 19s. 8d., as against £27,471. 2s. 5d. last year, showing an increase this year of £4,482. 17s. 3d., mainly in respect of coal, repairs, and maintenance of motors and public lamps. The total income for the year amounted to £53,324. 1s. 7d., as compared with an income last year of £51,371. 7s., showing an increase this year of £1,952. 14s. 7d. The flat rate of 3d. per unit for private lighting came into operation at the commencement of the year, and the charge for power to the tramways has been 1d. per unit, against 1½d. and 1d. respectively last year. There is an increase in the revenue from motors on hire and work executed for consumers. The gross profit is £21,370. 1s. 11d., as against £23,900. 4s. 7d. last year, being a difference of £2,530. 2s. 8d. After charging interest on capital and bank overdraft, repayment of mortgage loans, contributions to sinking fund, and setting aside an amount pending permanent borrowing, amounting in all to £23,574. 7s. 4d. (an increase over last year's figure of £2,152. 14s. 2d.), there is a net loss of £1,829. 13s. 11d. The amount to the credit of the reserve fund at the commencement of the year was £4,352. 6s. 6d. This account has been charged with the net cost to date of changing over a 600-kw. set to two-phase, and also with the outstanding debt over and above proceeds from the sale of a 300-kw. set, leaving a balance in the fund at March 31, 1907, of £1,658. 6s. 3d The expenditure on capital account during the year amounted to £44,604. 10s. 8d. The total capital expenditure on the undertaking to the close of the year was £381,960. A new item appears in the accounts this year to which publicity expenses are charged. This is evidence of persistent and systematic advertising and canvassing now being carried on in place of the spasmodic and periodical methods which have been for too long common to central stations. The full effects of this policy cannot, of course, be seen for some time, but experience teaches that the results are highly beneficial. At West Ham there has been completed during the past year the organisation of a sales department, which looks after consumers' requirements, hire and hire-purchase arrangements, motors on hire, canvassing, estimating, quoting to and advising consumers for all kinds of apparatus for using electricity, supervision of work, etc, and there is no doubt with the persistent advertising and canvassing adopted the loss on the undertaking will only be temporary.

Electrically-Equipped Cement Works.—The importance of cement in almost every class of work very

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properly attracts attention to the manufacturing processes. It has probably been the experience of no few engineers who have installed modern and expensive plant to have to uproot it after a few months through failure of the foundations, which have eventually been traced to the inferior quality of the cement used. The present-day tendency in cement manufacture is, however, towards the elimination of haphazard and "rule of thumb" methods, and the application of scientific principles in every stage of the manufacture. Recently the Association of Engineers in Charge were afforded facilities for inspecting the Northfleet works of the Associated Portland Cement Manufacturers (1900), Limited, where they were able to see the manufacture of cement carried on under the most modern conditions and upon the highest scientific principles. The extensive plant seen in operation was of the most improved type, and apparently no expense was spared by the directors to ensure the very best. There is a complete electrical installation at the works, under the management of the chief engineer, Mr. C. Percy Taylor. The generating plant consists of four sets of 250 kw. each. Each unit consists of a dryback boiler, a Belliss triple-expansion engine, with motor-driven Edward's air-pump driving a Westinghouse three-wire generator. By means of alternate currents delivered through slip-rings and static transformers these machines deliver direct current to a three-wire system with 500 volts between the outers. The machines are compound wound, part of the compounding being in each outer. This necessitates four-pole interlocked breakers on the switchboard, and these were specially designed by the I.T.E Company for this purpose. All four poles can be put in separately, and all four are thrown out together by an overload on either outer, or a reversed current on one of them. Condensing water is pumped from the River Thames at high tide by means of centrifugal pumps with vertical spindles about 20ft. long, the motors being at the top to avoid the possibility of flooding. The pumps deliver into a reservoir of sufficient capacity to last over the period of low tide. One of the four generating sets is kept as a stand-by, and the other three run the whole of the rotary plant and all the auxiliary machinery of the works, the heavy mills only being driven by steam-engine direct. Probably the most interesting motor-driven machine is the telpher which was put up by Messrs. Siemens Bros. for handling coal. The machine is of an exceptionally heavy type, weighing in all seven tons. The driver is carried on the machine and operates a grab, picking up a ton of coal at a time direct from the lighter. The machine then ascends a gradient of 1 in 5, and after travelling 100ft. to 300ft., according to circumstances, deposits coal direct into the hoppers at the rate of about 20 tons per hour. The rotary kilns, 12 in number, each require four motors—three for auxiliary and one (a 20-h.p.) for the kiln itself. This is regulated on the two-voltage system at speeds of from 240 r.p.m. to 600 r.p m. There are, in addition, two 250 Dick-Kerr motors driving mills and about 40 others operating the various conveyors, elevators, pumps, etc., almost all the materials being mechanically handled throughout. The company have also extensive engineering works at the same premises, which are entirely motor driven. About 200 men are employed here on repairs and manufacture of all sorts of special plant in connection with cement manufacture. A fully-equipped electrical shop for the repair of armatures and all descriptions of electrical plant is included.

Trade Openings in Egypt.—Although in Scripture Egypt is not described as "the land of promise," it appears that in these modern times exporters of all classes of goods are scrutinising with careful attention the opportunities which are rapidly developing for commercial expansion in this new market of the world. The population of Egypt is now rapidly awakening to the advantages which civilisation offers, and this, combined with the fact that the country is being rapidly developed as a fashionable resort during the winter months for the better classes of all European nations, should render it worth while the attention of any progressive manufacturer. Already the demand for agricultural machinery is very great, owing to the development of the Sudan and the general activity of Egypt. Older methods are rapidly passing away, and reaping and threshing machines are being more and more adopted. Numerous land companies have been established for the purpose of reclaiming the soil, and the market for plough and levelling plant is being developed. Centrifugal pumps for irrigation, sugar factories, drainage, and mine sinking have for years been in use, and their value to the exporter as an article of industry is becoming more pronounced. There is a demand for fixed and portable engines economic in fuel consumption, and there should be no reason why manufacturers of electrical plant for isolated positions should not meet with considerable success. The progressiveness of the country is illustrated by the fact that although motors are limited in the Alexandria district to the streets of that town and to a stretch of road of about six miles along between Alexandria and the residential suburb, St. Stephans, there is a great demand for cars ranging in size from 4½ h.p. to 35 h.p. The import of motorcars and accessories has gone up during the past year nearly fourfold. All kinds of machinery are being used and competition is keen, the comparative success of foreign trade rivals being largely found in the fact that they pay great attention to the particulars of the specifications and to punctual delivery of goods. In the report of the acting British vice-consul at Alexandria, Mr. Greig, published in the *Board of Trade Journal*, it is stated that there has been during the past year considerable increase in the demand for electrical apparatus of all kind, the value of imports into Egypt for this class of machinery having gone up during 1906 about 13 per cent. The supply comes mainly from the United Kingdom, France, Germany, and Austria-Hungary, and it is a notable fact that the value of the imports of electrical goods from the United Kingdom during the past year has shown a considerable decrease as compared with 1905, while progress has been made by some Continental countries. The uses of electricity in Alexandria, which, of course, is the most up-to-date city in Egypt, are for lighting, transport, and ventilation. Germany is supplying very large quantities of wires, lamps, bulbs, etc., and it behoves English manufacturers to pay very careful attention to this species of trade. The chief points which are necessary to gain success are that agents should be chosen very carefully, and preference given to men with some technical knowledge. Manufacturers seeking to introduce machinery into Egypt should be represented by first-class firms only, and they must be prepared to wait for their money. Some foreign firms stipulate that a quarter of the contract price shall be paid on receipt of order, another quarter on delivery of goods, a third quarter at the end of six months, and the balance within 12 months of delivery. There is no reason why first-class British goods should not secure acceptance in Egypt, inasmuch as the people of that country are quick to appreciate the value of sound workmanship and reliability. It only needs a little more careful attention on the part of English firms to this rapidly expanding market to make it a profitable source of revenue.

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REPORT ON TEST OF 1,000-KW. B.T.H. TURBO-ALTERNATOR SET MADE AT CONTRACTORS' WORKS, RUGBY.

Below are given the results of an official test on a 1,000-kw. Curtis steam-turbine supplied to the Lancashire United Tramways, Limited, by the British Thomson-Houston Company, Limited, of Rugby. The tests were carried out under the supervision of Prof. Ernest Wilson, of King's College, London, and Mr. J. R. Salter, M.I.E.E, engineer and manager to the Lancashire United Tramways, Limited.

The turbo-alternator set consisted of a vertical Curtis steam-turbine, mounted on sub-base condenser, running at a speed of 1,500 r.p.m., driving a two-phase alternator capable of giving a continuous output of 1,000 kw. (1,250 k.v.a.) with 80 per cent power factor, the pressure being 7,500 volts and the frequency 50. The steam consumption tests were made by measuring the amount of water discharged into the hot-well, the power taken by the air and circulating pumps being excluded. The test was run in the following order: half load for two hours, full load for six hours, and 1¼ load for one hour, after which the voltage regulation and insulation tests were taken.

In Table I. is given a summary of the electrical quantities obtained during the run, whilst Table II. gives the steam consumption figures, and Table III. the observed and calculated regulation.

The accompanying photograph shows the turbine set mounted on its sub-base condenser, with electrically-driven air-pumps, as erected in the power station of the Lancashire United Tramways Company at Atherton.

Steam Consumption.—The specification provided that the test for steam consumption should be made under the following conditions: (1) a steam pressure of 150lb. per square inch at the stop valve; (2) a vacuum of 28in. with the circulating water at a temperature not exceeding 80deg. F., and when the power absorbed by air and circulating pump motors does not exceed 52 kw. The guarantees were as follows: 1¼ load, 20lb.; full load, 19·3lb.; and half load, 21·8lb. The full-load figures were subject to a penalty or bonus of £50 for every 1 per cent. variation.

In each of the tests the rate of consumption in pounds of steam per hour has been obtained from the log sheets between the times set out in Table II., the test being made by measuring the amount of water discharged into two tanks. The 30cwt. platform weighing machines used during the test have been certified as accurate by the Government inspector of weights and measures, and all electrical measuring instruments were calibrated by the Board of Trade after the test. Correcting the test results at full load to specification conditions as regards (1) steam pressure, (2) superheat, (3) vacuum, and allowing for excitation losses and lubricating pump (9·8 kw.), the full-load figures work out to 18·5lb. per kilowatt-hour. This is 4 per cent. better than the guarantee, which thus entitles the contractors to a bonus of £200.

Temperature Rise.—The specification allows a rise of 75deg. F. in temperature after a 10 hours' run at full non-inductive load. Fig. 1 shows the temperatures observed by thermometers, in which A is the air 15ft

View of the Curtis Turbine driving B.T.H. 1,000 kw. 7,500-volt 1,500-r.p m. Alternator.

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TABLE I.

Tests.	Load: Average volts per phase.	Load: Average amperes. Phase 1.	Load: Average amperes. Phase 2.	Load: Average kw. from watt-hour meters. Phase 1.	Load: Average kw. from watt-hour meters. Phase 2.	Load: Average k.v.a. Phase 1.	Load: Average k.v.a. Phase 2.	Excitation: Volts across field coil. Start of test.	Volts across field coil. End of test.	Volts across field coil. Average amps.	Kw. in field coil. Start of test.	Kw. in field coil. End of test.	Kilowatts at 110 volts.
Half-load.....	7,500	33·7	33·5	—	—	252	251	60·5	66·5	69·5	4·17	4 65	7 65
Full load.....	7,500	66·7	66·4	506	505	500	498	71·0	75·0	75·0	5 31	5·63	8·25
1¼ load.....	7,500	85·4	85·0	643	638	640	637	79·5	81·0	79 4	6·29	6·45	8·73

TABLE II.

Time.	Load.	Steam: Pressure in lbs. per sq. in.	Steam: Temperature. Deg .F.	Steam: Superheat. Deg. F.	Exhaust vacuum.	Barometer.	Temperature of circulating water. In.	Temperature of circulating water. Out.	Pounds of steam per hour.	Total kilowatt hours.	Kilowatt hours due to field coil.	Net watt hours.	Pounds of steam per kw. hour.
7.30 to 8.30 p.m.....	Half.	153	384	18	28·65	29·60	35	47	9,650	503	4·65	498·4	19·4
9.36 p.m. to 2.5 a.m.	Full.	153	389	22	28·82	29·66	35	51	17,100	1,011	5 63	1,005·4	17·0
2.30 to 3.30 a.m.....	Full.	153	466	100	28·88	29·72	35	51	15,940	1,011	5·63	1,005·4	15·9
4 to 5 a.m.	1¼	148	508	145	28·77	29·72	35	54	19,390	1,281	5·54	1,274·6	15·2

TABLE III.

Load.	Where given.	Regulation per cent. from 7,500 volts.	Excitation. Amperes.	Excitation. Kw. in field coil.	Excitation. Kw. at 110 volts.
No load.....	Specification test	Nil	—	6·0	—
No load.....	—	Nil	68	4·5	7·48
Full load	Specification test	6·0	—	8·0	—
Non-inductive .....[Cos ϕ=1]	Specification test	5·75	75	5·6	8·2

away from the centre of the turbine; B is intake air temperature at top; C is intake air temperature at bottom; D, E, F, and G are temperatures of stator winding; H are temperatures of stator core. It will be seen that the temperatures in this full-load test are practically steady at the finish. If the rise is taken from the air temperature A, the highest temperature rise as given by G near steam-pipe is 39·2deg. C, whereas it is 31·2deg. C. if the air is assumed to have the value given by C. In either case the rise is within the specification limits. The temperature rises have been checked by resistance measurements, and agree closely

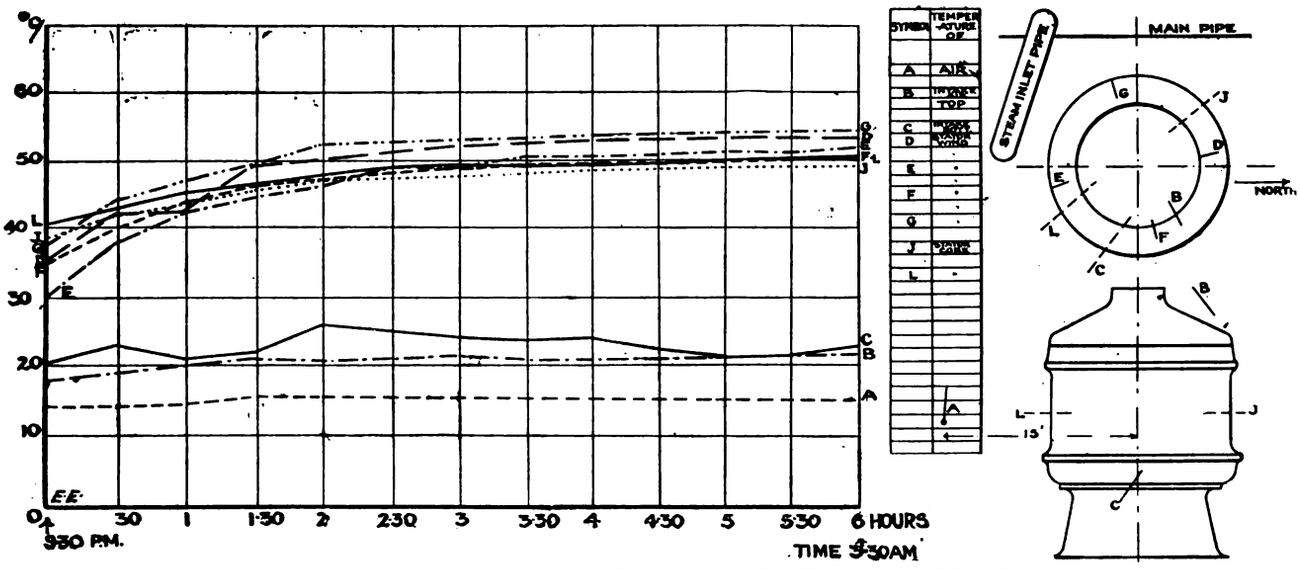

FIG. 1.—Curves of Temperature Rise on the Alternator at the different positions indicated.

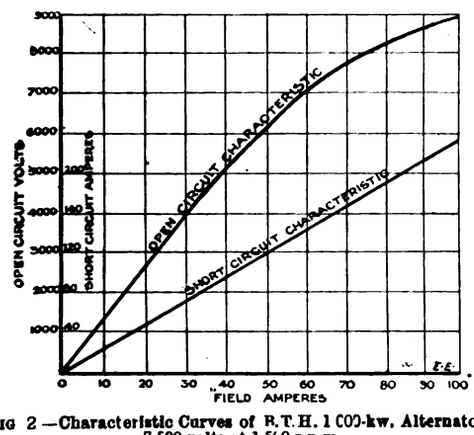

FIG 2.—Characteristic Curves of B.T.H. 1 000-kw. Alternator, 7,500 volts at 1,500 r.p.m.

Voltage Regulation.—It will be seen from Table III. that the regulation is within the specification limits. The short-circuit characteristic (Fig. 2) has enabled an approximate idea to be formed as to what the regulation will be on inductive loads. It will be seen that the field coil, according to theory, will have to be supplied with the full 110 volts for the requisite excitation of about 115 amperes

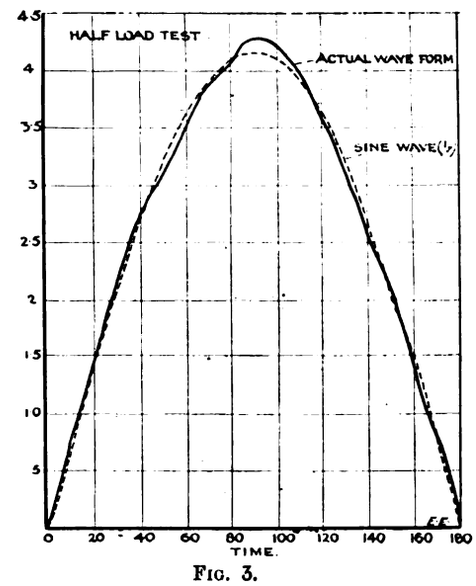

FIG. 3.

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when the generator is hot. Figs. 3, 4, and 5 give the wave-forms obtained by an ondograph, and the equivalent sine curve has been superposed thereon. That is the curve marked (*b*) in each of the figures which would give the

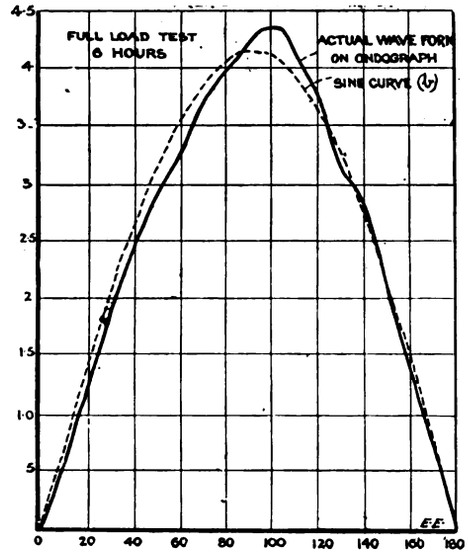

FIG. 4.

same reading on the same voltmeter that the actual curve gave. The deviation from a sine curve is not beyond the limit given in the specification, and is satisfactory. The

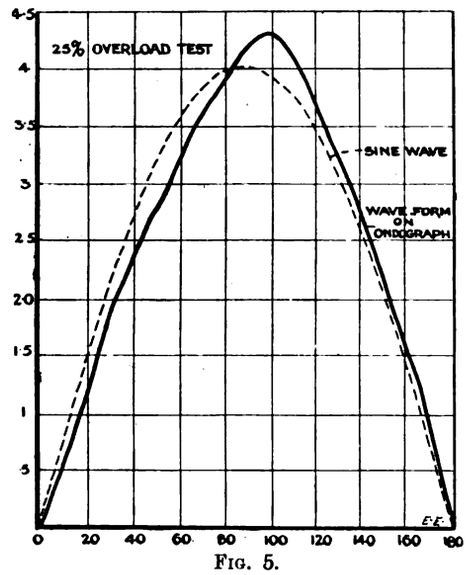

FIG. 5.

deviation becomes more pronounced as the load is increased, on account of the increased armature reaction.

ON THE MOTIONS OF ETHER PRODUCED BY COLLISIONS OF ATOMS OR MOLECULES CONTAINING OR NOT CONTAINING ELECTRIONS.*

BY LORD KELVIN, O.M., G.C.V.O., F.R.S.

§ 1. By atom is meant an indivisible element of ponderable (gravitational) matter, or of electricity; by molecule, an assemblage of two or more ponderable atoms, held together by mutual attractions balanced by mutual repulsions.

§ 2. In the atomic theory of electricity, electrion means an atom of resinous electricity, commonly hitherto called negative electricity. It is at present commonly assumed, and I believe in all probability rightly assumed, that all electrions are equal and similar.

§ 3. An ancient hypothesis, which has had large consideration among philosophers in all times, assumes that there is only one kind of atom, and that groups of equal and similar atoms constitute the chemical elements with all their marvellous variety of quality. But, though no doubt some important and interesting differences of quality, such as the difference between ordinary and red phosphorus, are due to differences of grouping in assemblages of one kind of atom, it seems extremely improbable that differences of grouping of atoms, all equal and similar, suffice to explain all the different chemical and other properties of the great number of substances now commonly called chemical elements. It seems, indeed, almost absolutely certain that there are many different kinds of atom each eternally invariable in its own specific quality, and that different substances, such as gold, silver, lead, iron, copper, oxygen, nitrogen, hydrogen, consist each of them of atoms of one invariable quality, and that everyone of them is incapable of being transmitted into any other.

§ 4. The sole properties of an atom are: (1) its mass (being the measure of the inertia of its translatory motion); (2) its law of mutual force between itself and every other gravitational or electrical atom in the universe, varying according to the distance between them. For the mutual force between ponderable atoms, we have strong reason to believe that this law practically is the Newtonian law of universal gravitation for all distances exceeding the millionth of a centimetre. For distances considerably less than the millionth of a centimetre the Newtonian law of attraction according to the inverse square of distance merges into repulsions resulting in mutual pressure of two bodies resisting joint occupation of space. For smaller distances we have again, in the inevitable theory of Boscovich, attraction constituting cohesions and chemical affinities.

§ 5. The assumption that the mutual force between two atoms depends merely on the distance between their centres implies that each atom is utterly isotropic An aelotropic atom—that is to say, an atom having different attractive and repulsive forces in different directions—is conceivable, and may possibly come in future to have a place in atomic theory. Hitherto it has been universally assumed that every atom, whether gravitational or electrical, is thoroughly isotropic, and I do not propose at present to enter upon any theoretical consideration of aeolotropic atoms.

§ 6. I do not propose to enter on any atomic theory of ether. It seems to me, indeed, most probable that in reality ether is structureless, which means that every portion of ether, however small, has the same elastic properties as any portion, however great. There is no difficulty in this conception of an utterly homogeneous elastic solid occupying the whole of space from infinity to infinity in every direction. We sometimes hear the "luminiferous ether" spoken of as a fluid. More than 30 years ago I abandoned, for reasons which seem to me thoroughly cogent, the idea that ether is a fluid presenting appearances of elasticity due to motion, as in collisions between Helmholtz vortex rings. Abandoning this idea, we are driven to the conclusion that ether is an elastic solid, capable of equi-voluminal waves, in which the motive force is elastic resistance against change of shape.

§ 7. We now meet the question, Is ether incompressible We should be compelled to answer, Yes, it is incompressible, if it is subject to the law of universal gravitation. But presently, when we try to account for motion produced in ether by ponderable or electrical atoms moving through it, we shall feel ourselves persuaded that ether is compressible.* Believing this, we are forced to believe that it is non-gravitational. Thus we find ourselves settled in the conviction that ether is compressible and that ether experiences no gravitational forces between its parts.

§ 8. Suppose now that an atom, whether ponderable or electrical, disturbs ether solely by attracting it or repelling it with a force varying according to distance, and that, with no other mutual influence than this, the atom and the ether jointly occupy the same space. If ether were incompressible, this attraction or repulsion would be utterly ineffective, and the atom would move through the space occupied by the ether without giving any motion to the ether, and without itself experiencing any influence of force due to the ether. Hence, in order that atoms may take energy from motions of ether, and that ether may take

* Paper read before Section A of the British Association at Leicester, August, 1907.

* "Baltimore Lectures," Appendix A, Appendix B; Section 3.

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energy from motions of matter, we must suppose the ether to be compressible and dilatable, and to be compressed or to be dilated, or compressed at some distances and dilated at other distances, in virtue of the force exerted on it by the atom

§ 9. While assuming ether to be compressible, we suppose its resistance to compression (positive or negative) to be so very great that the velocity of compensational refractional waves in pure ether is practically infinite, and that the energy of whatever of such waves may be produced by collisions of atoms or electrions is practically *nil* in comparison with the energy of the equi-voluminal waves, constituting radiant heat and light, which are actually produced by those collisions. It is only under the *enormous* forces of attraction or repulsion exerted by atoms on ether that augmentation or diminution of its density is practically influential.

§ 10. By purely dynamical reasoning, it may be proved to follow from the hypotheses of Sections 4, 6, 8, and 9 that an atom (supposed for a moment to be infinitely small), kept moving through ether at any velocity, q, greater than v, the velocity of light, produces no disturbance in the ether in front of a cone having its vertex at the atom and semi-vertical angle equal to $\sin^{-1}\frac{q}{v}$;* but that the moving atom produces in its rear wholly within the cone an ever-growing disturbance of ether, and, therefore, requires the application of a continual pull forward to keep it moving uniformly at any constant velocity exceeding the velocity of light. In 1888 Oliver Heaviside† arrived at a corresponding conclusion by purely mathematical work, from Maxwell's electromagnetic formulæ, without any dynamical foundation; and in 1897,‡ still without assuming any dynamical or chemical properties of ether and atoms, he corrected an erroneous hypothesis, that no force, however great, could give an atom a velocity equal to the velocity of light, which has been somewhat extensively adopted within the last 10 years in speculations and reckonings regarding radio-activity.

§ 11. Purely dynamical reasoning‖ on our physical assumptions of Sections 4, 6, 8, and 9 teaches us further that: (*a*) No force is required to keep an atom moving uniformly through ether at any velocity less than the velocity of light. (*b*) To start an atom suddenly into motion from rest causes a spherical pulse to travel outwards with the velocity of light, from the place in which the atom was when it was receiving the supposed velocity. (*c*) The magnitude of this spherical pulse is a maximum in the plane through the centre perpendicular to the line of motion, and is zero at the two points in which the spherical surface is cut by that line.¶ (*d*) This spherical pulse carries outwards through infinite space a finite quantity of energy, l, due to a part of the work, w, done by the force which was applied to the atom to start it in motion. The sharper the suddenness the greater this l. (*e*) If at any time a resisting force suddenly stops the atom, work is done on the ether, in virtue of which another pulse carries away an amount of energy, l', and work is done on the stopping agent amounting to $w - l - l'$. (*f*) If the suddenness of the stopping is equal and similar to the suddenness of the starting, the second pulse is equal and similar to the first, and l' is equal to l.

§ 12. To understand clearly the meaning of (*e*) take an example. Let three equal and similar electrionless atoms, A, B, C, be given in a straight line, A moving with velocity q towards B, and C moving towards B in the contrary direction with a velocity just so much less than q that B is left at rest after its collision with C. The initial distances are such that the collision between A and B precedes the collision between B and C. Amounts of energy equal to l and l' are carried away into infinite space in the pulses produced by the two collisions. In the arrangement now described, the suddennesses of the starting and stopping of B are not precisely equal and similar; and because of their difference l' would generally be somewhat less than l: but the law of force between the atoms might be such as to render l' equal to or greater than l for certain ranges of values of q. Take an analogous case of collisions between three ideal billiard balls each perfectly elastic. The clicks of A on B, and of B on C, cause losses of energy, l and l', carried off through air by sound waves.

§ 13. Consider now the collisions in a non-electrified monatomic gas—that is to say, an assemblage of single atoms, each having within it its neutralising quantum of electrions, except a small proportion from which the electrions may have been temporarily knocked out. For simplicity we shall first take the case in which a single electrion is the electric neutralising quantum for each ponderable atom. The collisions will keep the electrions continually in a state of vibration within the atoms, except in the comparatively rare case of an electrion knocked out of an atom, or in the infinitely rare case of the relative motion of an atom and electrion being reduced exactly to zero by a collision.

§ 14. The law of force between the electrion and atom may be such that the centre of the atom is the only position of stable equilibrium for an electrion within it.

§ 15. Or the law of force may be such that there are any number, i, of concentric spherical surfaces, on each of which an electrion may rest in equilibrium radially stable; and $i - 1$ intermediate surfaces, on each of which an electrion would be in equilibrium radially unstable.* In the statistical average of collisions the electrion may, immediately after a particular collision, be ranging in non-sinusoidal vibration through several spherical surfaces of stable and unstable equilibrium, losing energy by sending out irregularly reciprocating waves through ether. Before the next collision, the electrion may probably have settled settled down into very approximately sinusoidal vibrations in and out on each side of any one of the surfaces of radial stability.

§ 16. This last condition we may suppose to be generally prevalent during the greater part of the free path between successive collisions. We may, indeed, suppose it to be more frequently the immediate result of a collision than the wilder vibration described in Section 15, which, however, must undoubtedly be an occasional, though probably a rare, condition immediately after a collision.

§ 17. We are not bound to assume that a single electrion is the saturating quantum of any particular ponderable atom, nor are we bound to suppose that it is electrically neutralised by any integral number of electrions.† The most general supposition we can make is that, with j electrions, the atom and electrions act externally as a vitreously electrified body, and with $j + l$ electrions the atom and electrions act as a resinously electrified body.

§ 18. It seems to me, indeed, exceedingly probable that the persistence of the two-atom molecule in the common diatomic gases O_2, N_2, H_2, Cl_2 is due to the impossibility of electrically neutralising the ponderable atom by any integral number of electrions. Suppose, for example, that one electrion suffices to electrically neutralise two atoms of nitrogen. A monatomic nitrogen gas, if non-electrified as a whole, would have half of its atoms without electrions, and, therefore, vitreously electric, with electric quantity equal and opposite to half that of a single electrion. Each of the other half of its whole number of atoms would have one electrion within it, and, therefore, its external action would be resinous with half the potency of a single electrion. Thus, there would be a strong electric attraction between the atoms without electrions and the atoms each containing one electrion within it. This attraction would tend to bring the atoms together in pairs, N_2, each pair containing one electrion of which the position of stable equilibrium would be at the middle of the line joining the centres of the two ponderable atoms. It seems quite probable that this is the real condition of ponderable atoms and electrions in the ordinary diatomic gases.

§ 19. The dissociation of a considerable number of such pairs of atoms would be exactly the "ionisation" by which,

* "Baltimore Lectures," Appendix B, Sections 6, 7.

† Heaviside's "Electrical Papers," vol. ii., pp. 494, 516.

‡ Heaviside's "Electromagnetic Theory," vol. ii., Appendix G.

‖ "Baltimore Lectures," Appendix B, Sections 4, 7.

¶ "Baltimore Lectures," Section VIII., p. 88; Section XIV., p. 197.

* "Plan of an Atom to be capable of Storing an Electrion with Enormous Energy for Radio-activity," by Lord Kelvin, *Phil. Mag.*, December, 1905.

† "Aepinus Atomised," §§ 5, 6; Baltimore Lectures, Appendix E.

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following Schuster's and J. J. Thomson's theory of the conduction of electricity through gases, the latest developed theories of radio-activity explain the specially induced electric conductivity of diatomic gases, such as Lenard found to be produced in air by ultra-violet light traversing it, and Becquerel found in air all round an apparently inert piece of metallic uranium, or a uranium salt.

§ 20. But, to give electric conductivity to a monatomic gas, the "ionisation" could not be anything else than dissociation of electrions from ponderable atoms. This kind of dissociation might be produced in a very hot gas by mere impacts between the atoms of the gas itself with the large translational velocities to which high temperatures are due. Or it might be produced by extraneous bodies such as the "α" or "β" particles shot out with high velocities from radio-active substances. We are now, however, chiefly concerned with the motions of ether produced by collisions of atoms, in circumstances less abnormal than those in which dissociations and recombinations are largely influential.

§ 21. The pulses described in Sections 11, 12, due merely to mutual collisions between ponderable atoms (without consideration of electrions whether present or not), constitute a kind of motion in the ether, which, if intense enough to produce visible light, would, when analysed by the spectroscope, show a continuous spectrum without the bright lines, which, when seen, prove the existence of long-continued trains of sinusoidal vibrations of particles of ether in the eye perceiving them, and, therefore, also in the source, and in all the ether between the source and the eye. On the other hand, the vibrations of electrions referred to in Section 13 would, if intense enough, produce bright lines in the spectrum.

§ 22. There is another kind of vibration in the source which might produce, and which probably does produce, bright lines in the spectrum. If there are two or more ponderable atoms in the molecule of a glowing gas, not dissociated by the violence of the collisions, each atom of the molecule must have a vibratory motion, of which an isolated ponderable atom is incapable, and these vibratory motions of the atoms of a group must give rise to bright lines in the spectrum, when the frequency of the vibrations in any one, or in all, of the vibrating modes is between 400 million million and 800 million million per second, if we take this as the range of frequencies for visible light.

§ 23. The spectroscopic phenomena to be accounted for in a dynamical theory of light include continuous spectrums with large numbers of bright lines superimposed on the more or less bright background of continuous spectrum. Even when every care has been taken, in artificial sources of light, to eliminate influence of more than one of the substances commonly called chemical elements, the number of bright lines is generally very large; indeed, we are not sure that we have been able to count the whole number of those which are presumably due to any single element.

§ 24. In a glowing monatomic gas, with just one electrion to each atom, and only the central position of stable equilibrium for the electrion in the atom, there could be only one bright line in the spectrum. But, in reality, every one of the known monatomic gases—mercury vapour, argon, helium, neon, krypton, xenon—gives a highly complicated spectrum with a large number of bright lines. We infer that if there is just one electrion to each atom, it has many positions of stable equilibrium; or that there are many electrions, with only the central position of equilibrium for one of them alone; or that there are many electrions, and many stable positions for one of them alone in the atom.

§ 25. It seems as if only by the third supposition—many electrions and many positions of stable equilibrium—we can imagine the great number of bright lines and the great complexity of their arrangement in the spectrums of the monatomic gases.

§ 26. But we can feel little satisfaction in this or any other attempt to discover details of dynamical theory, unless it gives some reasonably acceptable explanation of the laws of arrangement of trains of bright lines in the spectrums of different chemical elements which have been experimentally discovered by Runge, Kayser, Rydberg, and Schuster.

THE SALE OF ELECTRICITY FOR LIGHTING PURPOSES COMMERCIALLY CONSIDERED.

BY L. E. BUCKELL, A.M.I.E.E.

The present time for those interested in the sale of electricity is of great interest for several reasons, and it may be profitable to study these and draw further deductions. It is generally realised that the supply of electricity is entering on an entirely new phase, and that a much more important one than hitherto. From the time when the public supply of electricity commenced until quite recently electricity was sold at comparatively high rates, almost exclusively for lighting purposes, and had a fairly definite market among the larger shops, the well-to-do class of private residents, and in hotels, clubs, etc., where cost was not of very great importance. Almost the whole attention of those engaged in this industry was, therefore, focussed on the purely engineering questions of simplicity, economy of generation, and, in a lesser degree, the reduction of capital cost in station, mains, and similar expenses. Then came the time when attention was directed to the much larger field of power supply with the absolute necessity for much lower generating and capital costs, which, however, was partly ensured by the much larger volume of supply and the load factor. This was really the commencement of applying commercial methods, which are now looked upon as essentials in all other industries, to the industry in which we are interested. We may take it for granted that to-day such points as the importance of keeping capital costs on essentials low, sweeping away non-essentials, the importance of a large turnover rather than a high price per unit, the value of pushing business by all possible means, the necessity of seeing that a consumer does not through ignorance fail to get the best value from the current he pays for, and other similar points, are well understood and appreciated at their true value by those responsible for such undertakings. Still, there are one or two points bearing more especially on the sale of current for lighting purposes which are worth a little consideration.

It has largely, in this country, become the custom to endeavour to obtain as customers for electric light those who use other forms of illumination by discussing the relative costs of the different forms, this point being specially insisted on by some of those interested in the sale of the older forms of illuminant. While no doubt with the modern forms of incandescent and arc lamps and at the prevailing low rates for current it is correct that even on this basis electricity holds a high place, it has always appeared to the writer that it is not from the point of view of cost that electricity should be commended to prospective customers. It is as if one tried to sell butter by explaining that the cost was as low as that of margarine, or a water-colour drawing by comparing the cost with that of a chromo-lithograph. If the possibilities of electric lighting are fully considered and understood, it is at once apparent how for almost every possible use there are such great advantages possessed by no other illuminant that quite a different line of comparison seems necessary.

If we consider the users of light we find them principally falling into one or other of the following classes: (1) private residential consumers; (2) hotels, restaurants, public-houses, etc.; (3) offices; (4) factories, warehouses, and large works generally; (5) retail shops.

The first class will not need much consideration, as all those who have dealt in a large way with supply to private houses know that it is the rarest thing for a householder who has once used electricity in his house ever going back to any other form of illuminant, even in places where the cost of electricity is in excess of that for, say, gas. The cleanliness and convenience here need only to be experienced to ensure not only a satisfied consumer, but many new customers from among the consumer's friends. All that it is necessary for the station engineer to do is to exercise sufficient supervision among contractors to see that every installation in a private house is not only well carried out, as far as the work goes, but, what is far more important, well arranged to give a rational illumination and with switching arrangements to give the maximum convenience. These last lines touch a subject on which there is, perhaps, a good deal to say, but this article does not propose to

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further deal with this. For this class of supply (and one may say for all others) a simple and easy understood system of charging is essential for combined expansion.

Omitting for the present our second group, we will consider our third. This, which is, perhaps, the least profitable of any to the supply authority, is likewise the easiest to obtain and retain, and is, therefore, not worth at present further comment. The fourth class, while as a rule having a bad load factor, is in the case of large towns a valuable source of revenue, and one needing a good deal of careful study and attention to the peculiar requirements of each individual case, and can hardly be dealt with in a general article.

Returning now to our second class and taking with it our fifth class, we get a very large group of consumers, or possible consumers, and one with which at the present time a good deal of difficulty is experienced, and here it is most necessary to consider our butter and margarine analogy. In all consumers of these classes the importance of lighting is very great indeed, and relatively very much greater than the importance of the cost. The cost of lighting should, without doubt, be looked upon entirely as an advertising cost, and should be carried out more in accordance with the methods adopted in carrying out large advertising schemes. The amount of trade done by any retail establishment depends very largely on the conception the public have as to the amount of business that concern is already doing. And the conception of the public is largely based on external appearances, of which not the least important is lighting. Retail traders seem to have great difficulty in realising that economy and cheeseparing in lighting is one of the most radical mistakes that can be made. And this difficulty can only be got over by long-continued effort on the part of the electricity supply representative. Most readers of this article will find in his own experience some case of a new trader in a certain locality having opened an establishment where business had always been reputed slack or non-existent, and only by dint of display, lavish use of paint and plate glass, and, above all, by what would be called extravagant lighting, has built up almost immediately a large and successful business. Another phase of this question will be found occasionally in a combined effort, by a number of traders co operating to brilliantly light up a previously gloomy thoroughfare, with a consequent diversion of the foot traffic after dark into the brilliantly lighted street, with an all-round increase in turnovers to the occupants of that street. Those who have been got to see their lighting bill in its true value as the cost of an advertisement, and to act accordingly, have invariably endorsed the soundness of this point of view, and find that the increase of their lighting bill (which is itself some 5 per cent. or even less of their working expenses) brings an increase in their turnover when times are good many times that paid away for lighting, and (more important still) when times are bad prevents the business they are doing from going away to their competitors.

The writer has been very much struck by a certain class of establishment which has sprung up in many parts of London recently, where certain cheap classes of amusement are offered, or cheap articles are offered for sale, which would almost certainly not in themselves attract the attention of the public sufficiently to ensure a large sale, but all these establishments make an immense use of electric light displayed in various effects, with the result that after dark each is crowded. Once electric light is looked upon as an advertising (or active business getting) expense, it becomes possible to get the consumer not only to consider, but to expect many things which previously were objected to as "increasing the lighting bill." The use of illuminated display signs, large and small, the illumination of facia boards, the placing of arc lamps outside the windows to attract attention to the establishment, the illumination of the windows after the shop is closed, and many other things, all come as a matter of course.

It is essential that an electric light salesman should, if he means to convince shopkeepers, hotel proprietors, and similar consumers that they must put in this illuminant, himself get away from the idea of pounds, shillings, and pence idea of electricity supply. He is selling advertising material: the use of it will recoup the buyer over and over again. What price is paid for the advertisement is not a matter of halfpence: the outstanding point is to make the advertisement effective. The electricity bill in this connection is not a lighting cost, but an advertising charge, and many an enterprising draper spends as much on a single day's advertisement in the newspaper as he does on his quarter's electricity account. The value of electric light as a salesman, the "silent partner," the magnet for passers-by, must be driven home. Tabulated costs of gas and electricity supply are beside the point.

RADIO-TELEGRAPHIC CONVENTION.

Report of the Select Committee.

(Continued from page 341.)

This report, together with the minutes of the evidence heard, has now been published by the Government, and contains a great deal of most valuable information. As an historical record of what has been accomplished it surpasses any previous publication. The following further extracts from the report will be of general interest:

POLITICAL HISTORY.

21. The progress of the invention was carefully watched by the British Government from its first entry into the field of practical application. When Mr. Marconi first came to England he was introduced to Sir William Preece, then engineer-in-chief at the Post Office, and experiments were conducted on Salisbury Plain, at the General Post Office, and in South Wales in 1896-7. The early experiments of Mr. Marconi were made with the assistance and co-operation of the Post Office, and Mr. Marconi cordially acknowledged the good relations which existed between himself and that department. By the year 1899 the Marconi system had reached a point of development where the Admiralty thought it desirable to obtain sets of the apparatus for experiments. In 1901 an agreement of a limited character was entered into between the Admiralty and the company which had acquired the Marconi patents for the supply of Marconi apparatus for naval use. In July, 1903, the Admiralty entered into a further and more complete agreement with the Marconi Wireless Telegraph Company. The text of this agreement was laid before Parliament. The agreement, which covers a period of 11 years (expiring in 1914), grants the Admiralty the right to the full use of the Marconi patents then existing and future, and to the exclusive use of a long-distance station for 20 minutes every day, to priority over all other messages, to the supply of all apparatus at current prices, and to information concerning any improvement in apparatus or in methods of signalling. In consideration for this the Admiralty paid the company £20,000, with £1,600 royalty for 32 existing installations, and £5,000 a year for the duration of the agreement. The committee have been informed by one of the Admiralty witnesses that since 1905 no new idea or technical advice has been offered to the Admiralty in accordance with this agreement, and that the navy is not dependent for further developments in wireless telegraphy upon the Marconi Company.

22. Lloyd's has some 1,300 agents and sub-agents, who, in addition to other important duties as representatives of that corporation, are specially charged to transmit at once all the latest maritime intelligence from their respective districts. As the principal agency for collecting maritime intelligence, Lloyd's was necessarily interested in an invention intended to facilitate communication with ships at sea; and an agreement was signed in September, 1901, expiring 1915, between Lloyd's and the Marconi International Marine Communication Company (an offshoot of the Marconi Wireless Telegraph Company), under which Lloyd's have the right to use Marconi apparatus at all their stations, and engage to use no other, and also not to communicate with ships using any other system, or to permit the use of any other system at or in connection with their signal stations, the only important exception being the United States of America. Lloyd's entered into their agreement because at the time the Marconi system was the only one being worked on a commercial basis. The committee have been informed that the agreement is a complicated one, and has given rise to considerable differences of opinion and litigation as to its construction between the parties concerned. As the result of litigation, the agreement has been modified in several respects, but all the difficulties have not been removed, and further litigation is pending. The agreement is of importance because of the restrictions which it imposes on Lloyd's against employing or communicating with any other system than the Marconi system. An instance was given when the general public interests were endangered and human life jeopardised owing to

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the refusal of the Marconi Company to allow intercommunication. In 1906 the United States steamer "Lebanon" was engaged to destroy a derelict said to be endangering vessels crossing the North Atlantic. While searching for the derelict, the "Lebanon" got into wireless communication with the Marconi-equipped Red Star steamer "Vaderland," in the hope of getting information. The "Vaderland," however, declined to communicate. Lloyd's have also been unable to establish wireless telegraph stations at various British Colonies (Jamaica, Ceylon, Barbados, St. Helena, Perim, Straits Settlements, Mauritius), because these Colonial Governments make it a condition of their licences that intercommunication shall be permitted, if required by an international convention, a condition with which Lloyd's are at present precluded from complying by their agreement with the Marconi Company.

23. By the year 1903 the increasing use of wireless telegraphy for maritime purposes had raised questions of international interest, and it had become evident that on many points regarding the interchange of messages, international agreement would soon be urgently required. A conference met at Berlin in August, 1903, on the invitation of the German Government. Great Britain was represent at the conference by delegates from the Admiralty, War Office, and Post Office. The report proceeds to discuss the outcome of this conference. The Wireless Telegraph Act of 1904, which was renewed in 1906, is then dealt with, after which the work of the second Berlin Conference (1906) is referred to.

The primary object of this convention was to facilitate ship and shore communication, and its main provisions may be classified under the following heads: (1) the acceptance and transmission of telegrams; (2) the adoption of uniform rules of working; (3) the provision of the means of collecting charges and settling accounts between the different countries; (4) arrangements for the publication of all information necessary for intercommunication; (5) rules to prevent interference and confusion in working, with adequate provisions for their enforcement; (6) provision that, with certain exceptions, intercommunication must not be refused on account of differences in the systems of wireless telegraphy employed. A proposal was brought forward by the representatives of the United States to extend the scope of the convention so as to include ship-to-ship communication. The British delegation opposed this suggestion, mainly on the ground that the question had not been considered by the preliminary conference of 1903, and that the time was not ripe for international regulation. An "additional undertaking" was entered into by certain Powers rendering it obligatory on ships belonging to those Powers to intercommunicate without regard to differences of system, and providing that non-signatory Powers (including Great Britain) might at any time adhere, by adopting certain procedure. Evidence was given to show that compulsory ship-to-ship communication would be a distinct advantage from a commercial point of view. Although ship-to-ship communication is not rendered obligatory by the convention, yet interference would be avoided, because a ship's licence to carry wireless telegraph apparatus would compel her to obey all the regulations of the convention.

31. The rules of working laid down coincides so far as circumstances permit, with those of the Telegraph Convention. They embrace the manner of calling from one station to another, of answering calls, the order and nature of the service indications, the signals to be used, the form of telegrams, etc. If this were not done, different countries would adopt different signals and methods, and confusion would result. Article XXX. of the regulations provides that ships should communicate with the nearest coast station. This provision is of considerable value to Great Britain having regard to the crowded condition of the Channel, to the number of stations already existing on the South Coast and their proximity to the main lines of traffic in the Channel; whilst throughout the world it secures to British possessions the enjoyment of the advantages arising naturally from their geographical position. The regulations regarding charges and accounts secure that the whole charge should, in all cases, be collected from the sender, wherever the radio-telegram may be handed in, and a system of accounting has been framed which renders this possible. In this connection it is well to observe that the regulations (Article IV. (2)) permit—but do not require—the publication of information regarding naval stations or other stations not open for public correspondence. When it is to the interest of ships of war or naval stations to communicate with other ships and stations, they are entitled to do so.

Apart from the articles and regulations already referred to, which are in many instances adaptations of the Telegraph Convention, special provisions were required to meet the circumstances peculiar to radio-telegraphy, to prevent interference and confusion:

(*a*) *Excess of Power.*—The range of effect, and, therefore, the range of possible disturbance, is greater the more the energy used. It was, therefore, desirable to lay down that stations should not use a greater amount of energy than was necessary for the particular purpose in hand. Article XXVIII. of the regulations provides that "all stations are bound to exchange traffic with the minimum expenditure of energy required for obtaining effective communication." A specific limitation of the power to be used by ships is contained in Article VI. of the regulations.

(*b*) *Uniformity in Methods of Working Traffic; Use of International Code.*—The rules described above under (2) secure uniformity of working and contribute largely to the prevention of interference and confusion, especially by the regulation of the order in which ships must communicate. The international code is intended to prevent confusion arising from operators of different nationality not knowing each other's language. In such cases the international code is to be used.

(*c*) *Efficiency of Apparatus and Operators on Ships.*—Inefficient apparatus or operators on board ships would naturally be a fruitful source of confusion. To prevent this, Article VI. of the regulations lays down that every ship and shore station must be licensed by the Government to whose authority the station is subject, and that no ship station shall be licensed unless the system used is a syntonised system, capable of transmitting and receiving at a reasonable speed (12 words a minute the minimum), and not using an excessive amount of power. Further, every ship fitted with wireless apparatus must also have a telegraphist licensed by the Government, to whose authority the ship is subject, and in order to allow him to be licensed he must have a competent knowledge of the adjustment of the apparatus, be able to transmit and read by sound at a speed of at least 20 words a minute, and must have a knowledge of the regulations applicable to the exchange of radio-telegraphic traffic. In addition, the certificate must testify that the Government has bound the telegraphist to an obligation of preserving the secrecy of correspondence.

(*d*) *Control of Operators.*—Article V. of the regulations prohibits useless and superfluous communications between operators. Article VII. prescribes the course to be taken in cases of breach of the regulations. An administration which has information of a breach of the convention or regulations, committed at a station which it has authorised, is required, after inquiry, to take the necessary disciplinary steps, and, if need be, to withdraw the certificate of the operator or the ship.

(*e*) *Appropriation of Specific Wave-Lengths.*—Articles II. and III. of the regulations specify two wave-lengths of 300m. and 600m. for the service of general public correspondence. These lengths are sufficiently wide apart to admit of the establishment of shore stations within a reasonable distance of one another, and yet not likely to interfere with each other, if fitted with the most modern apparatus. The normal wave-length on board ship is to be 300m., so that any ship may at all times place itself in communication with any other ship within range. Wave-lengths between 600m. and 1,600m. are excluded from commercial use, and are entirely reserved for Government purposes.

(*f*) *General Obligation not to interfere.*—Besides the above special regulations, Article 8 of the convention requires that the working of radio-telegraph stations shall be organised, as far as possible, in such a manner as not to interfere with the working of other stations of the kind. This general obligation extends to all wireless telegraph stations without exception, and not merely to the commercial stations to which the convention as a whole applies.

32. The Marconi Company urged before the committee that they were able to secure a strict discipline under their own stringent regulations, and that under the proposed convention a loose, dilatory, and cumbrous system of international control would be substituted. To this it was replied that the ships in question would for the most part belong to a limited number of maritime countries, all of which would be interested in maintaining an efficient service, and that the necessary communications would pass directly between the administrations concerned, without passing through a diplomatic channel. There does not appear, therefore, to be any reason why unreasonable delay should be anticipated; and, in any case, Article VII. of the regulations provides that in the event of repeated breaches of the regulations by the same ship the shore stations may be instructed to refuse communication. In case of difference between two adhering countries there is an appeal to arbitration, but meanwhile the ship may be black-listed. In regard to shore stations, they are within direct control of their respective Governments, and the same difficulties do not arise as in the case of ships, which, being migratory, are a more dangerous source of confusion. Much has been made of the possibility that an irresponsible ship may cause confusion and interference in defiance of the regulations. But this could happen under the present circumstances, with this material difference, that if the convention were in force the Government of every ratifying country would be bound in the event of such a violation to withhold a licence. It may be pointed out in this connection that the organisation provided by the convention is international only so far as it binds each of the signatory Powers to lay down and enforce specified regulations for the control of wireless stations on their territory and in their ships, so as to facilitate intercommunication and to avoid as far as possible confusion

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and interference. Thus, though communications from country to country will be required for bringing to notice breaches of regulations, the machinery for enforcing the regulations in each case is national, and not international. The committee elicited that the Marconi Company maintained their discipline by a system of bonus to their operators. They are of opinion that, other things being equal, a bonus system is a less satisfactory method of securing discipline than a system of penalty internationally directed and nationally controlled.

33. A strong contention was raised by the witnesses who appeared on behalf of the Marconi Company, and by Mr. Marconi himself, that, whereas the convention specifies wave-lengths for particular purposes, other essential factors—namely, "amplitude" and "damping"—have been ignored, and that, therefore, the treatment of the matter had been incomplete and unscientific. The committee, accordingly, have endeavoured to examine closely into this complaint, and to arrive at some conclusion as to the different types of waves which the above terms describe. With this object the committee had an opportunity of witnessing a demonstration at the Post Office, where these different types of waves were illustrated by Mr. Gavey. Amplitude represents the vertical height of the wave, or the potential which the wave peaks reach to at each oscillation. It is the size of the rise and fall. Damping represents the dying away of the wave-train. (*a*) A highly damped train is one where the train dies away in two or three oscillations; (*b*) a moderately or feebly damped wave-train is one that persists for 10, 15, or 20 oscillations; (*c*) an undamped or continuous wave is one that persists and maintains a (more or less) continuous series of uniform oscillations.

34. The highly damped wave (*a*) was that used when Mr. Marconi first introduced his invention, wherein no attempt was made at tuning, and is the type which Sir Oliver Lodge described as the "snap" or "whip-crack" system. This method enables considerable distances to be reached without discrimination or selection, and gives the largest amount of interference with partially tuned systems—that is to say, the highly damped wave interferes more with partially tuned systems than the partially damped or continuous wave would do, and is practically prohibited by the convention for use between ship and shore.

35. As regards type (*b*), Article VI. of the regulations specifies the use of a syntonised system on ships, which implies the employment of a moderately or feebly damped wave. Article XXVIII. limits the amplitude, not by any attempt to define the height of the wave, but by limiting the power to be used to the minimum necessary to establish communication, so as to avoid interference with neighbouring stations. Article VI. (*c*) of the regulations provides: "The power imparted to the radio-telegraphic apparatus must not, in normal circumstances, exceed 1 kw. Power in excess of 1 kw. may be used if the ship finds it necessary to exchange messages at a distance of more than 300 km. from the nearest coast station, or if, by reason of intervening obstacles, communication can only be effected by an increase of power.'

36. Undamped waves (*c*), also called continuous or persistent waves, are produced by various methods, one of which is known as the arc system, the two former types of waves being variations of the spark system. This third type of the undamped wave belongs to a system which, according to the impression derived by the committee from witnesses who spoke on it, is still in its infancy, but which may prove an advance on the spark system. No evidence was given to show that a single station on this system is yet in commercial operation.

37. The conference refrained from dealing in a more detailed manner with questions relating to amplitude and damping, because they considered at such an early stage it would have been injudicious to have imposed restrictions which might conceivably have impeded the progress of the science. Had the contention of the Marconi Company been anticipated, it appears to the committee that the company might then have had greater reason for objection, in that embarrassing limitations might have been inadvertently introduced.

38. In relation to the question of wave-lengths, the Marconi Company raised the double objection—first, to the naval appropriation of wave-lengths between 600m. and 1,600m.; secondly, to the commercial use being restricted to 300m. and 600m. (*a*) With reference to the first objection, it is sufficient to state that the naval delegates were unanimous on the question of the reservation of these wave-lengths, to enable the respective navies to carry on wireless telegraphy with the least interference. The claims of a commercial company, even if well founded, must give way to considerations of the highest national importance. It is clear that, whether there be a convention or not, it will obviously be the duty of the Government of any nation to specify such wave-lengths to be used at each station as will safeguard all national interests, and to prohibit the use at commercial stations of wave-lengths which it is intended to reserve for naval purposes. (*b*) As regards the second objection, it is not the fact that only two wave-lengths are available for commercial use. Article II. of the regulations provide: "Two wave-lengths, one of 300m. and the other of 600m., are allowed for general public correspondence . . . nevertheless, each Government may authorise the use at any coast station of other wave-lengths for the purpose of providing a long-distance service, or a service other than that of general public correspondence, established in accordance with the provisions of the convention, on condition that these wave-lengths do not exceed 600m. or do exceed 1,600m." Therefore, at "exempted" stations and at stations with a restricted public service any wave-lengths except those between 600m. and 1,600m. may be authorised by the respective Governments. Evidence was given to satisfy the committee that the prescribed wave-lengths of 300m. and 600m., taken in connection with the exemptions and restrictions provided for in the convention and regulations, afforded sufficient elasticity for commercial purposes.

39. The committee desire to lay emphasis on the following position. Marconi witnesses were closely cross-examined on the alleged oversight in not including provisions regarding amplitude; and, on it being shown that the provisions above set out met every contingency, then raised the objection that these provisions would not be effective, and that Governments generally would not feel inclined to encourage improvements—that is to say, the Governments, having internationally recognised the existing systems which admit of intercommunication, would discourage new and improved systems which would not at the outset intercommunicate; that control in itself would stereotype existing systems and sterilise invention; that the British Government, for example, would hamper improvements in wireless telegraphy by pedantically adhering to conventional regulations which took no account of progress in invention. The convention deals with things as they are, and regulates wireless telegraphy as it stands. It leaves the door open for improvements, and there is no reason for assuming that any Government would willingly embarrass science by artificial obstacles. The British Government itself—indeed, every Government—has the greatest interest in the development of this art, and naturally would be concerned in seeing it advance towards perfection.

40. *Intercommunication between Different Systems.*—The committee have had to give close attention to this point, which on the evidence proved to be controversial, and, in many respects, the most important arising under the convention. The question arises, in consequence of the policy pursued by the Marconi Company of refusing to allow any ship or shore station fitted with Marconi apparatus to enter into communication with a station of any other system. The reason for this policy put forward by the Marconi witnesses was that by unity of control they hoped to secure more effectually the observance of their rules and the avoidance of confusion and interference; but evidence was also given by other witnesses to show that in their belief they had in view the establishment, as far as possible, of a general monopoly for their system—since being in possession of shore stations at many of the most important points of the coast, they hoped to compel ships to adopt the Marconi system in order to communicate with those stations, and other shore stations to adopt the same system in order to communicate with the ships. Under Article 3 of the convention, coast and ship commercial stations are required to exchange radio-telegrams reciprocally, without distinction of the radio-telegraphic system adopted by the station. For example, a Marconi shore station would be deprived of its present power to refuse to interchange messages with a ship fitted with the De Forest or Lodge-Muirhead apparatus merely because the apparatus was not Marconi apparatus, and, conversely, a ship equipped with Marconi apparatus would be required to interchange messages with a shore station irrespective of the apparatus with which it was furnished.

41. It was generally admitted that all existing spark systems intercommunicate readily, the fact being that the so-called systems are really different methods of one system. A considerable doubt arises, however, in regard to the present possibility of commanding intercommunication between the arc (or continuous wave) and the spark systems. The doubt is due to the fact that no arc systems are in operation as commercial stations, and, therefore, it has been difficult to prove or disprove the possibility of intercommunication in actual practice. Mr. Maskelyne stated that he believes it can be done, but (as he describes it) only by elevating the inferior spark system to the standard of the arc system, or by degrading the arc system apparatus to the level of the spark system. This he deprecates, contending that the superiority of the former will at no distant date make it the prevalent system throughout the world. Sir Oliver Lodge stated that by a careful system of syntonisation—by the superior perfection to which he has brought the tuning of his method—all difficulties in the way of intercommunication can be removed. Mr. Marconi and Prof. Fleming, however, question whether, for practical purposes, it can be done at all. Sir William Preece, on the contrary, asserted that there would be no difficulty in securing non-interference by syntonisation. Commander Payne, the Admiralty wireless expert, speaking from actual experience, claimed that he can show there is no physical

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difficulty in making an undamped wave system, which produces greater selectivity, intercommunicate with a moderately damped spark system, and that, as apparatus could be easily tuned, without suffering depreciation, to make the damped and partially damped wave work together satisfactorily, so it might equally be anticipated that the partially damped wave may be made to work with the undamped wave. The committee do not feel themselves competent to draw any deductions from the conflicting views of such distinguished scientists. They must, however, point out that the convention clearly provides by Article 4 of the final protocol for the introduction of new systems, even if they cannot intercommunicate with the existing systems. The terms of this article are as follows: "It is understood that, in order that scientific progress may not be impeded, the provisions of Article 3 of the convention do not prevent the possible use of a system of radio-telegraphy incapable of communicating with other systems, provided always that this incapacity is due to the specific nature of the system, and is not the result of arrangements adapted solely with a view to prevent intecommunication." In regard to the general question of the development of wireless telegraphy, the convention is intended to oppose no obstacle to the experimental and practical development of all new inventions, and, if the continuous wave system is proved to be superior to any of the spark systems, it will inevitably displace the latter and become universal. In the meantime the convention provides for present intercommunication without intended prejudice or detriment to the development of the arc system or any other that may be devised. Indeed, such systems will enjoy the advantages and protection of the convention. Further, under Article I. of the regulations it is laid down that the choice of apparatus is unrestricted and the installations should keep pace, as far as possible, with scientific and technical progress. It may be added that the witnesses representing systems other than the Marconi system expressed themselves strongly in favour of the ratification of the convention, on the twofold ground that under existing conditions the adoption and extension of their systems, which they claim to be more perfect, were greatly hampered; and that under the convention the free competition ensuing would ensure full opportunity for the development of improved systems of wireless telegraphy.

42. Under Article 22 of the convention it is laid down that any contracting party may withdraw from the convention by giving a year's notice, but this in no way disturbs the convention as regards the remaining parties. Assuming it is ratified, the convention will come into operation on and from July 1, 1908, and subject to the foregoing provision will remain in force for an indefinite period.

43. An important provision was inserted at the instance of the British delegates reserving to India and all the Colonies perfect freedom of action, and making it clear that (before or after it comes into operation) each may separately adhere to or withdraw from the convention as they think fit, independently of the mother country or any other colony.

Naval Interests.

44. The committee are strongly impressed with the all-essential consideration that naval interests are fully protected and provided for by the convention. The evidence shows that since February, 1904 (when the matter was first fully considered by the Admiralty with the other departments of the Government principally concerned), the policy of the Admiralty has been the same—namely, that the principle of compulsory intercommunication should be accepted, provided that such regulations should be drawn up, together with provisions for their enforcement, as would, in the opinion of the Admiralty, be adequate for the purpose of effective control over the general transmission of messages to or from stations in British territory, and of preventing interference and confusion. To this another condition was added, as the result of the further and detailed consideration given to the question in the summer of 1906, in view of the forthcoming conference—namely, that the Government should have a discretionary power of exempting particular stations from the obligation to intercommunicate. The British representatives throughout the conference were guided by instructions calculated to attain the paramount object of full protection for naval interests, and they were instructed not to sign the convention unless it were modified in such a manner as to satisfy the above-mentioned conditions. The Admiralty witnesses before the committee, speaking on behalf of the Board of Admiralty, stated emphatically that the objects the Admiralty had had in view were fully secured, and that from the point of view of naval interests ratification was desirable, while a refusal to ratify would be seriously prejudicial to these interests. The following are the points to which the Admiralty attached the greatest importance: (*a*) Naval and military stations are placed outside the convention by Article 21, except only in respect of Article 8 (general obligation to avoid, *as far as possible*, interference with other stations); and Article 9 (ships in distress). The Admiralty considered these two obligations to be desirable. (*b*) Processes of secret working are not to be divulged. (*c*) Supplementary secret apparatus may be set up at stations open for public correspondence. By Article 7 of the convention it is allowed, in addition to the apparatus for public use, to make arrangements for radio-telegraphic transmission of a special character, the particulars of which need not be published. This secures facilities for experimental work with due regard to secrecy, should it be required, *e.g.*, to make trial of any new system at a public general station. (*d*) A reservation to which the Admiralty attach much importance was introduced into the convention at the instance of the British delegates. By Articles 2 and 3 of the final protocol the Government have reserved full discretion to exempt such commercial coast stations as they may think fit from the obligation to intercommunicate, subject only to the condition that other sufficient provision for general public correspondence in the region affected must be maintained or permitted. It was considered essential to retain this right of exemption for the following reasons: (1) The system of general intercommunication was felt to be necessarily to some extent experimental. It is possible that, at any rate for a short time at the outset, it may lead to some confusion in crowded waters. The power of exemption will enable non-intercommunicating stations to be maintained in suitable positions for such periods as may be found necessary. (2) It may be found convenient in some cases for experimental purposes to have stations communicating only with the same system. (3) If, as the use of wireless telegraphy increases, the traffic at particular points becomes too great to be dealt with by a single station, the provision of an "exempted" and a "non-exempted" station will provide a ready means of dividing the traffic. (3) Generally, the power of exemption gives greater flexibility to the proposed arrangements, and provides for unforeseen developments. The British delegates were, therefore, instructed not to accept the principle of general intercommunication unless it were qualified by the power of exemption. A declaration to this effect was made by them at the first meeting of the conference, and their requirements were met by the insertion of Articles 2 and 3 of the final protocol, whose purport has been indicated above. Certain countries which had strongly supported the principle of intercommunication without any exception inserted a declaration that they did not propose to avail themselves of this power. The committee consider that there is no foundation for the suggestion that this renunciation on the part of some countries affects the utility of the provision for those countries which may wish to avail themselves of it. There is no provision in the convention making it obligatory on the Government to provide a second station for general public correspondence alongside a naval station. This is only made obligatory when a commercial station is exempted and, therefore, withdrawn from general public correspondence; whilst it rests in the power of the Admiralty, if they deem it desirable, to allow a naval station under certain conditions to carry on commercial correspondence. (*e*) Stringent regulations have been drawn up, together with provisions for their enforcement, to the satisfaction of the Admiralty for the purpose of securing effective control over the general transmission of messages to or from stations in British territory, and of preventing interference and confusion. The regulations which were proposed by the British delegates to meet this object, and which had been carefully drawn up in accordance with the views of the Admiralty, were accepted by the conference without any material alteration. (*f*) One essential consideration from the Imperial point of view is that as many as possible of the shore stations of the world should be on British territory, and, therefore, able to be brought, in times of emergency, under the control of the British Government. Much evidence was presented to the committee as to the probable effect of the convention from this point of view. It appears to the committee that if shore stations on British territory are rendered freely available for communication with the ships of all countries, without restriction as to the system employed, the natural advantages arising from the geographical position of the British Islands and various British possessions will draw traffic to British stations, and will provide a commercial inducement for the erection of such stations. If, on the other hand, a policy of non-intercommunication is supported, and foreign ships wishing to communicate with British stations are required to comply with unacceptable conditions, there will be a direct and powerful motive for the erection of stations on foreign territory. (*g*) If Great Britain adheres to the convention, in war time she would derive benefits from having all wireless telegraph stations on her shores, at home and abroad, available for communicating with any one of her ships (whether naval or mercantile marine) at will, independently of the systems in use, and the commercial ships would be in a state of organisation which would allow of their being used for naval purposes if required. It is to Great Britain's advantage to increase the development of wireless telegraphy for commercial purposes so as to be able to utilise her large mercantile marine as sources of information for naval requirements in war time. (*h*) The reservation of the use of wave-lengths between 600m. and 1,600m. for naval purposes. This was considered of importance by the Admiralty. It does not mean that the

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navy cannot use wave-lengths below 600m. or above 1,600m., but leaves this range free from interference by commercial installations. (*i*) A period of nearly two years was reserved before the convention was to come into force. This gives the Government, and especially the Admiralty, time to consider and decide on which stations are to be exempted, and where others are considered necessary in substitution, and to take such steps as may be required. (*j*) In time of war or national emergency, all or any wireless stations on British territory can be occupied or closed at the discretion of the Government, stringent powers in this respect being contained in every licence granted by the Postmaster-General. Articles 7 and 8 of the St. Petersburg Convention, which are applied to wireless telegraphy by Article 17 of the present convention, give international sanction, so far as it is required, to such action.

Commercial Interests.

45. Approaching the question from the point of view of British commercial interests, there can be no doubt that the freest utilisation of wireless telegraphy is to the general interest of commerce and of the mercantile marine. It would be a manifest advantage for commercial purposes that every British ship, fitted with any form of existing apparatus, should be able to communicate freely with the greatest number of other ships and land stations throughout the world. Evidence was laid before the committee giving conspicuous illustrations of the commercial inconvenience, due to the exclusive conditions attaching to the use of Marconi apparatus. The Royal Mail Steam Packet Company's ships are fitted with De Forest apparatus, which enables them to communicate on their line of services from the River Plate to New York with that and other systems established along these coasts, but on entering the English Channel, where only Marconi stations are established, these ships are refused communication. On the other hand, if these steamers were fitted with Marconi apparatus they would then be debarred from communicating with the stations along the line of service mentioned above, and even with other ships of their own line fitted with the De Forest apparatus. The convention removes this obstacle to intercommunication, a result which can only be attained by international agreement. The convention expressly provides by Article 9 that "radio-telegraph stations are bound to accept with absolute priority calls of distress from ships, to answer such calls with similar priority, and to take the necessary steps with regard to them." It is clearly desirable, in the interests of humanity, that such an obligation should apply to all stations without exception, and it is, therefore, made binding upon all stations, whether naval or other.

46. Lloyd's is an institution financially interested in no particular wireless company, but directly concerned in the welfare of the British mercantile marine. In the matter of wireless telegraphy, regarded from its commercial side, the evidence of Lloyd's is entitled to consideration, and the committee have been impressed by the support which that corporation gives to the convention. In this matter the interests of Lloyd's would naturally be identical with British commercial interests as a whole.

47. Ship-and-shore communication is essentially an international matter commercially, and its development has reached a stage at which international agreement becomes indispensable, as in the case of the postal and telegraph services. As the use of wireless telegraphy becomes more widely spread, its importance to our mercantile marine can hardly be overestimated. It follows, therefore, that any artificial restrictions imposed in the interests of any particular company are to the detriment of commercial and mercantile interests. Under the present system controlled by the Marconi Company, which prohibits intercommunication with other systems, a large and increasing number of ships and stations, using other systems, are excluded from the advantages of intercommunication. There is little room for doubt that free intercommunication (properly safeguarded) and international control will, at an early date, become inevitable. It is clear from the evidence that if Great Britain refuses to ratify, the convention will be ratified by the other Powers notwithstanding, and that Great Britain would subsequently be constrained to come into the convention, possibly under much less favourable terms. Among other points secured by the British delegates in favour of commercial interests may be mentioned: (*a*) Regulation XXXIX. provides that arrangements are to be facilitated "for communicating to maritime news agencies information respecting wrecks and shipping casualties, or of general interest for purposes of negotiation." This specially affect Lloyd's, who have already arranged for reports of casualties and other maritime intelligence from foreign wireless stations to be forwarded to them. If Great Britain declines to ratify, foreign Governments may, by way of retaliation, decline to supply Lloyd's with maritime intelligence, and may possibly also cancel the privileges granted to Lloyd's at foreign semaphore stations, which have been of great advantage to shipowners, consignees, charterers, and all interested in ships and cargoes. (*b*) Omission of the draft article which sought to require all adhering countries to "boycott" systems refusing to intercommunicate. (*c*) The arbitration article was rendered optional instead of compulsory. This alteration was important and desirable in view of the complicated and delicate nature of the questions on which arbitration might be invoked.

Position of the Marconi Company.

48. The above paragraphs deal with radio-telegraphy as a matter of national and international concern. It remains for the committee to touch upon a subsidiary matter, but one that requires consideration—namely, the position of the Marconi Company. The Marconi Company, the only opponents to the convention who have appeared before the committee, cannot be regarded as having any claim to a monopoly of wireless telegraphy, although, under present conditions, they have secured what amounts to something approaching a monopoly in respect of Great Britain, Italy, and Canada. As regards Great Britain, the position is due to the fact that for various reasons, and pending a settlement of the policy to be finally adopted, the Postmaster-General has hitherto refrained from issuing licences for competing stations on the South Coast of England and Ireland. Had the Marconi system been the only one in existence, there would still have been necessity for regulations for the proper working of the system through inter-governmental control; but this necessity becomes accentuated by the existence of other systems with stations working throughout the world. As evidence of the fact that free competition even in the crowded waters of the English Channel was contemplated, Clause 3 (1) and (2) in the Post Office-Marconi agreement of 1904 (inserted at the instance of the company) stipulated that if the Post Office licensed stations at which any system of wireless telegraphy, other than the Marconi system, is installed, every licence or permission granted by the Government should contain "suitable conditions with the object of securing non-interference with other wireless telegraph stations"; "provided that such conditions shall not unreasonably require the companies to change the position of any station, or to make any change in apparatus or arrangements which have already been adopted by them *bonâ fide* for the purpose of communication, and which for the purposes of each station are in conformity with the best and most efficient methods at their disposal for preventing interference. The companies shall, in any case, work their stations, as far as possible, so as not to interfere with the working of other stations." This agreement of 1904 between the Postmaster-General and the Marconi Company conferred upon the company certain rights, privileges, and advantages, and contained the following: Clause 10—"In the event of his Majesty's Government adhering for the United Kingdom to a convention based substantially on the stipulations contained in the protocol of the recent Berlin Conference on Wireless Telegraphy, the companies undertake, if required by the Government, to observe in the United Kingdom and on British ships the provisions (except Article 6) of the convention, and of any detailed regulations made thereunder for carrying these provisions into effect, and in particular, and without prejudice to the generality of the foregoing undertaking, the companies undertake, if required by the Government, in relation to shore stations in the United Kingdom and ships equipped with Marconi apparatus for ship and shore messages, to accept (without prejudice to the patent rights) the obligation to interchange messages with ships and shore stations in the United Kingdom respectively, equipped with other apparatus, and to relieve the Admiralty and Lloyd's, and all other persons with whom the companies have contracted, from any obligation arising under their contracts to refuse to interchange messages with ship or shore stations in the United Kingdom so equipped, or to make any compensation in respect of the interchange of such messages." The Marconi Company propose to make use of the words "without prejudice to their patent rights" in order to evade the obligation to intercommunicate which the above clause places upon them. The Marconi Company contend that an obligation of compulsory intercommunication between different systems under an international convention must result in an infringement of their patent rights, and, therefore, that the expression in the Post Office agreement, "without prejudice to their patent rights," continues to put the company in a superior position throughout the period of the agreement to any arrangement, international or otherwise, involving intercommunication that may during that period be brought into force. This contention may or may not be found sound in a court of law, and the committee feel precluded, therefore, from expressing any opinion upon it, but it appears obviously inconsistent with the intention of the parties when making the agreement. The wording of the clause referred to clearly indicates the desire of the Post Office to contemplate an international convention, and seems to dispose of the contention that an international convention would be a reversal of a policy which the Marconi Company must have contemplated at the time of signing the agreement. If this intention was in the minds of the Marconi Company when they negotiated the agreement, it would appear to be open to grave criticism, in that they are now endeavouring

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to evade the main condition which led the Postmaster-General to enter into an agreement granting them advantages which they have enjoyed, still enjoy, and propose to retain.

49. There appears to be little doubt, from the evidence placed before the committee, that even if Great Britain declines to ratify the convention the other Powers will do so. Assuming that the Marconi Company maintained the policy of non-intercommunication, the result would be that, under Articles 1, 2, and 3 of the convention, Marconi apparatus would have to be removed from all ships and stations belonging to signatory nations, thus seriously diminishing the scope and effectiveness of the Marconi organisation on which the company lay so much stress. On the other hand, if Great Britain were to ratify, and if, as a consequence, the company abandoned the policy of non-intercommunication, there would be no necessity for this removal. Once intercommunication is assured, other British steamship lines which have not hitherto adopted wireless telegraphy will, it may be anticipated, find it to their advantage to do so, and there is no reason why the apparatus employed should not be Marconi. In any event, whether ships are equipped with Marconi or other apparatus, the existing Marconi shore stations under the convention should, and no doubt would, in consequence of their advantageous geographical position and under the conditions of intercommunication established, receive a greater volume of business. It may be pointed out also that the Marconi Company will receive until 1911 an additional rate for messages interchanged with other systems, "such additional rate not to exceed the rate allocated to the shore stations." (Clauses 10, 11. Agreement, Marconi and Postmaster-General, 1904.)

50. In reviewing the relations of the Government with the Marconi Company, two points stand out especially clear in the light of subsequent events: (1) if, at the time when the Post Office were giving to Mr. Marconi effective assistance, the Government had thought it expedient to secure a right of pre-emption of his invention and patents, an enterprise of national importance would have been prevented from passing into the hands of a private company, and subsequent difficulties might have been avoided; (2) the fact, to which reference has already been made, that the Post Office has largely refrained from issuing licences to other companies, has given the Marconi Company something approaching a monopoly during an important period, and may, therefore, have encouraged their dreams of a general monopoly.

51. Whilst the committee consider that the Marconi Company have exaggerated the case against ratification, under the apprehension that they will suffer commercial injury by the operation of the convention, the committee would be very reluctant to make any recommendation which would impede or be injurious to the fair working of their business. They recognise the valuable work which has been done by the Marconi Company as the pioneers of practical wireless telegraphy, and this work is fully appreciated by the nation. From the evidence placed before them, the committee see no reason to apprehend that the obligations of the convention, if faithfully carried out by all concerned, will prove injurious to the Marconi Company. If, on the other hand, it is found by practical experience that the Marconi Company are injuriously affected, the committee recommend that they should be treated with a generous consideration quite irrespective of and without prejudice to their legal position. In all cases of legislation in the public interest, and where damage can be shown to accrue to private interests, something in the nature of compensation is and should be granted. In this case, as already stated, the committee are not of the opinion that the Marconi Company can found an equitable claim upon the terms of their agreement with the Post Office. But in view of the particular circumstances of the case, the committee recommend that, provided the Marconi Company loyally co-operate in carrying the convention and the policy which it represents, and in the event of it being shown, under proper conditions of audit, that the Marconi Company during the transition period under the new conditions brought about by the convention have suffered diminution of business at their British stations, they should be granted compensation for a period of three years from the day of the convention coming into operation—and that the compensation should be based upon a comparison with the average annual net traffic receipts from their British stations during the three years preceding ratification.

General Observation.

52. This being the analysis of the evidence, the committee proceeds to conclusions. There appear to be three alternatives open to Great Britain: ratification, rejection, postponement. It may be convenient to dispose of the two latter first.

Rejection.—Rejection would seem to be the more obvious alternative to ratification. The only evidence in favour of rejection was that of Mr. Cuthbert Hall, general manager of the Marconi Company; of Prof. Fleming, scientific adviser of the Marconi Company; of Mr. Henniker Heaton; and, with much less intensity, of Mr. Marconi. An examination of the statement of these witnesses shows that their arguments were based mainly on a consideration of the interests of the company. Rejection would seem to the committee to involve the following results: (*a*) Great Britain took a prominent part in the conference, and the convention was modified in many important respects in order to meet her wishes and secure her adherence. If Great Britain now refuses to ratify, doubt will be thrown upon the sincerity of her expressed views at the conference. The contrast between the attitude of the British Government at the time of the conference and its attitude in refusing to ratify, would be emphasised by the fact that the next conference was invited to meet in London. (*b*) It would create a direct and powerful motive for the erection of stations on foreign territory; and such stations will be in no way subject to British control in time of war or emergency. (*c*) Foreign ships and coast stations would seriously interfere with British stations. Such interference would arise from the normal operations of ships in the Channel and elsewhere communicating with distant stations on foreign coasts. Not only would other nations be forced to erect additional shore stations, but these stations and the ship stations as well would be obliged to use additional energy. This natural interference might probably be increased by intentional action, and, without the convention, British stations would have no remedy. (*d*) In the absence of international arrangements and rules for working, accounts, collection of charges, etc., the development of the service would be seriously embarrassed. (*e*) The drawbacks indicated in the three previous heads would be specially detrimental to Great Britain, owing to the predominance of her maritime interests and her geographical position. (*f*) Under the terms of the convention, the nations adhering are bound to refuse to license, on board a ship or at shore, stations the apparatus of any system which declines to accept the principle of intercommunication. If Great Britain, therefore, refuses to ratify, the Marconi apparatus at present installed at foreign shore or ship stations will be removed, and its place will be taken by some system that accepts intercommunication.

53. *Postponement.*—No evidence was given to your committee in favour of postponement as distinguished from non-ratification. It may be pointed out that postponement would in no way diminish any of the unfortunate results which would follow on rejection, while it would be attended by the grave additional result that the action of Great Britain might be open to much misconception in regard to the position she took up at the conference, through which important concessions were obtained by her delegates. Further, it would prolong a period of uncertainty, without securing any conditions by which the future would be determined. No evidence has been brought before the committee to show that within any specified time the scientific aspects of the question will undergo any substantial alteration of a kind which, in the committee's opinion, is not already amply provided for and protected by the various provisions of the convention. Moreover, the convention would, it is assumed, be brought into operation without reference to Great Britain. Great Britain, having such a predominant interest in the question, ought to be in a position to make her influence felt from the start in interpreting, administering, and enforcing the terms of the convention. The fact that by 12 months' notice Great Britain can at any time withdraw from the convention if it is found that British interests are in any way jeopardised, appears to secure all necessary liberty of action, especially during the experimental period. It appears to the committee, therefore, that, from the point of view of national and public interests, rejection presents serious drawbacks, and that postponement is even less defensible.

54. *Ratification.*—These alternatives being disposed of, the committee proceed to set out the effect of the adhesion of this country to the convention. Many of the advantages attending ratification have been stated in the body of the report. The principal of those advantages may be summarised as follows: The primary object of the convention is to facilitate and promote the use of wireless telegraphy, especially for maritime purposes, a matter essentially of an international character and, having regard to her predominant maritime interests, of high importance and benefit to this country: (1) the convention facilitates the use of wireless telegraphy by providing international arrangements for rules of working, control, licensing of operators, efficiency of apparatus, collection of charges, transmission of messages, publication of information, etc.; (2) the convention provides the means of preventing confusion and of avoiding interference between neighbouring ship or shore stations, a result increasingly difficult or impossible of attainment except by international agreement; (3) the convention secures general freedom of communication between ships and coast stations, thus giving British ships fitted with any form of apparatus the advantage of being able to communicate freely with the greatest number of other ships and land stations throughout the world; (4) the freedom of communication thus secured, and the protection from interference thus afforded, will give free play to all systems, and will thus tend to the encouragement and progress of invention in connection with wireless telegraphy. These advantages, important though they be, are secondary to the supreme consideration of naval interests and national defence. The unanimous evidence of witnesses

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representing and speaking on behalf of the Admiralty and War Office is conclusive that the convention (now framed largely on the initiative of the British delegates) obviates injury and secures substantial advantages not otherwise attainable. Among these advantages are the following: (*a*) A general obligation is imposed on all stations not to interfere with the working of other stations. (*b*) Exempted stations are allowed and given international sanction. Certain wave-lengths are reserved for naval use, so as to be absolutely free from interference by commercial stations. (*c*) International sanction is obtained for such censorship arrangements as may be necessary. (*d*) The effect of the convention, if adhered to by Great Britain, would be directly to encourage the erection of stations at suitable points in British territory, and the general development of the use of wireless telegraphy in the British mercantile marine, thus providing a widely extended system over which the Admiralty would have control in time of emergency. (*e*) It may be added that the convention has been framed with careful regard to the interests of his Majesty's dominions beyond the seas, the several Colonies and India being able to adhere and withdraw separately, as may appear to them expedient; and the means of adequate representation at future conferences has been obtained for such colonies or dependencies as may subsequently adhere. (*f*) Finally, the fact may be emphasised that at any time, if she finds the convention to be in any way detrimental to her interests, Great Britain, by giving a year's notice, may retire from the convention. Meanwhile, if she ratifies, no alteration to her detriment can be made in the convention without her consent; and it has been already explained that the bureau has no initiative or executive powers of any description. (*g*) Some apprehension has been expressed that the convention may have the effect of impeding the progress of scientific invention. The committee are of opinion that it will not have any such effect; but if, contrary to their expectations, it should be found in practice that any of the regulations have the result of discouraging invention, they recommend that steps should be taken to obtain such amendments as may be necessary in order to avoid that result; and it may be borne in mind that, in the last resort, Great Britain would be able to take advantage of Article 22, and withdraw from the convention.

55. In view of the foregoing considerations it is manifest that universal free intercommunication, with the exceptions and exemptions secured in the convention, is a principle to be aimed at, and one that must be of benefit both nationally and internationally. A careful perusal of the *proces verbaux* will show that the representations of the British delegation for amendments and modifications of the draft convention were met in the most considerate manner by the conference. In all essential points the convention now conforms to the conditions laid down by the Government with the view of securing national interests. The committee, in conclusion, desire specially to lay stress upon the observation that if, after the substantial changes made on the initiative of the British delegates, Great Britain refuses to ratify, the result might have a material effect in weakening the moral position of Great Britain at future international conferences.

56. The committee have set out these arguments and considerations in elaborate detail because they interpret the reference to them to mean that their report is intended by the Government to be an important factor in the final action which it may take, and they have, in consequence, given fully the grounds on which they now base their conclusion and report.

57. The committee, therefore, report that, in their opinion, the effect of the adhesion of this country to the convention would be advantageous to national and public interests, and that its non-adhesion would be detrimental to those interests.

58. The committee further venture to recommend that, if, in accordance with this report, it is decided to ratify the convention, the Government should endeavour to arrange for simultaneous ratification by the principal countries who composed the conference. This would prevent the necessity for exceptional and provisional arrangements in the contingency of other countries not ratifying, and would be in accord with the spirit of international amity which marked the proceedings of the conference.

BOLT BOXES FOR CONCRETE FOUNDATION BEDS.

BY S. L.

In laying down concrete foundations for heavy machinery the holding-down bolts are usually grouted in after the machine has been set up in position. Wooden boxes are mostly used for keeping the bolt holes clear during the building up of the bed, the boxes being tapered slightly (usually, about 1 in 70) to facilitate drawing out.

Sufficient attention is not always paid to the design and preparation of these boxes, with the result that considerable trouble is often experienced, to say nothing of time wasted, in withdrawing the boxes. In the accompanying sketches Fig. 1 shows the type of box commonly used; Fig. 2 is a much better design. It is obvious that the construction of the latter renders it far easier of withdrawal than that of Fig. 1. After prising in one of the sides, the rest of the box easily collapses, and is readily withdrawn. Although spruce boards are oftener used, a box built up of deal (pine), without any shakes, makes a sounder job. It is better to use as few nails as possible in building up. French oval wire are best, just sufficient to hold the sides together and withstand knocking about.

To prevent the boxes from adhering too intimately to the surrounding concrete, the exterior of the box sides are sometimes given a coat of soft-soap or tallow, and there are a good few compounds, having highfalutin names, on the market which are specially recommended for this purpose. Another method is to ease the boxes

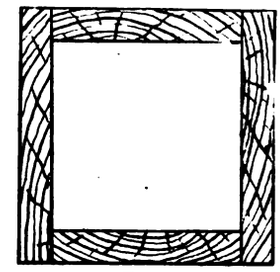

FIG. 1.

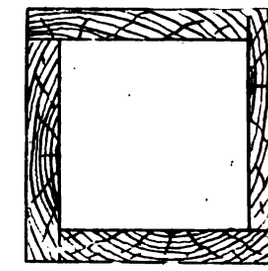

FIG. 2.

slightly each day during the building up of the bed of concrete.

POOR ENGINEERS!

Readers, come gather, in mood sympathetical,
Since this recital will move you to tears;
This is the theme, and the thread, of my story—
Pity the sorrows of poor engineers!

We have contended, and not unavailingly,
Fought with gas-mantles for years upon years;
Now our own scientists turn round and rend us—
Pity the sorrows of poor engineers!

Oh, how we wrestled with matters commercial,
Argued with customers long in arrears;
Now we are faced with a fate cataclysmal—
Pity the sorrows of poor engineers!

Now they are dealing with points of efficiency,
Filling our bosoms with nebulous fears;
Making new lamps with appalling celerity—
Pity the sorrows of poor engineers!

We, when they first made a glow lamp with osmium,
Welcomed its coming with modified cheers;
But now they are *pouring* new filaments on us—
Pity the sorrows of poor engineers!

Every fresh journal the Post Office brings to us,
Ghoulishly gloats o'er each lamp that appears;
Destined still further to cut down our output—
Pity the sorrows of poor engineers!

Osmium, tantalum, nitrate of strontium;
All the gas managers greet us with jeers—
Wolfram, zirconium, nothing seems safe from them—
Pity the sorrows of poor engineers!

Osram, iridium, tungsten, niobium,
Now can you wonder we quake with our fears?
Graphitised filaments, mercury-vapour lamps—
Pity the sorrows of poor engineers!

What in the world is the industry coming to?
Where is our load, when our load disappears?
Where can we make the connections to save us?
Pity the sorrows of poor engineers!

G. BASIL BARHAM.

[This wail reminds us of the cry of a few gas engineers when the incandescent gas mantle was first introduced. The new electric lamps are welcomed by most engineers.—ED., *E. E.*]

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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BUSINESS IN RADIO-TELEGRAPHY.

The further extracts published this week from the report of the Parliamentary Committee on the Radio-Telegraphic Convention deal with the business side of the subject. A quotation from Oliver Goldsmith's "Vicar of Wakefield" is not inappropriate to the present state of affairs: "I was ever of opinion that the honest man who married and brought up a large family did more service than he who continued single and only talked of population." There will yet be many legal battles over the patent rights of the inventors of wireless telegraphic apparatus which may or may not settle the question of the priority of Marconi's invention over those of others, but there can be no dispute as to who has done most from the business point of view. The Marconi Company has by a happy combination of inventive skill and commercial acumen secured the business of supplying the Admiralty, Lloyd's, and all the large shipping companies, and has agreements with them for terms of years. But for this business success there would have been no Radio-Telegraphic Convention, and no keenness on the part of Germany to adopt the "large family" reared on this side of the channel. We hear much of what the other systems of wireless telegraphy can do, but very little of any systematic business carried out. It is idle for these rivals to complain that they are hampered by the agreements made between the Marconi Company and the steamship companies, unless they can show that the service given is inadequate. We see no evidence as to this in the report before us. In fact, the business success of this company induced four out of nine members of the Parliamentary Committee to sign a minority report, in which the following clauses appear: "In conclusion, the committee wish to reiterate their belief that it is at present premature to attempt to control wireless telegraphy by international regulations. At the same time they recognise the undoubted advantages of general intercommunication, and hope to see these reaped at a later period, without having to destroy or injure existing and efficient organisations, and without hampering the development of a science manifestly still in its infancy. The committee have no objection to the principle of international control, but feel that it is at present too early to effect it, and in the meantime believe that free competition (under the full control of the Government) is more in consonance with British ideas and more likely to bring about a right and lasting solution of the whole problem. The committee, therefore, recommend that the Government, whilst expressing its willingness to consider the adoption of any rules for the international working of wireless telegraphy which experience may have shown to be essential, should avail itself of Article 16 of the convention, and postpone ratification until after the conference of 1911, or until such time as the scope and ultimate character of wireless telegraphy are more clearly established and sufficiently stereotyped to make international control both feasible and desirable." Reverting to our opening quotation, we do not want German husbands for the "large family," and even a Radical committee has recognised this by the narrow majority by which ratification of the convention was recommended.

ABERDEEN ELECTRICITY ACCOUNTS.

A short time ago we commented upon the report of Mr. J. A. Bell to his committee dealing with explosions. The statement of accounts of the electricity works for the past year has just been issued, and with it is another short report of Mr. Bell's which has been presented to the Gas and Electricity Committee. This report is a kind of

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interpretation of the accounts; the addition, however, of tabular details to the report gives it a much greater and wider interest. At Aberdeen supply commenced in March, 1894, so that the undertaking has been in operation for thirteen years—a period of time sufficient for the work to get into a fairly normal condition. We have always been strenuously antagonistic to the sly, vapid, and deliberate misleading criticisms which are founded upon the expenditure and working of these municipal undertakings during the first three or four years of their existence. Mr. Bell's tabular statement, leaving out the first ten months' work, shows that during the year 1895 the total units generated were 159,777, of which 138,372 units were sold; the interesting feature here being that the generation per unit sold required 10·64lb. of coal or other fuel. Now see the difference in the last completed year, when 5,540,120 units were generated and 4,794,507 units sold; each unit sold in the latter case required only 4·87lb. of coal or other fuel. In fact, as would be naturally supposed, with the increased number of units a far greater efficiency has been obtained, and the coal per unit at the latter time is less than half of what it was at the former time When we come to consider the cost of fuel per unit sold, we encounter greater difficulties in comparison, because it is impossible to record the various fluctuations in prices. Whatever these fluctuations may have been, we may just note that in the first year above referred to the cost of fuel per unit was ·33d., while during the last year it was ·27d. A few years ago—in 1901, to be exact—the cost reached to as much as ·73d. A still more interesting point, as showing the absolutely misleading views if based on too early working, is found in the wages cost per unit. In 1895, with the smaller output, this was ·46d. per unit, while in 1907 it had fallen to ·09d. per unit. Taking the total works costs per unit at the two periods, these were respectively 1 30d. and ·51d., and it is singular, perhaps, to some critics to notice that of this amount "repairs and maintenance" during the early year amounted to ·42d. per unit, and this in the later year had decreased to ·13d. per unit. Most of these figures are of a natural order, easily understood, but wilfully misrepresented by those who can see no good in municipal work. Taking the total costs (including not only works costs, but also rent, rates, salaries, etc.), the respective figures are 2 36d. per unit and ·84d. per unit. At the same time, total revenue has decreased from 6·26d. to 2·02d. per unit. The details of the division of the balance after total costs are taken from total revenue is very interesting, and we would commend the study of the Aberdeen figures to those anti-municipalists who found their conclusions upon one case, such as St. Marylebone. Aberdeen in 1895 used its surplus per unit thus: sinking fund, ·83d.; interest, 1·24d.; depreciation, ·11d.; reserve, ——. In 1907 the figures per unit are: sinking fund, ·27d.; interest, ·41d.; depreciation, ·40d.; reserve, ·10d. Aberdeen is to be congratulated upon its responsible officer, whose energy and assiduity so largely contributes to the excellent results obtained.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

FIRE PROTECTION IN FACTORIES.

SIR,—With reference to the letter of "W. H. T." appearing in the columns of your issue of Sept. 6, I presume your correspondent refers to "first aid" apparatus, and that the local fire brigade would not be long ere they arrive. There is no doubt that portable hand fire pumps are very useful appliances for coping with fires in their early stages, and by placing a number of them in readily accessible positions about the factory buildings, available for instant action, a fire could in all probability be extinguished, or at any rate be kept in check pending the arrival of the fire brigade. These portable appliances have the advantage that their working is readily understood, so that lads, girls, or other inexperienced persons would not hesitate to use them. They are more reliable than chemical extinguishers, which have been known to fail at the critical moment. If each hand pump is equipped with two or three buckets, it can be replenished with water and kept at work continuously. There are numerous instances of fires, which might otherwise have assumed alarming proportions, being extinguished at the outset by means of these handy appliances—in fact, in one year out of 4,199 fires in London no less than 2,540 were put out with the London Brigade hand pump.

Of course, prompt action is everything when fires have to be dealt with, and a good course to be followed is for the employés to have periodical drills with the fire appliances, by which means they are rendered more familiar with their working, and will be more liable to act with resource, judgment, and rapidity in the event of an actual fire occurring. The firm of Merryweather send out trained inspectors to give drills of this description, and the advantages of this system have been proved in many instances where fires have taken place.—Yours, etc.,

H. S.

RE QUESTION 992.

SIR,—I cannot agree with "A. I." saying it is highly improbable that the machines would run together for such a short time. The prime mover being a turbine, one would be perfectly justified in saying that the alternator is one of modern design—*i.e*, with revolving field and stationary armature of low resistance and high reactance. Now, the back E.M.F. or E.M.F. of self-induction would prevent currents of the magnitude flowing estimated by "A. I."

I have known two 7,000-volt, 500-kw., three-phase star-connected machines to work under similar conditions for a longer period than that stated in the question without disastrous results. The field current was brought up to its normal and then switched on without operating the circuit breaker, which was set for 100 per cent. overload.—Yours, etc.,

M.

SUMPNER ALTERNATE-CURRENT INSTRUMENTS.

When chairman of the Birmingham Local Section of the Institution of Electrical Engineers in 1904, Dr. W. E. Sumpner chose as the subject of his address "The Use of Iron in Alternate-Current Instruments." He then described several new forms of measuring instruments designed with liberal proportions of iron. These have since been perfected, and are now being manufactured by the General Electric Company at Manchester. The list of this instrument about to be issued describes wattmeters, voltmeters, power-factor indicators, etc., of the Sumpner type, and gives a great deal of information as to their connections and usage. The general principles underlying the construction of the wattmeter will be found in the address above referred to, which appeared in our issues for Dec. 2, 9, and 16, 1904. The instruments are of the moving-coil type, and the iron circuit is shunt wound. This ensures that the flux in the air-gap is proportional to the voltage of the circuits. A quadrature transformer is then used to supply the moving coil with current proportional to the current in the circuit in which the power is to be measured. A strong field is used with this type of instrument, which gives them many advantages over wattmeters of the dynamometer type, where the forces are extremely small. The sensitiveness thus secured makes it possible to use a strong spring to control the deflection of the moving-coil system, whilst external magnetic fields have no influence on the readings. Iron-cored electromagnets have previously been tried in such instruments, but, as is well known, the effects arising from varying permeability and hysteresis in the core have rendered such instruments inaccurate. By taking advantage of the properties of the shunt magnet, Dr. Sumpner has shown how to use iron in such a way that variations in the magnetic reluctance of the core do not

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affect the accuracy of the instrument readings. The magnetism of the shunt magnet is caused and controlled by the applied voltage, and the relationship between the two is not affected by any change in the reluctance of the magnetic circuit when certain conditions are fulfilled. A change in the magnetic reluctance affects the ratio of the magnetism to the magnetising current, but does not alter the relationship of the magnetism to the magnetising voltage, provided that the resistance of the windings is so small that the product of this resistance and the magnetising current is a negligible fraction of the whole voltage applied to the coil

FIG. 1.—The Sumpner Portable Wattmeter and Voltmeter.

The wattmeters are made by the General Electric Company in two patterns—*i.e.*, switchboard type and portable type—and by a suitable arrangement of switches, etc., either the switchboard or portable standard type can be used as an idle current ammeter or as a voltmeter. The portable standard form of instrument (Fig. 1) has been designed for general experimental purposes. It is provided with two scales, one for volts and the other for watts Normally, it can be used as a voltmeter having two ranges, or as a wattmeter having two ranges for volts and three ranges for amperes. The switching arrangements provided are such that the moving coil can be connected up to any condenser, transformer, or other device for some special experimental purpose. One of the scales supplied will apply to the measurements made if the correct constant be ascertained in each case. When wide ranges of power have to be measured experimentally, the same instrument will serve if a series of transformers of different transforming ratios are obtained. In fact, this type of instrument is as adaptable for alternate currents as the well-known moving-coil instruments are for direct-current working.

Fig. 2 shows one of the Sumpner quadrature transformers, which is like an ordinary transformer with an air-gap. Fig. 3 gives the connections when measuring

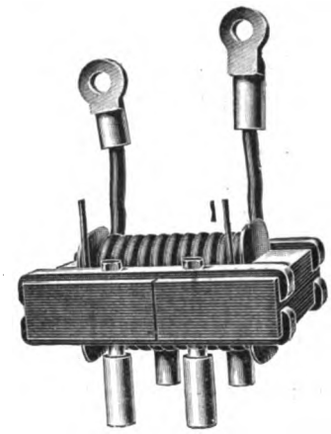

FIG. 2.—Sumpner Quadrature Transformer.

three-phase currents with balanced loads when neutral point is not available. The field coils are connected with

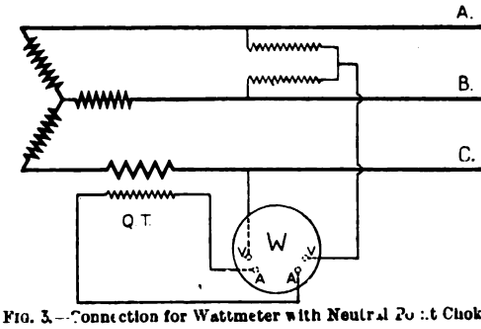

FIG. 3.—Connection for Wattmeter with Neutral Point Choker.

the mains through a specially designed choking coil. Thus the total power equals twice the wattmeter reading, or the instrument may be calibrated to indicate total power direct. For circuits above 600 volts a potential transformer is used to insulate the wattmeter entirely from the high-tension main.

The ease with which the wattmeter can be connected with or disconnected from the main circuit without disturbing the latter renders it suitable for a number of special purposes. For instance, the total output of a number of alternators in parallel may be measured by using one indicator and as many current transformers as there are alternators in parallel, connected as shown in Fig. 4. The summation wattmeter will read correctly whether a particular alternator is generating, or motoring, or out of circuit.

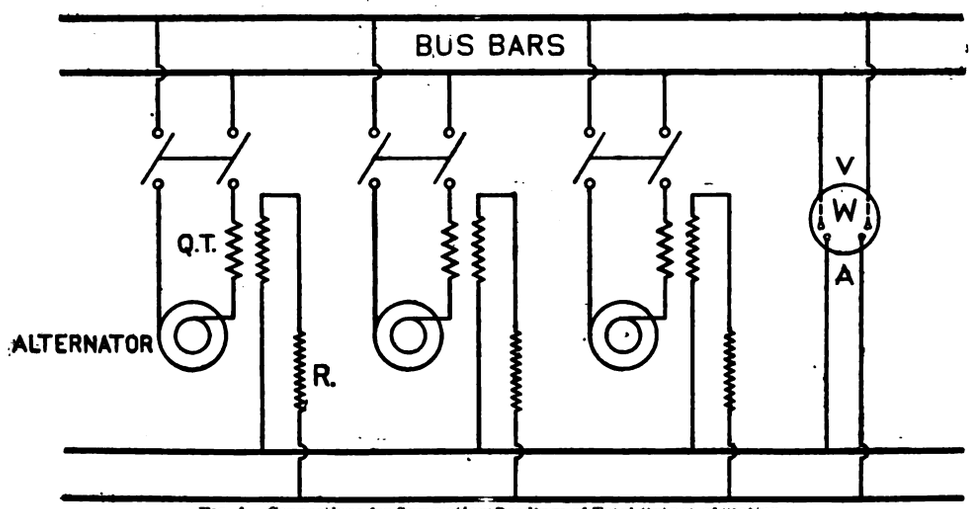

FIG. 4.—Connections for Summation Readings of Total Output of Station.

The power-factor meter (Fig. 5) consists of two parts, one of which is fixed and the other movable. The fixed part is formed of two laminated iron blocks excited by currents traversing a three-phase star-connected system of coils attached to the iron. The two iron masses are

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separated by a narrow annular air-gap in which the moving system can turn, and across which a strong magnetic field is produced by the currents traversing the fixed coils. The moving system is very light, consisting of a coil and pointer, the movement of which is not controlled by any forces except those due to the interaction of the currents. The position taken up by the coil depends solely on the phase relationship of the currents through the fixed coils to the moving-coil current, and the scale is calibrated so that the pointer indicates the power factor of the load to which the instrument is connected. The lightness of the moving-coil system, and the strength of the magnetic forces acting on it, renders the working of the instrument far more satisfactory than that of others for the same purpose.

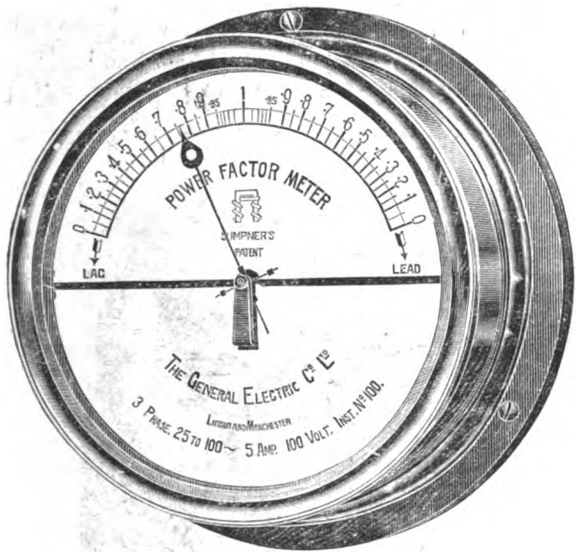

FIG. 5.—Sumpner Power Factor Indicator.

The General Electric Company are manufacturing these instruments in a number of standard forms.

BRITISH STANDARD SYSTEM OF LIMIT GAUGES FOR SCREW THREADS.

The Engineering Standards Committee have just issued their report (No. 38) which deals with the above subject. The Special Committee on Screw Threads and Limit Gauges issued in April, 1905, their report on standard screw threads. The committee's findings as to the limits to be allowed on plain cylindrical work have been published in their report on British standard systems for limit gauges (publication No. 27) issued in June, 1906, and their recommendations as to standard sizes and limits for

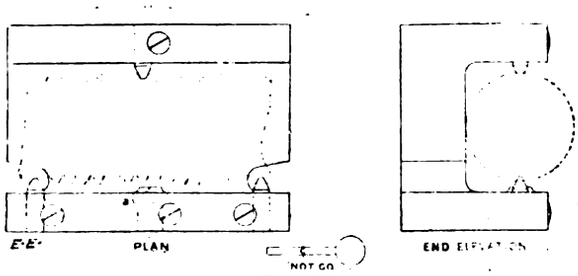

FIG. 1.

nuts, bolt heads, and spanners in their report (publication No. 28) issued in August, 1906. The present report deals only with the limits which the committee recommend for British standard screw threads from ¼in. to 3in. diameter inclusive in order to secure interchangeability and the degree of accuracy of fit which is practicable in ordinary work. The limits laid down apply to the two standard threads standardised by the committee in their report (No. 20)—viz.: (1) British standard Whitworth (B.S.W.) and (2) British standard fine (B.S.F.). The present report can be purchased for 1s. from the committee at 28, Victoria-street, S.W., and does not lend itself to condensation. The committee make no recommendations as to the methods to be employed for gauging the threads on bolts or in nuts. They have, however, examined and experimented with several types of gauges, and descriptions of gauges which it is possible to use effectively for this purpose are given in an appendix.

The Engineering Standards Committee have recently been presented by Mr. W. Taylor (of Messrs. Taylor, Taylor, and Hobson, Limited), a member of the sectional committee, with the rights covered by patent No. 6,900

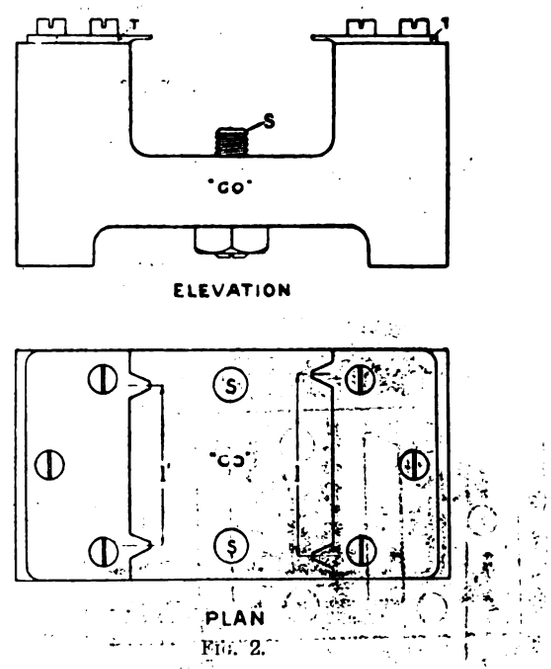

FIG. 2.

of 1905 for a method of gauging the pitch and effective diameter of a screw conjointly. This gift enables the public to make free use of the invention. A modification of the gauge designed by Mr. Taylor for simultaneously gauging pitch and effective diameter of bolts is described below, and the figures give the general appearance. The three conical points, accurately ground to an angle of 55deg., and truncated so as to clear the root of the thread, are distributed as follows: (1) two are fixed on the lower jaw of the gauge, so that the distance between them is an exact number of threads representing twice the length of screw contained in a standard nut of corresponding diameter; (2) the third is fixed on the upper jaw midway between the two points on the lower jaw, and the three points are set to a standard male gauge having correct pitch and the maximum effective diameter given. Opposite

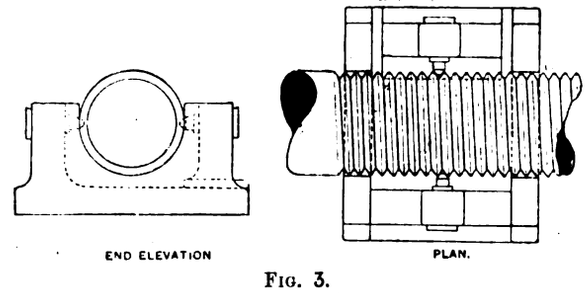

FIG. 3.

the single point is fixed the flat face, *a*, which is adjusted so that the small cylinder, *c* (of such a diameter that it will touch the thread about half-way down its depth), will just enter the thread of a bolt made to the minimum effective diameter. Then in testing, if the bolt enters the gauge, and the "not go" cylinder refuses to enter the thread, the bolt is within the limits for pitch and effective diameter laid down in the tables, while any error in pitch which may be present will be duly compensated by a reduction in the effective diameter.

Another form of gauge designed to deal with a shorter

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length of thread than the last is described below. Here the "go" and "not go" tests are applied by different gauges. Fig. 2 shows the "go" gauge, in which T—T are plate gauges of hardened steel, containing four truncated V teeth of 5deg. in angle, set as shown. The distance *l* represents an even number of threads immediately above the number contained in a length of screw equal to the nominal diameter of the bolt, while the distance *l'* is one pitch shorter. These plates are secured to a suitable base, and are set to a bolt of correct pitch and maximum effective diameter. S—S are screws which can be so adjusted that the measurement is carried out exactly in the axial plane. A snap gauge, such as that shown in Fig. 3, answers as a "not go" gauge, the cones being adjusted to a male gauge having the minimum effective diameter. By preference this "not go" gauge should be constructed so as to gauge only near the mean depth of the thread.

It may be mentioned that an ordinary screw ring gauge may be used instead of the "go" gauge described above, provided that such gauge has a length of thread equal to that in a standard nut, is of correct pitch, and has an effective diameter of the maximum dimensions allowable. The full and core diameters of such a gauge may be cleared away, if desired, so that the pitch and effective diameter are checked alone. The difficulty of determining the accuracy of such a gauge constitutes the chief objection to its use.

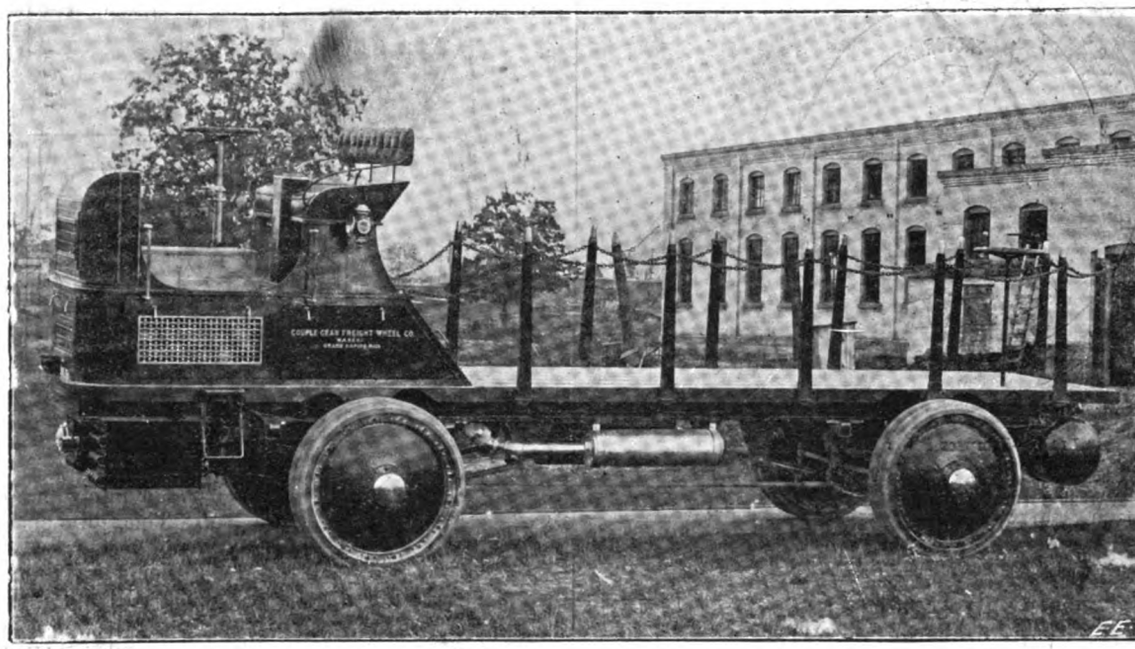

FIG. 1.—A Gasolene-Electric Truck at the Carnegie Solar Observatory.

CARNEGIE SOLAR OBSERVATORY GASOLENE-ELECTRIC TRUCK.

BY FRANK C. PERKINS.

The accompanying illustration shows a most unique and interesting gasolene-electric truck recently constructed for the Carnegie Solar Observatory by the Couple-Gear Freight-Wheel Company, of Grand Rapids, Michigan. The couple-gear electric truck without the gasolene engine equipment is provided with a storage battery, and four electric motors are provided, one in each wheel. In the couple-gear motor the single force of the armature is divided between two forces, which act in different directions, forming a couple, and relieving all thrust from the wheel bearings. The motor is within the wheel, and a pinion is on each end of the armature shaft, these pinions meshing with a double cog rack on the circumference of the wheel. The power is applied to both sides of the wheel through a single shaft bearing the two pinions which pull up on one side of the wheel and down on the other side, while an evener is provided on the armature shaft, which ensures an equal division of the work between the pinions.

The Carnegie Solar Observatory gasolene-electric truck has wheels 3ft. in diameter, all live, all driving, and all steering. A 40-h.p. gas-engine is utilised of the Continental four-cycle type directly connected to a direct-current Western Electric dynamo of 12 kw. capacity. The current from this electric generator is conducted directly to the wheel electric motors without the use of a storage battery, which is used only on the truck for exclusive electric drive without gasolene motor. An electric motor is provided in each wheel with a capacity of about 14 h.p., each motor developing a trifle over 3 h.p. They are so connected that the torque is equally divided, the shafts of the armatures, as above mentioned, being connected to both sides of the wheels, forcing upward the rear and downward the front side of the wheel when moving forward, and the reverse in driving backwards. The truck platform is 246in. long over all, and has a width of 79in. over the wheel hubs, while the width of the platform is 4ft. It is stated that the car is designed to carry a load of 10,000lb. up a grade of 10 per cent. at a speed of two miles per hour, the normal speed on the level being nine miles per hour. Electric as well as mechanical brakes are provided, and it is claimed that the steering from all four wheels enables the car to make the short turns on the winding trail up the mountain without the slightest difficulty. It is maintained that the couple gear delivers to the wheel 97 to 99 per cent. of the mechanical energy developed by the motor, showing a total loss for the gears and the wheel bearings of less than 3 per cent. The speed reduction is 25 per cent. without the aid of any countershafts, and the rear wheels may be locked and steering effected from the front wheels only if so desired. In the oblique steer the four wheels are all turned in the same direction. It is maintained that the truck can be turned around in a space of 23ft. without backing, the rear wheels following exactly in the track of the forward wheels, the same as on a straight course, and the steering can be done equally as well in either direction.

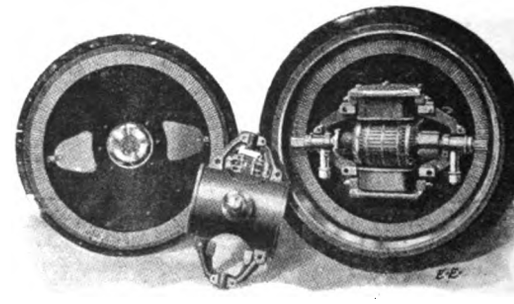

FIG. 2.—View of the Motor and Gearing.

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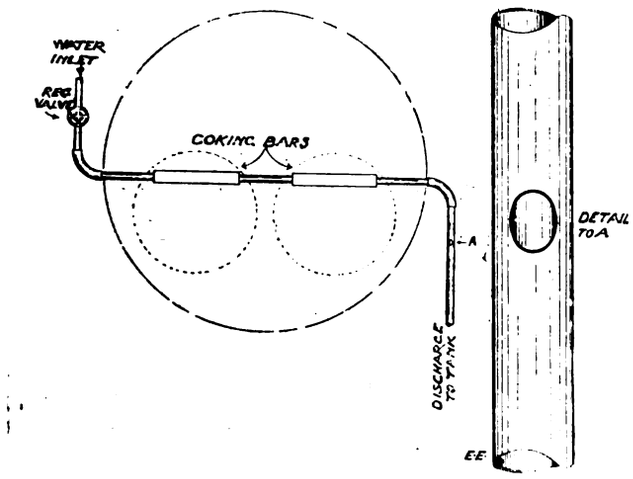
A USEFUL DEVICE FOR WATER-COOLED COKING BARS.

BY S. L.

In most types of coking stokers when applied to shell boilers the coking bar or plate used is a solid casting. Owing to the rapid deterioration of this type of bar, a special form of hollow casting is favoured by some makers. This is so arranged that when the boiler is under steam a stream of cold water is allowed to circulate through the bar, the outlet end of which, for economy's sake, should discharge into the boiler feed tank. As it is important that the circulation of water be not interrupted, the pipe at the outlet end of the bar usually dips into an open-ended pipe provided with a bellmouth, which communicates with the pipe to feed tank, thus providing the attendant with



a rough indication as to the supply of water. This method has one disadvantage—namely, the liability of the pipe to become stopped up due to small coal, ashes, etc, lodging in the pipe. Having experienced considerable trouble in this respect, the writer devised the arrangement which is shown in the accompanying sketch fitted to a Lancashire boiler. As will be seen on reference to sketch at A, this consists simply of a sight hole cut in the discharge pipe. The hole should be oval in shape, and cut out clean with a half-round file. If a more elaborate job is desired, a piece of glass tube could be slipped on the pipe so as to cover the hole, but the writer has found the former arrangement to give every satisfaction. Stopped-up pipes, which hitherto were of daily occurrence, are now things of the past.

LEADLESS-GLAZE INSULATORS.

Another discussion as to the merits of leadless glazes, and the possibility of them supplanting glazes which contain lead, in the manufacture of pottery, has been aroused by the answer given by the Postmaster-General in the House of Commons when Mr. Verney questioned him concerning what progress has been recently made towards the introduction of leadless-glazed ware in Post Office contracts. Mr Buxton's answer to the question was: "I am sorry that my experience with leadless-glazed insulators, which have been bought in large quantities for years, has not, so far, been altogether satisfactory Up to now, the glaze is so much inferior to the lead glaze as to affect adversely the insulation of a telegraph line." Mr. Buxton added that, notwithstanding this, he was still using a considerable number of leadless-glazed insulators where it was possible, and that he had been much in communication with Sir Charles Dilke with a view of increasing the number of firms which would make them at a reasonable price, and, he hoped, with improved insulation.

The leadless-glaze question is one upon which Staffordshire manufacturers have worked for years. It has engaged the attention of the most expert chemists the industry possesses, and large sums of money have been expended in the attempt to introduce a glaze innocuous to the workers and possessing, at the same time, the essential qualities of a lead glaze. But although something has been accomplished in the direction of applying leadless glazes to china and other vitreous bodies, the problem of applying it successfully and marketably to ordinary porous earthenware still defies solution, in spite of exhibitions in London and the constant agitation aroused from time to time. For some eight or ten years, now, leadless-glazed insulators have been supplied by some firms, and at one time it was hoped that a really satisfactory article had been produced, but, as Mr. Buxton's statement shows, the lead-glazed insulator, despite all that has been done, is still superior to insulators glazed without lead.

The *Staffordshire Sentinel* has collected the following personal opinions on the question by interviews:

Mr. J. W. Harris, the managing director of Messrs. Bullers, Limited, who are large makers of insulators for the Post Office, explained that the leadless glaze did not work so well in the oven as a lead glaze, and, therefore, did not produce so saleable or efficient an article. It was not easy, either, to make the leadless article at the same price as the other. Leadless glazes did not "flow" so well as lead glazes. If a piece of lead glaze became accidentally detached from the ware before passing through the glost oven, the subsequent firing would cause the surrounding glaze to flow over the spot and cover it again. But with a leadless glaze the place would probably show up in the finished insulator, and it would have to be replaced. Leadless glaze was also specially liable to cause "ruckling"—a slight inequality in the surface, due to the glaze not flowing evenly. Mr. Harris showed a specimen of a leadless-glazed insulator which had been spoiled by this defect, and contrasted it with the fine even surface and hard polish of a perfect lead-glazed insulator. Of course, articles in which the slightest defects occur are thrown away whether made with lead or leadless glazes, only insulators which are quite perfect and which have been submitted to a severe electrical test being sent out for actual use. Proceeding to refer to the question of insulation, Mr. Harris pointed out that all insulators must possess a vitreous body. If the body were porous, and the glaze came off, or any portion of the surface of the body was left exposed, the rain would soak through it, and, water being a conductor, the electric current would escape from the wire down to the spindle of the insulator, and thence to earth. Therefore, it was necessary that the insulators should be vitreous, so as not to be dependent upon the glaze alone for its insulating properties. But even with a vitreous body, a glaze was essential in order that the insulators should be always clean. The film of dirt and smoke which collected in busy districts upon the insulators would be washed off the smooth glazed surface by rain, but it would not be similarly washed off the rougher surface of unglazed ware, whether vitreous or not. The insulation was probably not so perfect on a leadless-glazed surface as upon a lead-glazed surface, because, in the former case, the surface was slightly less smooth, and, under conditions of smoke and rain, would permit dirt to accumulate more easily. If a trial telegraph line of leadless-glazed insulators were placed alongside a trial line of lead-glazed insulators, and the insulators in both instances were very dirty, it would probably be found after a heavy storm that the latter insulators had been washed cleaner, by reason of the perfect smoothness of the lead glaze, than the others. Then, if the two lines were afterwards tested, it would be found that the line with the lead-glazed insulators would give the better result, because the very fact that there was a deposit of dirt on the others would cause a leakage over the surface of the insulators. Mr. Harris agreed that the prominence given to the question of plumbism had been productive of good, because it had induced more care on the part of both manufacturers and operatives, but, at the same time, he did not admit that his own firm had ever been careless. No glaze which does not conform to the Home Office standard of insolubility is used, and he alluded with satisfaction to the fact that no case for compensation had occurred in their works.

Mr. J. C. Bailey, managing director of Doulton's, Limited, Burslem, who are likewise large contractors in electrical ware for the Government, said that telegraph

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wires upon which leadless glazed insulators were used did not transmit messages so clearly as lines upon which lead-glazed insulators were in use. In the former instance the insulators apparently allowed some portion of the current to escape, probably by the leadless glaze being more hygroscopic, and, being less even, more liable to collect dirt. In some countries where the atmosphere is dry glass insulators are used, but the English atmosphere was too damp for this. Water being a conductor, if there was a slight film of damp upon the glaze, the current would go from the surface down to the earth through the spindle and post. A lead glaze imparted to the insulators a finer surface, which kept the insulator more free from the accumulation of dirt. It was much easier to get a leadless glaze on a vitreous body than on a porous body, and it was for this reason that manufacturers could get a better leadless glaze on china than on earthenware. Similarly, it was easier to treat vitreous insulators with leadless glaze than it would be to treat dinner-ware. The unfortunate part about it was that the leadless glaze when it had been put on was not so good for insulating purposes as lead glaze. All the insulators sent out by his firm had been properly glazed, and nobody could be blamed because the leadless-glazed insulators had not proved efficient.

APPOINTMENTS VACANT.

Tramways Manager, Wigan Corporation. Salary, £250 per annum.

Shift Engineer, Battersea Borough Council. Salary, £117 per annum. Applications by Sept. 26. See advertisement.

Mechanical Engineer for large public institution. Salary, £3 per week. Applications to the Vestry Clerk, Parish Offices, Liverpool, by Sept. 18. See advertisement.

Junior Assistant Engineer, Birmingham Electric Supply Department. Salary will commence at £100 per annum, rising to £150. Applications by Sept. 17. See advertisement.

Assistant Engineer, to act as canvasser and agent to the Electricity Department, Hammersmith Borough Council. Salary, £2. 10s., rising by annual increments of 5s. to £3 per week. Applications to Mr. G. G. Bell, borough electrical engineer, 85, Fulham Palace-road, Hammersmith, W., by Sept. 20. See advertisement.

OPENINGS FOR CONTRACTORS.

ABERAVON—Municipal market (£4,020).

ABERGAVENNY—Enlargement of town hall (£2,500).

ABERYSTWYTH—Electric plant to be installed for cliff railway.

AYR—Entrances and offices to racecourse (£285).

BALSALL—Social institute.

BARNSLEY—Erection of shops in Eldon-street.

BARROW—Erection of baths and wash-houses.

BARRY—Erection of shelters and bandstand.

BATLEY—Co-operative laundry for Co-operative Society (£5,000).

BELFAST—Repairs to University-road Church (£500); Falls-road Church (£30); Donegall-road Church (£30).

BILSTON—Renovation of St. Leonard's Church (£1,000).

BIRDWELL — Two houses on Sheffield-road. Architect, Mr. A. Whitaker, Worsborough Bridge, Barnsley.

BIRMINGHAM—Building of new station at Moor-street for G.W. Railway Co.

BIRSTALL — Enlargement of St. Patrick's Schools. Architect, Mr. E. Simpson, Manningham.

BISHOP AUCKLAND—Erection of a billiard saloon. Architect, Mr. F. H. Livesay, 107, Newgate-street.

BLACKBURN—Erection of a gymnasium for the Corporation.

BONHILL—Enlargement of the Vale of Leven Academy (£5,000); enlargement of Jamestown school (£2,000).

BONNYRIGG—The erection of a public library is contemplated.

BOSTON—A new coal hoist, alterations to the power station (£7,500). Harbour engineer, Mr. G. E. Clarke.

BOUGHTON—School for Education Committee (£1,888). Mr. T. Huxley, Malpas.

BOURNEMOUTH—Building of new church for St. Augustine's Parish (£11,500).

BRADFORD—Sunday school in connection with Muff Field Wesleyan Reform Chapel. Architects, Messrs. Walker and Collinson, Bradford.

BRIGHTLINGSEA—A new police station (£2,400).

BRIXHAM—Alteration to the classroom of Furzeham School.

BUCKHAVEN—Block of villas for Methil Land Investment Co.

BURY—Erection of refuse destructor for Corporation.

CALLAN—Provisional order for electric supply applied for by Council.

CALVERLEY—Alterations to Council School. Architect, Mr. H. Beswick, Newgate-street, Chester.

CARDIGAN—Two villas on St. Dogmael's-road. Architect, Mr. L. Lewis; improvements to the St. Dogmael's National School buildings.

CARNARVON — Improvements at the slaughter-houses (£400); extension of cable by the Council.

CANTERBURY—Improvements at the police station (£3,040).

CATHCART—New Council school (£12,000).

CHAGFORD—New wing to Gidleigh Park House. Architect, Mr. J. Crocker, 98, Queen-street, Exeter.

CHERITON—Erection of a Baptist church.

CHESHIRE—Repairs, equipment, and drainage to the Theological College (£3,000).

CHESTER—Underground lavatory construction (£2,200).

CLAYTON—Erection of Council school in Burnley-road.

CIRENCESTER—Electric power station for Earl Bathurst.

CLITHEROE—Two houses at Chatburn for Mr. Robinson.

CORKBEG—A wireless telegraph station at the mouth of Cork Harbour.

CORSLEY—Additions to "Sandhayes." Architects, Messrs. Long and Glass.

COVENTRY—New dwellings (180) are to be erected from plans passed by the Town Council.

CREWE—New offices for the North Staffordshire Railway Co.

DARLINGTON—Electric light to be installed at the new Palace Theatre.

DISS—Secondary school. Architect, Mr. A. H. Tiltman.

DONAGHADEE—Erection of Methodist church (£2,000).

DONCASTER—Upper decks are to be provided on the Corporation tramcars.

DOVER—A new post office in Biggin-street.

DOWLAIS—An extension of tramways is advocated by the Chamber of Trade.

DRUMCOLLOGHER—Improvements to Roman Catholic Church (£500).

DUDLEY—Erection of secondary school (£4,230).

DUNDEE—Workshop for Mr. Alex. Scott, Milnbank-road; sanitary conveniences for Messrs. Langlands and McVinish, Seagate; villas for Mr. J. Alexander, Strathmartine-road; warehouse for Messrs. J. and J. Cunningham, East Dock-street; central reading room, etc. (£11,000).

DYSART—Improvements of the municipal slaughter-houses.

ECCLES—Erection of elementary school (£10,734).

ELLON—Telephone offices are to be opened.

FRASERBURGH—Erection of houses in Denyduff-road. Architects, Messrs. Reid and McRobbie.

GALWAY—A scheme of artisans' dwellings has been initiated by the Urban District Council.

GELLIGAER—Bedlinog School is to be electrically lit.

GRANTHAM—Alterations to fire station (£400).

GRAYS—Extension to the police station (£600).

GRIMSBY—Extensions to the electricity undertaking (£1,964).

GRINSLEY-ON-THE-HILL—Erection of cemetery chapel.

GORDON—Alterations at school offices (£70).

HARLOW—A new police station (£3,400).

HARROGATE—Extension of the electricity undertaking (£16,500).

HEYSIDE—Erection of vicarage.

HINDLEY—Improvements to the Church of England Schools.

HUDDERSFIELD—Extension of electric lighting undertaking (£16,500).

HYTHE—Stable and coach-house in Theatre-street for Mr. W. Sharpe.

ILFRACOMBE—Concert hall and enlargement of pavilion.

KETTERINGHAM—Repairs to parish church (£1,500).

KILMARNOCK—New lace factory in Tannock-street (£1,000).

KINGUSSIE—Building a villa. Architect, Mr. A. McKenzie.

KIRBY—Eleven houses and shops in Cemetery-road and four houses in Rosebury-street.

LANARK—Attendants' houses at Gartloch Asylum for the Glasgow District Lunacy Board.

LANCASTER—A children's home (£4,200).

LLANSAMLET—Provisional order for electric light applied for.

LAURIESTON—Establishment of a tramway system is in contemplation.

LEICESTER—Receiving wards at workhouse (£1,929).

LEISTON—Higher elementary Council school. Architect, Mr. T. B. Johns, Tower-chambers, Ipswich.

LEEK—Wesleyan Sunday school in Mill-street (£800). Architect, Mr. J. T. Brealey. Erection of a laundry (£3,500).

LIVERPOOL—Construction of corn market at Pier Head.

LONDON, E.—Police station for Wapping (£13,000).

LONDON, N.E.—Additional pavilion to the workhouse infirmary Hackney (£21,000).

LONDON, N.—Elementary school, and alterations to St. Joseph's Retreat, Highgate (£4,000). Architect, Mr. R. L. Curtis.

LONDON, S.W.—Church, Cottenham Park (£10 000), and another at Wimbledon Park (£5,000).

LONGTON—Extension of the electric lighting undertaking (£2,000); erection of additional offices at Corporation yard (£500).

LURGAN—Establishment of municipal baths.

LUTON—Extension of the electricity works (£2,500).

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LOWESTOFT—New valve chest for pump in boiler-house at the Corporation Electricity Station.

MARGATE—Enlargement of post office in Cecil-square.

MARYHILL—Additions to janitor's house at Possil School for the School Board of Maryhill.

MERTHYR—Additions to the workhouse infirmary (£1,900).

MIDDLETON—Erection of a Dutch barn for the Corporation; building a cotton shed for the L. and Y. Railway Co. Mr. R. C. Irwin, Hunt's Bank, Manchester.

MONTROSE—Erection of store for the Harbour Trustees.

MOUNTAIN ASH—Electric lighting station (£4,630).

NELSON—Alterations to weaving-shed at Throstlenest Mill.

NEW BARNET—Erection of mortuary for Urban District Council.

NORMANTON—Small-pox hospital (£850).

OKEHAMPTON—New Council schools.

OXFORD—New buildings for Ruskin College (£20,000).

PELTON FELL—Workmen's institute (£4,000) for the owners of Pelton Fell Collieries.

PENTREBACH—School for accommodation of 500 scholars for the Merthyr Education Committee.

PENTROBIN—Alterations to St. John's School (£700). Mr. Propert, Hope.

PERTH—Repairs to tramway shelters; lady chapel at east end of cathedral (£2,000).

PONTELAND—New Methodist church (£1,200). Architect, Mr. J. W. Taylor, Newcastle.

PORTHCAWL—Erection of 25 villas for the Porthcawl Syndicate.

PUDSEY—A new Council school.

PURLEY—Construction of public convenience for the Croydon Rural District Council.

REDCAR—Plans for 30 new houses have been approved by the Urban District Council.

RHYMNEY—Erection of town clock in High-street.

ROCHESTER—Alterations and additions to municipal offices.

ROLLESBY—Enlargement of Board-room for Guardians.

ROMFORD—Remodelling of the police station (£300).

ST. HELENS—Wesleyan mission hall (£1,000).

ST. IVES—Roman Catholic church (£4,000). Architect, Mr. G. Raymond, Basingstoke.

SANDYCROFT—Alterations to Council school.

SCUNTHORPE—Building a Primitive Methodist church and schools in Frodingham-road.

SHEFFIELD—Extensions to the Royal Infirmary (£25,000).

SILCOATES—Proposed Congregational school (£12,000). Architects, Messrs. Oliver and Dodgshun, Leeds.

SOUTHSEA—Reconstruction of South Parade Pier. Quantity surveyor, Mr. C. W. Ball, Southsea.

SPENNYMOOR—Erection of Good Templars' hall.

SOUTHPORT—New school for Education Committee.

STALYBRIDGE—Extension of cables for the Tramway and Electricity Board.

SUNDERLAND — Extension of education college, engineering laboratories, etc. (£10,000).

SUNNINGHILL—Alterations to schools (£350).

SWANSEA—Hydraulic crane for King's Dock.

THORNHILL—Erection of a carbide factory for Messrs. C. H. Marriott, Son, and Shaw, Dewsbury; establishment of an electricity supply by the Council.

THORNTON HEATH—Salvation Army hall (£3,225).

TORRINGTON—Extensions to the laundry of the workhouse.

TREDEGAR—New offices for the Tredegar Iron and Coal Co.

UXBRIDGE—Extensions to the workhouse (£3,000).

WALLINGFORD—County school to accommodate 250 scholars.

WALLSEND—Erection of aluminium works.

WEDNESBURY—Improvement of parish church (£550).

WESTCLIFF-ON-SEA—New police station (£2,250).

WESTON—Building a parish room (£100).

WESTONING—Erection of a residence for Mr. E. T. Tutt, Market-place, Ampthill.

WEST WALTON—Restoration of parish church (£1,500).

WEST WITTERING—Erection of church room.

WHITBY—Erection of mission church.

WILLINGTON—Provision for electric lighting has been made by Corporation.

WISHAW—Provisional order for free wiring promoted by Council.

WOKINGHAM—Additions to Albion House, three shops in Peach-street, and extension of coach-house at High Close.

WORKSOP—Erection of public baths.

WREXHAM—Extension of electricity cable for the Council.

YARBOROUGH—Repairs to tower of St. John the Baptist's Church (£600).

YARMOUTH—Erection of tram shelter for Corporation.

FORTHCOMING EVENTS.

Iron and Steel Institute.—Sept. 23, 24, and 25, Vienna meeting.

COMPANIES' MEETINGS AND REPORTS.

BUENOS AYRES AND BELGRANO ELECTRIC TRAMS.

An extraordinary general meeting of shareholders of the above Company was held on the 9th inst. at Winchester House, Old Broad-street, E.C., for the purpose of considering a resolution approving the completion of the purchase of the property agreed to be sold by the contract dated April 20, 1907, made between the Company and La Compagnie Générale de Tramways de Buenos Ayres on July 1, 1908, notwithstanding that 12 calendar months' notice of intention to complete the purchase on that date has not been given, pursuant to Clause 9 of the said contract.

Mr. J. B. CONCANNON (chairman of the Company) said that the short circular sent out to the shareholders stated very clearly the object of the meeting, which was to give them all an opportunity of accepting payment of the balance of the purchase money of the property on July 1, 1908, instead of waiting for 12 months' notice from July 1, 1908, which meant that the sum would not be paid off till the following year (1909). The chairman said: We expressed the opinion that probably the majority would have been better pleased to have received your money, more particularly, as you all know, investments are now at a very low figure, and you might have the opportunity of reinvesting it at any time between now and July 1, 1908, anticipating the payment of the proceeds of your shares. No doubt if you wished to do so, you could very easily borrow money in the meantime from your bankers or of your brokers. The policy of giving you this option was a wise one, because we have proxies for nearly half of the entire holdings of each class of debenture and shares, and all of you who attend meetings will be aware how very seldom we get more than half the proxies from shareholders, no matter how favourable, or with what great object, the meeting may be called. People take it for granted that everybody will agree, and they do not trouble to send their proxies. At all events, it is quite clear to us that this policy of giving you the option of getting your money a year earlier than you might have done has been approved unanimously. I might mention for the information of the ordinary shareholders the reason why we do not intend to pay a dividend until we distribute the whole of the assets is due to the fact that technically we have sold the property at a loss, and our legal advisers tell us that it is much safer not to pay a dividend on the ordinary shares in the meantime, as it might be said to be payment out of capital. We could have got over that difficulty, but it would mean that we should have to hold two meetings of shareholders to reduce the nominal amount of capital. As a matter of fact, we sold the property for considerably over the nominal capital, but, as you know, the first debenture holders get a premium of 15 per cent. and the second debenture holders get a premium of 5 per cent., and these premiums put us in the position that we ordinary shareholders have nominally less money. I really think there is nothing more I have to say, except to formally move the resolution.

A SHAREHOLDER: Do the debenture holders get their 115 and 105 next year in cash?

The CHAIRMAN: Yes. I beg to move: "That this meeting approves of the completion on July 1, 1908, of the purchase of the Company's property agreed to be sold by contract dated April 20, 1907, made between the Buenos Ayres and Belgrano Electric Tramways Co. and La Compagnie Générale de Tramways de Buenos Ayres, notwithstanding that 12 calendar months' notice of intention to complete the purchase on that date has not been given pursuant to Clause 9 of the said contract, and authorises the directors to take such steps and give such assistance as may be necessary for that purchase."

Mr. JAMES ANDERSON seconded the motion.

Mr. W. W. CHAPMAN said as an ordinary shareholder he objected most strongly to anybody retaining the interest of money which ought to be distributed. He was not present at the last meeting, otherwise he would have strongly objected to the sale of the Company, because he thought it would be quite as open for the directors as for the shareholders who knew anything about the Argentine to know that the purchasing company had make a profit of £250,000 on the purchase of the property.

Mr. BARBER GLENN said that the last shareholder had got hold of really a very small matter, because the ordinary shareholders would not get any dividend in any event until April. He would get his money, he had no doubt, on July 1, or during that month, so that the postponement of it for the half-year of 1907 was simply a postponement from April to July, and the profit to June, 1908, would not be postponed at all, because they would be paid in July. He wanted to ask a question as to whether the directors had made up their minds regarding the compensation to themselves and the staff for loss of office. If it had been in order, he should like to have moved a resolution at this meeting that, considering the price they had got for the property, an adequate sum be voted to the directors and the secretary and staff as compensation.

The CHAIRMAN said that with regard to the remarks of the first speaker, Mr. Chapman, on the point of the payment of dividend on the ordinary shares, Mr. Glenn had really answered him, pointing out that the rule had been to pay the annual dividend early in the year, so that, as a matter of fact, a shareholder had only to wait two or three months longer before he got his dividend in the general distribution. In addition to this, he thought he had made it quite clear that the directors had no power to pay that dividend unless the ordinary shareholders were called together twice to alter the articles of association and to write down the capital, and then those resolutions would have to be submitted for the confirmation of the courts, and law courts cost money. He might add that the money, whatever it was, would be invested or deposited at interest, and that interest would accrue to the ordinary shareholders. Mr. Chapman had also referred to the profit made by the Belgian company in the sale of this

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undertaking to the Anglo-Argentine Co. He (the chairman) was in the peculiar position of knowing all the facts of the case. He was chairman of the Anglo-Argentine Co. The Belgian company sold this Belgrano undertaking, for which they were paying the Belgrano Co. £1,350,000 in cash, to the Anglo-Argentine Co. for £1,600,000 in paper, in practically deferred ordinary shares; and that was a very different thing from selling for cash, and that £250,000 profit was quite a problematical one. Those gentlemen who got the shares—1,600,000 shares—would have probably to wait a long time before they could market them, and the price would depend to a great extent on the future of the combined properties, but the result of the working of the two companies together would undoubtedly result in considerable economies being effected. He did not think he need say anything more to explain the bogey about the big profits which had been got out of the Belgrano Co. No profit had been got out of that Belgrano Co., and it remained to be seen whether the Belgians would get profits out of the Anglo-Argentine, and the deal of the Anglo-Argentine Co. also provided that the present ordinary shares of the Anglo-Argentine should, instead of getting an ordinary dividend as they were of 8 per cent., get a 10 per cent. dividend, and the shares became second preference shares, and the profits of this Company were going to strengthen and make secure that dividend to the preference shareholders of the Anglo-Argentine. With regard to the question of compensation to the directors and staff, a resolution giving the directors additional remuneration, and also giving them power to give compensation to the staff, would be proposed at the next general meeting.

The resolution was agreed to unanimously, and the proceedings terminated.

UNITED ELECTRIC CAR.

The report of the United Electric Car Co. for the year ended June 30 last, to be submitted at the meeting at Preston on the 19th inst., states that, after paying debenture interest amounting to £2,500, and charging £6,106 for depreciation, the profit is £20,459, to which is added £2,135 brought forward, making a total of £22,595. The directors recommend to write off £2,000 balance of the preliminary expenses in connection with the purchase of the Hadley and Manchester works and the issue of preference shares; to pay a dividend on the ordinary shares of 5 per cent., less income tax, for the year; to carry £2,000 to general reserve fund, and to carry forward £5,095.

LANARKSHIRE AND AYRSHIRE RAILWAY.

The report of the Lanarkshire and Ayrshire Railway Co. for the half-year ended July 31 last, to be submitted at the meeting at Glasgow on the 27th inst., states that the gross receipts are £43,720, against the receipts for the corresponding period of last year of £45,076, showing a decrease of £1,355. After providing for all prior charges there remains a balance of £6,639, and the directors recommend a dividend on the ordinary shares at the rate of 2¼ per cent. per annum, carrying forward £616.

NEW COMPANIES REGISTERED.

Illuminating Engineering Publishing Co., Limited.—Registered Aug. 30. Capital, £2,000 in £1 shares. Objects: to establish, print, and publish a newspaper or newspapers in London or elsewhere for the purpose of furthering the interests of illuminating engineering, and to carry on the general business of publishers, printers, lithographers, illuminators, etc. No initial public issue. Registered office: 13, Bream's-buildings, Chancery-lane, W.C.

Liens Registered.

Great Central Co-operative Engineering and Ship Repairing Co., Limited (Great Grimsby).—A second debenture, dated Sept. 2, 1907, to secure an amount not exceeding £10,000 by way of bank overdraft, charged on the company's undertaking and property, present and future, has been registered. Holders: Union of London and Smith's Bank, Limited.

Cleveland and Durham Electric Power, Limited.—A deed of indemnity and security, dated Aug. 10, 1907, covering any moneys payable under a bond of suretyship for £5,000, for performance of contract, given to the mayor, aldermen, and burgesses of Middlesbrough by Sir Hugh Bell, Bart., of Rounton Grange, Yorks, and Sir John D. Milburn, Bart., of Guyzance, near Acklington, Northumberland, has been registered. Property charged: the company's assets, present and future, except uncalled capital.

National Electric Construction Co., Limited.—Particulars of £75,000 debentures created by resolution of May 6 and secured by a trust deed dated May 7, 1907 (already registered), have been filed pursuant to Section 14 (4) of the Companies' Act, 1900. Property charged: the company's undertaking and property, present and future, including uncalled capital. Trustees: L. B. Schlesinger, 21, Cornhill, E.C., and R. Williams, Norfolk House, Victoria-embankment, W.C.

PERSONAL.

The Town Council of Ayr have increased the salary of Mr. Rowland Marshall, the electrical engineer, from £300 to £350 per annum.

The Brush Electrical Engineering Co. has appointed Mr. W. L. Madgen vice-chairman, Mr. B. Broadhurst and Mr. J. J. Steinitz joint general managers, and Mr. F. M. Hodson secretary and chief accountant of the company.

Messrs. C. P. and H. C. Sparks inform us that they have taken offices at 49-51, Moorgate-court, Moorgate-street, London, E.C., where they propose to carry on the business of consulting engineers under the style of "Charles P. Sparks."

Mr. W. B. Turner has resigned his position as chief assistant engineer to the Wycombe (Borough) Electric Light and Power Co., having joined the staff of Mr. A. J. Fippard, consulting engineer, Victoria-street, Westminster.

Mr. W. E. Apted, A.M.I.C.E., at present on the staff of the county engineer of Middlesex, has been appointed surveyor to the Corporation of Kharga, Western Egypt. Mr. Apted takes up the duties of his new appointment in October.

On severing his connection with the North of Scotland Electric Light and Power Co., Mr. W. Hudson has been presented by the employés with two beautiful hand-painted panels in black and gold frames, and a handsome brooch for his wife.

Mr. S. E. Fedden, the general manager of the Sheffield Corporation Electric Supply Department, on behalf of the staff, has presented to Mr. F. A. Dear, the chief correspondence clerk, a case of cutlery as a token of the staff's goodwill towards him on the occasion of his forthcoming marriage.

Last Friday evening the workmen did honour to their employer, Mr. Charles D. Phillips, Emlyn Engineering Works, Brass and Iron Foundry, by presenting him with a beautiful silver cigar case with the following inscription: "Presented to Charles D. Phillips, Esq., J.P., by his Gloucester employés, as a mark of esteem and appreciation of him as an employer."

Mr. W. Cowburn, who for some years has been manager of the National Telephone Co.'s Grimsby exchange, was last week presented by Miss Riggall, chief operator, on behalf of the staff, with a gold-mounted fountain pen as a token of goodwill and esteem, he having been promoted to an important position on the company's electrical staff at Leeds. Mr. Cowburn is succeeded at Grimsby by Mr. Jones, of Wakefield.

The British Westinghouse Electric and Manufacturing Co. are informed by their agents (Messrs. Turnbull and Jones, Christchurch, New Zealand) that they have been awarded at the Christchurch exhibition one gold medal for the best 25-b.h.p. gas-engine in the show, and a second gold medal for the best general electrical exhibit. British Westinghouse apparatus has thus secured two gold medals at this exhibition.

The annual staff outing of the Amorduct Manufacturing Co. took place on Saturday, Aug. 31. The London staff, accompanied by several of the company's depôt managers and friends, joined the launch "Formosa" at Molesey Lock, and got under way at 9.30 a.m. and proceeded as far as Old Windsor. Favoured with fine weather, a very enjoyable trip was made, luncheon and tea being served on board. A return was made at 3 p.m. and the party was landed at the managing director's residence at Teddington at 8 o'clock, where dinner was served. After dinner, Mr. Schmahl, in a brief speech, mentioned his appreciation of the efforts of the employés on behalf of the company, and accompanied his thanks with an agreeable surprise in the shape of a substantial cheque to the staff. A most pleasant and successful day concluded with music and singing.

On Saturday, Aug. 31, the staff of Messrs. Browett, Lindley, and Co., Patricroft, held their annual picnic. About 30 members visited Chester, and were accompanied by the managing director (Mr. F. C. Gibbons) and the secretary (Mr. T. C. Kay). The party left Eccles at noon by the London and North-Western Railway, a saloon carriage having been attached to the train for their comfort. Immediately on arrival at Chester a steam launch was in readiness to take them up the River Dee for the afternoon. The party returned to Chester for 6.30, where arrangements had been made for dinner at the Albion Hotel, at which Mr. Gibbons presided, with Mr. Kay in the vice-chair, and, needless to say, full justice was done to the excellent menu provided. The toasts included "Browett, Lindley, and Co., Limited," "The Staff," "The President," and "The Committee," all of which were well received and suitably responded to. The return journey was made on the 9.10 p.m. train, the picnic being considered by all a great success.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Leghorn.—The Municipality invite tenders for electric lighting. Tenders by Sept. 21.

Paris.—Electric cables required for the Post and Telegraph Department, 103, Rue de Grenelle, Paris. Tenders by Sept. 30.

Brisbane.—The Postmaster-General invites tenders for telephones, cells, resistance coils, battery pole changers, operators' sets, etc. Tenders by Sept. 30.

Aldershot.—The Urban District Council invite tenders for electric light mains, bitumen, and troughing. Particulars from the Electrical Engineer, Laburnum-road, Aldershot. Tenders by Sept. 18.

Melbourne.—The Postmaster-General's Department invite tenders for 11 sets and a common-battery switchboard, and 3,000 subscribers telephones, etc., for the Windsor exchange. Tenders by Jan. 7.

London.—The London County Council invite tenders for three electrically-driven boiler feed pumps, each of 9,000 gallons per hour capacity, for the Greenwich tramway station. Tenders by Oct. 8.

Paris.—Pumping plant and electric dynamos and motors for the Municipal Waterworks Department. Estimate, £36,000. Particulars from the Canals and Waterways Department, Hotel de Ville, Paris. Tenders by Oct. 24.

Londonderry.—The District Lunatic Asylum require a 22-kw. steam set and dynamo, with switchboard, connections, etc., for the Gransha Asylum. Specification, £1. 1s. Particulars from Mr. R. V. Macrory, Londonderry. Tenders by Sept. 20.

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Dublin.—The Lighting Committee of the Corporation invite tenders for the supply of 500 alternating-current single-phase meters and 100 alternating-current three-phase meters. Tenders to the Secretary, 3, Cork-hill, Dublin, by Sept. 30. See advertisement.

Finchley.—The Urban District Council invite tenders for the supply of feeders, distributing mains, and other cables, network boxes, joint-boxes, etc. Particulars from Mr. E. Calvert, Electricity Works, Squire's-lane, Finchley, London, N. Tenders by Sept. 16.

Swinton and Pendlebury.—The Urban District Council invite tenders for the wiring, upon the hire-purchase system, of buildings for electric light. Tenders to the Chairman of the Electricity Committee, Council Offices, Swinton, Manchester, by Sept. 28. See advertisement.

Swinton (Lancs.).—The Swinton and Pendlebury Urban District Council invite tenders for the wiring, upon the hire-purchase system, of buildings for electric light. Tenders to the Chairman of the Electricity Committee, Council Offices, Swinton, Manchester, by Sept. 28.

Neath.—The Main Colliery Co. invite tenders for a 12 months' supply of various stores, including electrical goods. Particulars on application to the Neath Abbey offices of the company. Tenders to the Directors of the Main Colliery Co., Neath Abbey, near Neath, by Sept. 21.

Adelaide.—The Deputy Postmaster-General for Queensland invites tenders for a common battery switchboard and 3,000 subscribers' telephones. Specification No. 166. Particulars may be obtained from the Commonwealth Offices, 72, Victoria-street, London, S.W. Tenders by Jan. 8, 1908.

London, W.C.—Tenders are invited for the complete electrification and equipment with power for a monorail race track. Plans and particulars may be obtained on payment of 10s., the latter being returned on the receipt of a bona fide tender. Apply to Mr. Shurmur Sibthorp, 34, Norfolk-street, Strand, W.C.

Rangoon.—For pumping plant for Rangoon Municipality. Particulars, etc., of Messrs. Ogilvy, Gillanders, and Co., London agents to the Rangoon Municipality, Suncourt, 67, Cornhill, London, E.C., accompanied by a remittance of 10s., which will not be returned. Tenders to the Agents by Oct. 31.

Limerick.—Alternative tenders are invited for (1) the supply, delivery, laying, and connecting up complete, with all necessary material, or (2) the supply and delivery only of concentric feeder and pilot cables. Particulars from Mr. J. Gallinagh, Electricity Works, Frederick-street. Tenders by Sept. 17.

Victoria.—The Deputy Postmaster-General at Melbourne invites tenders for the supply and delivery at Melbourne of 11 sections of a common-battery switchboard and 3,000 subscribers' telephones and other apparatus for telephone exchange, Windsor, in accordance with Victorian specification No. 148. Tenders by Jan. 7.

Manchester.—The Tramways Committee invite tenders for the supply of hard-drawn copper wire. Specifications and forms of tender may be obtained on application to Mr. J. M. M'Elroy, general manager, Tramways Department, 55, Piccadilly, Manchester. Tenders to the Chairman of the Tramways Committee by Sept. 17.

Hull.—The North-Eastern Railway Co. invite tenders for the erection of an accumulator house and clock tower at Albert Dock, Hull. Particulars from Mr. William Bell, the company's architect, at York. Duplicate plans may also be seen at the Stationmaster's Office, Paragon Station, Hull. Tenders to the Secretary, at York, by Sept. 18.

Dublin.—For signalling (about 14 working levers) of the new station at Keady, for the Castleblaney, Keady, and Armagh Railway Co. Plan and specification may be seen at the office of Mr. W. H. Mills, engineer-in-chief, Great Northern Railway Co. (Ireland), Amiens-street Terminus, Dublin. Tenders to Mr. T. Morrison, secretary, Amiens-street Terminus, Dublin, by Sept. 16.

Alexandria.—Tenders are invited for the following electrical equipment for the port of Alexandria: five large and seven small transshipping engines, six cranes of four tons, 36 cranes of two tons, 25 windlasses, various small plant and necessary accessories, and the construction and installation of a central power station. Particulars from M. le Directeur des Ports et Phares, Alexandria. Tenders by Nov. 1.

Dundee.—The Corporation Electricity Department invite tenders for extra-tension armoured feeder cables laid direct in the ground, and low-tension armoured and low-tension paper-insulated, lead-covered feeder cables and distribution cables laid direct in the ground, and on the solid system in wood troughing. Particulars from the Engineer-in-Chief, Electricity Works, Dudhope-crescent-road. Tenders by Sept. 30.

New South Wales.—With reference to an announcement inviting tenders for the supply and construction complete of a pneumatic tube service to the General Post Office, Sydney, from the Pacific Cable Board's Office, Royal and Stock Exchanges, etc., the Postmaster-General for New South Wales give notice that the date for the receipt of such tenders has been extended from July 10 to 2.30 p.m. on Wednesday, Oct. 16 next.

Hastings.—The Corporation invite tenders for the supply during six months from Nov. 1, 1907, of the following coal for their electricity works: Nixon's Navigation colliery screened, Nixon's Navigation washed nuts, Glasbrook Merthyr best Welsh smokeless unscreened large, Bwllfa No. 1 large smokeless. Forms of tender from the Borough Electrical Engineer, Electric Light Works, Hastings. Tenders to Mr. Ben. F. Meadows, town clerk, Town Hall, Hastings, by Sept. 17.

Antwerp.—The Commercial Intelligence Branch of the Board of Trade have received from his Majesty's Consul-General at Antwerp a copy of a specification issued by the Municipal Authorities of that city calling for tenders for the installation of electric light in the Salle de Fêtes recently erected in the Place de Meir, Antwerp. A deposit of 8,000fr. (about £320) will be required to qualify any tender. Tenders to M. le Bourgmestre de la Ville, at the Hotel de Ville, Antwerp, by Oct. 17.

Brighton.—The Town Council invite tenders for the supply to the Corporation electric power station, Southwick, near Brighton, during six months commencing Oct. 1, of not less than 13,000 or more than 15,000 tons of washed nuts, or, alternatively, for supply during 12 months commencing same date of not less than 22,000 or more than 24,000 tons of washed nuts. Specification and form of tender may be obtained on application at the office of Mr. Hugo Talbot, town clerk, to whom tenders must be sent by Sept. 16.

New South Wales.—Tenders will be received at the office of the Deputy Postmaster-General, Sydney, until 2.30 on Oct. 23 for supply and delivery of the following material at the Departmental Stores, Sydney: 11 tons galvanised iron wire, 400lb. per mile, as per specification No. 164; 1,600 large best white porcelain insulators, as per specification N.S.W. No. 17, and sealed pattern N.S.W. No. 5. Specifications, general conditions, and sealed patterns may be seen and tender forms obtained at the General Post Office, Sydney, Melbourne, Brisbane, and Adelaide.

Epworth (Axholme).—The Axholme Joint Railway Committee invite tenders for the construction of the Hatfield Moor extension light railway, about five miles long, commencing at Epworth Station, on their Axholme Joint Line, and terminating near the peat moss works. Plans may be seen and specification, etc., obtained on personal application at the office of Mr. W. J. Cudworth, Engineer's Office, North-Eastern Railway, York. Tenders to Mr. H. Marriott, secretary, Axholme Joint Railway, Lancashire and Yorkshire Railway Offices, Hunt's Bank, Manchester, by Sept. 28.

Maidstone.—Tenders are invited for four electrical motors and centrifugal pumps, each capable of delivering 150 cubic feet of sewage, and three electrical motors and centrifugal pumps at 225 cubic feet per minute, together with two motor-driven air injectors, two travelling cranes, switchboard, starting switches, workshop fittings, and other appliances and connections, including a complete electric light installation, for the sewage-disposal works. Plans, etc., and form of tender from Mr. G. R. Strachan, 9, Victoria-street, Westminster, London, on and after Sept. 3. Tenders by Oct. 1.

Gothenburg.—The Commercial Intelligence Branch of the Board of Trade are notified by his Majesty's Consul at Gothenburg that tenders are invited for supply of the electrical equipment for the Government power station at Trollhattan, comprising three electric generators for direct current, each of 350 kw.; one accumulator battery of 4,800 ampere-hours capacity; four three-phase generators, each of a maximum of 11,000 kilovolt-amperes; 12 transmitters, each of a maximum of 3,670 kilovolt-amperes; connections; regulators; and control tables. Sealed tenders, marked "Anbud a elektrisk utrustning for Statens kraftverk," should be sent to the Managing Director of the Royal Trollhattan Canal and Waterworks, Trollhattan, Sweden, by noon on Oct. 1 next. Tenders are binding until Jan. 1, 1908. Delivery is to be completed by Sept. 1, 1909. Further information may be obtained from the Managing Director, from whom a copy of the programme can be had against a deposit of 50 kronor, which will be returned on receipt of a tender in accordance with the programme.

RESULTS OF TENDERS.

Aberdeen.—The Tramways Committee have accepted the tender of Hurst, Nelson, and Co., Motherwell, for six car tops at £148. 10s. per car complete.

Letchworth.—The First Garden City Co. have placed an order with Messrs. Johnson and Phillips for cables and troughing, etc., for extension to the existing network.

Colchester.—The Town Council have accepted the tender of the Underfeed Stoker Co. for supplying, delivering, and fixing six pairs of mechanical stokers for the sum of £1,017. 15s.

Portsmouth Dockyard.—The Admiralty have accepted the tender of Messrs. Johnson and Phillips for the supply and laying feeder and distributor cables, boxes, etc., for supply to the Royal Naval Barracks.

Birmingham.—The Birmingham Tame and Rea District Drainage Board have accepted the tender of Messrs. Johnson and Phillips for the supplying and erection of motors, pumps, high-tension switchgear, cables, etc.

Southampton.—The Electricity Department have placed an order for the supply of 530 yards one square inch, 1,200 yards ·5 square inch, and 300 yards ·15 square inch Paterson's vulcanised bitumen cable with Messrs. Johnson and Phillips.

Norwich.—Messrs. Mann, Egerton, and Co., of Norwich, have received an order from the May-Oatway Fire Appliances, for the wiring of J. and J. Colman's premises, Norwich, for their fire-alarm system, consisting of about 1,000 detectors.

Malvern.—The Urban District Council have accepted the tender of the British Westinghouse Electric and Manufacturing Co. for an electrically-driven sewage compressor at the Link Mill, and that of T. McCann, at £79, for erection of a building in connection with the compressor.

Hackney.—The Electric Light Committee recommend the acceptance of the tender of Kaye, Son, and Co. for Pinxton nutty slack for a period of six months from Sept. 1, 1907, at 13s. 9d. per ton, and that of Phillips and Co. for 1,500 tons of West Hall nutty slack at 13s. 5d. per ton, from Sept. 1 to Dec. 31.

Battersea.—The Lighting Committee recommend the acceptance of the tender of the British Insulated and Helsby Cables for the supply of five feeder pillars, at £25 each; and the tender of the Switchgear Co. for the supply of eight resistances, at £146. 16s., required in connection with the scheme for the provision of additional feeders and distributors to the electric light system.

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Eccles.—The Town Council have accepted the following tenders: British Insulated and Helsby Cables, feeder cable, £215; Ferranti Limited, feeder switchgear, £71. 10s.; Tudor Accumulator Co., booster, £38; W. T. Avery, Limited, 10-ton weighbridge at the generating station, £40; E. Beale, Eccles, wiring and fixing of electric lamps in the accumulator house, engine-house boiler-house, etc., £31.

BUSINESS NOTES.

TRACTION.

Aberystwyth—Preparations are about to be made whereby the Cliff railway may be worked by electricity during the next season.

Dudley—The Town Council have decided to apply to the Board of Trade for sanction of a loan of £95,000 to purchase the tramway undertaking in the borough.

Brighton.—The Tramways Committee have readjusted the running of the cars on certain routes over the Steine line, and have stated that the management is not opposed to the use of transfer tickets and a form of season ticket.

Whitland.—Owing to the breakdown on Saturday evening of the electric shaft system between Whitland and Narberth, believed to have been caused by lightning, the up and down Great Western Railway trains were delayed for some time.

Brockley.—A deputation of the inhabitants has been received by the chairman and vice-chairman of the London County Council to urge upon them the necessity of providing tramways to serve the district of Brockley and Forest Hill.

Darlington.—The return for the issue of workmen's tickets shows that the average number of workmen carried per day at special fares numbered 6,000. The system of return tram tickets appears to be satisfactory, the average per day being 123.

Bournemouth.—At the Council meeting attention was drawn to the necessity for more adequate provision of tramcars for the Westbourne district at the time of the closing of the theatre. The Tramway Committee are to consider the advisability of providing extra cars to meet the requirements.

Big Cable Contract.—Messrs. George Cradock and Co., of Wakefield, have received an order from the Glasgow Subway Co. for a tramway cable 36,300ft. long and 1¼in. in diameter. The weight will be between 50 and 60 tons, which it is claimed will be the heaviest rope in one piece in the world.

Ayr.—The Town Council have decided to apply for a provisional order to extend the tramways from the end of the new bridge along River-street, George-street, and Whitletts-road to Whitletts, and from the Whitletts-road by way of Craigie-road, Victoria Bridge, and Holmston-road to the main line at Burns's statue.

Doncaster.—Four of the Corporation tramcars will have covered and enclosed upper decks for the races. A trial was run with one of the covers on Monday, which proved satisfactory. It is probable that covers will be eventually introduced throughout the system. The Corporation have now 25 cars, and the alteration will cost £150 each car.

Yarmouth.—The tram receipts for four weeks in August were £3,930. 15s. 8d. The takings since April 1, excluding the Caister section, showed a decline of £866 compared with last year. On the Caister route in the past four weeks £818. 4s. 7d. was taken. The Council have decided to erect a shelter at the Gorleston end of the track at a cost of £50.

Wakefield.—At the last meeting of the City Council, Councillor T. H. Wordsworth referred to the application of the Wakefield and District Light Railway Co. to abandon the construction of their proposed lines from Wakefield to Ardsley and to Flanshaw, and stated that every effort would be made to compel the company to carry out the scheme for which they had received power.

London County Council.—Officers of the London County Council are not allowed to take out patents without receiving special sanction. The necessary permission has now been given to one of the engineers, who has devised an improved point for use in connection with the side-slot system of conduit tramway electrical traction. The Council imposes the condition that it shall have the right of using the invention if it so desires.

Lowestoft.—At the last meeting of the Council the Tramways Committee recommended the payment of bills amounting to £868. 0s. 11d., including Electricity Committee (current), £802. 14s. 3d. The traffic receipts, as reported by the general manager, for the week ending Aug. 18 were £484. 2s. 6d., and for the corresponding week last year £460. 3s. 11d., showing an increase in receipts of £24. The report was adopted.

Bradford.—The Lord Mayor of Bradford has opened the line of railway which the Corporation of that city have constructed between Pateley Bridge and Lofthouse. The railway was primarily made to relieve the Corporation of the heavy expense of road haulage in connection with the making of their Nidderdale waterworks, but it will also meet the public needs of the district and provide facilities to enable excursionists to visit Upper Nidderdale.

Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board.—At a meeting of the Tramways Committee the commercial manager reported that the traffic receipts for the five weeks ended Aug. 17 amounted to £4,644. 12s. 6½d., and that the total receipts to that date from March 31 last were £16,319. 17s. 9½d. The commercial manager submitted a detailed report as to traffic receipts and working expenses for the calendar month of July.

Nelson.—A sub-committee of the Corporation has considered the question of appealing from the decision of the Assessment Committee of the Burnley Union confirming the valuation of the Nelson tramway worked by the Burnley Corporation. It has been resolved that the town clerk be instructed to enter an appeal at the next quarter sessions to be held at Preston, and to retain counsel on behalf of the Corporation, and take all necessary steps for prosecuting the appeal to such quarter sessions.

Glasgow.—The Corporation tramway cars ran 397 062 miles last week, as compared with 384,770 in the corresponding week of last year; carried 4.518,836 passengers, as against 4.470.809; and drew £18,314. 10s. 7d., in comparison with £18,045. 11s. Since the beginning of the financial year on June 1 the number of passengers carried had been 60,306,508 as compared with 59 839.263; while the receipts have been £245,439. 8s. 4d., an improvement of £3,081. 11s. 10d.

Birstall.—Acting on the advice of their president, the Birstall Chamber of Commerce have decided to request the directors of the Yorkshire (Woollen District) Electric Tramways to reconsider the question of the fare between Birstall and Batley, which was recently advanced, with special regard to the interests of the working classes of the district. It is claimed that this particular part of the company's system must have been remunerative before, and it is urged that it is unfair to penalise Birstall because some sections of the line do not pay.

Dowlais.—Proposed tram or other vehicular service between Dowlais and Pant was considered by the Dowlais Chamber of Trade at their last meeting. The Pant district is a rapidly increasing one, and as the majority of the residents are employed at the iron and steel works and in business pursuits, a quick and ready means of access is desired. An extension from Dowlais of the Merthyr electric tramway service was advocated, and it was agreed to seek an interview with the local manager of the company with a view to setting forth the claims of the district in this matter.

Wigan—At the last meeting of the Tramways Committee the question of the advisability of issuing tram contracts to children attending secondary schools in the borough was considered, and it was agreed to issue privilege tickets, similar to those already granted by the tramways manager to shop girls and others, to school children entitling them to travel at half fare when going to or returning from school. The tramways manager was instructed to put on a special car on Saturday nights to run between Greenough-street and Springs Bridge, the fare for the single journey to be 1½d.

Portsmouth.—The traffic return records another decrease in the tramway receipts for the week ending Aug. 31, when the total takings were £2,717. 10s. 5d., against £2 818. 16s. 6d. in the corresponding week of 1906, being a decrease of £101. 6s. 1d. The receipts per mile last week averaged 14·23d., against 15 45d. in the corresponding week of last year. The passengers carried numbered 572,535 against 560,553, an increase of 11,982. The distance covered by the 78 cars last week was 45,822 as compared with 43,986 miles by the 76 cars in the same week of last year, an increase of 1,836 miles.

Musselburgh.—At a meeting of Musselburgh Town Council it was stated that the cost for the extra policing of the town during the strike disturbances was £120, while a claim from the tramway company for damage to their property amounted to £220. Included in this latter sum was £84. 9s. 4d. as the account of a local purveyor for housing and feeding the blacklegs. The replacing of the windows and other glass cost £64. 2s. 6d., and £10. 17s. 6d. was charged for refreshments and sandwiches for the policemen on the cars and drivers and conductors. The claim was remitted to the Provost and Law Committee.

Municipal Tramways Association.—The annual conference of this association will open on the 26th inst., and will continue over the two following days. All the leading local authorities in Scotland and England who work tramways are members of this association, and they send to the annual conference the chairmen and vice-chairmen of their tramway committees and the managers and engineers of the undertakings. Glasgow was prominently associated with the inception of the association a few years ago, and among the papers which will be read is one by Mr. Dalrymple, the manager of the Corporation tramways, on "Staff Organisation."

Eastbourne.—At the invitation of the Motor 'Bus Committee of the Corporation a deputation from the Eastbourne Boarding and Apartment House Proprietors' Association attended at the town hall on Monday. Councillor A. E. Killick (chairman of the committee) presided. The question of the sea-front 'buses was discussed. All the deputation urged the immediate withdrawal of the 'buses, and it was stated that wealthy visitors, medical practitioners, and others were strongly of opinion that the noise of the vehicles was most detrimental. The members of the committee were evidently greatly impressed by the force and cogency of the arguments and facts submitted to them.

Morley.—At a meeting of the Electric Lighting and Light Railways (Joint) Committee on the 26th ult., it was resolved that a sub-committee, consisting of four members of this committee and three members appointed by the Highways Committee, be appointed to have an interview with the engineer of the tramways company and obtain information as to the maximum demand, the date when it is expected the demand will be made, and, if the company intend to lay down any other lines than those shown on plans already submitted, that the borough electrical engineer be requested to submit all possible information as to the estimated cost of necessary additional machinery.

Aberdeen.—On Saturday afternoon last Williamina Watson, 2½ years of age, daughter of Andrew Watson, carter, Smithfield-lane, was saved from a terrible death by the successful operation of the cow-catcher on a Suburban Tramway Co.'s car. The car was proceeding southwards along Great Northern-road in charge of Alexander Walker, motorman, Lower Bucksburn, and when opposite Smithfield-lane the

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little girl, in crossing the road, fell in front of the car while getting out of the way of a cyclist, failing to observe the approach of the car. She was knocked down and caught up in the cowcatcher, and the motorman, acting with great promptitude, applied the brakes and had the child taken out. With the exception of a few bruises, she had escaped injury.

Dundee.—The accounts of the Dundee city tramways have been published in attractive form. Statistical data are embellished by an admirable series of photographic reproductions forming part of a brochure issued by the department. It may be recalled that the result of the year's working shows that the gross receipts have amounted to £57,672. 1s. 11d., and the working expenses, including maintenance of lines, to £35,403. 16s. 3d., leaving a balance of revenue over working expenses of £22,268 5s. 8d. This sum has been appropriated in meeting interest, sinking fund, and depreciation; £6.900 has been allocated to the fund for renewals, and a surplus of £85. 19s. 6d. is carried to reserve.

Laurieston.—We learn that there is a movement on foot among the inhabitants of the village of Laurieston to approach the directors of the Falkirk and District Tramways Co. to impress upon them the need and urgency of the tramway system being extended to their village. It is proposed to appoint a large and representative deputation to wait upon the directors to lay before them the advantages which would accrue to the company as well as to the general public by extension. So great is the desire on the part of the people of Laurieston for the travelling facilities mentioned that in the event of the tramway company not being disposed to proceed with the work of extension, the railway companies will be approached and asked to open a station for the district in the vicinity of the Skew Bridge.

Spen Valley.—The Heckmondwike District Council have unanimously adopted resolutions protesting against the increase of fares by the Yorkshire (Woollen District) Electric Tramways, and the proposal of the Midland Railway Co. to postpone the construction of their new line to Bradford through the Spen Valley. The Chairman said the Council did not think the company ought to carry passengers at fares which did not pay the shareholders a reasonable dividend, but before fares were increased representative public bodies ought to have an opportunity of inspecting balance-sheets and ascertaining what the profits really are. A special effort ought to be made to bring about the reintroduction of workmen's tickets. With regard to the Midland scheme, the purchase and closing of mill premises in the town by the company made Heckmondwike proportionately one of the worst sufferers by the delay. In both matters, he added, the Council were willing to act in conjunction with either Bradford or other places.

New Malden.—The Finance Committee of the Council have considered a report from the rate collector upon the subject of the assessment of the tramway company's lines in the district, and recommended that steps be taken to ascertain the views of other local authorities in the matter. Commenting upon this, the Chairman said that the sum the tramway company was prepared to pay towards the local rates was very inadequate, more especially when they regarded the narrow state of the road, and the consequent inconvenience caused to ordinary vehicles. The committee thought the same difficulty might have occurred in other districts, in which case it would be advisable to find out whether other local authorities had been better treated; and, if necessary, a conference might be arranged. He thought the payment of £63 as the rateable value of the Kingston-road was insufficient. He then moved the adoption of the report. The report was adopted without further discussion.

Luton.—The borough engineer has reported to the Tramways Committee that in January last he received a letter from the chief engineer of the Midland Railway Co. stating that his company could not agree to the lowering of Old Bedford-road under their bridge unless the foundations were carried down to the new level and the abutments strengthened by means of new counterforts, the estimated cost of which would be £890; and that, after interviewing representatives of the railway company and considering the plans, he informed the company that he was prepared to recommend the Corporation to pay the cost of underpinning the abutments and one-half of the cost of erecting the new counterforts, which would amount to about £620. This offer the Midland Railway Co. were prepared to accept. It has been recommended that the Council make the offer above referred to, and that the borough engineer be instructed to approach the company with a view to the work being commenced as early as possible, so as to avoid any delay in the construction of the tramways.

Matlock.—At the Council meeting the cable tramway foreman (Mr. Foster) stated that he was pleased to report a profit of £127. 12s. 5d. on the month of August working of the tramway. The income for the month was £217. 8s. 8d., and expenses £89. 16s. 3d. The income is £6. 14s. 2d. more than in the corresponding month of last year. The income from the delivery of luggage for August was £9. 9s. 7d. The total amount in the bank in hand when all the accounts are paid up to date is £150. 6s. 9d. If they had a good month's working for September and October, they should have a good balance in hand to commence the winter season. Last year, with Easter being in March, the cars just paid their way in the winter, so if the takings increased this winter in proportion to what they have done this last three years, the cars will pay their way, and not run at a loss during the winter months. Early on Saturday last the cable had to be stopped, as a strand broke, and the cars restarted again at 12.30 mid-day. The chairman said the report was very favourable.

Tramway and Vehicle Workers.—The Amalgamated Association of Tramway and Vehicle Workers (East London branch) held a supper at the Lifeboat, East India-road, on Friday last, to celebrate a successful issue of the concert at Limehouse Town Hall on Aug. 29, for the benefit of Harry Churchman. A nice spread was prepared by Mr. H. Emmens (proprietor of the above establishment), which gave everyone the utmost satisfaction, and during the supper the following toasts were proposed and acknowledged: "The King" "Host and Hostess," "Visitors," and "Committee, Chairman, and Secretary," which were followed by a musical evening. Messrs. Badcock, Brooks, Horey, Watts, Turner, Johnson, Fuller, Blackburn, and H. Emmens contributed towards the programme. At the conclusion the chairman (Mr. Robson) spoke of the support they had received and said it was most gratifying to the branch to see such a splendid muster on the concert night, and on behalf of the committee, secretary, and himself he thanked everybody most heartily for the way they had responded to the tram men's appeal.

Dalkeith.—The Town Council have received a reply to a letter written by the town clerk inquiring what progress was being made with the scheme for commencing the electric trams between the Edinburgh city boundaries at Nether Liberton and Dalkeith and Eskbank, a distance of half a dozen miles, which undertaking aroused so much interest a year or more since both in Edinburgh and Dalkeith. The promoters obtained permission to not only run passenger trams, but to convey articles of general merchandise, and also live stock if so inclined. The secretary of the syndicate states in his letter that arrangements for financing the undertaking are still under consideration, and until these have been satisfactorily concluded he is unable to give a definite reply. He can assure the Council that no effort has been wanting on the part of the promoters, but the delay is solely attributable to the extreme stringency of the money market. Owing to this their financial advisers inform the syndicate that progress is at present impossible. The secretary added that the syndicate hope to be in a position to write a further reply towards the end of October.

Battersea.—Except for the Nine Elms route, Battersea and Wandsworth town are badly served by tramways. The line from East-hill over Lavender-hill and through Wandsworth-road is worked by horse cars. The time-table, if one exists, is by no means adhered to, mainly because of the vexatious delays inevitable on a single line sparsely provided with loops and passing places. A scheme of electrification was proposed by the late County Council, trial holes were made, and widenings were commenced. When the subject came before the committee of the new Council, however, it was decided to defer the carrying out of any scheme because of the cost and difficulties which would attend the widening of portions of the road for a double line. This decision gave rise to considerable dissatisfaction in the district, and called forth protests from Battersea borough councillors. Mr. Shirley Benn, L.C.C., who is a member of the Battersea Borough Council, offered "informally" to arrange a conference of representatives of the authorities concerned for the purpose of ascertaining the requirements of the district and of considering the best methods of meeting them. A resolution was moved on the Council to send a deputation, but the date of the conference has not yet been fixed.

District Railway Fatality.—Mr. John Troutbeck held an inquiry at Wandsworth concerning the death of Violet Blanche Foster, 28, wife of an electrician, residing at 472, Merton-road, Wandsworth. She received fatal injuries in falling from a train on the District Railway, at Southfields Station, on Saturday night. The Coroner said it had been clearly proved that the gateman opened the gates before the train had stopped, and it was marvellous that the four or five passengers who were standing with their backs against the middle door did not fall out. That the train did not give a jerk or increase its speed after slowing down was borne out by the evidence. How Mrs. Foster came to fall out was not quite clear, but it was possible that Hutchin grasped her in falling. Although the gateman's act was wrong, he did not suppose the jury would regard it as a criminal matter. Whether or not there would be consequences on the civil side was not a matter for them. The jury returned a verdict that Mrs. Foster died through falling from a train, and added, "We wish to blame the gateman for opening the doors before the train had stopped."

Clayton-le-Moors.—The District Council have received the following communication in reply to their suggestions as to an alteration of material for paving the tramway tracks and for the provision of double lines throughout the route from Mr. A. H. Aitken, town clerk of Accrington: "My Council do not think the gradient from the Load of Mischief to the terminus so great as to call for any change from the style of granite paving that has existed for 21 years. Any new granite setts that may be required will be of a rough, non-slippery kind. Quite apart from the question that any possible service to Clayton can easily be met without delay on the lines as proposed to be laid, all the special points and crossings have long since been ordered and are delivered, and these would have to be sacrificed if double lines were now put down. There are also other, and obviously serious, reasons against the extra expense, not only of construction, but of maintenance that would prohibit the doubling of these lines throughout. We are doing all we can to keep steam tram communication open to the fullest possible extent during the progress of reconstruction, and will offer every reasonable facility for vehicular traffic that any private party may desire to run. In any case it is clear great inconvenience will be caused for a time, but we shall do everything in our power to make the period of upset as short as possible."

Turkey.—The British consul at Damascus reports that the work for the electric tramways and lighting of Damascus was continued throughout the year 1906, but the company failed to bring it to an end at the expiration of that year. It was not till Feb. 7 of the current year that the company could inaugurate the enterprise and announce the completion of the tramway part of it, which is 5 300m. long, connecting the two furthest extremities of the city. The rolling stock in possession of the company now is 19 motorcars and six tandem cars ("voitures remorques"), brought from Belgium at a cost of 15,000fr. each. The minimum power at the waterfalls of Tekiyeh (some 90ft. high) is calculated at 1,000 h.p., produced by three turbines imported from Switzerland at a cost of 10,000fr. each. The electric power conveyed from Tekiyeh to Damascus—a distance

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of 19 miles—is produced by three motor dynamos, three current transformers, and 250 accumulators, all imported from Belgium. The total expenses of the company incurred for the realisation of this undertaking are approximately as follows: concession, 900,000fr.; materials, 1,200,000fr.; expenses of construction, 1,400,000fr.—total, 3,500,000fr. The capital of the company was 6,000,000fr., of which 4,000,000fr. were held by the Société Générale de chemins de fer économiques, the Société Générale Belge d'Entreprises électriques, and the Compagnie de Railways et d'Electricité. These three Belgian companies have their headquarters at Brussels. As regards the prospects of the company it is too early yet to make and forecast.

New South Wales.—The report of the Public Works Committee on the proposed construction of an electric tramway from Harris-street, *via* the Glebe Island Bridge, to Evans-street, Balmain, has been laid upon the table of the Legislative Assembly. The committee recommended that the line should be constructed as the first section of a line from Balmain to Sydney, *via* Glebe Island and Pyrmont Bridges. The estimated cost of the line is £50,720, including £16,500 for rolling-stock, and £11,500 for power and feeder cables. The Railway Commissioners estimated the annual expenditure (including interest on the proposed service at £43,600, and the annual revenue at £46 381.—The report of the Chief Commissioner of New South Wales Government tramways shows a very prosperous state of affairs. The number of miles of line open on June 30 last was 128¾. The expenditure charges to capital account during the year amounted to £68,302, but was reduced by credits to £428. The total capital expenditure on lines open for traffic on June 30, 1907, was £3,659,524. The total earnings amounted to £908.701, as compared with £851,483 last year, being an improvement of £57,219, or 6·72 per cent. After making liberal provision for the general upkeep of the property, and providing a sum of £20,000 for the North Shore line and £25,000 for the Ocean-street line towards writing down the capital cost of the old cable plants, conduits, etc., also £25,000 for a similar purpose in connection with the old steam and cable rolling-stock, not required since the introduction of electric working, the total expenditure on revenue account amounted to £727,947, as compared with £665,083 for the previous year, an increase of £62,864, or 9·45 per cent. The percentage of expenditure to receipts is 80·11 per cent., as compared with 78·11 per cent. last year. The net result, after providing for all working expenses and £131,791 interest on the capital interested, is a surplus of £48 961, as compared with £55,960 last year. The earnings per tram mile were 1s. 1d., and the working expenses per tram mile 10¼d. The number of passengers carried was 165,017,982, as compared with 145,262,779 in 1906.

Liverpool.—The traffic returns were presented to the Corporation at their last meeting. These showed that for the fortnight ended Aug. 31 the receipts were £21.974, as compared with £22,403 in the corresponding period of last year; passengers carried numbered 4,719,646, as against 4.822,017; while the mileage showed an increase of 2,609 miles. The chairman of the Traffic Sub-Committee remarked that the traffic returns were not satisfactory, inasmuch as that although they had run 2,609 miles more their receipts were down £429, and the number of passengers carried reduced by 102,000. This showed a loss which the committee had suffered in common with all the passenger-carrying concerns in the country, and they attributed it to the bad weather. The traffic manager's report was read regarding the request of a deputation of the tradesmen of Manchester-street that some of the cars now passing along Dale-street should be run down Manchester-street, up St. John's-lane, and thus to Lime-street. This proposal, said Mr. Mallins, would be seriously opposed by passengers, as the cars would take a longer time to cover the distance. A similar objection applied to the suggestion that some of the South-end cars should be diverted so as to pass along Manchester-street and St. John's-lane, instead of along Elliot-street and Church-street, as at present. Five more cars would be necessary to cover the increased distance, involving an additional expenditure of £5,000 a year, while there was little hope of the receipts increasing. There was only a single line along Manchester-street, and single lines, where operated, were unsatisfactory. Manchester-street would have to be widened and a double track laid to meet the requirements. This street was only 209 yards long; at the Dale-street end 170 cars passed per hour, while at the Old Haymarket end the number was 64 per hour. Mr. Lloyd stated that in view of that report the sub-committee could not grant the request of the deputation. This was the first complaint received of trade being destroyed because the cars did not pass along a street. Generally the grievance was the other way. It was necessary for the committee to consider the interests of passengers as well as ratepayers in a particular locality. The sub-committee's decision was then confirmed.

LIGHTING AND GENERAL

Harrogate.—The Council are seeking power to borrow £16,500 for an extension of the electricity undertaking.

Huddersfield.—The Local Government Board have sanctioned the borrowing of £16,500 for electric lighting purposes.

Escrick.—The village has been illuminated by the introduction of the electric light through the instrumentality of Lord Wenlock.

Llansamlet.—The Swansea Rural Council have decided to apply for a provisional order for the lighting of Llansamlet by electricity.

Gelligaer.—The school managers have asked Messrs. Guest, Keen, and Co. to quote terms for supplying electric light to Bedlinog School.

Electricity Supply Co. for Spain.—We are informed that the offices of this company have been removed to 88, Leadenhall-street, E.C.

Boroughbridge.—Telephone exchanges have been opened at Boroughbridge and Hammerton in connection with the National Telephone Co.

Carnarvon.—At the last meeting of the Council it was decided to enter into an agreement with the Harbour Trustees for laying cable along Balaclava-road.

Kettering.—A Local Government Board inquiry is to be held into the application of the Council for sanction to borrow £3,500 for the electricity undertaking.

Bury.—The Council are seeking sanction to the borrowing of £2,900 to defray the cost of erecting a refuse destructor and building at the electricity works.

Gowerton.—Lighting operations are being pushed on, and during next week Gowerton will rank as a modern town by having its streets illuminated by electricity.

Dudley.—The Corporation have decided to apply for sanction to the borrowing of £95,000 for the purpose of purchasing the tramways and light railways in the borough.

Bolton.—We learn that the boom in the coal trade will make a difference in the municipal electricity departments here of between £1,300 and £1,400 on the year's working.

Stalybridge.—The Tramways and Electricity Board are applying for sanction to borrow £3,908 for electricity purposes. Cables are to be laid to Thompson Cross and the Woodlands, Stalybridge.

Broughty Ferry.—The amount of electric current generated at the Corporation electricity works during August was 7,215 units, an increase of 1,607 units as compared with August of last year.

Kalgoorlie Electric Power and Lighting Corporation.—The directors have declared a dividend on the preference shares at the rate of 6 per cent. per annum for the six months ending Sept. 30, 1907.

Chloride Electrical Storage Co.—The directors of the Chloride Electrical Storage Co. in their report for last year declare a dividend of 10 per cent., with £5,000 carried to reserve and £12,382 forward.

Callan.—The Rural District Council have resolved to take the necessary steps to obtain a provisional order to provide and supply electricity for public and private purposes within the Council's jurisdiction.

Notice of Intended Dividend.—The *London Gazette* announces that the last day for receiving proofs in the estate of K. C. Moran, electrical engineer and contractor, 30, High-street, Coventry, Warwickshire, is Sept. 21.

Thornhill.—The District Council have decided to recommend the Council to apply to the Board of Trade for a provisional order authorising the Council to supply electricity for all public and private purposes throughout the district.

Northallerton.—At the last meeting of the Urban District Council the clerk was instructed to write to the electric lighting company asking them if they were prepared to make them a definite offer to sell the Council the electric lighting works.

Crook.—At the monthly meeting of the Urban Council a letter was read from the County of Durham Electrical Power Distribution Co. stating they expected to give a general supply of electricity to the district not later than January of next year.

Edinburgh.—The Electric Lighting Committee of the Town Council have agreed to recommend the Council to reduce the rate per unit by ¼d. to ordinary consumers. Should the Council adopt the recommendation, the rate will be 2¾d. per unit.

Wishaw.—The Town Council have agreed to the promotion of a provisional order, the object being to have legalised the system known as "free wiring" in connection with the electric lighting undertaking, and to obtain power to borrow a sum of £3,000.

South Metropolitan Electric Light and Power Co.—The transfer register for 4½ per cent. first mortgage debenture stock of this company will be closed from the 17th to 30th inst., both days inclusive, for the preparation of warrants for payment of interest.

Bishop's Stortford.—At the last meeting of the Urban District Council notice was given that at the next meeting a resolution would be moved that the Council take into consideration the provisional order for electric lighting which was granted to the Council some time ago.

Ellon.—The necessary guarantee bond has been signed by four guarantors for a telephone installation. Several business men have indicated their intention of taking an instrument, and when the call office is established it is anticipated that several traders will adopt the method of communication.

Yarmouth.—The Local Government Board, in granting sanctions to loans for £940, £3,000, and £2,800 to defray excess expenditure on previous loans for additional plant by the Corporation, and to meet mains extension and house services, have cut out £295 for "interest and sinking fund during construction."

Bangor.—The tariff of charges for the use of electricity has been revised as follows: for all units used between 11 p.m. and dusk the day following, 3d. per unit, provided that not less than 200 units per quarter be taken during those hours—the rates now current to apply if the consumption be under 200 units.

Agency.—We understand that the United Electrical Co., of Budapest (who are members of the European Incandescent Lamp Manufacturers' Syndicate), have placed the sole agency for the sale of their incandescent lamps with Messrs. G. Straus and Co., London, including also the "Wolfram" metal filament lamps.

Eccles.—The Council have resolved, as a case of urgency, to lay a new feeder cable from the generating station *via* Trafford-road to Church-street, and connected up so as to supply consumers in Church-street from Trafford-road to Eccles Station, without waiting for the formal sanction of the Local Government Board to the loan.

Roydon.—Strong complaints were made at the last meeting of the District Council as to the manner in which the paving flags had been relaid by the Post Office authorities after laying underground tele-

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phone wires. The Council decided to take up with the authorities with a view to securing an agreement for the proper completion of the work.

Stock Exchange.—The Stock Exchange Committee has appointed Sept. 26 a special settling day in Kepitigalla Rubber Estates' further issue of 5,500 vendors' shares of £1 each, fully paid, Nos. 219,501 to 225,000. The committee has also ordered Kepitigalla Rubber Estates' 225,000 shares of £1 each, fully paid, Nos. 1 to 225,000, to be quoted in the official list.

Willington.—The Council have agreed to ask the County of Durham Electrical Power Distribution Co. to give a price per unit for supplying electricity for lighting purposes in the Council's area by overhead mains, with the exception of that portion of the main road between North-lane End and White House Bank, the mains for this part to be underground.

Eastbourne.—The Telephone Co. have asked permission of the Council to erect a telephone call office at each of the following points—viz., on a space near the free library, at the corner of Devonshire-place and Cornfield-road, and at the junction of Meads, St. John's, and Milnthorpe roads—but the Council have replied stating they cannot entertain the application.

St. Annes.—The accounts of the St. Annes Council for the past year show that the income exceeded the expenditure by £56. The total income for the year was £14,849. The electricity department showed a surplus of £4,534, against £3,858 last year. After paying loan instalment and interest there was a surplus of £1,765. Of this £700 goes to the relief of the rates.

Cheltenham.—The adoption of the report of the Electricity Committee has been resolved upon by the Council. In it an expenditure of about £80 on the electricity main in High-street appeared, owing to there having been large additions to the lighting system in the part of High street from the grammar school to North-street, and consequently the cable put down was not large enough to carry the current.

Oxford.—At the last City Council meeting the General Purposes Committee recommended that permission be granted to the Oxford Electric Co. to place two electric feeder pillars, one at the south-west corner of Walton-street and Walton-crescent, and the other at Carfax close to the southern wall of the tower, on payment of the sum of 10s. per annum for each pillar. The recommendation was adopted.

Manitoba.—The Provincial Cabinet of Manitoba has let the contracts for the construction of a telephone system for the province, commencing with Winnipeg. The central exchange will be in Winnipeg, and work is to be pushed forward in connection with this exchange and the subways of the system with all speed. As rapidly as possible the system is also to be placed at the service of the outlying parts.

Gillingham.—At the last meeting of the Council the electrical engineer reported that the equivalent of 346 8-c.p. lamps had been connected with the mains, and the equivalent of 12 8-c.p. lamps had been disconnected, owing to removal, since the last meeting of the committee, making a total of 27,123 equivalent in 8-c.p. lamps with 299 consumers connected, and that applications had been received for the equivalent of 66 8-c.p. lamps.

Rugby.—The Postmaster-General is seeking sanction from the Council for placing underground telegraphic lines along Pinders-lane, Castle-street, Church-street, Chapel-street, Little Church-street, Sheep-street, and Barley-road. The Council have given their consent, but have pointed out to the G.P.O. authorities that the proposed wires will be in close proximity to their electrical cables, and have asked for the observance of special precautions.

Darlington.—The Electricity and Light Railways Committee have reported to the Council that they have authorised the engineer to arrange terms for supplying electric light to the new Palace Theatre. An application had been received from the Darlington Wireworks Co. to have a new main laid to their works, and it was recommended that the town clerk and the engineer be authorised to enter into an agreement with the company for the supplying and laying of the same.

Belfast.—A scheme is on foot for the supply of electrical power and light in a large area outside Belfast, the consulting engineers of the scheme being Messrs. Miller and Wilson, Belfast. The scheme embraces the erection of one or two large power stations for the supply of power and light in bulk at low rates to mills, factories, and other large public concerns, with which the district around Belfast is covered. Of course, this would in no way interfere with the municipal lighting and power.

Perth.—At a recent meeting of the Electricity Committee of the Town Council it was reported that the contract with the Electrical Storage Co. for the maintenance of the battery at the electric works had expired, but that the battery had been left in an unsatisfactory condition. The committee instructed the clerk to insist on the battery being put in order. During the month of August 66,937 units were generated, as compared with 57,307 units in the corresponding month of last year.

Corbridge.—In consequence of the gaslight company and the Parish Council at Corbridge being unable to agree as to the terms for lighting the village and approaches during the ensuing winter the lamps have not yet been lit, and as the former show no signs of relenting, the sub-committee of the Parish Council were at their last meeting empowered to make such other arrangements as might be deemed necessary in regard to the matter. Probably an installation of electricity will be considered.

Colchester.—At the monthly meeting of the Town Council the Electricity Supply Committee recommended that an electric exhibition be held in order to bring the undertaking more prominently before the public. The members of the committee had inspected the mechanical stokers in use at supply stations at Smithfield, Hampstead, and Great Northern Central, and they recommended that six pairs of mechanical stokers be obtained at a cost of £1,017. 15s., payment to be made out of revenue by four yearly instalments. The report was adopted.

Bo'ness.—At Linlithgow County Court the National Electric Construction Co. and the Town Council of Bo'ness appealed against the assessor's valuation of the Bo'ness electric lighting works. The assessor's valuation was £1,300, and the appellants asked it reduced to £400, which was the figure the valuation judges fixed last year. After hearing expert evidence by Mr. J. W. Spencer Hawes, engineer, London, and Mr. M'Gowan, resident engineer, the Court reduced the valuation to £720. The appellants intimated that they would again appeal to the valuation judges.

Longton.—In the electricity department of the Corporation the number of units generated for the five weeks ended Aug. 22 was 12,652, against 6,956 for the corresponding period of last year, being an increase of 81 per cent. During the past five weeks 40 additional lamps have been fixed. Sanction of the Local Government Board has been granted for the loan of £2,000 for electric lighting purposes for a period of 17 years only. It has been recommended that the town clerk be requested to represent to the Local Government Board the desirability of extending the time of repayment from 17 years to 25 years.

Altrincham.—The Altrincham Urban Council have passed a resolution calling a conference of representatives of the Councils of Altrincham, Bowden, and Hale for the purpose of drawing up a scheme for the acquisition of the Altrincham Gas Co. and the Altrincham Electric Supply, on the basis of a joint and mutual ownership and the creation of a joint board of management. It was stated that the price at which the gas company was offered to the Council three years ago was £187,000. The price fixed by the directors of the electric supply was £99,000, but the negotiations at that time were not carried through.

Helmsley.—Reforms of any kind usually come tardily in the villages, and the action of the Helmsley Parish Council in laying aside the telephone question is rather disappointing to many who are anxious to see it introduced in the Ryedale district. The fact that not many districts where there are towns and villages of any importance are without the telephone call office at once proves that modern conditions demand it, and surely Ryedale has towns and villages large enough and business men and women with sufficiently important commercial interests to make the question of acquiring telephonic communication a matter for serious consideration.

Dundee.—The Electricity Committee of the Town Council is awaiting a further fall in the copper market before they place the contract for the high and low tension mains for the new electric generating station. The engineer has submitted eight offers from leading British firms to a meeting of the committee, but in view of the high price of copper quoted and the gradual fall in the market during the past few weeks he was instructed to take in fresh tenders, and to call for offers from foreign manufacturers. With this end in view it was decided to defer consideration for three weeks. In the matter of the coal contract, it was reported that the chief contractors adhered to their position, and that no change could be made.

Lowestoft.—At the last meeting of the Council the Electric Lighting Committee reported that the engineer's statement showed that there were now connected to the mains 784 consumers, representing 39,430 8-c.p. lamps. Since the last meeting two consumers, representing 183 8-c.p. lamps, had been connected. There were five or six installations in hand. The engineer reported that a new valve-chest was required for one of the pumps in the boiler-house, and was authorised to procure the same at a cost of £7. 10s. The engineer reported that he had obtained fresh tenders for free wiring, and after submitting the same to the chairman, the tender of Messrs. Mann, Egerton, and Co., being the lowest tender, had been accepted, and this was approved.

Liverpool Electrical Association.—By the courtesy of the Liverpool United Gaslight Co., the members of this association paid a visit to the Linacre gasworks on the 7th inst. The party were met by the works manager, Mr. M'Ewan, who, with his assistant, conducted the members all over the plant, explaining the various processes of gas manufacture. After an exhaustive inspection had been made of the whole works, the party were very thoughtfully served with refreshments. Mr. S. Frith, the hon. secretary and treasurer, afterwards proposed a hearty vote of thanks to the gas company, Mr. M'Ewan, and his assistants for the very kind way in which they had been received and entertained. Mr. Myer supported the proposition, which was carried with applause.

Lichfield.—The surveyor has reported to the Rural District Council that he has received a letter from the National Telephone Co. asking permission to erect a line of telephone poles, 60 in number, from Aldershaw through Wall and Chesterfield to the railway bridge at Shenstone. He suggested that the following conditions should be agreed to by the company before the Council gave their consent: (1) poles to be removed or set back on three months' notice by the Council at the expense of the company; (2) the payment of 1s. per pole per annum to the Council for all poles erected on the road side of the hedge; (3) the adjoining landowners' consent to be obtained; (4) the poles to be erected in such places to be agreed upon between the landowner and the surveyor. The Council approved of the surveyor's suggestions.

Yardley.—A matter which has been in hand for some considerable time, and has come before the Council on several occasions, will be considered at a special meeting of the Rural District Council. The meeting is convened to receive and consider the report of the Tramways and Electric Lighting Committee. The committee have had under consideration two proposals for the supply of electric power to the district—one from Birmingham Corporation and another from Shropshire, Worcestershire, and Staffordshire Electric Power Co.—and the proposals of each have been discussed and rediscussed. At a recent

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meeting of the Council the whole matter was referred back to the committee, who have been making various investigations and inquiries. Their report and the action of the Council thereupon is being looked forward to with much interest.

Morley.—At the Electric Lighting Committee's last meeting a statement presented by the borough electrical engineer, Mr. J. E. Ellis, showed that the output from the electricity works for the month of July was 8,568 units, as compared with 6,072 units the same month last year, being an increase of 2,496, and that there had been sold to consumers by meter 7,177 units, as compared with 4,229 units the same month of last year, being an increase of 2,948. Two motors had been connected during the month, making 30 motors connected, with an aggregate of 96 h.p. It was resolved that, in order to determine the charge to be made for steam for heating the public baths for the year ending March, 1908, the engineer be instructed to make an observation of the quantity of coal and water consumed during November next in raising the steam exclusively used by the baths department.

Swansea.—At the last meeting of the Corporation Electric Lighting Committee a report was presented which showed that the total units generated (excluding the tramways) from April 1 to Aug. 29 was 600,653, as against 499,658 in the corresponding period of last year. The number of consumers at the end of July last was 1,012, and there had been 12 added since and seven discontinued, leaving the number on the books at Aug. 31 at 1,017, as against 850 in the same period last year, an increase of 19·6 per cent. A committee was appointed to consider the question of holding an electrical exhibition in Swansea shortly. The borough accountant at the final meeting of the Swansea Corporation Telephones Committee stated that the Corporation had received from the National Telephone Co. a cheque for £26,939 for the telephone undertaking, and the profit to the Corporation would be at least £1,000.

Dunrobin Castle.—The work in connection with the instalment of the electric light at Dunrobin Castle is now completed, and it will be largely used during the functions connected with the visit of H.R.H. the Duke and Duchess of Connaught. It has been found possible to retain the magnificent historical candlelabra in the dining-room, drawing-room, and main staircases. In place of wax candles, electric lamps an exact imitation of the shape and colour of a wax candle have been fitted. In many of the other rooms the existing valuable fittings have been adapted and fitted with electric lamps. Electric fans for ventilating purposes have also been fitted, and now gas has been dispensed with for lighting, heating, and ventilating purposes. The Duke of Portland has also recently had Langwell House, on his Caithness estate, similarly lighted and heated by electricity.

Luton.—The electrical engineer has reported to the Electrical Light Committee that since July 12 105,666 units had been generated, an equivalent of 358 8-c p. lamps, and 13 motors of 130 h.p. connected, making a total of 414 consumers with 23,316 lamps and 204 motors of 1,279 h p. ; that the units generated showed an increase of 106 per cent. over the number generated during the corresponding period of last year ; and that at the present time applications were in for over 1,000 additional lamps and 53 h.p. in motors. To the same committee the town clerk has reported that he had applied to the Local Government Board for their sanction to the Council borrowing the sum of £2,500, required for the purpose of extending the plant and buildings necessary to supply the tramways with energy, which formed part of the recent inquiry held by the Board. Instructions have been given to the electrical engineer to advertise for tenders for supplying the plant.

Seaham Harbour.—The inquest on the bodies of the two men, George Attwood and Henry Dunn, who were killed at the Dawdon Colliery on Friday last has been held, Mr. Donald Bain, Government inspector, being present. Six men were descending a new shaft, an electric lamp being lowered after them, when the cable of the lamp broke. It was shown that the break was due to the electric light cable fusing. Fourteen hundred feet of cable fell 1,500ft. down the shaft. The men were in a kibble close to the bottom. Arthur Andrews, of Messrs. Reid, Ferens, and Co., electrical engineers, said that the cable was ample for the purpose for which it was used. As the result of his examination he came to the conclusion that the breakage was due to fusion. There was no means of providing against fusion. A cable might be all right when examined and yet fuse soon afterwards. In answer to Mr. Bain, the witness said that fusion had been set up by chemical action, moisture having got through. He had never known it happen in a shaft cable before. The jury returned a verdict of accidental death.

Glass Telegraph Poles.—Consular-Agent Gustav C. Fothe, of Cassel, an agency of the Frankfort consulate, states that an architect of that city has been granted patents in Germany and other European countries, and also in the United States, for an invention for the manufacture of glass telegraph and telephone poles. Mr. Kothe writes: "A stock company has been organised and a factory for the manufacturing of glass poles has been built at Grossalmerode, a town near this city. The glass mass of which the poles are made is strengthened by interlacing and intertwining with strong wire threads. One of the principal advantages of these poles would be their use in tropical countries, where the wooden poles are soon destroyed by the ravages of insects, and where climatical influences are ruinous to wood. The selling prices of the poles has not been fixed yet, but the company is willing to accept 25s. for a pole of the length of about 23ft. The Imperial Post Department, which has control of the telegraph and telephone lines in this country, has ordered the use of these glass poles on one of their tracks."

Wireless Telegraphy.—A new naval wireless telegraph station has been erected in the New York Navy Yard, and is now being put to a series of tests. The station was projected for the specific purpose of maintaining communication between the Navy Department at Washington and the New York station, and was particularly designed in order that these centres might be independent of the telegraph companies. Tests have been made with Washington, Boston, and Newport, and officers in charge of the station declare that further tests will be made with ships far out at sea, probably as far distant as 1,000 miles. When the apparatus is further perfected it is believed that communication with England may be accomplished. It is the ultimate purpose of the Government to establish a chain of wireless stations which will connect Washington with all of the large cities on the Atlantic, Gulf, and Pacific coasts, and practically free the Government from dependence upon the telegraph. In connection with the station in New York there is a training school for operators, attended by 147 students. The course of instruction covers a period of six months, and applicants are required to pass a rigid examination before they are admitted into the school.

Grimsby.—An Act of Parliament has been passed confirming the Grimsby Electric Lighting (Extension) Order, 1907, authorising the supply of electricity by the Grimsby Corporation to the Immingham Dock area, and the parish of Immingham and other neighbouring parishes. At a meeting of the Public Lighting Committee, Mr. W. A. Vignoles, the electrical engineer, reported a considerable increase in the number of units of power sold during August upon the corresponding period of the previous year. The increases worked out as follows : for traction, 5,432 ; public lighting, 29 ; Great Central Railway Co., 2),992 ; private consumers, 10,467 (33½ per cent.) ; or a total increase compared with August of last year of 41,920. The committee considered tenders for a two years' supply of cables, and decided to accept that of Messrs. Johnson and Phillips, amounting to £1.358. 4s. 3d. The committee acceded to requests received to increase by six the number of lamps in the People's Park. The engineer reported that the load upon the plant was increasing even faster than had been anticipated, and that the plant would be fully loaded during the coming winter, leaving very little margin for maintenance of a satisfactory supply in case of breakdowns. Whilst from one point of view this might be considered satisfactory, it was not, said Mr. Vignoles, a desirable position to be in, as any failure, even of a temporary character, would prove highly detrimental to the progress of the undertaking. In view, further, of the rapid developments now going on in the docks, the probability was that the plant would become heavily overloaded, and it was decided to proceed with the erection of the new extension plant, which will increase the power of the station by 316 kw. It was reported that the sanction of the Local Government Board had been received to the borrowing of £1,964, repayable in 18 years, for the new plant required.

Robertson Social and Athletic Club Sports.—The second annual sports of the above club took place on the club's large and spacious ground at Old Oak-road, Shepherd's Bush, and proved an immense success. Mr. H. Hirst (chairman of the directors) and Mr. C. Wilson (manager) were unable to be present owing to a business engagement, but sent a telegram expressing their regret at not being able to be present, and wished the employés an enjoyable time. Mr. F. P. Driver (works manager), Mr. C. J. Robertson (director), and Mr. A. Heden officiated as judges. Mrs. C. Wilson presented the prizes. Other officials present were : Mr. A. W. Pettitt (starter) ; Mr. H. Purle (timekeeper) ; Messrs. A. Kirkby, F. Pluck, and P. Pring (handicappers) ; Mr. G. H. Freeman (secretary) ; Messrs. J. Parrott, W. King, G. Hillman, E. Dobson, E. Furnell, Misses D. Dallender, L. Dazely, E. Payne, L. Langdon (stewards) ; Mr. and Mrs. Saville, Miss E. Willoughby, Miss Rowe, Miss D. Bailey, Miss P. Kimpton, Mr. S. G. Lowe, Mr. F. C. Brooks, Mr. Batstone, Mr. Vanhinsbergh, Mr. C. Wise, and Mr. and Mrs. Parrott. The North Middlesex Silver Prize Band played selections during the afternoon, and at seven o'clock the course was cleared for dancing. Mr. F. Pluck officiated as M.C. The ground was illuminated by hundreds of Robertson-made fairy lamps, and presented an extremely pretty sight. The total attendance was 700 to 800 people. The number of entries for races reached a grand total of 305. The chief events of the day were the men's 100 yards handicap, which was won by Mr. G. H. Freeman off scratch (time 11¼ seconds), and the ladies' three-lap bicycle race, which was won by Miss D. Dallender off scratch. Only inches separated her from Miss K. Morgan, who was a good second. The winner won on the post. At 9.30 the proceedings were brought to a close with "God save the King" after a most enjoyable day's sport.

Shoreditch.—At the last meeting of the Borough Council the Electric Lighting Committee presented an important report on the electric lighting accounts for the year ended March 31 last. The large increase in the sales (4,218,574 units as against 3,702,457 in 1905-6) had resulted in a reduction in the cost per unit from 2·49d. to 2 28d., but, on the other hand, the revenue had dropped from 2·55d. per unit to 2·36d. per unit, the reduction in the prices charged having been in force the whole year. The net profit of £1,756. 16s. 11d., after interest on and repayment of capital and all other charges except renewals, was carried to the appropriation account to meet the yearly instalment of the cost of change of pressure and the deficiency brought forward at the beginning of the year, with the result that there is an adverse balance of £665. 4s. 1d. to carry forward. The tonnage of refuse dealt with by the destructor showed a large increase (40,169 tons as against 34,994 tons for the previous year), but the refuse destroyed for the scavenging department was only 29,790 tons 13cwt., at a net cost to the general rate, including loan charges, of £6,013. 3s. 8 l., against 31,672 tons 14cwt., at a cost of £6,302. 16s. 2d., for the year preceding. The revenue from destroying trade refuse and sale of clinker increased by £126. 14s. 9d. The committee recommended that the accounts be approved subject to audit, and the balance of £665. 4s. 1d. carried forward, which was agreed to. The Lighting Committee further reported that they had considered a communication from the Hackney Borough Council drawing attention to the cost which would be incurred in providing testing stations for testing the pressure of supply all over the distributing network, if the powers

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possessed by the London County Council to require undertakers to provide such stations are enforced. The Hackney Borough Council consider that as such testing can be undertaken at any time on consumers' premises, the additional expenditure in erecting special testing stations is unnecessary until grounds of complaint are shown to exist. In order that common action should be taken by all the local authorities, a conference has been called by Hackney, and the committee appointed the borough electrical engineer as their representative. The action of the committee was approved.

Wrexham.—At a meeting of the Electricity Supply Committee the electrical engineer submitted his monthly report, which stated that during July 13,237 units had been used for tramways and 22,881 units for lighting. The electrical engineer and the borough accountant suggested the adoption of the following revised scale of charges for electrical energy for consumers whose quarterly consumption exceeded 250 units: for all energy supplied to such customers up to an amount equivalent to five units for each 8-c.p. lamp installed, 5d. per unit; for all energy consumed beyond such five units per 8-c.p. lamp installed, 2½d. per unit, the present discount of ½d. per unit for prompt payment to be continued. It was resolved that the above scale be approved, to come into operation on Oct. 1 next. The town clerk reported that the Council at a meeting in committee on the 7th inst. passed the following resolution: "That the Electricity Supply Committee be requested to prepare a scheme for such extensions of cables within the borough as may be deemed desirable with a view to its submission to the Local Government Board." The electrical engineer submitted estimates of the cost of extending cables along Bradley-road and King's Mills-road. It was resolved (*a*) that the electric cable be extended from Regent-street for a distance of 120 yards along Bradley-road, at an estimated cost of £90, in order to afford a supply of current to Messrs. G. F. and A. Brown's bottling stores; (*b*) that the electrical engineer be instructed to submit to the next meeting a scheme for such extensions within the borough as may be deemed desirable (including an extension in King's Mills-road), and that in the meantime the Watch Committee be requested to defer taking any further steps for altering the lighting of King's Mills-road. The electrical engineer reported that Messrs. Davies Bros., contractors for the erection of the Alexandra Schools in Holt-road, had applied to him for the hire of a 10-h.p. motor for a mortar mill on the site, and for a supply of electrical energy therefor. The engineer recommended that, as the Education Committee intended to light the schools by electricity, a cable be at once laid for a distance of 300 yards, at an estimated cost of £150, for the purpose of affording a supply of energy to Messrs. Davies Bros., and stated that the estimated cost of such a motor as was required by them was £60. It was resolved that the necessary cable be laid for the purpose named, and that in the event of Messrs. Davies Bros. being unwilling to purchase a motor, the electrical engineer be authorised to purchase one at the price named, and to let it on hire at an annual rental equivalent to 20 per cent. of the cost.

Bristol.—An inquiry has been held by Mr. H. R. Hooper into the application of the Council for sanction to borrow £34,600 for the purpose of their electrical undertakings at Avonmouth. The Town Clerk stated they were constructing a new dock at Avonmouth, where a large supply of current would be required. It was felt that the present was an opportune time for developing the Bristol electrical undertaking in the direction of Avonmouth, if it could be done there. Avonmouth was a considerable distance from the central generating station, and with a view to seeing if the Corporation could supply current at Avonmouth, negotiations took place between the Electrical Committee and the Docks Committee. The reason why the Corporation should supply the current, if possible, was that the Docks Committee could only supply themselves and not supply any other persons. It was very important for the development of their dock undertaking that they should have on the spot the general supply. The result of the negotiations was that the Docks Committee undertook to take 500,000 units per annum at a cost of 2d. per unit, an all-round charge for power and lighting, the Electrical Committee to make the supply as they thought fit. These arrangements were to be from time to time subject to revision, so that as the business at Avonmouth increased, and more customers came along to take the current, the arrangements would be revised, so that probably the Electrical Committee would be able to supply the current at a rather less price. In addition to the 2d. per unit, £150 a year was to be paid so that the Docks Committee should have the current for power purposes at two distinct pressures—500 volts for the new dock and 250 volts for the old dock. The change from 500 to 250 volts involved the extra expense, and it was thought by the two committees that it was fair that they should share that extra expense, and it was agreed that the Docks Committee should pay £150 a year. In the application they asked for a loan of £34,600, but in reality that would be reduced by £2,700, leaving £31,900, because the Board of Trade had now given their consent to the laying of three cables in one trench, instead of two as formerly required. Mr. Faraday Proctor then gave particulars as to the estimate for laying the cables to Avonmouth, and was then questioned by the inspector as to statistics. He stated that he asked the Local Government Board if there was any further information they could prepare, but had received no reply. The Inspector stated that he had come there to take evidence, and it was part of Mr. Proctor's evidence that he was expecting. He wanted the evidence that had been given to the committee that the scheme was the best and cheapest. Mr. Proctor stated that he had shown the committee that the cost of generation by the utilisation of the Temple Backs plant was greater than the transmission scheme. The Inspector: Now I want the proof. Mr. Proctor then supplied certain figures as to the comparative cost of the two schemes, but was pressed for further details, and said he could not supply figures of what had not come before the committee. The Inspector stated that in view of the want of evidence on material points he would adjourn the inquiry until Oct. 1. He had conferred with the town clerk, who agreed that they could not get ahead that day, as they had hoped to do, so that it was best to adjourn the inquiry.

PROVISIONAL PATENTS, 1907.

SEPT. 2.

19626. Improvements in electric locking apparatus for railway signalling. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

SEPT. 3.

19670. Friction permeameter for testing magnetic materials. William Henry Fullarton Murdoch and Alfred Thomas John Kersey, Technical College, Halifax, Yorks.

19672. Improvements in metallic filaments or the like for electric glow lamps and in the method of making same. Ges. für Verwertung Chemischer Produkte, m. b. H., 55, Chancery-lane, London. (Date applied for under Patents Act, 1901, Aug. 2, 1907, being date of application in Germany.) (Complete specification.)

19697. Improvements relating to the suspension of electric motors for electrically-propelled vehicles. Kalman v. Kando, Westinghouse Building, Norfolk-street, Strand, London.

19699. Improvements in and relating to signalling and like systems. Allgemeine Elektricitäts Ges., 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Sept. 3, 1906, being date of application in Germany.) (Complete specification.)

19708. Improvements in or relating to contacts for electric controllers or switches. Alfred White, 70, Chancery-lane, London.

SEPT. 4.

19734. Improvements in or connected with electric arc lamps. Otto Gross, 5, John Dalton-street, Manchester.

19738. Improved means for controlling mechanism operating valves, electric switches, rheostats, and the like. William John Poole, 121, West George-street, Glasgow. (Complete specification.)

19784. Improvements in and relating to switch mechanism for electrical signalling and like systems. Allgemeine Elektricitäts Ges., 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Sept. 5, 1906, being date of application in Germany.) (Complete specification.)

19789. Variation of candle-power in electric lamps. John Robert Quain and Charles Leland True, 109, Victoria-street, Westminster, London.

19794. Improvements in detectors for wireless telegraphy. Gesellschaft für Drahtlose Telegraphie m. b. H., 6, Lord-street, Liverpool. (Date applied for under Patents Act, 1901, Sept. 8, 1905, being date of application in Germany.) (Complete specification.)

19806. Improvements relating to dynamos especially applicable for exploding electric igniters. Harold Williamson Lake, 7, Southampton-buildings, London. (Fabrik Elektrischer Zünder, G. m. b. H., Germany.) (Complete specification.)

19805. Improved device for transferring drawings, manuscripts, and the like by electricity. Karl Wackermann, 116, High Holborn, London. (Complete specification.)

19808. Improvements in incandescent electric lamps. William Edward Barras and George Weddell, 24, Southampton-buildings, London. (Complete specification.)

SEPT. 5.

19855. Improvements in electrical switches. Thomas Large Boyden, 36, Queen-street, London. (Complete specification.)

19856. Improved means for connecting alternating-current generators to their prime movers. Siemens Bros. Dynamo Works, Limited, Queen Anne's-chambers, Broadway, Westminster, London. (Siemens-Schuckertwerke, G. m. b. H., Germany.) (Complete specification.)

19875. Electric hot-water radiator for heating buildings or the like. Cornelius George Nobbs and Cornelius George Nobbs, jun., Birkbeck Bank-chambers, Southampton-buildings, London. (Complete specification.)

19882. Improvements in and relating to dynamo-electric machines. The British Thomson-Houston Company, Limited, and Frederic Horton Clough, 83, Cannon-street, London.

19883. Improvements in and relating to protective devices for alternating electric current distribution systems. The British Thomson-Houston Company, Limited, Reginald Charles Clinker, Edmund Basil Wedmore, and Jonathan Edwards Woodbridge, 83, Cannon-street, London.

19891. Improved automatic safety device for overhead electric lines. Francois Fernand Bourdil, 7, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Sept. 7, 1906, being date of application in France.) (Complete specification.)

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SEPT. 6.

19907. New or improved portable electric vulcanising apparatus. John Hay, Haden Richardson Couper, and William Henry Lindsay, 100, Wellington-street, Glasgow.

19926. Electromagnetic separators. Wilfrid L. Spence, 31, St. Vincent-place, Glasgow.

19943. Process for manufacturing oxalates from the corresponding formates by heating in a space from which the air has been partially exhausted. Elektrochemische Werke, G. m. b. H., 27, Chancery-lane, London. (Date applied for under Patents Act, 1901, Oct. 13, 1906, being date of application in Germany.) (Complete specification.)

19945. Improvements in or relating to variable candle-power electric incandescent lamps. Thomas Nicholson Atkinson and Atkinson's Patents, Limited, 111, Hatton-garden, London.

19954. Improvements in and relating to connections for the windings of dynamo-electric machines. The British Thomson-Houston Company, Limited, and Karl Adolf Emanuel Tunelli, 83, Cannon-street, London.

19955. Improvements in and relating to electric power transmission systems. The British Thomson-Houston Company, Limited, and A. A. Pollock, 83, Cannon-street, London.

19975. Improvements in apparatus actuated by the passage of trains to control railway points or signals. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, London. (Siemens und Halske Aktiengesellschaft, Germany.) (Complete specification.)

SEPT. 7.

20005. Improved ceiling rose for use in connection with electric lighting. Stanley Johnston, 100, Wellington-street, Glasgow.

20040. Improvements in the regulation of continuous-current electric motors. Percy Bisset Down and Ernest Vyse, Birkbeck Bank-chambers, Southampton-buildings, London.

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Sept. 26.)

1906.

17384. Barrels for electroplating. Walker.

19461A. Systems of electrical distribution in which vapour-electric devices are employed. Thomas. (Date applied for under International Convention, Sept. 1, 1905. Originally included in 19,461/06.)

19805A. Receivers for wireless telegraphy. Artom. (Date applied for under Rule 5, Patents Rules, 1905, Sept. 5, 1906.)

19945. Electric storage batteries. Boyle and Hartley.

19956. Reading machines in which electrical apparatus control phonographs and telegraphones. Dragoumis.

20115. Telegraphic transmitters. Yetman.

20369. Switches for use in electric circuits. Broadbent.

21243A. Vaporisers for incandescent vapour lamps. Meissner and Danischevski. (Date applied for under Rule 5, Patents Rules, 1905, Sept. 25, 1906.)

22091. Bases of electrical fittings. Hirst.

24236. Manufacture of metallic incandescing bodies for electric lamps. British Thomson-Houston Company. (Allgemeine Elektricitäts-Ges.)

25632. Magneto-electric generators. Williams.

25685. Fuse heads for electric blasting. Render.

27099. Electrolytic manufacture of metal wire, strip, or the like. Cowper-Coles.

1907.

633. Alternating-current commutator electric machines. Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, Jan. 29, 1906.)

708. Electrical apparatus for signalling on railways. McMaugh and Welch.

5036. Manufacture of tubular articles by electrolysis. Uzac. (Date applied for under International Convention, March 3, 1906.)

5203. Brush carriers of electric machines. Kriéger and Compagnie Parisienne des Voitures Electriques (Proc dés Kriéger). (Date applied for under International Convention, Oct. 16, 1906.)

10993. Electric lighting of surgical specula and the like. Kaplan and Batault. (Date applied for under International Convention, May 14, 1906.)

12532. Contact spring for electrical apparatus. Deutsche Telephonwerke Ges. (Date applied for under International Convention, May 31, 1906.)

14238. Telegraph sounders. British Insulated and Helsby Cables, Limited, and Bartlett.

17894. Electricity meters. Compagnie de Construction Electrique. (Date applied for under International Convention, Nov. 10, 1906.)

COMPANIES' STOCK AND SHARE LIST.

Name	Amount paid.		Last price
Commercial and Industrial.	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	–	¼-⅜
—— Ord., 1 125,000	1	..	¼-¼
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	–	5/32 9/32
British Aluminium Co., Ordinary, 2,001-40,000	5	..	4¾-5¼
—— 7 per cent. Cum. Pref., 1-40,000	5	..	5-5¼
—— "A" 6 per cent. Cum. Pref., 1-20 000	5	..	4¾-5¼
—— 4 per cent. Funding Certificates, 1-20,000	5	..	3¾ 4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	100-103
—— 5½ per cent Loch Leven Deb (Reg.), Red., 1-3,000	100	..	96-99
British Insulated and Helsby Cables, Ord., 1-100,000	5	–	6¾ 7¼
—— 6 per cent. Cum. Pref., 1-100,000	5	–	6⅝-6¾
—— 4½ per cent. Mortgage Debentures	100	–	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	–	85 8) xd
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	3	–	1-1½
—— 4 per cent. Mortgage Debenture Stock	100	–	60 65
Brush Electrical Engineering, Ordinary, Nos. 1-105,751	2	–	¼-⅜
—— Non. Cum., 6 per cent. Pref.	2	–	⅜-1⅛
—— 4½ per cent. 1st Debenture Stock	100	–	86 89 xd
—— 4½ per cent. 2nd Debenture Stock	100	–	7 -74
Callender's Cable, Debentures	100	–	105)-107½
—— Ordinary	5	–	9¾ 10¼
—— 5 per cent. Pref.	5	–	5¼-5⅝
Consolidated Electrical Co., Ordinary, 1-110,000	1	..	⅜-½
Crompton and Co.	5	..	1⅞-2⅛
—— 5 per cent. Debentures	100	–	5 5 8
Dick, Kerr, and Co., Ordinary, 1 260,000	1	..	1⅛-1⅜
—— 6 per cent. Cum. Pref., 1-305,000	1	..	1-1¼
—— 4½ per cent. Debenture Stock, Red.	100	..	101-104
Edison and Swan United, "A" Shares, 1-99,261	5	–	1 1/16 1 5/16
—— "A" Shares, 01-017,139	5	–	2¼-2⅜
—— 5 per cent. Debentures	100	–	8) 82
—— 4 per cent. Deb. Stock, Red.	100	–	83 85
Electric Construction, Nos. 1 to 112,100	2	–	⅜-½
—— 7 per cent. Cumulative Pref.	2	–	1¼ 1⅜
—— 4 per cent. Perp. 1st Mort Deb.	100	–	77 81
Electrolytic Alkali Co., Ordinary, 1-202,218	1	..	⅜-⅝
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	—
General Electric Company (1900), 5 per cent. Cum. Pref.	10	–	8 8¼
—— 4 per cent. 1st Mort. Deb. Stock	100	–	92-96
W. T. Henley's Telegraph Works, Ordinary	5	–	11¼ 12½ xd
—— 4½ per cent. Preference	5	–	5-5½ xd
—— 4½ per cent. Debentures	100	–	105½ 107½
India Rubber, Gutta Percha, and Telegraph Works	10	–	13½ 14½
—— 4 per cent. Debentures	100	–	97-99
National Electric Construction Co., 1-170,000	1	..	27/32-31/32
Parker, Thos., Limited, Ordinary	10	–	10-10¼
Peebles (Bruce) and Co., 5 per cent. Cum. Pref., 20,001-50,000	5	..	3¼-4
Telegraph Construction and Maintenance	12	–	51-53
—— 5 per cent. Bonds	100	–	69½ 02½
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	..	9½-9¾

Electric Lighting and Supply.—

Name.	Amount paid.		Last price
	£		£
Adelaide Electric Supply Co., 6 p. c. Cum. Pref., 1-10,000	5	..	4¼-5 xd
Bournemouth and Poole, Ordinary	10	–	9¾ 0¾
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	–	9¾ 10¼
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	–	10 0¼
—— 4½ per cent. Debenture Stock, Red.	100	–	99 1 2
Bromley (Kent) Electric Light and Power Co.	5	–	4¾ ¼
—— 4½ per cent. 1st Debenture Stock, Red.	100	–	98 100
Brompton and Kensington, Ordinary	5	–	7¼ 8¼
—— 7 per cent. Preference	5	–	7¼ 8¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	–	6¾ 7¾
—— Nos. 80,001-100,000	4	–	6¼ 7¼
Cambridge Electric Supply Company, £10 Ord.	8	–	13¾-14¼
Canadian General Electric Co., Common Shares	$100	..	118-122
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	–	99 102
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	–	3¼ 4
—— 4½ per cent. Cum. Pref., 1-80,000	5	–	3¼ 4
—— 4 per cent. Debenture Stock, Red.	100	–	95 98
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	–	3⅜ 3¾
—— ditto (1905) 40,001-80,000	5	–	3¼ 4¼
Chelsea Electricity Supply	5	–	3¼ 4¼
—— 4½ per cent. Debentures	100	–	101-104
Chicago Edison Co, 1st Mt. 5 p. c. 30-yr. Gld. Bds, Red., 1-1,200	$1000	..	98-101
City of London, Ordinary	10	–	9-10
—— 6 per cent. Cumulative Pref.	10	–	10¼-11¼
—— 5 per cent. Debenture Stock	100	–	122-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	–	96-99
City of Wellington Electric Light and Power Co, 5 per cent. Registered 1st Debs., Red., 1-1,650	50	–	50-53
Cordoba Light and Power Co., 1st Mt Stl. 5 per cent. Bds., Red., 1-1,000	100	..	90-98
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5	..	4¼-5
—— 5 per cent. Preference, 1-50,000	5	..	4¼-5
County of London Electric Supply, Ordinary	10	–	7-8
—— 6 per cent. Cum. Pref.	10	–	10-11
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100	–	106-109
—— 4½ per cent 2nd Debentures Prov. Certs.	100	–	94 97
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5	–	½-1
—— 6 per cent. Cum. Pref.	5	–	1¼ 2
—— 4½ per cent First Mort. Deb	100	–	76 81
Electrical Development Co of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, (0,751-15,750)	—	..	74½-76½ p.c. xd
Electric Ry & Traction Co of Aust., 6 p c Cm Pf 1 30,000	5	–	2¼-2⅝
5 per cent Debenture Stock Red	100	–	85½ 89½
Electric Supply Co of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red	100	–	94½ 96½
Folkestone Electric Supply, Ord. Nos. 1-10,000	5	–	4¼-5½
—— 4½ per cent. First Deb. Stock, Red.	100	–	96-99
Hove Electric Lighting, Ord., 1-13,000	5	–	6¾-7¼
Indian Electric Supply and Traction Co., 5 per cent. Construction Deb. Stock, Red.	100	..	103-106
Isle of Wight Elec. Lt. and Pwr., 4½ p c. Db. Stk. Red.	100	–	94-97
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	–	—
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5	–	8¼ 8¾
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	–	94-97
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9¾-10¼
London Electric, Ordinary	3	–	1⅜ 1⅝
—— 6 per cent. Pref.	5	–	4¼-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	–	88-92

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Name.	Amount paid.		Last price
	£		£
Madras Electric Supply Corporation, 5 per cent. Construction Deb. Stock., Red. (Prov. Certs.), all paid	100	..	94-97
Metropolitan Ordinary, 100,001-300,000	5	..	5 6
—— 4½ per cent. First Mortgage Debenture Stock	100	..	103 07
—— 4½ per cent. Cum. Pref.	5	..	4⅞ 5⅛
—— 3½ per cent. Mortgage Debenture, Red.	100	..	87 92
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds. 1935, C 1-1,000 ($100), D 1-5,000 ($500), M 1-4,400 ($1,000)	—	..	73-75 p.c.
Mexican Light and Power Co., Capital Stock	$100	..	43-45
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($50), 4,001-14,000 ($1,000)	—	..	80 82
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	..	95-98
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,000	5	..	6½ 7
—— do., 57,001-75,000	5	..	6⅝ 7
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid)	5	..	6½ 7
—— 5 per cent. Pref., 1-57,000	5	..	5 5⅛
—— do., 75,001-87,500 (issued at 10s. prem., 4s. paid)	5	..	5-5⅛
Notting Hill Electric Lighting	10	..	11 12
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	..	95 97
Oxford Electric, Ordinary, 1-96 and 40-14,510	5	..	5⅛ 5⅜
—— 4 per cent. Debenture Stock	100	..	95 97
River Plate Electricity Co., Ord., 1-119,687 & 120,501-120,507	1	..	⅜-½
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	..	⅝-1
—— 4 per cent. Debenture Stock, Red.	100	..	95-98
Rosario Electric Co., 6 per cent Cum Pref., 1-20,000	5	..	5-5½
—— 6 per cent. Cum. 2nd Pref., 1-15,000	5	..	5-5½
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	..	96 98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	—	..	99-101 p.c.
Smithfield Markets Electric Supply, Ord. 1-12,000	5	..	½-1½
—— 4 per cent. Debenture Stock	100	..	71-75
South London, Ordinary	5	..	2-2½
South Metropolitan Electric Light and Power, Ord.	1	..	⅝ ¾
—— 7 per cent. Cum. Pref.	1	..	⅞-1 xd
—— 4½ per cent. 1st Mort. Deb.	100	..	100-103
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	7⅛ 8⅛
—— 7 per cent. Pref.	5	..	6⅝ 7⅜
—— 3½ per cent. Deb.	100	..	86 91
Urban Electric Supply Co., Ordinary, 8-30,007	5	..	1½ 2¼
—— 5 per cent. Cumulative Preference, 50,001-50,000	5	..	2 3
Westminster, Ordinary	5	..	8½ 9½
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	..	5-5½

Electric Tramways.—

Name.	Amount paid.		Last price.
	£		£
Anglo-Argentine, 5½ per cent. Cum. Pref., 1-260,007	5	..	5 15/16 6 3/16
—— Ord.	5	..	8 1/16 8 5/16
—— Permanent 6 per cent. Debenture Stock, 1888	100	..	121-124
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	..	102-105
Barcelona Tramways, Ord., 1-20,000	10	..	—
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	..	—
—— 5 per cent. Deb., Red., 1-600	100	..	—
—— 4½ per cent. Red. Deb. Stock	100	..	—
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1	..	⅜ ⅝
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	..	13/16-15/16
Birmingham and Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100	..	94-97
Blackpool and Fleetwood Tramroad	10	..	12⅝-13⅝
Bombay Elec. Supply & Trams. Co., 6 per cent. Cum. Pref.	8	..	7⅜-8⅛
—— 4½ per cent. Deb. Stock, Red.	100	..	94-96
Brisbane Tramway Invest., Ord., 1-75,000	5	..	3 3/16 3 7/16
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	..	4⅝-5⅛
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	..	96-100
British Columbia Electric Railway Co., Ord. Def.	100	..	127-132
—— Ord. Pref.	100	..	110-114
—— 5 per cent. Cum. Perpetual Pref. Stock	100	..	104-107
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	..	100-103
—— 4½ per cent. Vancouver Power Deb.	100	..	101-103
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	..	2⅛ 2⅜
—— 6 per cent. Cm. Pf., 30,001-60,000	10	..	6⅜ 6⅝
—— 5 per cent. Perpetual Debenture Stock	100	..	100-103
—— 4½ per cent. 2nd Deb. Stock	100	..	78-81
Buenos Ayres and Belgrano Trams.	5	..	4⅜ 4⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	..	4⅜-4⅝
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	4⅜-4⅝
—— 5 per cent. Deb. Stock, Red.	100	..	105-115
—— Prov. Cert., all paid	100	..	100-103
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100	..	92-97
Buenos Ayres Gl. Nat. Trams Co., 5½ per cent. Pref. Deb. Bonds, Red., 1-1,500	100	..	99-103
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	..	100-105
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red	100	..	91-94 xd
Calcutta Tramways, 1-105,000	5	..	7⅜-7⅝
—— 105,001-137,610	5	..	6-6½
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	102 106
Cape Electric Tramways, Nos. 1-480,000	1	..	5/16 7/16
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	..	4¼ 4½
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100	..	98 101
City of Buenos Ayres Trams. Co. (1904). 1-248,000	5	..	5½-5⅝
—— 4 per cent. Deb. Stock, Red. 1985	100	..	97-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	00	..	94 98
Cork Electric Tramway and Lighting Co., Ordinary	10	..	13-14
—— 6 per cent. Cum. Pref.	10	..	12⅞ 13⅞
—— 4 per cent. Debentures	100	..	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	..	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	..	12⅞-13⅞
—— 3½ per cent. Mort. Debs., 1-3,000 Red.	100	..	93-97
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100	..	98-101
Havana Electric Railway Consolidated Mort. 5 per cent, 50-year Coupon Bonds of 1952, 1-6,957	$1,000	..	82 87
Imperial Tramways, Ordinary	all	..	18-19
—— 6 per cent. Cum. Pref.	all	..	14-14½
—— 4½ per cent. Deb. Stock	100	..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5	..	1 1½
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	66-71
Kalgoorlie Electric Tramways, 1-250,000	1	..	3/32-5/32
—— 5 per cent. "A" Deb. Stock	100	..	89-93
—— 6 per cent. "B" Deb. Stock	100	..	78-82
Kidderminster and District Lighting and Traction, Pref.	5	..	9¾-10¼ xd
Lancashire United Tramways Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	..	94-97
—— £236,500 2nd Mort. Deb Stock	—	..	—
—— £83,330 Deferred Deb. Stock (all fully paid)	—	..	—
Lisbon Electric Tramways Limited, Ord., Nos. 1-594,188	1	..	1-1¼
—— 6 per cent. Cum. Pref., Nos. 1-425,553	1	..	1-1¼
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100	..	96 98
London United Trys. (1901), 5 per cent. Cum. Pref.	10	..	7⅞ 8⅛
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	82 86
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Rd.	100	..	96-99

Name.	Amount paid.		Last price
	£		£
Manila Elec. R. R. and Lghtg. Corp., 5 p.c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000	..	90-92
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 23,436-25,000	5	..	4⅞-5⅛
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	97-100
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	..	3/32 5/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	..	27/32-31/32
—— 4½ per cent. Deb. Stock, Red.	100	..	94-97
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	—	..	79-81 p.c. xd
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	..	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 601-2,000 (1922	100	..	101-103
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 54,001-74,000	5	..	⅜-1⅜
Oldham, Ashton, and Hyde Tramway, Ordinary	10	..	12
—— 5 per cent. Cum. Pref.	10	..	8⅜-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Sk.	100	..	100-104
Potteries Electric Traction, Ordinary, 1-245,000	1	..	5/16-9/16
—— 5 per cent. Cum. Pref., 300,001-545,000	1	..	⅛-⅜
—— 4½ per cent. Debenture Stock	100	..	95-98
Provincial Tramways Co., Ordinary, 1-24,912	10	..	4½-5
—— 6 per cent Cum. Pref., 1-10,000	10	..	10¼-11¼
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-30,000	5	..	5¼-5⅝
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	97-98
Sao Paulo Tramway Light, and Power Co.	$100	..	118-123
—— 5 per cent. 1st Mort. Deb., Red. 1929. 1-11,000	$500	..	92-94 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1	..	⅛-1
—— 4 per cent. Deb. Stock, Red. 1940	100	..	80-84
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs, Red., 1-1,600	100	..	84-88
Yorkshire (West Riding) Elec. Tram Co., Ord., 70,001-110,000	5	..	1-1⅛
—— 6 per cent. Cum. Pref., 1-46,261	5	..	3⅛-3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	87-90

Electric Railways.—

Name	Amount paid.		Last price
	£		£
Central London, Ordinary	100	..	71-73
—— 4 per cent. Pref	100	..	89-91
—— deferred	100	..	53-56
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	..	102-105
City and South London, Consolidated Ordinary	100	..	46-48
—— 4 per cent. Debenture Stock	100	..	102-105
—— 5 per cent. Pref. Stock '91	100	..	115-118
—— " " " '96	100	..	113-116
—— " " " '01	100	..	113-116
—— " " " '03	100	..	108-111
Liverpool Overhead, 5 per cent. Pref.	10	..	10-10¼
—— Ordinary, 1-50,000	10	..	3⅜-4⅛
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	..	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	..	55-58

Telegraphs and Telephones.—

Name.	Amount paid.		Last price.
	£		£
Amazon Telegraph Co., 1-25,000	10	..	3-3½
—— 5 per cent. Debs., Red., within 1-1,069	100	..	85-88
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000	$1,000	..	90-92
Anglo-American Telegraph Co., Ordinary	100	..	60-63
—— 6 per cent Preferred Ordinary	100	..	105-106
—— Deferred Ordinary	100	..	17½ 18
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort Deb. Stock, Red.	100	..	99-102 xd
Chili Telephone Co., 1-44,000	5	..	6¾-7⅛
Commercial Cable Co., Ster. 500-year 4 p.c. Deb Stk., Red.	100	..	91½-92½
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	..	6½-7
—— 10 per cent. Preference, 1-6,000	10	..	15⅞-16⅜
Direct Spanish Telegraph Co., Ordinary	5	..	3⅜-3⅞
—— 10 per cent. Cum Preference	5	..	9-9½
—— 4½ per cent. Debs., 1-600	50	..	98-101
Direct United States Cable Co.	20	..	14½-15
Direct West India Cable Co., 4½ per cent. Debs., Reg. within 1-1,200, Red.	100	..	99½-101½
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100	..	97½-100½
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8,000, 1913	25	..	98½-100½
Eastern Extension, Australasia and China, 1-300,000	10	..	12⅝-13⅛
—— 4 per cent. Mort. Deb. Stock, Perp.	100	..	102-104
Eastern Telegraph Co., Ordinary Stock	100	..	132-137
—— 3½ per cent. Preference Stock	100	..	84½-88½
—— 4 per cent. Mortgage Debenture Stock	100	..	103-105
Great Northern Telegraph Co. (of Copenhagen)	10	..	34-36
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1,200, Red.	100	..	99½-101½
Indo-European Telegraph Co.	25	..	56-58
Marconi's Wireless Telegraph Co., 1-256,127	1	..	⅜-½
—— 256,128-384,190	1	..	⅜-½
Monte Video Telephone Co., Ordinary, 1-72,680	1	..	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492		..	¾-1
National Telephone, Preferred	100	..	106-108
—— Deferred Stock	100	..	105-107
—— 6 per cent. Cum. First Pref.	10	..	11-13
—— 6 per cent. Cum. Second Pref.	10	..	10-12
—— 5 per cent. Non. Cum. Third Pref.	5	..	5¼-5½
—— 3½ per cent. Deb. Stock, Red.	100	..	96-98
—— 4 per cent. Deb. Stock, Red.	100	..	101-103
Oriental Telephone and Electric Company	1	..	1¼-1⅜
—— 6 per cent. Cum. Pref.	1	..	13/16 15/16
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100	..	97-100
United River Plate Tele. Co., Ordinary, 1-100,000	5	..	7-8
—— 5 per cent. Cum. Pref., 1-40,000	5	..	5-5½
—— 5 per cent. Debenture Stock, Red.	100	..	—
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	..	98-101
West African Telegraph Co.	10	..	10-10¼
West Coast of America, 1-30,000 and 53,001-53,008	2½	..	1¼-1⅜
—— 4 p.c. Debs., 1-1,500, Gua. by Western Telegraph	100	..	97-100
West India and Panama Telegraph Co., Ordinary	10	..	7/16 9/16
—— 6 per cent. Cum. 1st Preference	10	..	7¼-7½
—— 6 per cent. Cum. 2nd Preference	10	..	6¼-7¼
—— 5 per cent. Debs., Red., 1-800	100	..	99-102
Western Telegraph Co., 1-207,930	10	..	12¼-12⅜
—— 4 per cent. Debenture Stock, Red.	100	..	100-103

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1907.	1906.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Passenger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Sept 4	1,574	1 801	- 227	— h	25½	25	May 31	64,071	15,530 351	1,379 723	) 98	11·14	2,512	6·45
Ayr Corporation	,, 7	3 3	303	+ 0	—	8	8	,, 18	14,328	3,316,380	353,945	1	9·71	1,830	5·16
Baker Street and Waterloo Ry.	,, 7	2 160	1,290	+ 770	+ 9,595	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 8	1 122	1,119	+ 3	- 485	23 53	3·53	March 31	55,025	11,145,531	1,309,903	1·18	10·08	2,338b	6·05
Birmingham Corporation	,, 7	6,240	—	—	—	56½	—	,, 31	17,133	4,709,768	266,526	86	14·5	8 866	—
Blackburn Corporation	,, 4	1,217	1,232	- 14	+ 1,185	24	24	,, 25	48,875	8,661,720	986 963	1·35	11 29	2,036	7·44
Blackpool Corporation	,, 5	2 769	2 599	— 330	- 2 652	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	,, 7	1,147	1,505	+ 142	- 1,374	16½	16½	Dec. 31	31,846	2,325,677	57,264	3·28	13 19	—	7·27
Bolton Corporation	,, 8	2,382	2,174	+ 214	+ 2,853	42	40	March 31	95 766	20,205 196	2,161,130	1·13	10 63	2 394	6·14
Bournemouth Corporation	,, 4	2,287	2,429	- 52	+ 158	17·41	16·82	,, 31	55,276	10,058,288	1,121,623	1·32	11 83	3 226	7·19
Bradford Corporation	,, 7	4,833	4 858	- 53	+ 334	95	95	,, 31	230,085	47 168,000	5,053,362	1 172	10 1·27	2,395	—
Brighton Corporation	,, 8	1,103	1,281	— 179	- 2,751	9½	9½	,, 31	50,339	11 321,160	1,152,828	1 16	10·48	2,914·8	8·0.4
Bristol Tramway Company	,, 6	5,375	5,608	- 233	—	51½	51½	Dec. 31	259 799	65 312,373	6 127,135	—	—	—	—
Burnley Corporation	,, 7	1,357	1 325	— 32	—	40	40	March 31	57,942	11,032,704	1,197,772	1·31	11 61	5,388	8·17
Burton Corporation	,, 8	302	—	- 7	- 363	8½	8½	,, 31	17 950	3,878,269	454,082	1 07	9·21	2,018	6·76
Cardiff Corporation	—	—	—	—	—	32 62	†32·26	,, 31	112,209	24,134,363	2,770,049	1·12	9 72	3,782	9·44
Carlisle Tramways Company	,, 7	193	279	- 36	- 505	8 5	8·5	Dec. 31	10 713	2,935 002	359,756	—	7·14	—	5 18
Central London Railway	,, 7	4,781	5,478	- 697	- 5,728	6	6	,, 31	347,588	4,875,547	1,261,214	1 86	65·10	57,931	55·80
Charing X, Euston, & Hamp. Ry.	,, 7	2 355	—	—	—	8	—	—	—	—	—	—	—	—	—
City and South London Railway	,, 8	2,913	2 333	+ 580	+ 6,287	6½	6½	,, 31	—	—	—	—	—	—	—
Colchester Corporation	May 8	195	195	—	--	8	8	March 31	10,588	2 457,553	720,788	·97	7 47	1,401	6·12
Cork E. T. and L. Company	Sept. 5	498	580	- 82	- 740	15½	15½	Dec 31	24,895	5,814,376	882,256	1 01	6 64	—	4 69
Croydon Corporation	,, 6	1,483	—	—	—	12 c	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 7	255	287	- 22	+ 52	7 23	7·23	March 31	—	—	—	—	—	—	
Dover Corporation	,, 7	273	333	- 60	- 831	4½	4½	,, 31	11 250	2 853,200	284,343	·94	9·49	2,500	
Dublin and Lucan Electric Ry.	,, 4	163	141	+ 21	+ 1094	6½	6½	Dec 31	6 358	402,511	110,738	3 79	13·78	943	7 33
Dublin U.T.	,, 6	7 575	6 225	+1 350	+ 16,505	48½	48½	,, 31	267,489	50,060,949	7 077,272	1· 8	9·07	691	5·55
Dundee City Tramways	,, 4	1,307	1 376	- 69	+ 358	23	22	May 15	50 154	13 086 396	1,005 911	·906	11·96	2,180	7·42
East Ham Corporation	,, 7	958	990	- 52	- 476	14	14	March 31	56,652	3,689,658	863,816	64	10 18	2 934	6 79
Glasgow Corporation	,, 7	18,314	18 045	+ 269	+ 3 032h	79½	79½	May 31	756,490	195,767,519	17,946,595	—	0·12	—	—
Gloucester Corporation	July 10	278	304	- 26	—	15	15	March 31	15,46	3,902,077	563,595	·0	6·58	999	5·32
G.N., Piccadilly, and Brompton	Sept. 7	3,675	—	—	—	9	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	37	37	,, 31	74 019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	Aug 31	1 622	1,593	+ 29	+ 1,690	35	35	,, 31	63,938	12 838,150	1 665,262	1·14	9·71	1,923	—
Hull Corporation	Sept 7	2,455	2,231	+ 221	+ 2,815	26	26	,, 31	112,651	27,103,921	2,910,698	1	9 29	—	—
Ilford Corporation	—	—	—	—	—	10½	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 5	156	162	- 3,370	- 3,208	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	11,586	3,626,656	419,800	·7 7	6 62	1,480	5·22
Lancashire United Tramways	,, 4	1,352	1,185	+ 177	+11,349	38½	28	—	—	—	—	—	—	—	—
Leeds Corporation	,, 7	6,723	6,680	+ 43	+ 5,743	89½	89½	March 25	298,233	64.223 666	7,121,038	1 10	10·02	351	—
Leicester Corporation	,, 7	2,210	2 340	- 129	—	42	42	Dec. 31	26,011	12 039,252	1,229,507	1	9·79	—	4 82
Liverpool Corporation	Aug. 31	10,918	11 280	- 362	+ 6 921	103	104	,, 31	547 625	116,642 663	12 166 419	—	—	—	—
Liverpool Overhead Railway	Sept. 8	1,536	1,502	+ 34	+ 1,076h	6·65	6 65	June 30	81 302	11 171,865	1,024,275	—	—	—	—
London County Council	Aug 24	30,718	26,133	+4,525	+103,123	98	98	—	—	—	—	—	—	—	—
Lowestoft Corporation	—	—	—	—	—	6	6	Sept. 30	14 511	3,128 817	359,435	1 08	9 68	2 630	6 48
Maidstone Corporation	—	—	—	—	—	2	2	March 31	4,740	850 121	112,227	1 33	10 13	2,370	—
Manchester Corporation	Sept 7	15,971	15,014	+ 957	+ 24,897	149	149	,, 31	631,956	126,900,875	14,123,124	1 19	10·73	4,299	6 59
Metropolitan District Railway	,, 8	7,038	7,112	— 74	+ 663	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 8	14,339	14 035	+ 304	+ 1,450	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 7	164	179	- 15	+ 81	2½	2½	,, 31	6 159	1,992,647	206,358	82	7 14	2,239	—
Newcastle-on-Tyne Corporation	,, 7	3,954	3,921	+ 33	+ 367	50	50	,, 31	197 849	43,06 ,934	4,326,162	1·07	0 88	3,957	7·0
Newport (Mon.) Corporation	June 29	639	628	+ 11	+ 1,397	15½	15½	,, 31	30,356	7,252,535	783 435	—	9 29	—	6·4
Oldham Corporation	—	—	—	—	—	34	34	,, 25	65 553	15,466,245	1,504,740	1·16	10·45	1,885	—
Portsmouth Corporation	May 2	2,330	1 578	+ 752	+ 632	23½	28½	,, 31	95,702	19.625,329	197,499	1·17	11 63	—	—
Reading Corporation	Sept. 5	660	723	- 63	- 676	33½	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	11·29	21·29	,, 31	14,881	2 837,110	386,547	1·24	9·24	1,102	7 82
Rotherham Corporation	—	—	—	—	—	9½	9½	,, 31	23,569	6 251,472	593,054	1 07	9 53	2,612	7·49
Salford Corporation	,, 2	4 731	4,850	- 119	+ 2,121	70¾	70¾	,, 31	214,111	39,213,560	4,894,590	1·28	10 29	—	—
Scarborough Tramways Co.	—	—	—	—	—	4½	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 8	5 628	5,358	+ 280	+ 5,576	35¾	35¾	,, 25	210,515	63 952,283	,049 899	803	9 543	3,653	6 477
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,365	9 294,771	1,108,569	1 27	11·02	—	7 83
Southend-on-Sea Corporation	,, 4	543	666	- 23	- 394	9	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	,, 31	39,550	6,766,031	1,027,730	—	9 23	—	4 75
Sunderland Corporation	,, 8	1,578	1,571	- 63	+ 546	20	20	,, 31	64,858	15 364 463	1 495,685	1·004	10·36	—	6·37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	4,937	1,315,757	102,751	0·87	11 53	1,371	—
Torquay Tramways	Aug 29	470	—	—	—	5·16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	Sept. 7	941	931	- 10	+ 339	12 68	12·43	,, 31	43,607	7,995,451	862,12	9 27	12·14	3,132	7·50
Warrington Corporation	—	—	—	—	—	9	9	,, 31	17,057	4,418 225	403 363	—	9 85	—	6·33
West Ham Corporation	,, 5	2,321	2,419	- 98	+ 1,101	14·7	14 7	,, 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	,, 4	967	800	- 33	+ 249	20	20	,, 31	41,905	8,847,066	950,338	—	10 583	2,062	6·15

† And 98 miles of interlacing track. a Train mile. b Per mile of single track. Miles of route. h Half-year's figures. k Double track.

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NOTES.

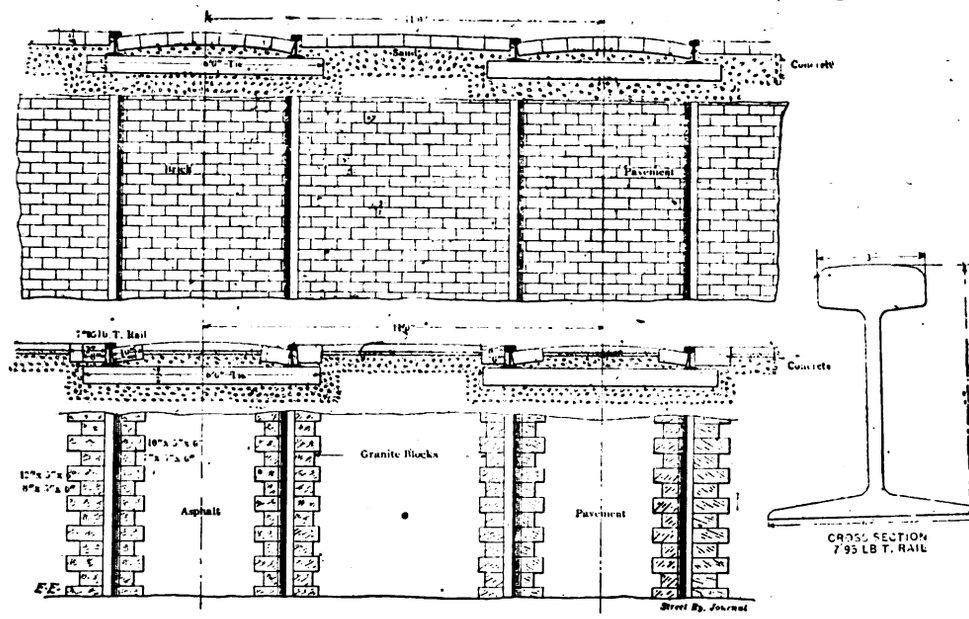
London, Brighton, and South Coast Single-Phase Equipment.—It is expected that early in 1908 electric trains will be running experimentally on the London, Brighton, and South Coast Railway between London Bridge and Victoria Stations, and a regular passenger service is promised next summer. The high-voltage single-phase system is being used for the equipment, as has been mentioned in previous issues.

London County Council Trams.—The Bethnal Green Council have endeavoured to get the speed of the London County Council tramcars reduced, but the letter from the Board of Trade on the subject of the electrical tramways in Hackney-road does not help them. It states that the Board is not prepared to reduce the rate of speed of the cars, but have amended the by-laws so as to provide for the stopping of all cars before passing on to the single line of track between Goldsmith's-row and Tuilerie-street. It is curious that the metropolitan borough councils should do so much to check the spread of tramways which are needed by the bulk of the inhabitants. The opposition to many of the London County Council schemes could not be keener if a company had put them forward.

The Technical College for the North of Scotland.—A meeting of the sub-committee of the promoters of this institution was held within Robert Gordon's College last week, Lord Provost Sir Alexander Lyon presiding over a large attendance. The announcements of the Scottish Education Department's contribution of £40,000 and the Harbour Board's donation of £5,000 towards the scheme were received with much satisfaction. A committee was appointed to frame an appeal to the local authorities in the various counties in the North for support. The Lord Provost made reference to the fact that he had been in communication with gentlemen who, he thought, might be in a position to assist the scheme in a substantial way, and stated that, from such answers as he had already received, it was evident the scheme was likely to be regarded in these quarters with favour.

Pernambuco Tramways.—The information given n this consular year's report with regard to the Companhia Ferro Carril de Pernambuco will be of interest. The number of mules owned by the company was 700 in 1906, as compared with 600 in 1905. The number of cars was 74. The average number of passengers carried during each of the years 1904-06 was about 5,000,000, and the dividends paid during the same period were from 10 to 12 per cent., the earnings having been: 1904, £54,600; 1905, £56,700; 1906, £58,500. Referring to the negotiations with a British company for the purchase and electrification of these tramlines, mentioned in last year's report, the terms of purchase were eventually agreed to by the Board of directors and the transfer to the British company voted. The contract was subsequently rescinded by a newly-constituted Board, and the whole question is now in litigation.

City Track Construction at Milwaukee.—In all its new construction in paved streets the Milwaukee Electric Railway and Light Company has adopted a method of letting the paving brick or block project under the inside of the head of the T-rail, instead of bevelling the ends of the brick or block or using specially-moulded brick so as to form a groove alongside the rail. The argument for the construction adopted is that when the wheels of a wagon or other vehicle is travelling in the flangeways and attempt is made to turn out, the wheels do not have to climb out over a shoulder on both sides. In the construction a 7in. 95lb. rail is used. The ties are completely immersed in concrete, the bed extending down about 6in. or 8in. below them. For brick paving a sand cushion is placed above the concrete. In asphalted streets granite blocks are used adjacent to the rail. Where traffic is heavy, special work with hardened centres is used. In suburban municipalities, where the single-truck cars are used, or where the cars are run under a headway of 15 minutes or more, special work built up in the company's shops is employed. We are indebted to the *Street Railway Journal* for the above illustrations.



Minimum Charge.—It is difficult to make a non technical man understand that it costs a certain amount to give him a supply independent of the number of hours he uses his apparatus. Thus, at Glasgow, one who signs himself "A Small Consumer" sends the following grievance to the local papers: "Sir,—Before the surplus on the electricity accounts is disposed of I think the case of the small power consumer should have consideration. For a small motor used during 12 months the charge came to 6s., and at the end of that period £1. 14s. was added to the bill as the 'minimum charge,' making £2 in all. Were this charge made only during the first year to pay for cost of connection it would be reasonable, but to pay nearly six times the actual cost every year is, I consider, a downright robbery, and out of the handsome profit realised I think some concession might easily be afforded." He does not

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say how small the motor is, but £2 per annum is not a large sum for the convenience of having power when wanted. The cost averages about 1½d. per working day, and the "Small Consumer" could not hire a boy to turn a handle for less.

London County Council Testing Stations.—At the Hackney conference of representatives of metropolitan borough councils possessing electricity undertakings on the subject of the proposals of the London County Council with reference to the erection of testing stations for electricity supply and the fees of inspectors, held at the town hall, Hackney, on Monday, July 1, 1907, the following resolutions were passed: "(*a*) That this conference is of opinion that the establishment by the London County Council of testing stations in London is at the present time unnecessary, and, therefore, wasteful, having regard to the fact that a sufficient test can be made on the premises of any consumer; (*b*) that the borough councils be asked to request the members of the London County Council for their respective districts to support the action of this conference when the matter is being considered by the County Council; (*c*) that a committee be appointed, consisting of one representative from each borough council, to take what steps may from time to time be considered necessary." The attention of the members of the London County Council for the boroughs interested has been called to these resolutions, and they have been asked to support the action of the conference.

Steam-Turbines for the "Lusitania."—It might be of interest to note at the present time that Messrs. John Brown and Co., the builders of the turbines for the "Lusitania," acquired a licence from Messrs. Willans and Robinson, Limited, to enable them to use the special method of building up the blades in sections, which forms so important a feature of the Willans-Parsons turbine. Her sister ship, the "Mauretania," the turbines for which have been built by the Wallsend Slipway Company, of Newcastle-on-Tyne, also employs this method of blading, and in the case of this ship the blading was manufactured by Messrs. Willans and Robinson, Limited. It should be noted that in the case of both these ships the turbine rotors and casings had already been made when it was decided to adopt Messrs. Willans and Robinson's method of blading; consequently the channel section shrouding, into which the ends of the blades are riveted—another feature of the Willans-Parsons turbine—which necessitates a slightly increased diameter of the casing, could not be adopted in the blading of either of these ships. It is of interest to note that since this introduction on a commercial scale of building up the blades in sections, other turbine builders, including Continental manufacturers, have copied the principle by wiring together the necessary blades and dividing caulking pieces by stringing blades and caulking pieces alternately on a wire, sufficient in number to make up a given segment The result can, however, scarcely be claimed to be as mechanical as the principle on which the "Lusitania" and "Mauretania" blading has been built.

United States Navy Standard Lightning Conductor.—The following extracts from the standard specification of the U.S.A. navy show the latest requirements on that side of the Atlantic: For chimney protection for power plants the lightning conductors shall be laid up in the form of a seven-strand cable, and each strand laid up with seven copper wires of No. 10 B. & S. gauge. For chimneys of 50ft. and less in height, two lightning conductors shall be used. For chimneys over 50ft., up to and including 100ft., three conductors shall be installed. For chimneys higher than 100ft., four conductors shall be installed. All heights to be considered from ground-level. All conductors or cables shall be symmetrically arranged about the chimney, with one cable on the prevailing weather side of the chimney. Said lightning conductors or cables to be securely attached both mechanically and electrically to independent, pure copper earth plates or bars. In cases where the chimney foundations have already been filled in, instead of earth-plates earth terminals may be used, composed of pure copper bars 3in. by ½in. by 3ft. In all cases the lightning-conductor terminals shall extend to the ground water-level, and in no case shall they extend to less than 15ft. from the ground surface. Earth-plates shall consist of pure copper 3ft. by 3ft. by ⅛in. Each rod shall terminate in a two-point aigrette, each spur or point of this aigrette to be at least 3¾in. long, the bases of which spurs shall be at least ⅜in in diameter, tapering to a sharp and well-finished point; said aigrette to be provided with approved means to secure a strong mechanical and electrical joint with the vertical rods heretofore described and to which it is attached. The joints shall be "sweated with solder" as heretofore described. For chimney-base protection all lightning conductors shall be enclosed at bottom with a heavy galvanised iron pipe of 1½in. in diameter, and extending 3ft. into the soil and 10ft. above. Said iron pipe to be provided with approved brackets to securely hold it to the chimney; brackets to be not over 3ft. apart.

Manchester and Salford Electrical Exhibition, 1908.—The following letter has been addressed to a large number of the chief electrical engineers to corporations by Mr. W. Davenport, the secretary of the National Electrical Manufacturers' Association: "As you have doubtless noted from articles recently appearing in the electrical Press, the above corporations have decided to promote, in conjunction with this association, an electrical exhibition in Manchester. As the benefits of this exhibition will have a very far-reaching effect in such a largely populated and important manufacturing area, and will undoubtedly tend greatly to increase the present use of electricity for lighting, power, and other purposes, it is hoped that your corporation will see their way to give active and financial support to the scheme. It is intended to ask for this in the form of donations, in exchange for which tickets of admission to the exhibition, printed specially for each authority, will be supplied to the various contributors for free circulation in their respective areas at the rate of 3s. per dozen, proportionate to the amount voted. So soon as the list of contributors is complete, a meeting will be arranged to elect representatives to serve on the advisory committee. The profits arising from the exhibition will be allocated in a percentage—to a return to exhibitors, to a return to contributors, to the charities connected with the electrical indury, and to a charitable institution nominated by the Manchester and Salford Corporations, and situated in their respective districts. For your information, I might say that the general scheme of carrying on the exhibition will be based on the lines adopted so successfully by the supply companies and municipals in London in conjunction with this association at Olympia in 1905. The Lord Mayor of Manchester, supported by the Mayor of Salford, has kindly consented to convene a meeting of chairmen and engineers of corporations, urban councils, and supply companies in the district, to be held on Tuesday, Sept. 24, the invitation to which you will receive in due course. In the meantime, I would ask you to be good enough to bring this letter before your committee in order that they may become interested in the matter at an early date."

Sheffield Technical School.—The success of a technical school in a large manufacturing centre depends

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on the close connection between the subjects taught and the trades carried on in the district. Employers can do much to help such schools, and gain enormously by so doing. Thus at Sheffield Prof. Ripper acknowledges the encouragement the department of applied science is meeting with from the great Sheffield firms. To an editor of the *Sheffield Daily Telegraph* he said that considerable interest is shown by several of the leading firms in Sheffield in connection with the attendance of their apprentices at these classes. For example, Messrs. Vickers, Sons, and Maxim increase the wages of those of their apprentices who are able to show successes at the end of the year in the annual examinations of evening students. Messrs. John Brown and Co. allow their apprentices who are attending classes in the evening to commence work the following morning at nine o'clock instead of at six o'clock. This is a very great boon to the students, and makes it possible for them to devote themselves to their studies as they could not do if they were obliged to be at work at six o'clock in the morning. Messrs. Jonas and Colver and Messrs. Samuel Osborn and Co. also take a keen interest in each apprentice. It is very desirable that other firms should show similar interest, and there is no doubt that such interest is on the increase. Seven large firms receive regularly from the school monthly reports on the attendance and progress of their apprentices, and this shows an interest which augurs well for the quality of the apprentices trained at such works. The electrical engineering classes at the Sheffield Technical School are among the very best attended in the institution, and they cater for all types of persons who require training in this branch. There are no fewer than 13 different classes in electrical subjects. The useful applications of electricity are growing so rapidly that but for such training it would not be so easy for local firms to take advantage of this progress, and to introduce the new electrical arrangements as is the case at present, owing to the fact that there are so many young fellows in the works who have received instruction at the school.

Northampton (Polytechnic) Institute, Session 1907-1908.—The provision last session of increased accommodation in the rooms of the British Horological Institute in Northampton-square has made it possible to introduce further developments in the work of the departments which continue to find their quarters in the original building, as well as in that of the department of technical optics. The most noteworthy of these developments is a course on the production and measurement of light, which is being given to both day and evening students by the electrical engineering and applied physics department and by the department of technical chemistry jointly. The lectures and laboratory work in the electrical engineering department deal with all the various kinds of electric lamps, incandescent, arc, and luminescent, with the problems of the production of light, and photometry, and general questions of radiation. In the technical chemistry department the subject is taken up from the chemical side, and the whole subject of incandescent lighting dealt with The properties of rare metals and rare earths, their production, extraction, and use for all kinds of incandescent lighting, both gas and electric, are fully dealt with, and the production of metallic filaments for electric incandescent lamps is thoroughly studied. In the engineering day courses further options have been introduced for the more advanced work of the third and fourth year, and advanced work for an additional year has been provided in the technical optics day courses. The subject of electric wiremen's work has been remodelled, and is dealt with in accordance with the revised syllabuses recently issued by the City and Guilds of London Institute. The classes in telegraphy and telephony have also been remodelled. In the technical optics department four new classes especially suitable for artisan students are being started, and minor changes have been made in the syllabuses. There are also special classes for the instruction of kinematograph operators, which, it is hoped, will meet a much-felt want, and place this kind of work upon a sound scientific basis. Many minor developments in various directions have been made and are in contemplation.

Noise from Tramcars.—The town clerk of Ealing has circulated copies of the minutes of the conference convened by the Ealing Town Council, which met on July 26, when representatives attended from the Ealing, Hammersmith, Hampton Wick, Hanwell, Teddington, and Twickenham Councils. The clerk of the Teddington Urban District Council read to the conference correspondence which had passed between him and the Board of Trade with respect to the condition of the tramway track in the Teddington district, from which it appeared that he had applied to the Board of Trade to cause an inspection to be made by one of their inspectors of the tramway track in Teddington under the provisions of Section 27 of the London United Tramways Act of 1898, which is incorporated in the company's Act of 1900, and that the Board had replied that they were not disposed to order an inspection unless action had first been taken against the company under the first part of the section, and such action had failed on the evidence then available. The conference passed the following resolutions: "That this conference approach the Board of Trade and ascertain whether their reply to the application of the Teddington Urban District Council to appoint an inspector to inspect and report upon the condition of the tramway track under Section 27 of the London United Tramways Act, 1898, is to be taken as final; that in the event of the reply being affirmative the President of the Board of Trade be requested to receive a deputation on the matter from this conference, consisting of one representative from each of the said authorities who have appointed representatives to attend it; that in order to save time the clerks to each of the said authorities be requested as soon as possible to notify to the town clerk of Ealing the name and address of the nominee of his Council appointed to represent his authority as one of the deputation, and, further, that the members of Parliament for the constituencies in which the districts of the several authorities are comprised be requested to attend with the deputation; and that further consideration of the subject matter for which this conference is convened be adjourned pending the result of the suggested communication with the Board of Trade aforesaid." In the meanwhile the Councils interested are appointing representatives for the proposed deputation to the Board of Trade.

Transatlantic Wireless Telegrams. — Mr. Marconi, before sailing for Canada on the Allan Line turbine mail steamer "Virginian," said to a reporter of a daily paper that during the six weeks which had elapsed since he came last from Canada he had been able to carry out a number of improvements at the powerful and complete wireless installation at Clifden, in Galway. As a result, he was confident that in a very few weeks he would be able to ensure the transmission of messages as clearly and successfully from Canada to Great Britain as he had already succeeded in maintaining from this side to the Western Dominion. On his arrival in Canada he will proceed to the new Transatlantic wireless station at Glace Bay, Cape Breton, to complete the arrangements there for the new, constant, and cheap commercial service from continent to continent. This has been arranged

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under agreement with the Canadian Government. The Poulsen equipment for telegraphing to Canada is also being erected with dispatch near the little townland of Knockroe, in co. Kerry, by the shores of Dingle Bay. To the uninitiated at present all that can be seen at Knockroe are two gigantic masts 360ft. in height, standing up boldly against the sky-line, and a third lying on the ground waiting to be stepped. Near by carpenters, masons, and engineers are busy erecting the buildings and equipment, and preparing the smaller masts which form an outer circle for the antennæ linked up between them and the three great masts in the centre. A similar station is to be erected in Canada on one of the numerous islets in the St. Lawrence River, and it is hoped by the beginning of next year to be able to operate on a commercial basis. While Herr Poulsen will not at present commit himself to any definite announcement on the subject, he believes it will be possible to telephone right across the Atlantic. Already the value for telegraphic use of the system has been proved. On Aug 21 the "Holig Olaf," fitted with a ship station, sent a message of 21 words when near the coast of America to Berlin, 2,062 miles distant. The message in transit passed over the Atlantic, Ireland, England, and part of Germany. Messages have been sent by small portable "army" pattern stations, with a 60ft. mast, quite easily over a distance of 700 miles. By means of a phonographic recorder a speed of over 40 words per minute has been maintained in receiving messages, and Herr Poulsen and his 20 assistants who work in the Copenhagen and Berlin laboratories hope to eclipse this record when the Knockroe station is opened, especially as by this means signals can be recorded where the waves have been too faint to be audible in the ordinary telephone receiver.

Australian Commonwealth New Tariff.—The new Commonwealth tariff consists of 444 items. The schedule is new in every sense of the term, for it not only embodies the increased protection given to native industry and elaborates a scheme of British preference, but it regroups the items in the old tariff under more reasonable headings—a work for which the commercial community will warmly thank Sir William Lyne and Dr. Wollaston—and separates the main divisions into self-contained compartments. The duties apply, of course, to all imitations of the articles to which they relate, and they are subject in certain cases to departmental by-laws. When articles consist of a combination of other articles, some of which are dutiable when imported separately, and of others free of duty when imported separately, they are to be dealt with under the schedule as follows: (*a*) When the value of the dutiable portion exceeds the value of the free portion duty shall be charged upon the whole article at the same rate as would be chargeable on that portion of the dutiable portion which, if imported separately, would be liable to the highest rate of duty. (*b*) When the value of the free portion exceeds the value of the dutiable portion of such article the whole article shall be admitted free of duty. In interpreting the phraseology of the items it will be noted that the letters "n.e.i." mean "not elsewhere included." The British preference provisions of the tariff vary according to the character of the item under consideration. In some cases a 10 per cent. reduction in the ordinary duty is given; in others a 5 per cent. reduction is given, or a reduction is made in the fixed duty; and in others the items are placed on the free list when they are of British origin, a duty of 5 per cent. being levied on the foreigner. Preference to the United Kingdom is given on over 250 items. The schedule for electrical machinery reads: (*a*) generators, motors up to the capacity of 500 h.p., fans, starting and regulating rheostats, *ad valorem*, general tariff 30 per cent, tariff on British goods 25 per cent.; (*b*) n.e.i., *ad valorem*, 17½ per cent. and 12½ per cent. Electrical and gas appliances—viz.: (*a*) electroliers, gasoliers, chandeliers, pendants, brackets, switches, controlling devices, n.e.i., radiators and zinc tubing, *ad valorem*, 25 per cent. and 20 per cent.; (*b*) n.e.i., *ad valorem*, 17½ per cent. and 12½ per cent. Electrical materials—viz.: accumulators or storage batteries, including glass cells used therewith, cable and wire (covered), carbons, testing meters and instruments, translators, insulating tapes, meters, resistance coils, static transformers and terminals, photometers for gas and electricity, 5 per cent. and free. Engines (including traction and portable) n.e.i., turbines, winches n.e.i., boilers n.e.i., pumps, windmills, elevating and conveying machinery, economisers, cranes, lifts, water and gas meters, machines and machinery n.e.i., *ad valorem*, 32½ per cent. and 27½ per cent. This new tariff should stimulate our trade with Australia.

A Point in Electric Power Development.—Engineers who are interested in developing the power load of their central stations should not neglect the influence that auxiliary uses of electricity in workshops have upon the power factor of the supply. Although the mechanical property of the electrical current is the one that is chiefly used for general operations, and considerable attention has lately been paid to electrochemical processes, there is yet another mode in which electric energy can be used which seems to be rather overlooked. This is the use of heating appliances in workshops. It may at once be granted that with supply of electricity at anything like 3d. per unit such heating was absolutely out of the question from an economical point of view, but nowadays, when scientific methods have been applied to the costing of electric energy and sliding scales have been developed, taking into account the load factor of the installation, prices have been given for electric power expressed in fractions of a penny. Electric heating at such figures is a paying possibility, and forms a steady increment to the load of the station in the early morning hours, and to some extent throughout the day, shutting off automatically when the peak is nearing its maximum. Firms such as the British Prometheus Company and the British Thomson-Houston Company have already perfected apparatus of the convection type, suitable for placing against walls, under benches, etc., for the purposes of distributing heat, and these pieces of apparatus appear to carry out their functions without any undue cost of repairs. The subject is raised considerably above the level of an optional convenience in the minds of manufacturers by the memorandum issued by the Home Office on July 8, in the health and safety section of which is written: "The occupier is under statutory obligation to maintain a reasonable temperature in every workroom. In general, for sedentary occupations the arrangements for warming should be such as to secure a temperature of not less than 50deg. F. They must not, however, be such as to interfere with the purity of the air in any workroom. Hence, gas jets or gas stoves without adequate flues cannot be regarded as complying with these statutory requirements." The Home Office is evidently very fully awake to the noxious effects of gas fumes on the workers in such factories, as is evidenced by the succeeding paragraph, which states that "Occupiers are required by the Act of 1901 to provide sufficient means of ventilation. Inspectors are instructed to pay special attention to this. In the absence of mechanical ventilation, it is incumbent on the occupier to see that the other means upon which he relies for adequate ventilation of each room are sufficient for the purpose, and maintained in use throughout the working hours. This is especially necessary

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where the air space of each worker is small—say, under 500 cubic feet—and in all workrooms in which gas is consumed" With the twin advantages of cleanly and hygienic electric heating and a simple and economical means of ventilation found in the electric fan, central-station supply engineers should find it a very easy matter to induce manufacturers to augment their load by means of electric heating and ventilating devices."

British Trade in Belgium.—The British Consul-General at Antwerp has recently issued his report for 1906 and the first half of 1907, and in it he includes some remarks which, although written in quite a general way with regard to English manufactures, might very well be taken to heart by exporters of electrical goods in particular. As is well known, Belgium is not a particularly favourable market at present for English electrical machinery or accessories, export trade from the United Kingdom to Belgium being represented in a great degree by raw material for Belgian industries and minerals, the balance to a great extent being made up by manufactured goods not being made in Belgium, manufactures peculiar to English industries, or goods of a superior quality to those made by Belgian manufacturers. In the *Board of Trade Journal* of Sept. 12, Sir C. Hertslet writes: "It is practically impossible for a consular officer to give general advice to British firms with regard to the best way for them to further their business with the foreign country or town in which he may be situated, inasmuch as most individual business houses and trades have a separate way of carrying on their affairs, and advice which is given to one person is resented by another who conducts his business in a different manner." One point, however, on which he lays stress is that "although British firms engineering the sale of their goods in Belgium obtain the names of likely buyers of their goods through the medium of a consular officer or the Intelligence Branch of the Board of Trade, and in many cases share a fair trade, it is not often taken into consideration that the foreign taste in regard to certain articles is not necessarily the same as the British." This may probably be interpreted in the case of electrical goods that Continental practice is not in the direction of such solidity of design as is customary in Britain, and English designers would probably find it worth while, if it is desired to establish strong Continental trade, to produce goods which might almost be classed in England as having insufficient factors of safety. Publicity is made a strong point in the consular report, it being said that "the advertising of British goods in Belgium is, of course, an excellent way of making them known, but in the case of firms in a fairly large way of business there is no better way of making their goods known than by sending travellers to show the goods to likely buyers, and to impress the merits of the same upon them. These travellers should endeavour to find out the style of article required, and British firms should be prepared to make it of the particular model required if they wish to enlarge their trade. It is in this way that German firms obtain so large a share of Continental trade. The idea of educating the foreigner to British tastes is not, generally speaking, the way to make him purchase British-made goods, though, of course, in certain cases it has done so." A point which may be of value to some of the smaller branches of the electrical trades is that in inquiries at consular offices for names of likely buyers, British firms often make it a point to give the most technical name of the article referred to rather than the name by which it is generally known. It is conceivable, for example, that a Belgian may not know exactly what is meant by a "tumbler switch," and in cases where electrical firms find it necessary to apply to consular offices we suggest that it would probably be expedient to send a photograph or drawing of the article which it is desired to push, together with a short specification of its uses and properties. The concluding remarks in the *Board of Trade Journal* article practically contain the old adage, "Go and see for yourself." It is advised that British manufacturers, instead of relying on reports furnished by representatives or even by foreign consuls, should go to Belgium to see for themselves what openings there are for the development and expansion of industry.

The Possible Outlets for Electrical Manufacturers.—There are not wanting signs that a period of stagnation may possibly set in for manufacturers of electrical machinery. Until recent years the design of plant for generating electricity in central stations was in anything but a standardised condition. The older forms of machines were badly constructed mechanically, and had a short life. Moreover, it was found that one part of the machinery installed in a central station did not efficiently perform its functions with regard to the other parts. Of late years, however, the design of central stations and distributing networks has been considered scientifically as a whole, with the result that a certain finality of design has been reached, and the process of scrapping and substituting machinery will not proceed with such rapidity as heretofore. Failing the alteration of design, the natural depreciation of plant is hardly sufficient to keep a considerable bulk of trade in manufacture alive. Sir William Preece, in his report on the Bristol power station, gave his opinion that the life of dynamos and alternators was 30 years, having a residual value of 8 per cent.; the life of armoured cables he gave as 35 years and a residual value of 15 per cent.; the life of motors was put at 25 years, with a value of 9 per cent. at the end of that period; water-tube boilers 25 years and 5 per cent. residual value; engines and other machinery 25 years and 6 per cent. residual value; storage batteries 15 years, 10 per cent. residual value; arc lamps, 12 years; lamp-posts, 40 years; meters and accessory instruments, 12 years. It is evident that with these lengthy periods of wear and tear the amount of annual replacement necessary in the four hundred odd stations in the British Isles, and the foreign stations which are more or less under the control of British manufacturers, is so small that the business accruing from replacement will not be very extensive. Turning to the possibility of expansion, the chief openings seem to be in the direction of electrochemical processes and mining industries. At the present time there is a considerable amount of price cutting between rival manufacturers anxious to secure the latter business, but in course of time, which will not be very extended, the market in this direction will be filled. Electrochemical industry offers a promising field, the extent of which cannot be at present gauged, but which would, at the time of writing, appear to be a highly specialised industry, which will require a considerable reorganisation of industries at present depending on electrical engineering manufacture. It may be urged that the steady expansion of electric motive power which will undoubtedly take place will induce a constant sale of small goods such as motors, measuring instruments, lamps, small cables, etc. Our German competitors are already alive to this fact, and are endeavouring to induce severe competition in the supply of electric light and power accessories, and should English manufacturers wish to retain their hold of this market they should immediately set to work to adopt the latest means, both of reducing manufacturing costs by the most modern of efficient works operation, and, on the other hand, of increasing sales by paying special attention to advertising and business-getting methods.

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THE LENTZ ENGINE.

Our readers doubtless will be interested in the illustrations we produce of the Lentz shortened tandem compound engines, one showing an engine and generator and the other a sectional view. These engines are now being built by the Société Suisse des Machines Lentz at their new works at Bellinzona. This company has been formed by a number of influential engineers and capitalists with a view to turning out an engine of standard design at a reasonable cost, at the same time combined with high-class workmanship and material. With this object in view they have put down works which are installed with the most up-to-date machinery, and they have confined themselves to the manufacture of one type of engine only, in about four sizes. In order to cheapen the cost of machinery, special tools have been installed to allow of all work on each part to be done at one sitting. The engines are passed through the shops in series of six at a time, and can thus be delivered into stock. The type of engine built is that designed by Mr. Hugo Lentz, of Berlin, and all are fitted with the Lentz patent valve motion and shaft governor. The design combines large powers with reduced floor space. All steam parts are specially suited to the use of highly superheated steam.

As will be seen from the sectional view, the high and low pressure cylinders are cast in one, and so arranged that the steam has a very short travel between the cylinders: valve chests, steam passages, and cylinders are all lagged up under one covering, with the result that the radiation losses are reduced to a minimum. Indicator cards show a marked increase in the diagram factor over the ordinary design of tandem and coupled engine; in other words, a higher mean effective pressure is obtained for a given initial pressure, and an increase in power and improved steam consumption. Each cylinder has four double-beat valves, each operated by a separate eccentric, these eccentrics being actuated by a lay shaft driven through bevel gearing from the undershaft. The upper end of each eccentric rod works a lever held in the pocket of the valve bonnet: this lever is curved to suit the lift of the valve, and, sliding on a roller, lifts and closes the valves without noise or hammer the roller always being in close connection with the curve, and held there by a light spring. This enables a higher number of revolutions per minute to be used, the speed in any ordinary drop-valve engine being limited by the trip-gear. The governor is of the inertia type, and consists of two masses pivoted on a carrier, which is keyed to the lay shaft These two masses and the carrier are attached, in the case of the carrier by a steel spring, and the masses by links, to an outer ring which performs the action of a flywheel. The governor is designed so that for normal speed the centrifugal force of the masses and the inertia due to the flywheel effect of the ring, are in equilibrium. Immediately the speed increases, the inertia of the outer ring

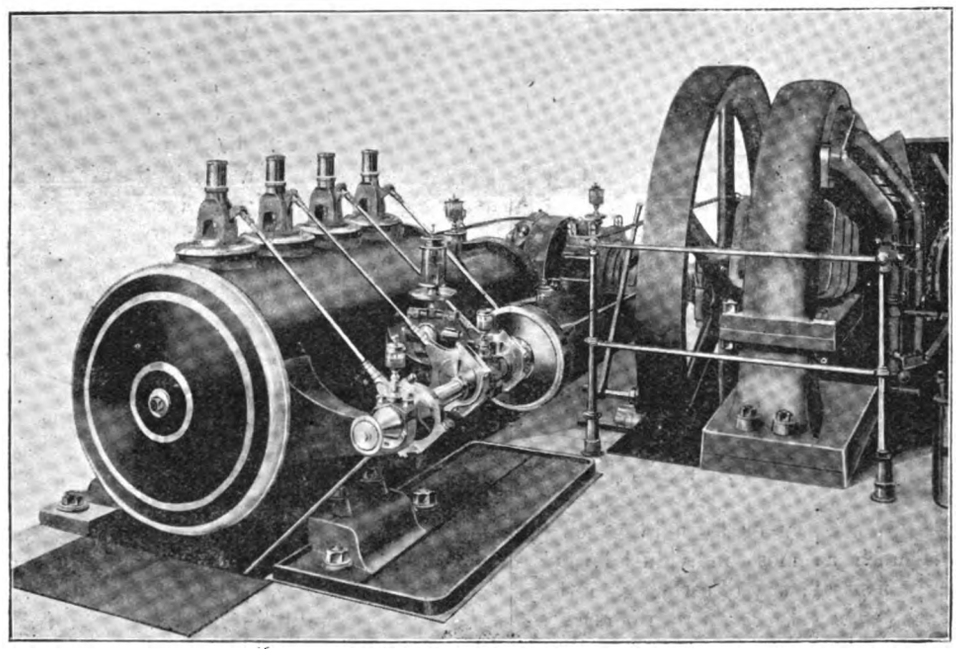

FIG. 1.—View of a Lentz Engine Driving an Electric Generator.

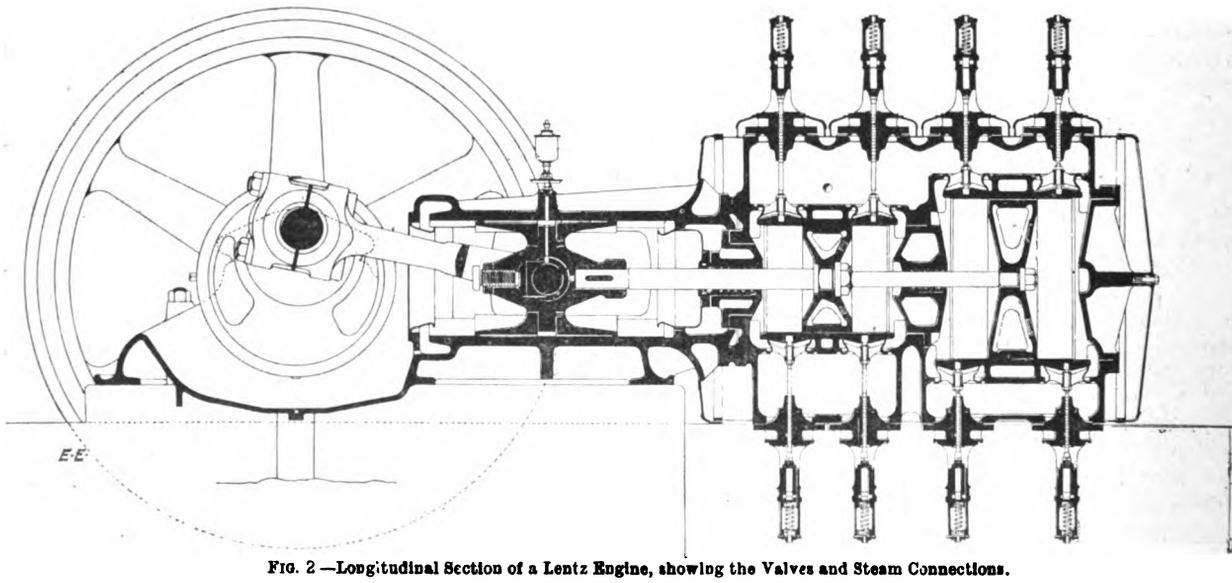

FIG. 2.—Longitudinal Section of a Lentz Engine, showing the Valves and Steam Connections.

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absorbs the portion of the tension of the spring and forces the masses out without the necessity of a further increase of the centrifugal velocity. The opposite effect takes place on a diminution of speed. The steam distribution eccentrics are connected to the outer ring, and move on a slide block keyed to the shaft, and are, therefore, displaced and the cut-off regulated. A hand-wheel is arranged on the end of the shaft, by which means the tension of the spring can be adjusted, the engine speed altered.

As an illustration of the economy attained, the following are the results of a test on an engine: engine, 14½in. by 24½in. by 18in. tandem condensing; speed, 202 r.p.m.; horse-power, 245; pressure at stop valve, 115lb.; total water in 3½ hours, 11,650lb.; total water per hour, 3,340lb.; total water per indicated horse-power hour, 13·6lb.; steam per kilowatt-hour, 21·9lb. Over-all efficiency was 83 9—a remarkable result for so low a steam pressure.

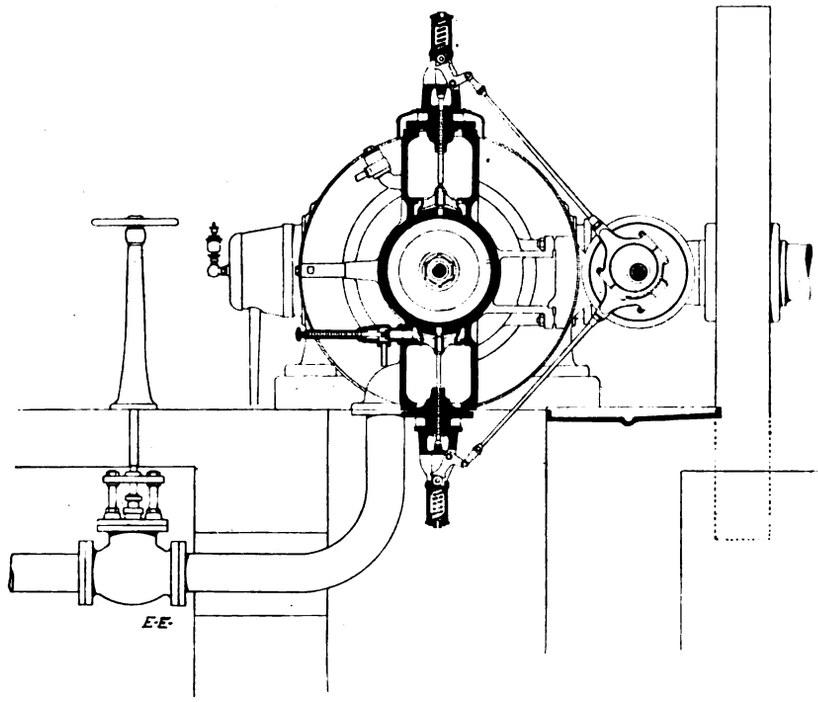

FIG. 3.—Cross-Section showing Valve Gear with Positive Drive.

The Swiss Company has lately opened a London office at 27, Clements-lane, E.C., with Mr. F. H. Preece as its representative.

THE DEFORMATION OF THE TANTALUM FILAMENT WHEN USED WITH ALTERNATING CURRENT.

BY F. STROUDE, STUD.I.E.E.

When a tantalum lamp has been used for a short time on an alternating circuit, the filament, if viewed through a microscope, has a disjointed appearance as though it had been cut into small pieces and the pieces fitted together again without any care being taken to obtain alignment; the bulb of the lamp, also, is found to be considerably blackened. The deformation of the filament was discovered simultaneously by Prof. J. T. Morris in England and by Dr. Clayton Sharp in America. The amount of deformation that takes place depends on the frequency of the supply voltage, a filament working at a high frequency becoming more disjointed than one working at a lower frequency. Up to the present time no real explanation of this phenomenon has been offered. It is thought by some to be due to crystallisation, while others ascribe it to the repeated expansion and contraction which takes place owing to the rapid alterations in temperature which the filament undergoes.

The first fact that strikes one, with reference to this peculiar deformation, is that it takes place in the only metallic filament which is produced by drawing. On looking through the history of incandescent lamp manufacture, we find that in 1845 Edison constructed a lamp from drawn platinum-iridium wire. This lamp was designed to be switched on to a voltage sufficient to fuse it. By the time the filament had reached a dangerous temperature, however, it had expanded sufficiently to allow a spring contact to disconnect it. When the filament had cooled sufficiently it had contracted enough to switch it into circuit again. It was thus exposed to fairly rapid alterations of temperature. Upon examination Edison found the filament to be deformed. *This deformation was similar to that now discovered in the case of the tantalum lamp on alternating current.* This phenomenon was ascribed by him to the explosive escape of the gases occluded during the drawing process. To test this theory, he tried drawn wires of other materials, and in every case found the same effect. He therefore tried to remedy this by treating the filament in the following manner: It was first heated electrically *in vacuo* to a red heat for 10 minutes. The current was now switched off and the filament allowed to cool. It was then heated by a larger current for 10 minutes and cooled again, the current being increased by a small amount after each switching off until the filament had arrived at a temperature not far from its melting point. The object of the gradually increasing current was to assist the escape of the gases without explosion, and the cooling was to allow the filament to contract and weld together.

The life of a filament so treated was considerably greater than that of an untreated filament, and it could be safely run at a higher temperature. The deformation no longer took place. The treated filament was of a smaller diameter than the original and possessed a peculiar property—viz., it could not be annealed. The success of this treatment seems to confirm the theory. It may be noted that this theory would also account for the rapid blackening of the bulb observed when the tantalum lamp is used on alternating current, since, due to the explosive escape of the occluded gases, finely divided tantalum would be shot out from the filament and would deposit round the bulb fairly thickly in the filament zone. This seems to indicate a method of treatment whereby the tantalum lamp could be much improved, and which would enable consumers on alternating circuits to profit by the high efficiency offered by the metallic filament without sacrificing the mechanical robustness which is the chief point in favour of the carbon lamp.

The large variations in the specific resistance of drawn tantalum, noticed by Bolton (*Zeitschrift für Elektrochemie*, No. 3, 1905), might possibly be accounted for by differences in the amounts of occluded gas in the different specimens.

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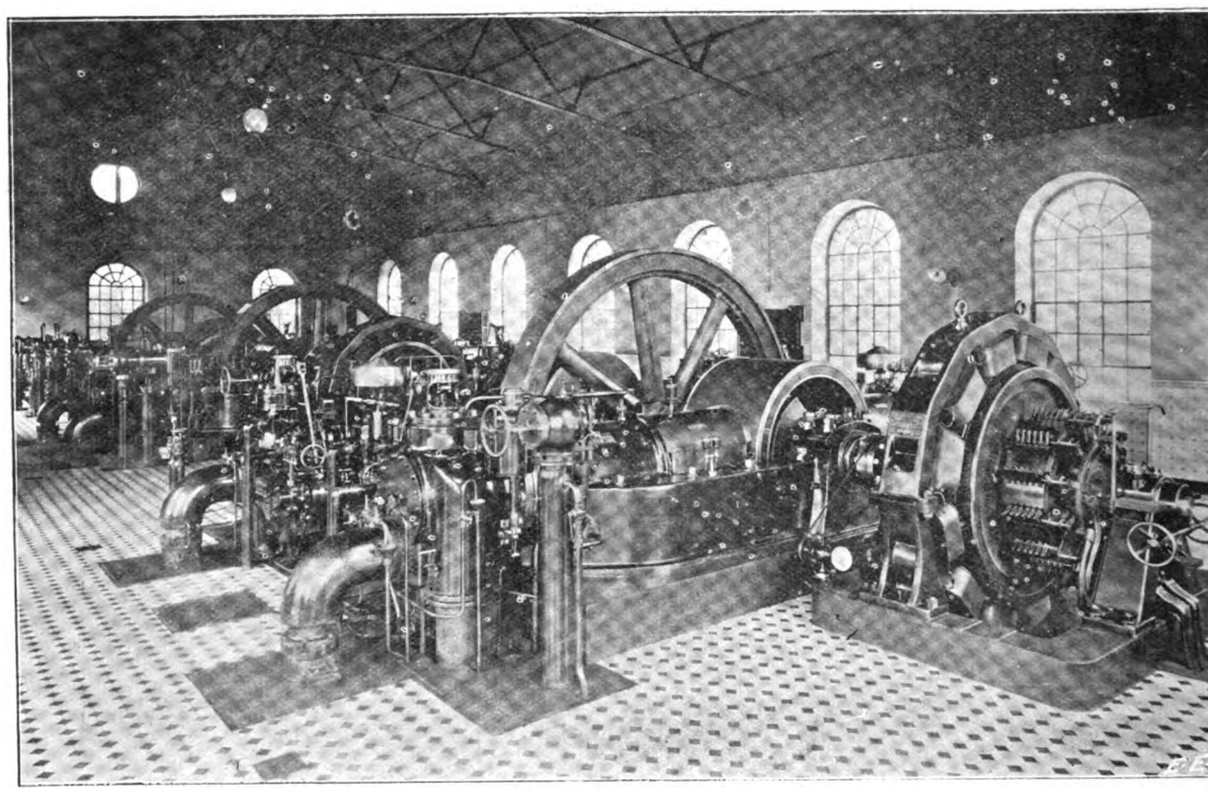
THE ELECTRIC POWER EQUIPMENT OF THE BURBACHER HUTTE.

BY FRANK C. PERKINS.

The electric power generating equipment of the Burbacher Hütte has recently been supplemented by a new high-power tandem gas-engine of the double-acting type, constructed by the Vereinigte Maschinenfabrik Augsburg und Maschinenbaugesellschaft Nürnberg A.G. This engine is direct coupled to a double-commutator dynamo constructed by the Siemens-Schuckertwerke of Berlin. This electrical generator supplies a continuous current of 2 × 2,025 amperes at a pressure of 2 × 240 volts, having a capacity of 980 kw. at a speed of 100 r.p.m. The high-power double-acting tandem gas-engine has a total output of 1,500 h.p., and is operated entirely on coke-oven gases.

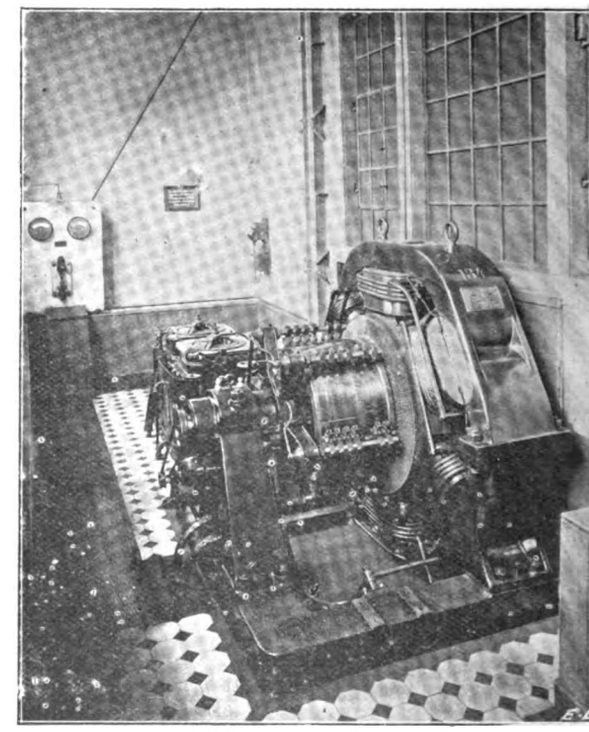


Three Direct-Connected Blast Furnace Gas Engines in Burbacher Hutte Power-House.

The first equipment of the original central power station of the Burbacher Hütte included three twin single-acting Deutz engines operating on waste blast-furnace gases, and direct coupled to multipolar continuous-current dynamos constructed by Schuckert and Co., of Nürnberg. These dynamos were of 420 kw. capacity each, and were driven by the gas-engines at a speed of 140 r.p.m. Each direct-current generator supplied a current of 1,740 amperes at a pressure of 240 volts.

Electric power has been demonstrated by a decade's service under most severe conditions to be the most satisfactory for the operation of a large part of the machinery of modern iron and steel plants. Electric locomotives are being utilised to advantage for hauling the ore, limestone, coke, coal, and other materials to and from the various parts of the steel plant, with great economy, reliability, and speed. Both in America and Europe the live rolls in rolling mills are now very largely electrically driven, and while the two-roll high mills are usually operated by high-power steam-engines on account of the necessity of quick reverse, a number of three-roll high mills are operated by electric meters directly coupled with flywheels, and having an output of from 1,000 h.p. to 1,500 h.p. Electrically-operated cranes, shears, punches, saws, and straightening machines are also very common, and electric power is being developed for operating these machines by waste blast-furnace gases, as well as the waste gases from the coke ovens.

Double-acting twin gas-engines of high power are now largely used in modern iron and steel plants, as well as tandem double-acting engines of large output, taking the place of the older type of single-acting engines, which were not able to supply sufficient power for service in iron and steel works for a given space occupied and a given first cost per horse-power of output. At the electric power station in Friedens Hütte, near Mordenroth, there is a 600-h.p. double-acting twin gas-engine operating on blast-furnace gases. This unit of the Oberschlesische Eisenbahn-Bedarfs Aktien-Gesellschaft is directly coupled to a three-phase flywheel generator of 580 kw. capacity. This dynamo was built by the Allgemeine Elektricitäts-Gesellschaft, and supplies current at 500 volts pressure for operating the various machine tools of the iron and steel plant. As an example of the earlier blast-furnace gas-engines of the single-acting type may be mentioned three units of 600 h.p. each operating on blast-furnace gases in the power-house of the Luxenburger-Berg-Werke und



780-h.p. Roll Train Motor at Burbacher Hutte.

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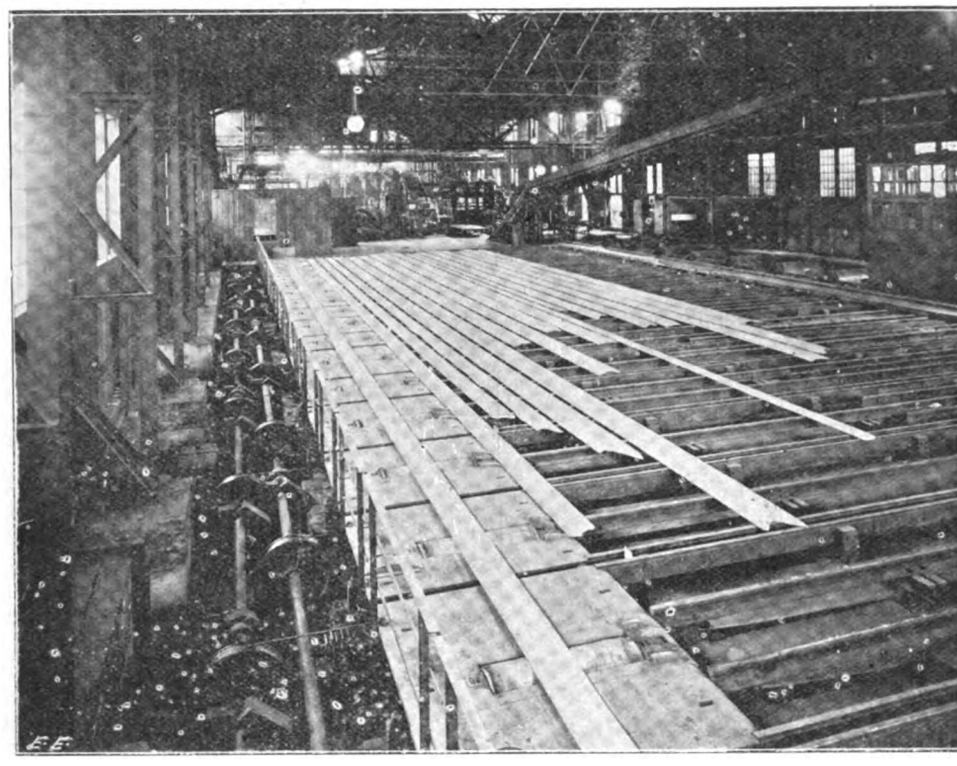
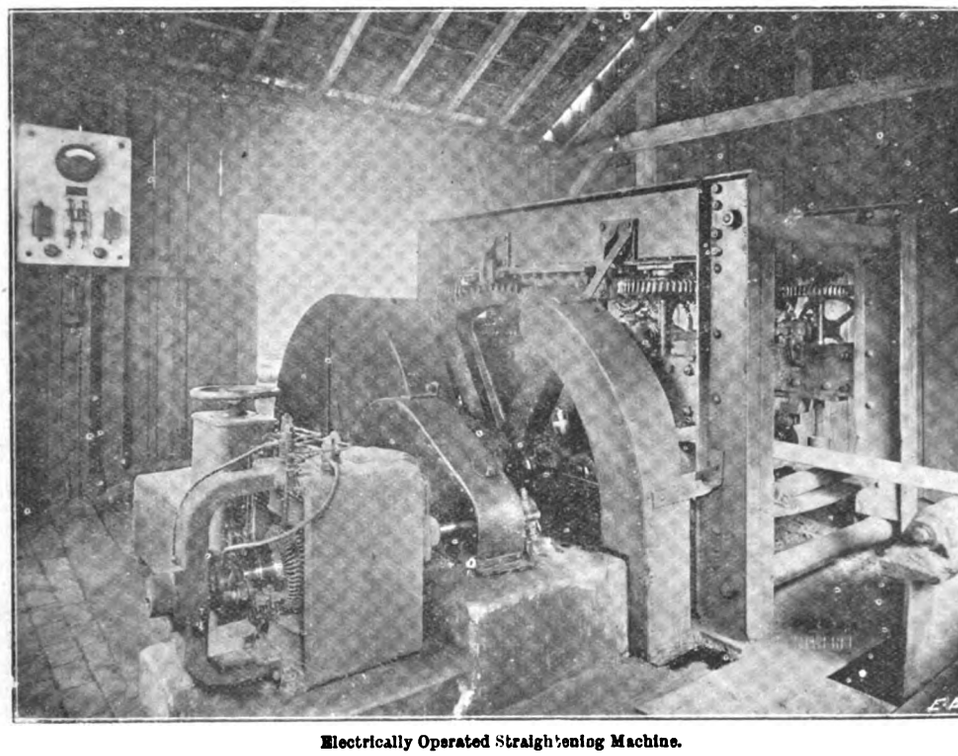
Saarbrücker Eisenhutten Aktien-Gesellschaft. These engines were constructed at Deutz, near Cologne, by the Gasmotoren-Fabrik Deutz.

The steam-turbine has recently found great favour in the eyes of engineers of modern iron and steel works on account of its advantages in readily taking care of variable loads, much in the same manner as a storage battery, and acting as an excellent regulator in modern power stations of iron and steel works. It will handle the peak of the load without difficulty, allowing the reciprocating steam-engines and gas-engines to operate at practically full load, and, therefore, working at their highest efficiency. One of the recent additions to the electric power station of the Burbacher Hütte, a celebrated German iron and steel plant near Saarbrück, is the installation of a steam turbo-generator of 1,250 h.p. This high-power steam-turbine unit is of the Zoelly type constructed at Nürnberg. It operates at a speed of 1,550 r.p.m., and is directly coupled to two continuous-current dynamos of the double-commutator type constructed at Berlin by the Siemens-Schuckertwerke. Each electrical generator has a capacity of 420 kw., and supplies a continuous current on the three-wire system at a pressure of 2 × 240 volts.



Electrically-Driven Trains of Universal Rolling Mill at Burbacher Hutte.

The electrically-operated machinery used at the Burbacher Hütte is most extensive and varied. It includes a motor of 380 h.p. driving the rolls of the fine iron mill by direct connection. This motor operates at a pressure of 440 volts, and varies in speed from 232 r.p.m. to 300 r.p.m. The live rolls of the universal rolling mills are also electrically driven, and it is claimed that the direct-current motors operating the electrically-driven trains have given most excellent service. For the transportation of coal and coke to and from the coke ovens electric locomotives have been utilised to great advantage, each locomotive being pro-



Electrically Operated Straightening Machine.

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vided with two direct-current motors of 25 h.p. each supplied with current at 220 volts. There are two direct-current trolley wires provided, and the length of the electric railway line is 1·8 km., the track gauge being 630mm. An electric crane of 10,000 kg. capacity, of the Nürnberg four-motor type, is used for handling the structural steel and carrying the same to and from the electrically-operated punches and shears. A unique combination punch and shear is in use at the Burbacher Hütte, the same electric motor operating the two tools. The motor has an output of 20 h.p., and is supplied with direct current at 220 volts. Another interesting tool which has been successfully driven by electric power is the straightening machine, the bipolar continuous-current motor driving the same through a system of gears.

The total number of motors employed is about 300, having a total capacity of 2,600 h.p The yards and buildings are electrically lighted by about 300 arc lamps and over 4,000 incandescent lamps of 16 c.p. each. The switchboard in the power-house is most artistic in design, and is equipped with usual circuit breakers, ammeters, and voltmeters as well as wattmeters. There are four panels, two of which control the electrical generators, and the remaining two the feeder circuits to the blast furnaces, rolling mills, and electrical industrial railway.

COPPER.

For the last year or two the high price of copper has seriously handicapped the electrical industry, and the recent drop in prices will be welcomed by all electrical manufacturers, whether they are cablemakers or dynamo builders. The curve (Fig. 1) shows the maximum quotation for standard copper for the last 10 years, and also the lowest price for each year in question. Again, in Fig. 2 will be found weekly figures since April this year. This curve for a period of under six months shows a drop of over £40 in the price per ton of G.M.B. It is obvious that the sudden fluctuations shown in this curve cannot be accounted for by the ordinary supply and demand, and further reference will be found to it in our leading article. The *Financial Times*, writing on this subject on the 14th, said: "When the price of the metal was forced up so high last spring there was considerable buying for fear rates might go higher still, and consumers then replenished their stores to an extent evidently not carefully calculated by producers at the time. Meanwhile a halt has been called in certain lines of industry in which copper is usually in great demand, and this fact has enabled many manufacturers to retain much of what they acquired in the early part of the year. Consequently, they have the whip-hand of the producers, and will not buy even at present dwindling rates. The producers, on the other side, have to finance a steadily growing accumulation of copper at a time of great monetary stringency, while the banks are not over anxious to lend on copper collateral except on fancy terms. Some authorities calculate that in America there is about two months' output, or 150,000,000lb., in hand, and the United Metals Selling Company has to advance to producers at least 70 per cent. of the metal actually mined, the producers paying 5 per cent. for the accommodation. With distribution at its present low ebb this is a situation pleasant neither for the United Metals Selling Company nor the mines, and we can understand why the former should have at length retreated from its old hard-and-fast attitude about prices, and why the latter should begin to talk of restricting output. In one quarter it has been suggested that producers should shut down for a month or two, and, as a matter of fact, some of the smaller properties have already ceased to ship. The Amalgamated is also reported to be considering the desirability of closing down some of its largest mines. Consumers so far have exhibited no eagerness to avail themselves of the recent cut in prices, and many manufacturers declare they look for a further reduction up to 30 per cent."

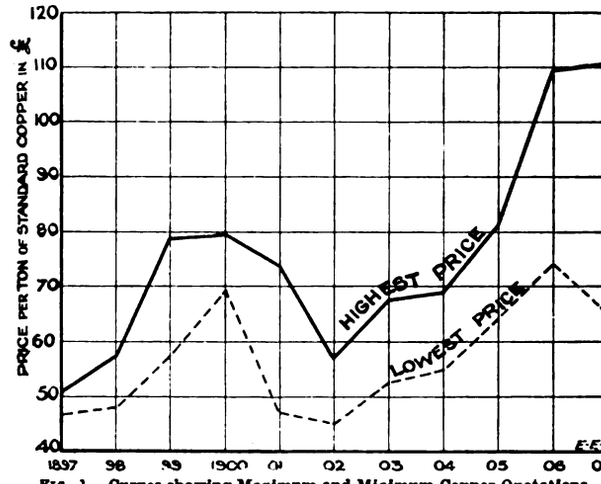

FIG. 1.—Curves showing Maximum and Minimum Copper Quotations Each Year since 1837.

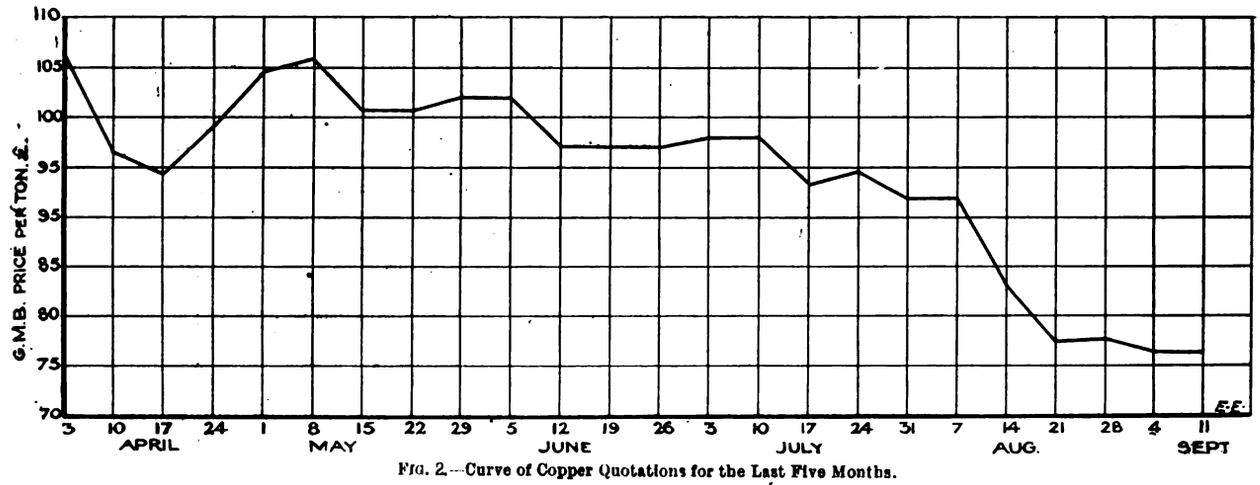

FIG. 2.—Curve of Copper Quotations for the Last Five Months.

THE CONNECTION OF CABLES TO SWITCHBOARDS IN UNDERGROUND SUB-STATIONS.

BY W. PLEASANCE.

Engineers in the employ of electricity supply undertakings will over and over again be confronted with the difficulty that arises from the necessity of connecting up two or three different kinds of apparatus which are good in themselves, but when combined give a lot of trouble. One of the instances is the construction of an underground sub-station, inasmuch as there are many switchboards splendidly designed for the work they have to undertake, and also many cables which are quite efficient in maintaining insulation. It sometimes happens, however, that the combination of a satisfactory board with satisfactory cable makes a most unsatisfactory job.

In deciding, for example, whether cables shall be carried from above the switchboard level directly on to the con-

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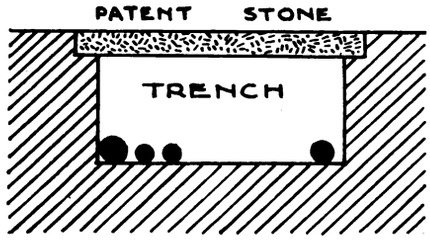
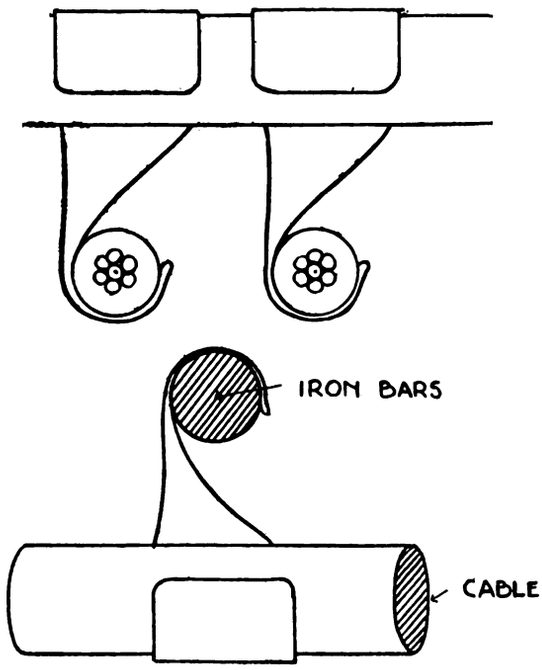
nectors, or shall be brought up from a trench underneath, one is governed to a great extent by the type of switchboard used, having regard to the expense involved, and also to certain mechanical and electrical properties of the arrangement. A sub-station with the cables carried in bunches and brought up to the board has the safest and best arrangement, but this procedure runs away with a considerable amount of heavy cable, and with the present high price of copper many engineers look very doubtfully at any system which means increase in the number of drums of cable ordered for a job. It should be borne in mind, however, that in the case of oil-insulated cables hanging down above the level of the board, great care should be taken to seal the ends joining on to the connectors in such a way that the oil does not creep, for with rubber-covered cables the oil rots the rubber, and should it get on to the switchboard will make the task of keeping the board clean almost impossible. Any seals, therefore, which contain a rubber composition should be carefully avoided for such work, as not only is the switchboard spoiled, but the oil in the cable itself running out, the cable insulation is made more precarious.



When the cables are carried into a trench, as suggested above, and from this to the switchgear, transformers, etc., a very convenient cover for the trench can be made out of artificial stone slabs, arranged as shown, a seating being left in the concrete trench to receive them, the cable being laid along the bottom of the trench.

A convenient arrangement for overhanging cables, where these have to be brought along the roof and dropped down to the switchboard, is made as shown in the second figure, by a bar being bolted to the girders of the roof or to the concrete by means of rag bolts, and the cable being carried by a broad double hook with a half bend in it, as shown



in the illustration. This arrangement provides a strong yet movable support, and is a very convenient form of suspension for such cables.

Where cables, such as three-core or three-phase, are taken into joint-boxes for the purposes of connecting the leads to the switchboard, these joint-boxes being filled with an insulating compound containing wax or a similar substance, continuous care should be exercised in seeing that the wax does not creep. Owing to the fact that sub-stations occasionally get considerably warm, the compound is apt to become a little less solid than it ought to be, and as it also has a high coefficiency of expansion it is liable to escape out of the pouring hole, or, if this has been effectively closed, to force its way past the cable entrances. This can be avoided to a certain extent by careful packing with yarn, but in some cases it is advisable to permanently arrange a sort of tunnel on the top of the pouring hole, so that when the wax expands it may rise up into the funnel. As the sub-station cools down again, due to the load passing off, the wax, contracting again, passes down to its own position in the joint-boxes. In this way there is no danger of the wires becoming bare and liable to flooding from any accidental inrush of water to the sub-station.

The above points illustrate the many small details which are always arising in the construction of underground sub-stations. Although they are small in themselves, they assume a very great degree of importance from the fact that unless a rigorous system of inspection of such sub-stations be instituted mischief is likely to go on quietly and uninterruptedly until a breakdown reveals a defect that was never even suspected. It will be interesting to hear from engineers in charge of cable systems as to the minor defects in cable connections which have proved sources of inconvenience and worry.

SOME NEW FLYWHEEL STORAGE SYSTEMS.*

BY A. P. WOOD, M.I.E.E.

The subject of electric winding is one which has had a considerable amount of attention during the last few years from electrical engineers. There were several papers read on this subject last year before the Institution, but they were principally on the question of electric *v.* steam winding. I do not propose to go into the merits of the two systems to-night, but I think it was agreed that electric winding could not be commercially practicable unless in such cases where the value of the coal used at the pit exceeded in value 2s. 6d. to 3s. per ton. The fact remains that a considerable number of electric winders are being installed in this country at the present time, and the practical results attendant on these installations will be, of course, the best warrant as to their merit. I, therefore, propose to describe a few patents which have been taken out during the last year, and are the property of my company. These patents comprise both three-phase winding and continuous-current winding; the former have been taken out by Mr. McLeod and the writer, and the latter by Mr. Kelsall, Mr. Warburton, and the writer.

Now, what are the principal requirements of electric main winding plants? (1) Cheap first cost; (2) low coal

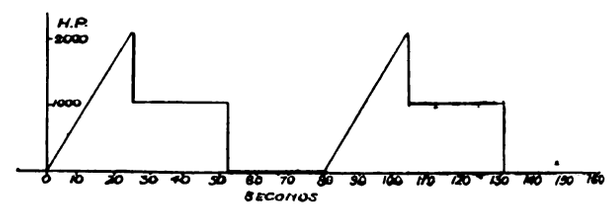


FIG. 1.

costs; (3) ability to run the main motor in case the flywheel storage system fails; (4) ease of control and simplicity; (5) desirability of running the winding motor at nights for lifting water, etc., without the use of the flywheel set (the winds in this case are generally about 1 per 20 minutes). The requirements of electric winding are, of course, very severe, and this is best shown by the diagram (Fig. 1) showing the power required during a complete wind, the maximum horse-power during acceleration being 2,000 h.p. and the average demand being about 800 h.p.

Three-Phase Systems.—The system best known in this country and abroad is the Ilgner, but this is not a true three-phase system, as it is necessary to convert to continuous current, using continuous-current motors on the

* Paper read before the Manchester Section of the Institution of Electrical Engineers.

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main winding gear. This system has been so fully described before that I do not think it necessary to go into details. It consists, briefly, of a flywheel system, consisting of a three-phase induction motor coupled to a continuous-current generator. The latter drives a continuous-current motor geared or direct coupled to the main winding gear, the control of the main winding motor being effected by the well-known Ward Leonard system. The three-phase motor is fitted with slip-rings, so that resistance can be introduced when required. Of course the flywheel cannot give out or store energy unless the speed is varied, and, therefore, it is necessary to introduce resistance into the rotor circuit when it is desired to make the flywheel give out energy; and to speed the flywheel set up again, this resistance is necessarily cut out. The main winding gear, therefore, is absolutely dependent on this flywheel system, and should the latter break down in any way the winding gear cannot be used. Of course, it is necessarily an expensive gear, and to duplicate the flywheel system would add so much to the cost as to make it practically prohibitive, unless the value of the coal burnt at the pit mouth was very high. The writer, therefore, thought it was most desirable that the winding motor should be three-phase, and so arranged that it could be worked in case of failure of the flywheel system. With this object in view, therefore, in conjunction with Mr. McLeod, he worked out a series of systems, and made a considerable number of experiments with the same. Of course, it is well known that the Westinghouse

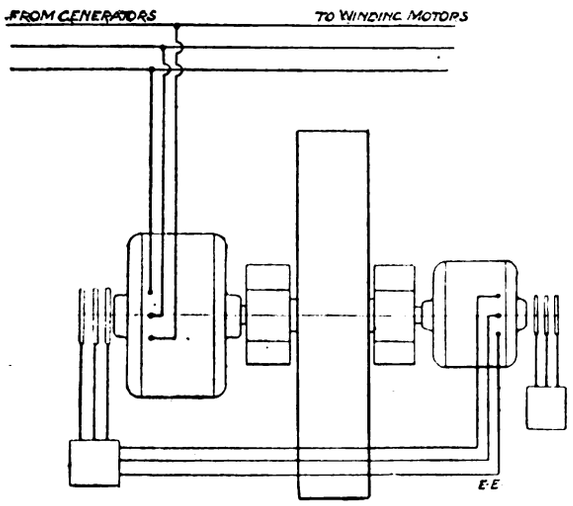

FIG. 2.

Company have a system which is known as the rotary converter system, and this has been fully described by Mr. Braun at the discussion on Mr. Mountain's paper. This system has the advantage over the Ilgner that the winding gear can be worked if the flywheel system breaks down.

The first system to describe is called the cascade flywheel storage system (see Fig. 2). This consists of two three-phase machines coupled together in cascade, and attached to a flywheel, the main winding motor being three-phase. The flywheel set is started up in the usual way by resistance in the rotor circuit of the speed machine; the latter is afterwards cut out, the speed of the flywheel rising in proportion. Assuming for a moment that we have a four-pole and two-pole machine in cascade, then if the second machine is in circuit, the speed of the set will correspond to that of a six-pole machine, and if the second machine is cut out, the speed will correspond to a four-pole machine. Assuming for a moment that 50 periods is used, this will give, say, 1,500 r.pm. and 1,000 r.p.m. respectively. Assuming that the flywheel set is running with the second machine cut out, the main winding motor is then started up by resistance in the rotor (preferably a liquid resistance tank controlled by a valve allowing the liquid to pass to the resistance box from a tank overhead, fed by a small centrifugal pump.) Simultaneously with the starting up of the main motor the second machine of the cascade is put into service, and the flywheel begins to reduce its speed, the cascade system delivering current back to the mains, and assisting the main supply until the speed attains synchronism, corresponding to six poles—*i.e.*, 1,000 r.p.m. It is, of course, well known that an induction motor, when running over synchronism, will deliver current back to the supply. This property is utilised in mountain railways when the cars are descending the hills. As soon as, or before, the current from the main winding motor is shut off, a bar is put across the three wires forming the connections between the two machines in cascade, and the flywheel begins to absorb energy and speed up to 1,500 r.p.m. It is, of course, then prepared to discharge itself as soon as the main winding motor is started up again. The operations of the motor during the ordinary working day are almost perfectly regular in time of stoppages, etc., for loading and unloading, and the energy required to be stored up in the flywheel can be calculated to the greatest nicety. The disadvantage of this system is, of course, the poor power factor (see Fig. 3), as the main generator has to supply the magnetising current for the flywheel set under all conditions.

The following are a few readings observed on a small cascade flywheel set, showing principally the poor power

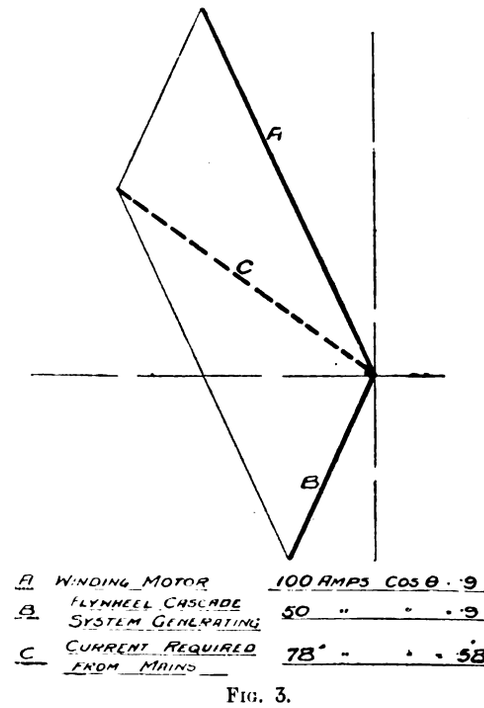

FIG. 3.

factor obtained when the flywheel set is delivering energy back to the mains.

Readings Taken on Cascade Set, Flywheel Discharging.

Power factor winding motor about ·9 at 15 amperes.
Power factor cascade set ,, ·93 at 8 amperes.
,, ,, ,, ,, ·83 at 15 amperes.

Winding motor. Amperes.	Flywheel set. Amperes.	Difference. Amperes.	Actual current supplied by three-phase generator. Amperes.
15·3	8·7	6·6	11·8
15·0	15·5	0·5	15·2
14·5	6·2	8·3	11·4

The second set of readings show practically equal currents on the generator main winding motor and flywheel set, the power factor on the generator in this case being 0·03. The third set of readings shows a power factor of ·64 on the generator. The writer does not think that power supply companies would quite appreciate loads with power factors in the neighbourhood of, say, ·5 as an average.

The second system which I propose to describe consists of two induction motors, say a four-pole and six-pole, coupled together with a flywheel between (see Fig. 4). These two machines are not in cascade, but a throw-over switch is arranged so as to connect either one machine or the other to the mains. It is, of course, obvious that when the four-pole machine is coupled to the mains, assuming that the periodicity is 50 per second, the synchronous speed will be 1,500 r.p.m, and when the six-pole machine is coupled the synchronous speed will be 1,000 r.p.m.

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Therefore, to store energy in the flywheel, the throw-over switch is put on to the four-pole machine, and to take energy from the flywheel the throw-over switch is put on to the six-pole machine. The latter will, of course, then deliver energy back to the mains until the speed of the flywheel is reduced to 1,000 r.p.m. The disadvantage of this system is, of course, that it is somewhat costly, and probably might give trouble with the switchgear, as the heavy currents have to be made and broken on the throw-over switch. The power factor, of course, is better than that of the cascade system, but it still has the disadvantage

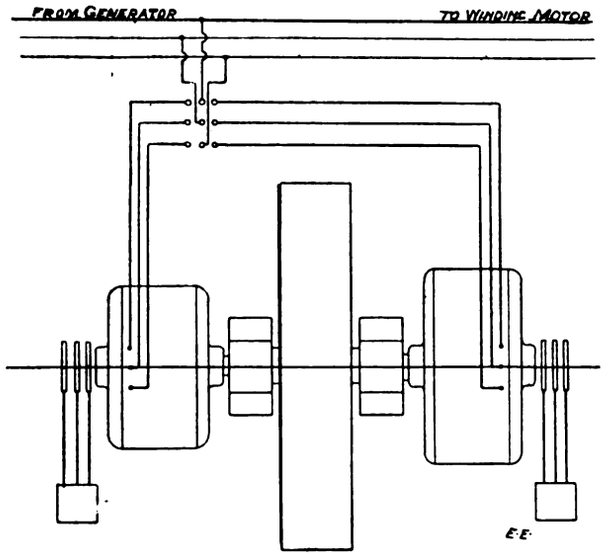

FIG. 4.

that the magnetising current for the flywheel system has to be supplied from the mains; therefore, the only logical conclusion to come to was that it was necessary to use a synchronous motor coupled to the flywheel set, which can, if necessary, be over-excited so as to give unity power factor on the supply mains. A synchronous motor necessarily must run at a constant speed, and, therefore, no energy can be put into the flywheel, or taken out, unless either the periodicity was altered, or the stator was revolved. The latter method, therefore, offered a very simple means of getting over the difficulty, and resulted in a new patent being taken out for a synchronous flywheel storage system. As

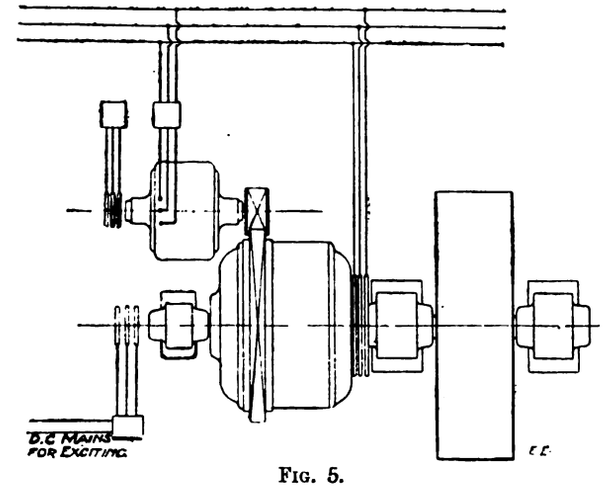

FIG. 5.

this is undoubtedly the best system of the three, the writer proposes to describe it at somewhat greater length than he has devoted to the other systems.

The flywheel storage set consists, as I said before, of a synchronous motor with a revolving stator; the rotor of this machine is of rather peculiar design, being almost exactly similar to a wound rotor of an induction motor (see Fig. 5). This motor is started up exactly as an induction motor—that is, with a resistance in each leg of the rotor—this resistance being gradually cut out as the flywheel attains its maximum speed. Suppose for a moment that we decided to use a six-pole machine, and the periodicity is 50; this will mean that the flywheel will run at 1,000 r.p.m. when the stator is stationary. As soon as the speed is near synchronism, continuous current supplied from another source (such as the exciter on the main generator) is inserted between one leg of the rotor windings and the common junction thereof, the rotor being, of course, star connected. The motor at once pulls into synchronism, and no phasing indicators are required whatever. The two unused legs of the rotor winding are then short-circuited and form amortisseur windings, the advantage of this being that it gives the synchronous machine a large overload capacity without coming out of step.

The stator is carried on ball bearings from the nose of two pedestal bearings attached to the bedplate, and is geared to a small three-phase or continuous-current motor by spur or skew gearing (see Fig. 6). The writer prefers to have this small auxiliary motor reversible, so that it will run at a speed of, say, 200 r.p.m. in either direction. It will, therefore, be obvious that when the stator is revolving in the opposite direction to the rotor at, say, 200 r.p.m., the synchronous speed of the flywheel will be 800 r.p.m., and if the stator is revolving with the flywheel at 200 r.p.m. the synchronous speed will be 1,200 r.p.m. Of course, it is quite easy to arrange to run the stator at a higher speed than this in both directions if required, but, generally speaking, it is not

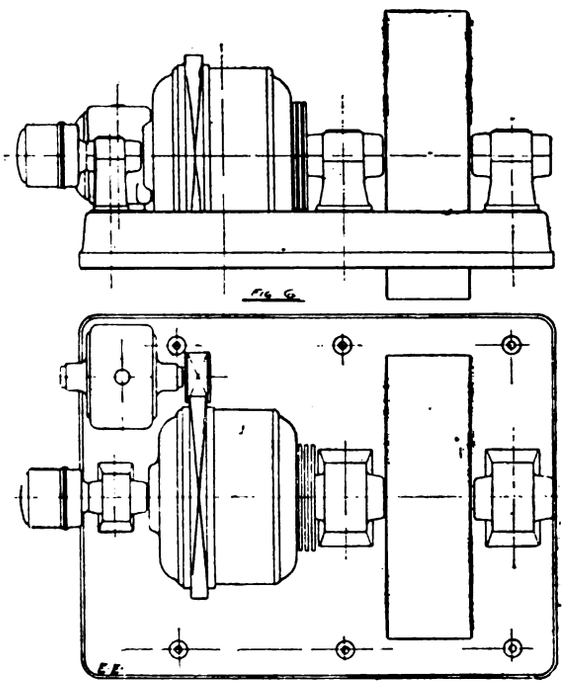

FIG. 6.

desirable to vary the speed of the flywheel to the extent of more than about 1 to 1·5. This auxiliary motor is, of course, very often stopped, and, therefore, it can be assumed that the capacity of it is only about one-fifth of that of the main flywheel motor, allowing for gearing losses. The main winding motor, of course, is three-phase, and takes its current at full pressure from the mains, the starting being effected through resistance in the rotor, preferably of the liquid type. After the flywheel has been speeded up to its maximum—that is, by revolving the stator at 200 r.p.m. in the same direction as the flywheel—the main motor is started up, the speed of the flywheel being reduced by gradually stopping, and afterwards reversing the motor controlling the speed of the stator. During this period the flywheel will be giving back energy to the supply mains. Better control of this system can be obtained by using a small continuous-current motor revolving the stator, this machine being supplied with current from a small continuous-current generator direct connected to the flywheel storage system, these two machines being controlled by the Ward Leonard system, the excitation being effected from the exciter on the main generator. In order to control the main winding motor, it is necessary, first, to have a lever arranged to open a valve, and admit water to the resist-

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ance tank connected to its rotor; at the same time, this lever must control a Ward Leonard shunt rheostat which controls the speed of the stator case. The readings (vector diagram, Fig. 7) taken on a flywheel storage set arranged as above will give an idea of its superiority over the cascade system, particularly as regards power factor.

In pointing out the advantage of this system as compared with the one using continuous current for the main winding motor, attention must be called to the fact that it is possible to use a flywheel running at a high speed. With this construction we can use a comparatively light flywheel, as it is possible to obtain a flywheel built up of armour plate which can run at a peripheral speed of 28,000ft. a minute, and with a large factor of safety. Such wheels are made and can be guaranteed by manufacturers in this country. It is, of course, necessary to use a slow speed on the Ilgner system, owing to the fact that a continuous-current dynamo is attached to one end, and this dynamo has to work under very difficult conditions. It must, of course, be capable of delivering its full current with practically no volts, and although it is fitted with interpoles, it is not possible with present practice to run these flywheel sets at a very high initial speed. In flywheel systems where a large amount of energy has to be stored up in the flywheel, it, therefore, becomes almost impossible to build a flywheel which can be transported on the railway for these slow speeds. These flywheels necessarily must be made of the plate pattern, and in one piece, and unless the colliery is situated at or near a seaport town, it is practically impossible to transport the flywheel to the site on which it is to be used. The three-phase flywheel storage system, therefore, does away with this difficulty, as the flywheels are of comparatively small diameter. They are also lighter on account of the considerable amount of energy which can be stored up in the rotor of the synchronous machine. It will be observed

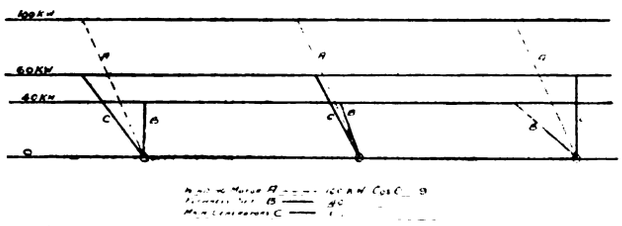

FIG. 7.—Diagrams showing Different Currents on Flywheel Set and Main Generators for the same Load at Varying Power Factors.

that in the system which we have patented the full power required for the motor does not pass through the flywheel set, which simply acts a buffer dealing only with such proportion of the current above that previously determined to be taken from the generator or source of supply, the normal energy going direct to the main motor without being transformed in any way. This, of course, means low capital cost, as the flywheel system is of relatively small capacity and high efficiency, as the major part of the current is supplied direct to the winding motor.

Attention must also be called to the fact that in many collieries they require to run the main winding engine intermittently during the night for lowering timber, etc., and for lifting water. With the above system the flywheel set can be shut down entirely, and the main motor simply run on a slower acceleration in order to keep down the peaks. There is also, as a rule, plenty of reserve power on the main generators during the night time, as the electric hauling engines down the pit, in addition to many other motors, will not be at work. Under these conditions, therefore, it is better to shut down the flywheel set at night altogether. Attention has been called to the fact that by varying the exciting current of the flywheel set, the power factor on the mains can be raised to unity, if necessary, but, of course, it is not desirable to do this to a too great extent owing to the fact that magnetising current does not represent energy, and, therefore, the flywheel set cannot help the main motor much if it is delivering wattless currents for magnetising to a too great extent.

A group of two or three main winding engines within reasonable distance for a high-tension transmission can be advantageously driven from one central station with one common flywheel storage set. The flywheel storage set in this case is controlled by a solenoid or small induction motor actuated by the main current coming from the generator and starting, stopping, or reversing the small motor driving the stator on the flywheel set according to the current demanded by the various winding motors. This method can also be applied to equalise the load on any system (a group of rolling mills, for instance).

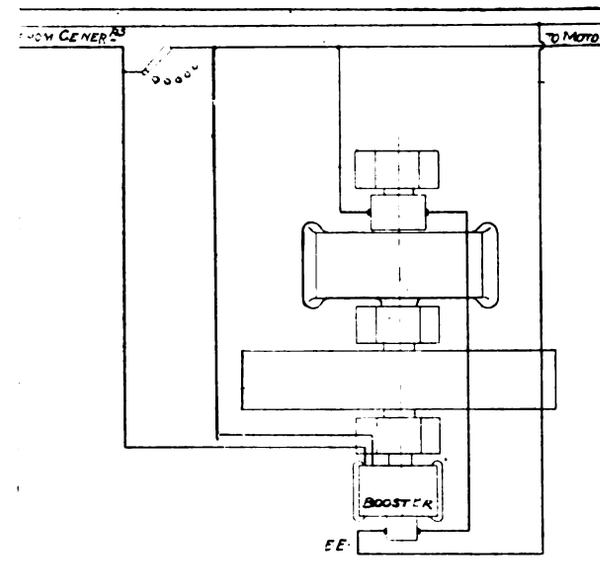

FIG. 8.

In comparing the cost of running of electric as against steam winders, the comparison ought to be made on a proper basis. It is generally admitted that electric power is desirable for practically all other operations in the pit, and, therefore, the cost of this generating plant ought to be taken into account in comparing the two systems. Assuming for a moment that the auxiliaries require 1,000 kw. with steam winding, this would mean three generating sets, each of 500 kw., allowing one set as a spare. With electric main winding taking an average load of, say, 800 kw. from the mains, making a total load of 1,800 kw., the total capacity of the generating plant required would be 2,700 kw., assuming that we have a stand-by set of 900 kw.—*i.e.*, three sets of 900 kw. each. The first cost of the larger plant will be considerably less per kilowatt than the smaller, and the coal consumption per kilowatt-hour will be less.

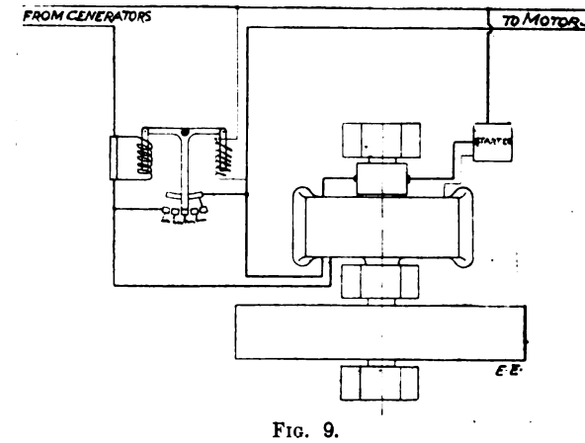

FIG. 9.

The first cost of the boiler installation will be considerably less with electric winding, and there will be no difficulty in using water-tube boilers, which are perhaps more suitable for burning low-grade fuels and for large powers. Water-tube boilers can only be used with success with steam winding if there is a considerable amount of steam taken for driving other engines, as the water-tube type is not suitable for the heavy draughts of steam required in steam winding. It may interest some of the members to know that some of the largest collieries in

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the South Wales district have as many as 70 Lancashire boilers.

Continuous-Current Systems.—The two systems which I propose briefly to describe in this paper we will call the booster flywheel storage system (see Fig. 8) and the compound flywheel storage system (see Fig. 9). In the former a plain shunt-wound generator excited across the mains is attached to a heavy flywheel, and its armature is coupled up in series with an automatic reversible booster, constructed according to the Turnbull and McLeod patents. This booster has been very fully described in papers read by Mr. Turnbull and Mr. Kelsall before the Institution. I, therefore, do not propose to describe it in detail. The main flywheel dynamo simply takes the place of the battery, and if the demand on the line is heavy, the booster will give a voltage in such a direction as to pull current out of the flywheel dynamo, and when the demand on the line is small the booster will give a voltage in such a direction as to charge or speed up the flywheel set. The speed of this flywheel set will correspond directly to the voltage across the armature terminals, as the dynamo is excited at constant pressure across the mains. There are not many cases where this system will be applicable, but it might be of service to some tramways, in addition to a main winding plant, when the peaks are of short duration. The flywheel system is, of course, of no value if the peaks are carried on for a period exceeding three minutes, as the first cost of the flywheel to store a sufficient amount of energy for a longer period than this is so enormous.

The compound flywheel storage system (Fig. 9) consists simply of one machine which acts alternatively as generator and motor, and is, of course, coupled to a heavy flywheel, and worked in conjunction with automatic switchgear to vary its field strength. In the typical case, briefly stated, the auxiliary machine is compounded to give constant external volts at all loads, whether motoring or generating. Its armature is connected across the mains between the generating plant and the fluctuating load, and its fields are equipped with a special series coil carrying the generator's load, or some proportion of it. As long as the flywheel auxiliary's speed remains the same, the generator's load cannot alter, for the smallest tendency of the generator's current to increase strengthens the auxiliary machine's field, causing a generating response, and, similarly, the smallest tendency of the generator's current to diminish causes the auxiliary set to motor. As the auxiliary set speeds up, due to motoring, the automatic switchgear diverts an increasing fraction of the generator's current from flowing through the special coil of the auxiliary set, so that the field of the auxiliary set is gradually weakened without diminution of the load on the generating plant. Similarly, as the auxiliary set slows down, due to generating, the automatic switchgear gradually reduces the fraction of the generator's current diverted from flowing through the auxiliary's field, so that the auxiliary's field is strengthening without increase in the load upon the generator. However much the load varies, the demand upon the generating plant is only the average demand, all the excess demand of the peaks being supplied by the auxiliary set from energy stored during the valleys of demand.

In conclusion, I can only say that I am sorry not to be able to give any actual results of working of the above systems, but before very long I shall have some actual results, which will probably be published in the electrical papers. I hope that the systems which I have described will be criticised, and that there will be a good discussion.

DIRECT AND INDIRECT METHODS OF ELECTRICAL PURIFICATION OF WATER.*

BY HENRY LEFFMANN.

It is about a century since the results of electrolysis began to attract attention, but the commercial exploitation of the processes was impossible until the economic production of the processes practical. So far as the purification of water is concerned, but little result was expected from electrolytic methods until the discovery of the microbic life in water and its relation to disease. The latter discovery was promptly made the basis of a rapid and brilliant, but in some respects untrustworthy, development. Water analysts, and sanitarians generally, were often misled by the statements emanating from bacteriologic laboratories. Even to-day we must receive with caution publications from such sources, especially tabulated results of experiments.

It is not necessary to review the history of the application of electrical currents to water purification, nor to describe even briefly the numerous patents that have been granted for such purposes. I propose to refer here only to some that have come under my own observation, in consequence of having been asked to make expert investigations.

Scheme of Arrangement of Tower for Mixing Ozonised Air with the Water.

Some attempts have been made to remove the mineral impurities from water by taking advantage of the electrolytic powers, but most processes have been intended to kill the microbes. The ordinary inventor has proceeded upon his (generally superficial) knowledge that the disease-carrying power of water is dependent upon bacteria, and that electricity in sufficient strength is fatal to living matter.

In some of the processes the method has been the crude one of simply passing electric discharges through the water, hoping to kill the bacteria by direct shock. Thus, in one patent which was submitted to my consideration a few years ago, the inventor proposes to have electrodes passed into the water-main through insulated sockets and discharge a succession of sparks across the stream. The impracticability of the method, on anything but the most minute

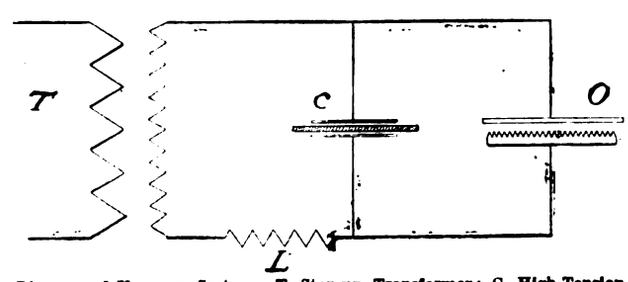

Diagram of Vosmaer System. T, Step-up Transformer; C, High-Tension Condenser; L, High-Tension Choking Coil; O, Ozonising Apparatus.

scale, seems not to have appeared to him, but, what I consider much worse, the absurdity was unregarded by the Patent Office. It has seemed to me that there are limits beyond which the authorities of the Patent Office should not allow the sanction of their protection. I am well aware of the fact that many processes ridiculed by experts have been successfully applied, but a limit of permissibility can be set without working injustice. Too many patents are granted that are inoperative, and are, or should be, known to be so by the examiners who have experience in such matters.

I have seen in operation several methods of water purification by means of electrolysis. In these aluminium

* From the *Journal* of the Franklin Institute.

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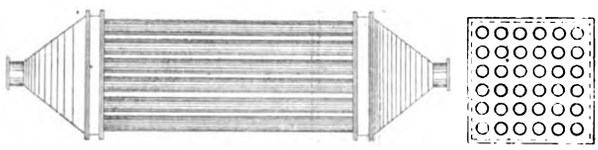
electrodes have been used, and more or less loss of the metal has occurred, it being converted into alumium hydroxide. This produces its usual effect, that of combining with the organic matter and entangling the suspended substances, so that the water, after treatment, can be subjected to a rapid filtration, and will show material improvement in microbic content, especially if the amount of suspended matter and microbic content were previously high. On waters containing but little suspended impurity, living or dead, the purifying action is relatively low. The constant loss of the electrode is, of course, a most serious item of expense, generally overlooked in the experimental plants.

Two of the plants in which aluminium electrodes were used may be described with advantage in some detail, as



Longitudinal and End View of Tubes of Ozoniser.

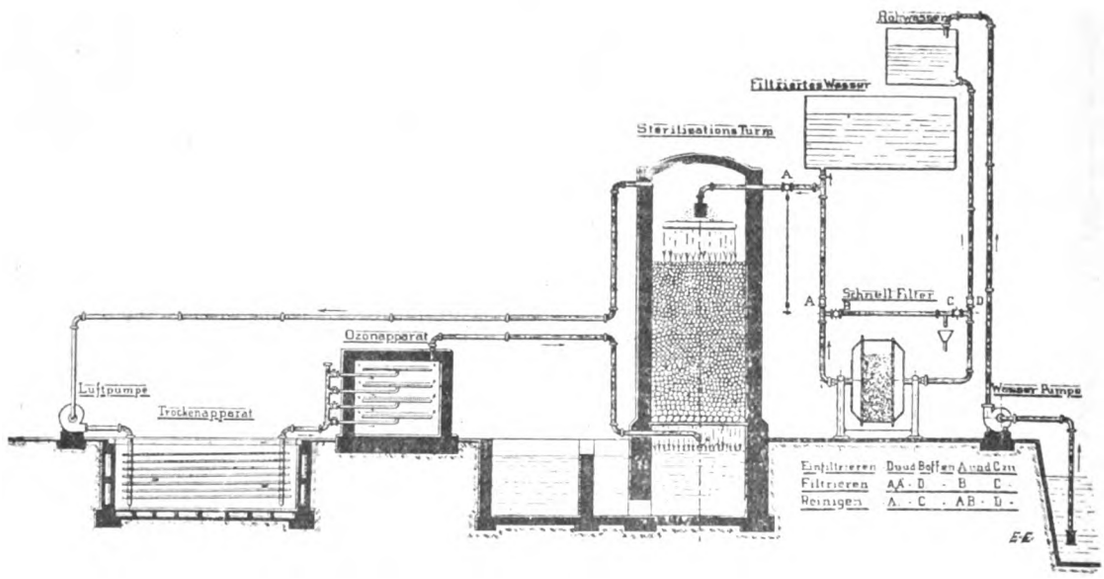
some incidental features are of interest. In one, large aluminium plates 2ft. long and several inches wide were immersed in the water in a tall jar and the current passed through. The experimenters selected (probably with a view of more profoundly impressing inexperienced observers) very muddy water from the street gutter in front of the building in which the plant was located. The current seemed to cause the mud to collect and settle rapidly, and the water became soon fairly clear, but analysis showed ammonium compounds and nitrates in abundance, and it was evident that the purification was nominal. The parties had but little money, and were trying to interest a Philadelphian business man, but I could not make any but an unfavourable report.

In another case I was asked to examine a plant that was in operation near Eighth and Chestnut streets, Philadelphia. One of the parties operating the plant claimed that the scale-forming ingredients could be removed from Schuylkill water as well as the other impurities. As this was a very broad and seemingly unwarranted claim, I was much interested in the basis for it. The promoter furnished me with a sample of water, said to be Schuylkill (city) water so treated and purified, but on taking the total solids I found the dissolved fixed matter to be just about that of the amount in the city water. It was evident that no material diminution of the dissolved solids had occurred. At the urgent request of the promoters, I visited the plant and found a very elaborate installation, mostly of closed vessels, some of which were taking the street current through ammeters and voltmeters, and from others of which a clear water could be drawn in considerable amount. The operators showed me specimens of water containing a large amount of sediment, mostly in flakes, which they claimed to be the "scale-forming ingredients." I was at first much puzzled by this sediment, as I had not been informed as to the construction of the electrifying apparatus, but when I learned that aluminium electrodes were used I recognised at once that the precipitate was aluminum hydroxide. The process was, of course, entirely unsuited to the purposes for which it was devised.

In the operation of the Anderson process of purifying water by agitation with metallic iron, attempts have been made to get more powerful action—that is, more rapid solution of the iron—by making it the positive pole of an electric system, but no practical advantage seems to have been attained. Recently, a process has been patented in which an electric current is passed from an inner to an outer pipe, the water flowing through the annulus, but I have no practical knowledge of this method.

It seems to me that the most practical benefit of the application of electricity to water purification will come from the indirect methods in which the electrical energy is used to produce an active disinfecting agent, and this then applied to the water. Of all the processes of this type, those which produce ozone seem to be most useful. The material from which ozone is obtained—air—is in unlimited supply, and the addition to water cannot be regarded as being dangerous, since if present in excess it soon reverts to the condition of ordinary oxygen.

The principal problem in this method is the economic production of ozone. This modification of oxygen can be obtained by several methods of different types, but those in which electricity is employed seem to be alone applicable to the processes in question here. For the purpose high-tension currents are most economical, and the best yield is obtained by the so-called "silent discharge." It is now known that a spark or arc discharge will produce nitrogen oxides which are corrosive. It has also been determined that the air intended for production of ozone should be dry, otherwise hydrogen dioxide will be formed. The principal mechanical difficulty encountered in producing ozone on the larger scale by means of the electric discharge is to secure a suitable dielectric. Glass, porcelain, rubber, and other materials have been tried, but are so liable to fracture or perforation that serious interruptions of operation frequently occur. Continuity of action is very important in commercial processes, such as the purification of water, and when a large unit of the plant is out of use in order to install a new dielectric, the condition is annoying.



General View of Plant for Purification of Water by Ozone.

The inventions of Vosmaer seem to overcome the difficulty, for he avoids the use of a special dielectric, employing only the dry air which is to be ozonised. The discharge takes place from thin metal strips, on which are saw-like teeth. These strips are held by insulating (porcelain) sockets firmly in the centre of metal pipes. Many of these pipes are combined in parallel, the strips being all connected with one pole, and the pipes with the

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other. An alternating current of high potential is allowed to flow through the arrangement, almost all the current passing by silent discharge, although at times a spark passes, but as there is no permanent dielectric no damage is done. The sparking is too seldom to produce damage or any appreciable amount of objectionable gases. The drying of the air may be done by any of the known methods. Preference is given by Vosmaer to refrigeration, by means of an ordinary ice machine.

A plant capable of purifying many thousand gallons in 24 hours has been for some time in operation on the west bank of the Schuylkill River at the foot of Locust-street, Philadelphia. The cuts will show the general arrangements, but a brief description will aid in understanding the operation. The water is first roughly filtered. This operation is merely intended to remove the grosser suspended matter, as the ozone process proper does not accomplish this. As the main part of the operation is the destructive action of the ozone on the bacteria, it is not necessary for the preliminary filtration to be nearly so close as when the latter is the sole reliance (as in ordinary filter plants), hence the filter area in the ozone plant is relatively very much smaller, the rate of filtration being so much greater. The filtered, or, perhaps, we may call it strained water, is passed into aerating towers. These are tall, narrow vessels, into which the water enters at the top and the ozonised air at the bottom, the latter under considerable pressure. In the experimental plant above mentioned, an exhibition mixing tower has been installed. This is a glass tube about 16ft high and 10in. in diameter. In this the admixture of the ozone current with the water current is well seen. Upon the thoroughness of this mixing depends, in large part, the thoroughness of the purification. The water escapes at the foot of the mixing tower, clear and practically sterile. It sometimes contains a small amount of ozone in solution, but this is not objectionable and soon disappears, either by conversion into ordinary oxygen or by combination.

The advantages of the process may be summarised as follows: no objectional chemical is introduced into the water; large filter-beds are not required; the operation expenses are not high; the plant occupies a limited area and the operation is simple and easily comprehended; the plant may be enlarged by the addition of new units without disturbing the original units; the sterilisation is rapid and certain; the plant may be placed at any convenient point. The process seems to me to find even more valuable application to the purification of sewage than to ordinary water supply. Both of these problems are now among the most urgent questions of sanitation. The extensive use of water in our domestic life, with the increasing sources of pollution, give importance to every method of purification, and processes that seem to be founded on scientific principles and seem capable of practical operation on a large scale, and to involve low operative cost, limited land area and freedom from dangerous chemicals deserve careful investigation. Many tests of the bacteriocidal efficiency of the plant have been made. Some made by myself showed that the water as discharged from the ozoniser is practically sterile The following more elaborate tests during 1905, extending over many weeks, were made by Dr. Rivàs, official bacteriologist of the city of Philadelphia, supplanted by independent tests by Drs. Jackson and Hale, city bacteriologists of Greater New York.

DR. RIVAS.

Date.	Sample.	Bacteria — Before ozonisation (including disease germs).	Bacteria — After ozonisation (no disease germs).	Organic matter in solution. Before.	Organic matter in solution. After.
May 15	1	720,000	16	15·21	7·7
May 15	2	253,000	37	13·33	8·89
May 18	1	500.000	55	11·96	7·51
May 18	2	500,000	38	19·92	7·11
May 19	1	700,000	5	10 07	6·52
May 19	2	700,000	0	12·64	6·72
Average		562,100	25		

DRS. JACKSON AND HALE.

Date.	Sample.	Bacteria — Before ozonisation (including disease germs).	Bacteria — After ozonisation (no disease germs).	B. coli after ozone.
May 19	1	665,000	15	0
May 19	2	648,000	13	0

More recent tests confirm the foregoing. The following figures show a series of tests with statement of operative cost:

Date.	Quantity of water. Gallons per hour.	Bacteria. — Before ozonisation.	Bacteria. — After ozonisation.	Electrical expenditure, kw. hours.	Rate per million gallons in kw. hours
Dec. 14	31,200	1,500	2	6·1	196
Dec. 14	30,000	2.000	2	6·0	200
Dec. 14	30.300	2.600	4	6·0	198
Dec. 15	30,900	2,100	2	5·5	178
Dec. 15	31,300	1,000	2	5·9	188
Dec. 15	30,000	1,300	5	5·8	193
Dec. 18	29.900	5,600	4	5·6	172
Dec. 18	31,000	1,000	5	5·6	181
Dec. 18	28,500	1,200	1	5·5	193
Dec. 19	30,000	750	2	5·5	183
Dec. 19	29,000	550	4	5·6	193
Dec. 19	27,000	9,900	19	5·6	208
Dec. 19	28,000	6,000	3	5·5	197
Dec. 19	30,000	3,700	4	5·5	183
Dec. 20	29,000	2,900	1	5·5	190
Dec. 20	28,400	4,100	2	5·6	197
Dec. 20	28,400	7,100	5	5·6	197
Dec. 20	28,000	5,700	5	5·8	207
Dec. 21	29,000	8,600	13	5·5	190
Dec. 21	28.000	8,700	11	5·5	197
Dec. 21	27,000	16,400	15	5·8	215
Dec. 21	26,000	2,700	6	5·5	212

REVIEWS.

Engineering Workshop Practice. By CHARLES C. ALLEN, Lecturer in Engineering at the Municipal Technical Institute, Coventry. Published by Methuen and Co. 3s. 6d.

This book is intended as a guide to modern engineering workshop practice, adapted to the requirements of students and of engineering workmen generally. Special attention has been given to the highly accurate methods of measurement now used in the best modern shops, and the various gauges and other measuring instruments are described in detail and very fully illustrated by numerous diagrams. The materials and methods in general use are dealt with, and the modern developments in the processes of milling and grinding, which are not described in books accessible to the majority of engineering students, are explained somewhat fully. Screw cutting and gear cutting as carried out in the modern workshop are fully treated, and the book concludes with two sets of exercises which form courses adapted to the first and second years of workshop training. It is hoped that the volume will prove of value to workmen in those branches of the engineering trade in which very exact work is requisite, such as motorcar manufacture and other classes of high-class work.

The Corpuscular Theory of Matter. By J. J. THOMSON, M.A., F.R.S., D.Sc., LL.D., Ph.D. Published by Archibald Constable and Co., Limited. 7s. 6d.

This book is an expansion of a course of lectures given at the Royal Institution in the spring of 1906. It contains a description of the properties of corpuscles and their application to the explanation of some physical phenomena. In the earlier chapters a considerable amount of attention is devoted to the consideration of the theory that many of the properties of metals are due to the motion of corpuscles diffused throughout the metal. This theory has received strong support from the investigations of Drude and Lorentz. The former has shown that the theory gives an approximately correct value for the ratio of the thermal and electrical conductivities of pure metals, and the latter that it accounts for the long wave radiation from hot bodies. The later chapters contain a discussion of the properties of an atom built up of corpuscles and of positive electricity, the positive electricity being supposed to occupy a much larger volume than the corpuscles.

FORTHCOMING EVENTS.

Iron and Steel Institute.—Sept. 23, 24, and 25, Vienna meeting.

Junior Institution of Engineers.—Sept. 26, at 3.30 p.m., Engineering and Machinery Exhibition at Olympia.

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TO CORRESPONDENTS.

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PROGRESS.

Some very peculiar criticisms have been heard during the past year or so because of the progress made in improving incandescent lamps. A few business men have wondered whether the improved lamps would not adversely affect central stations. Of course not. No real improvement ever affected an industry detrimentally, but always tended to greater success. By these pessimists it is assumed that the demand on the station by the introduction of a good 1·5-watt-per-candle lamp instead of a 3-watt-per-candle lamp will decrease by one half. On the contrary, the decreased cost per lamp is more likely to lead to a greatly increased consumption of current. Many of those still active in electrical work can look back to the 1878 and 1881 exhibitions at Paris, where the germs of the then future industry were open to inspection. The more thoughtful men then predicted the demand would be for "more light," even if the cost was a little high, and their prophecies have been abundantly fulfilled. The gas interests, in the face of competition, evolved new improved and more economical ways of giving light and power from gas, and this progress has reacted on the electric lamp industry, for it has brought about great improvements both in arc and incandescent lighting. The great point to consider is that the tendency of modern civilisation is to turn night into day, and whether the direct object be business or pleasure, light is required for longer hours and in greater quantity. We are not going to labour this point; the facts are too well known In business, the better the light the more economical the organisation; the work is performed better and quicker, and a direct diminution in the cost of the individual light will not mean less expenditure, but equal expenditure and more light. Pleasure does not count; light in this case is given and little attention paid to cost.

Briefly, more than half a century ago incandescent electric light was tried, the energy being obtained from batteries, the light from thin carbon rods in a vacuum, as then obtainable. Of course, such experiments could not succeed. Arc lamps came into use for laboratory and lighthouse purposes. Machines begun to supplant batteries, till in the seventies of last century arc lighting was energetically pushed. The division of light was the crux. Then came this division in the incandescent lamps of Swan, Edison, Maxim, etc. Metallic filaments were tried and failed. Carbon reigned supreme till experiments with the rare earths brought about the present type of metallic filaments, which are held to be more economical than carbon. Yet it will, we venture to say, be found that carbon has not said its last word, so we may expect keener and keener competition between carbon and metal filaments, greater and greater perfection, to the lasting good of the industry. Messrs Clark and Parker in the last issue of the "School of Mines Quarterly" (Columbia University) give an account of their experiments, especially with the "Helion" lamp. Some of their remarks are worth remembering. Thus, mentioning they had made a great number of experiments with everything that seem likely to make a lamp, they say: "We became convinced that while some metallic substances would withstand the temperature necessary to produce an efficient filament, the low resistance of metals would necessitate that the filaments should be of exceedingly small cross-section in order to secure sufficient resistance to utilise the voltage of an ordinary commercial circuit in a lamp of any modern or commercial size." As is well known, voltage has been consistently raised to obtain greater and greater economy, hence the question of producing metallic filaments for these higher voltages has been the endeavour. It is said, and in some cases it seems to be true, that success has crowned the experiments, but

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the forthcoming winter will no doubt give us a good deal more practical data rather than laboratory results. The gentlemen named tell us that much trouble arises from the cement junction of the platinum with the filament, and a new cement is being sought. Low resistance, small cross-section, delicacy of filament, troubles with cement, are all probably to be avoided, and the lamps of low consumption will be largely tried, and, if successful in practice, will greatly assist the central stations. Of course, economy in watts is only one factor that goes to make economy of lamps, but an important one.

COPPER SPECULATION.

The high price of copper has for two years played havoc with the electrical manufacturer, who has not been able, like cablemakers, to raise his prices in accordance with the increase in the cost of raw material. The cablemakers, while protected against this by sliding scales, have found orders more difficult to obtain, as no one would extend a distribution system unless it was absolutely necessary with copper at £110 per ton. Now that the artificial price of the metal has departed, it is of interest to see how quickly the fall has taken place. The curve giving maximum and minimum quotations for the last ten years published elsewhere in this issue, shows that the normal fluctuation caused by the ordinary supply and demand variations is about £15 per ton in the course of a year. Thus, when the fall is £45 in about three months, it is clear that some other cause has been responsible for the drop. The speculators who have kept up the prices by reducing output and accumulating stocks have found their holdings too costly, and their rush to sell has had the usual result. We trust that they have lost heavily, and that the copper market may be more healthy in consequence. The manufacturers and station engineers who during the past year have sold all the scrap copper they can lay their hands on will now congratulate themselves on the price obtained for the same. We know of several manufacturers who have made large profits by a wholesale clearing out of the odd remnants in their wire stores, which has to a small extent recouped them for the poor prices for manufactured articles.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

MANUFACTURERS AND MUNICIPAL TRADING.

SIR,—During the past two or three years a number of corporations have taken up municipal trading, and contractors throughout the country have resented them so doing. As manufacturers and patentees of Nernst lamps, we have every reason to know that various municipalities have had very good reasons for so doing. We have from time to time during the last year approached contractors in various towns offering to fit certain improvements which we have brought out free of charge, and to send a qualified electrician to attend to any Nernst lamps which were unsatisfactory We duly advised the contractors in question, but regret that they would not take the trouble to advise clients of theirs to have these improvements fitted, although they would have been put to no expense whatever. We therefore approached the electricity departments in different towns, and they readily acceded to our request, the result being that the corporations in question issued forms to all their consumers notifying them of these improvements and that same would be fitted free of charge. Further a large number of people availed themselves of our offer, and we have sent out our electrician to inspect the various installations and put the lamps in order. We regret to say that the state of things during our inspection showed us that, although there was a defect in the lamp—*i.e.*, faulty cut-out—it was burning under such conditions that it was impossible to obtain good results. (1) Half-ampere burners were being used on one-ampere lamps; (2) half-ampere burners were being used with one-ampere resistances; (3) holders of B and D lamps were not slotted; (4) Luna and A types were connected to wrong polarity.

We have engaged travellers, and the travellers in question are calling on the trade and private users. We have notified various contractors that we shall hand any orders our travellers take over to the contractor who usually does the wiring and repairs; under no circumstances shall we quote trade terms to private users We regret to say that the result of our travellers taking orders has been that the consumers have advised them in many cases that they would prefer orders executed by us, and hinted that if we do not agree to do this work the contractor would probably refuse to supply.

We are anxious to co-operate with the electrical contractor, but under the above conditions it seems it is impossible. We should be glad to have your remarks, as the present state of things should not continue. We would ask you in the interests of both electrical contractors and ourselves as manufacturers to take this matter up, and will gladly attend any meeting of contractors with a view to co-operation with them to secure good results and profitable business in future.—Yours, etc.,

THE A.E.G. ENGLISH MANUFACTURING CO., LIMITED.

FIRE PREVENTION.

SIR,—Replying to the inquiry of "W. H. T." in your issue of the 6th inst., I give my opinion as to the best means to have at hand to cope with an outbreak of fire in a large factory pending the arrival of the fire brigade.

1. Fire-buckets kept filled with water in sets of three hung upon brackets fixed not more than 5ft. above the floor in each room ready for instant use, because the bucket of water applied in time may avoid the necessity for more.

2. Portable hand fire-pumps known as the London Brigade pattern in cisterns charged with water, and hose, nozzle, and cover ready to be carried near a fire and set at work to make direct the water forcibly upon burning material. Or chemical extincteurs in which the liberation of an acid generates carbonic acid gas to furnish power to eject the water—but I prefer hand-pumps because they can be frequently tested and may be kept at work longer than the extincteurs, because they can be supplied with water while in use.

3. Hand fire-grenades are useful in some instances when circumstances favour, but Nos. 1 and 2 are the most reliable.

4. Hydrants fixed above ground equipped with hose and nozzle sufficient to reach the furthermost point they are extended to command, and the provision of hose should be ample to permit it to be laid out the longest route to the furthermost point, because in the moment of hurry a person may not take the shortest cut or there may be obstacles in the shortest route. The hydrants should be supplied with water through iron pipes of ample size to permit of three hydrants to be in use at the same time, and the water supply should be of the most reliable and greatest force obtainable. Items 1 and 2 should be maintained when items 4 are adopted, because there may arise some periods of time when water supplies are turned off to execute repairs or new connections to the water-pipes and fittings. All hydrants and hose should interchange with the couplings of the fire brigades likely to arrive in time of fire.

5. Small tap hose ¾in. bore attached to water-pipes with taps and nozzles should be located at different points in each room ready to use upon fires having early discovery, because such small tap hose is lighter to handle and does less water damage than the brigade size hose.

6. Hand oil lamps ready trimmed are useful for fire at night.

7. Hand hatchets and crowbars are useful to cut and

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break away doors, fixtures, flooring, etc., to get quickly at the seat of a fire.

8. A pressure gauge and draw-off best tap upon the water-main readable in the office is a good check upon the water supply.

9. Automatic sprinklers properly installed are very good in addition, but *not instead of* the foregoing.

10. Where high pressure water-mains and hydrants are not possible, it is prudent to have fire-engines kept ready to work from low-pressure water mains to increase the pressure, or from rain-water tanks, ponds, or streams. Fire-engines are preferable to be worked by hand for *home* fire protection because they can be got to work by worried and inexperienced persons, and are less liable to go wrong than mechanical worked engines. Persons called to a fire upon property in which they are not immediately interested will go to the fire and work with greater self-possession than they can at fires on property at home, and hence mechanically-worked fire-engines are more suitable for public fire brigades to take to distant fires, but a manual fire-engine should be always ready for a fire in the immediate locality in which it is housed.

Mill steam-pumps where steam is *always* sure day and night, or water-worked pumps when always reliable, or electric or petrol driven pumps will do if they are sure to be maintained always available for day and night immediate service.

I have known instances in which £1,000 has been spent on the purchase of a steam fire-engine for home fire protection when far less money would have provided a more reliable and satisfactory gravitation water supply with hydrants, so that it will be prudent to consider always if a gravitation hydrant supply can be adopted instead of a more costly and less reliable provision in the shape of a steam fire-engine.

Property owners should not neglect to insist upon the continual maintenance of all fire protectional provision in efficient condition ready for instant service, and if the person or persons who are told to be responsible to attend to this are negligent they should be severely and promptly dealt with in a way to act as warning to others

Immediately after working hours a reliable person should make a thorough survey of the premises to see there is no danger of fire, and another survey should be made after the last person has left the premises and previous to the property being left for the night.

In some premises the inspector, caretaker, or watchman are not permitted to enter the workrooms, and then it is a good plan to have a stout glass inspection window in the door of each room to peer through.—Yours, etc.,

J. H. HEATHMAN, Fire Protective Engineer.

Parsons Green, London, S.W., Sept. 14, 1907.

CORRECTION.

SIR,—We note in your current issue that you have a paragraph stating that Messrs. T. L. Miller and Wilson are engaged as engineers on a scheme for the supply of electricity in the district around Belfast. We would draw your attention to the fact that the style of the firm is now "T. L. Miller, Wilson, and Pegg," and that our Belfast office is under the charge of Mr H. V Pegg, A.M.I.C.E, who will be engaged principally in looking after the work of the suggested power company. We mention the above facts, as there appears to have been some little confusion owing to the altered style of the firm, and we shall be glad if you would make a correction at an early date — Yours, etc., T. L. MILLER, WILSON, AND PEGG.

18, Westminster-chambers, 1, Crosshall-street, Liverpool.
Sept. 18, 1907.

Neath.—A collision between a tramcar belonging to the Neath Tramway Co. and a brake driven by John Harries, of Felindre, Llangyfelach, occurred on the Neath Abbey-hill on the 13th, and as a result three persons were injured. It appears that Harries was driving a party of 18 people from Neath Fair back to Llangyfelach, and when midway up the Neath Abbey-hill he turned off to allow another vehicle to pass him. Simultaneously the tramcar rattled down the hill, ran into the brake, and overturned it, throwing the occupants out. Eye-witnesses of the accident state that the collision was unavoidable.

A TECHNICAL PUBLICITY ASSOCIATION.

BY A PUBLICITY ENGINEER.

One of the outstanding features of American engineers, particularly in the electrical and allied industries, is their readiness to fraternise. They seem to have got away from that preference for isolation, amounting to an almost fanatical suspicion of one's fellows, which seems to characterise the English engineer. Over there they have societies galore—societies grave, gay, professional, and social. They have their Institute of Electrical Engineers and cognate bodies. They run a flourishing society—the Illuminating Engineering Society—which has just celebrated its first anniversary by a convention at which the majority of the papers read were of a standard of crispness and conciseness that might well be emulated by some of the pundits of the Electrical Engineers who dole out platitudes at Westminster. They break out in a new spot in the establishment of the Society of the Sons of Jove, every member of which is solemnly bound to encourage everywhere at any time, and in every possible manner, the use of electricity by such methods as, for example, going into a barber's shop where it is known that there isn't any motor and asking for an electrical shampoo, and, moreover, sniffing disparagingly when told they can't get it. And with such symptoms, and knowing the bent of the American mind towards publicity, it is to be expected that some society or other would be formed to band together those interested in technical advertising. This has been formed by the constitution of the Technical Publicity Association, whose object, defined in its constitution, is the friendly interchange of ideas, the presentation to the members and guests of discourses upon various topics bearing upon matters relating to the advertising department, and the general study of all matters pertaining to the advancement of the art of publicity.

Now, a contrast has only to be drawn between the mode of thought shown in the above and the attitude which at present seems to be natural to the English advertising manager to give a considerable amount of food for thought. Advertising, to the English advertiser, is oftentimes not so much a friendly inducement to the outside customer to come in and buy as a cut-and-slash contest between two rival firms intent on shouting each other down. Ideas are naturally looked on as so much trade asset to be jealously guarded, and the average advertising man, if asked to come and give a gratis series of hints to his potential professional competitors, would probably have a fit. And yet the true attitude of thought should be, not so much the grabbing of the major part of the existing market by each individual firm, as the banding together of all interests involved in order to extend the existing market into one in which all can find freedom for business expansion. The present idea is to "prig what isn't hisn" without being "cotched and sent to pris'n." The correct thought ought to be how to "gather in all outside."

The membership of the American association is limited to any man or woman filling the position of advertising manager in any concern engaged in the manufacture of machinery or any concern which would rightfully come under the head of an "allied industry," and also to those assisting in the advertising department of any such concern. This disposes of an argument which might possibly be raised among English electrical engineers, that the number of firms on this side of the water maintaining their own specialists for advertising is so limited that an efficient society could not be formed. The number of cognate industries is so large that a considerable body of men specially interested in the efficient advertisement of electrical engineering could be gathered together in this small but thickly populated island of ours. The election of members is by proposal and seconding at a regular meeting of the association of the candidate by any two members, a recommendation by the membership committee being also obtained. A majority vote of those present at the meeting is necessary for election. If any member leaves the company with which he was connected when elected to membership, he is in duty bound to notify the association, and the membership committee then redetermines the question of his eligibility. Re-election, however, is possible

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even after suspension or expulsion, if arguments are adduced for such a course. The officers of the association, whose position is tenable for one year, consist of a president, a first and second vice-president, a secretary, and a treasurer, and the duties of the secretary are not only novel but onerous. He has, in addition to charge of the correspondence of the association, the custody of the roll of members and the minutes of the meetings, to keep all the photographs, clippings, and other records of interest to the association. This work, forming in effect a complete historical record of the cream of the advertising efforts of each member of the association, requires a specialist of no mean ability, and is a labour fraught with considerable benefit to the members, who have access to these records. Papers are read at the meetings of the association which deal fully with both direct and indirect forms of publicity, from newspaper advertisements to follow-up letter systems, and from poster art to card indexing. At present these papers are not published in an official way by the association; the information gleaned at the meetings is only transmitted to the outside world by the ordinary newspaper reports to be found in advertising magazines which have already found a specialised foothold in America.

Now, there is no valid reason, except a certain amount of insular prejudice, why a similar association should not be formed for advertising managers connected with engineering firms in Great Britain. The advantages which would accrue from the interchange of ideas would be incalculable. Obsolete and undignified methods of advertising could be weeded out by such a combination, to a very great gain in efficiency and the lessening of opprobrium which still attaches in some degree to the vocation of advertising in this country. So strongly is the writer of this article convinced that such an association, if formed in Great Britain, would conduce to the solidification of advertising managers' interests and to the improvement of the work of their departments, that he would be glad to have the ideas on the subject of any other publicity managers through the columns of this journal.

THE BALANCING OF HIGH-SPEED MACHINERY.

The centrifugal forces which occur in an unbalanced rotating body consist, as is well known, of a single force acting at the centre of gravity of the body and a twisting moment in a plane passing through the axis of rotation. If the body is to run quietly at a high speed, both these forces must be neutralised. The single force exists whenever the centre of gravity of the body does not lie in the axis of rotation. It can be dealt with by static balancing—*i.e.*, without rotating the body—by attaching a balancing weight on the opposite side of the body of an amount to give an equal and opposite turning moment. Owing to structural considerations, it is often impossible to place this balancing weight exactly opposite to the centre of gravity, and then the new weight, together with the original inaccuracy, produces a definite twisting moment even if no such moment existed before. In the case of disc-shaped bodies the twisting moment is seldom serious, but when the axial breadth is considerable, as in the case of the rotors of modern turbine sets, the occurrence of such twisting moments must be prevented. This twisting moment can only be discovered by rotating the body. One well-known method of dealing with the matter consists in running the body round (preferably after the static balancing has been completed) in a pair of special bearings arranged to be free to move slightly in the horizontal plane against the controlling action of springs. If a twisting moment exists, the bearings will vibrate to and fro in opposite directions to one another. By suitably fixing a scriber the overloaded side of the body at each end can be discovered. Balancing weights are then attached at points opposite to the scriber marks, and by adjusting the amount of these weights the vibration can be reduced to a negligible value. Experience has shown, however, that, owing to the inertia of the bearings, the correct point for attaching the balancing weight is not exactly opposite to the scriber marks, but somewhat ahead of this point in the direction of rotation. This fact adds to the time and trouble needed for this compensation.

In a recent number of *Elektrotechnik und Maschinenbau* Herr Moritz Kroll describes an improved arrangement of the bearings which should simplify the test. The body to be tested is placed in two bearings of the type shown diagrammatically in Fig. 1. The brasses are free to move slightly in the vertical direction, and the pressure on the bearing in this direction is taken by the bolt, B, and transmitted to the chamber, M. This chamber is divided into two parts by a diaphragm, the lower part being filled with a liquid and the upper part being nearly filled by a solid block resting on the diaphragm. In this way any

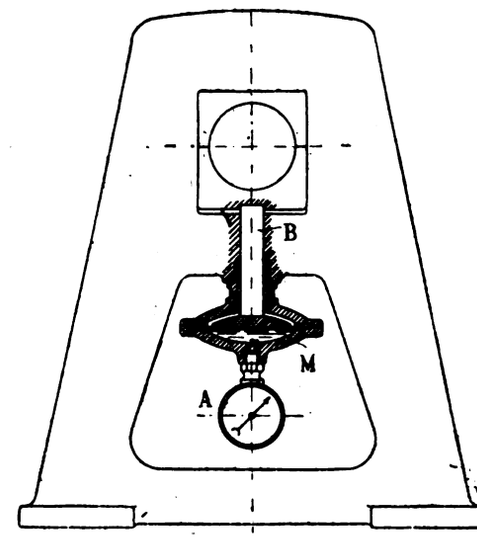

FIG. 1.

pressure on the bolt, B, is accurately transmitted to the pressure gauge, A. The whole arrangement can be of simple construction, as it is only a question of relative pressure that is dealt with in this case. In making a test static balancing is first accurately carried out, so as to bring the centre of gravity into the axis of rotation. The body is then placed in the bearings and, even when at rest, a certain value will be recorded on the pressure gauges. The effect of the driving belt can be minimised by arranging this horizontally. When the bed is rotated at a high speed the vertical components (variable in amount and in direction) of the centrifugal forces will occur at the two bearings. The pressure gauges will only be affected by the downward forces, which will form a resultant with the

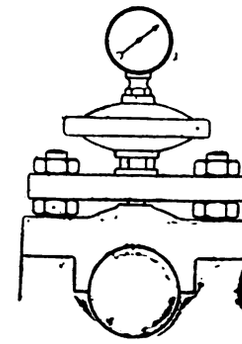

FIG. 2.

original constant downward pressure and, if the instrument is properly damped, will appear as a definite steady, or almost steady, deflection. By means of a scriber again the point on the rotor which swings out furthest at each bearing is marked, and two equal balancing weights, at equal distances from the axis, are placed approximately opposite to these marks. The correct *position* of these weights is found by moving them (always at 180deg. to one another) round until the minimum pressure is indicated. The correct *amount* of them is next found by altering them until the pressure gauge indicates no more than the original steady force.

Sufficiently exact dynamical balancing can often be

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obtained without the use of special bearings. If, for instance, the bearing cup is loosened and the gauge is actuated by it, as shown in Fig. 2, the whole process can be carried out in the machine's own bearings.

THE ELECTRICAL CO-OPERATOR'S CREED.

The Co-operative Electrical Development Association, of Cleveland, Ohio, offered a series of prizes for an "Electrical Co-operator's Creed." From among the creeds thus secured nine were selected as being entitled to share in the award. A further prize has now been offered to these nine winners for the preparation of a further creed, each having the advantage of the work of all the others From these new contributions it is expected that one will be selected as an electrical co-operator's creed which will express the spirit of co-operation, which brought this association into being. Herewith are two of the prize-winning creeds, one by Charles A. Parker, of Detroit, and the other by Frank B. Rae, jun., of Newark, N.J.

BY CHARLES A. PARKER.

I believe in Electri-city—the greatest "city" on Earth.

Daughter of Science and Mother of Progress.

Sister of Civilisation, Handmaid of Industry, and First Cousin of the Spirit of Peace on Earth and Good Will to Man.

Lightener of Burdens, Tamer of Wilderness, Annihilator of Distance and Goddess of Light.

The most necessary of luxuries

The most luxurious of necessities.

Who wouldn't believe in Electricity?

I believe in Co-operation.

Pennant-winning "team work" rather than individual grand-stand play.

Constructive and profitable combination as opposed to destructive and unprofitable competition.

Greater general progress through reduction of individual friction.

Working together for the Grand Prize instead of quarrelling together over scanty profits.

Co-operation!—who wouldn't be a Co-operator.

I believe in Electrical Co-operation.

"All together all the time for everything electrical"—The application of the Highest Law of Modern Business to the Greatest Business of Modern Times.

The massing of forces to boost the sale of current and everything under Heaven that uses current—the Generator of an enlightened "Current Opinion."

The step-up Transformer of low-efficiency selfishness to high-voltage helpfulness—the Incandescence of enthusiasm against the resistance of Conservatism—and the Short-Circuit to the final and complete Electrification of the Universe, and to that Millennium Age when what isn't done by electricity won't be done at all.

BY FRANK B. RAE, JUN.

I believe in Co-operation.

I believe that if one-half the time, labour, and money now spent in commercial strife within the electrical trade were turned to account in combating the natural competitors of the trade as a whole—if but a small amount of the energy now dissipated in fighting for the business that exists were devoted to the creating of new business—it would redound to the advantage of all.

I believe that this great advantage to all cannot be secured without the sacrifice upon my part of certain small advantages, the burying of certain animosities and, perhaps, the loss of certain immediate gains; nevertheless, I believe I am sufficiently broad-gauged and far-sighted to forego the lesser advantage for the greater.

I believe that this can be done without the submerging of my individuality or the loss of any material advantages which I will get back many fold, and of petty pride, which I can well afford to be without.

I believe the time for co-operative action is here. I am ready if you are.

POST OFFICE TELEPHONES.

The fifty-third annual report of the Postmaster-General gives some valuable information as to the working of the telephone system by the Department and of the financial results obtained. On the question of rates, which is so agitating to some, the report says:

The agreement made in 1905 for the purchase of the National Telephone Company's system at the end of their licence in 1911, provides for local intercommunication in the meantime between all the exchanges of the two systems, subject to the condition that the rates of charge are to be the same for both systems. After considerable discussion with the company a new scale of rates was adopted for this purpose on May 1. These rates are based on the principle of a measured service, under which each subscriber pays according to the quantity and quality of the service he requires. He may contract for any number of calls from 400 upwards, and he may share a line with another subscriber, or he may rent a line for his own exclusive use. The large user can have a private branch exchange connected by two or more lines with a public exchange, and with extension instruments to the different parts of the subscriber's establishment. By intercommunication between these extension stations a very convenient internal service is provided in addition to the exchange service, and this is a great convenience in hotels and large places of business. The new rates do not include the unlimited service or "flat" rate, except for lines to private residences. No satisfactory flat rate can be devised for lines on which the calls may vary from a few hundreds to many thousands a year. An equal rate for such varying conditions must necessarily be very unequal and unfair between different subscribers, the charge being unduly low in one case and excessive in another. Even if a fair average rate could be fixed at any one time, it would soon become unsatisfactory, because the cost of the telephone service increases in greater proportion than the number of subscribers or the number of calls, owing to the increasing complexity of lines and apparatus as an exchange system grows. Another very important objection to the flat rate is that it induces subscribers to overload their lines. It has been one of the chief difficulties and drawbacks of the telephone service in this country that the lines of large users are so frequently engaged when calls are made by other subscribers. This condition not only increases the cost of the service by causing useless operating work, but it is also a source of unnecessary trouble and inconvenience to the public.

The accounts published below show how much has been spent on the London, provincial, and trunk systems respectively, and the revenue from each. It is worthy of note that the bulk of the income from the London subscribers is now obtained on the message-rate system. The actual ratios of receipts and working expenses may be expressed as follows:

	Income.	Working expenses.	Working expenses / Income
London exchanges ...	£330,512	... £142,651	... 43·2 per cent.
Provincial ,, ...	116,973	... 78,746	... 67·5 ,,
Trunk lines	460,761	... 235,062	... 51 ,,

The balances available from each of the three departments are:

	Capital expenditure.	Balance available.	Ditto.
London exchanges ...	£2,614,696	... £187,861	... 7·2 per cent.
Provincial ,, ...	846,748	... 38,227	... 4·5 ,,
Trunk lines	3,376,252	... 227,699	... 6·75 ,,
Total.....	£6,837,696	... £451,787	... 6·6 ,,

POST OFFICE TELEPHONES.—General Capital Account to March 31, 1907, showing the Amount of Capital Authorised and its Appropriation to the several Telephone Services.

Cr.	£	s.	d.	£	s.	d.
Capital authorised by Parliament—viz.:						
Telegraph Acts, 1892-98				2,300,000	0	0
Telegraph Act, 1899				2,000,000	0	0
Telegraph Act, 1904				3,000,000	0	0
Total.....				£7,300,000	0	0
Dr.						
Trunk lines—						
Purchased from the National Telephone Company in 1896	459,114	3	7			
Construction of lines by Post Office—To March 31, 1906...	2,438,389	19	1¼			
Year ended March 31, 1907 ...	478,749	0	4¼			
				3,376,252	3	0¼
London exchange (including private wires)—						
Construction—To March 31, 1906	2,131,300	16	4⅔			
Year ended March 31, 1907 ...	361,870	9	9½			

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Expenditure on sites and buildings—To March 31, 1906 ...	101,287 17 4		
Year ended March 31, 1907 ...	6,816 11 4		
Miscellaneous expenses — To March 31, 1906 ...	11,222 15 8½		
Year ended March 31, 1907 ...	2,197 7 2		
		2,614,695 17 8¾	
Provincial exchanges (including private wires)—			
Construction to March 31, 1906	403,195 19 5½		
Year ended March 31, 1907 ...	443,552 12 4		
		846,748 11 9½	
Stores purchased and remaining unused on March 31, 1907 ...		204,745 3 5½	
Balance not expended on March 31, 1907...		257,558 4 0	
Total ...		£7,300,000 0 0	

The amount of the capital advanced by the Treasury to March 31, 1907, was £7,130,000. Repayment by the Post Office is effected by means of terminable annuities running for varying periods (12 to 20 years) and charged against sub-head R of the vote. The amount so charged up to March 31, 1906, was £1,836,542. 1s., for the year ended March 31, 1907, £469,887. 15s., making in all £2,306,429. 16s., being £1,681,840. 10s. 5d. in repayment of capital, and £624,589. 5s. 7d. for interest.

LONDON EXCHANGE SYSTEM.—An Account, partly estimated, of Income and Expenditure for the Year ended March 31, 1907.

Subscribers' rental— *Income.*	£	£
Proportion of subscriptions paid in 1905-6, but proper to 1906-7 ...		102,720
Paid in the year 1906-7—	£	
At flat rates...	50,949	
At toll rates ...	189,326	
	240,275	
Less proportion proper to 1907-8...	123,546	
		116,729
Message fees, in addition to fixed minimum of £1. 10s. per message-rate circuit...		50,116
Call office fees ...		11,079
Rental of wires leased to National Telephone Company ...		42,813
Miscellaneous receipts...		4,169
Value of services rendered to Government departments without payment ...		2,886
		£330,512
Expenditure.		£
Maintenance of system ...		50,210
Salaries, wages, etc., of staff, including provision for pensions of established staff ...		77,143
Rent, rates, fuel, and light, including estimated rental value of premises already belonging to the Department...		11,365
Miscellaneous expenses (stationery, travelling, etc.)...		3,933
Balance available towards meeting depreciation, interest, etc. (*vide* footnote) ...		187,861
		£330,512

NOTE.—The estimated amount required to provide for depreciation of plant, inclusive of spare wires, is £81,545, and interest at 3 per cent. on the capital expenditure of £2,691,000 is £80,730. making together £162,275. The capital expenditure is the sum of £2,614,696 shown in Appendix N, plus £121,583, the amount of salaries and cost of construction charged to the parliamentary vote, and minus £45,279, the expenditure on private wires charged to capital.

PROVINCIAL EXCHANGE SYSTEM.—An Account, partly estimated, of Income and Expenditure for the Year ended March 31, 1907.

Subscribers' rentals— *Income.*		£
Proportion of subscriptions paid in 1905-6, but proper to 1906-7 ...		28,330
Paid in 1906-7 ...	£136,741	
Less proportion proper to 1907-8...	62,483	
	74,258	
Deduct amount payable to, in excess of that receivable from, National Telephone Company for terminal fees ...	86	
		74,172
Message fees for excess calls ...		2,433
Call office collections ...		5,804
Rentals of junction lines leased to National Telephone Company ...		4,137
Miscellaneous receipts...		1,166
Value of services rendered to Government departments without payment...		931
		£116,973
Expenditure.		£
Maintenance of provincial exchange systems...		39,584
Salaries, wages, etc., of staff, including provision for pensions of established staff ...		34,030
Rent, rates, fuel, and light, including estimated rental value of premises already belonging to the Department...		3,532
Miscellaneous expenses (stationery, travelling, etc.)...		1,600
Balance available towards meeting depreciation, interest, etc. (*vide* footnote) ...		38,227
		£116,973

The estimated amount required to provide for depreciation of plant, inclusive of spare wires, is £29,035, and interest at 3 per cent. on the capital expenditure of £835,000 is £25.050, making together £54,085. The capital expenditure is the sum of £846,749 shown in Appendix N, plus £87,925, the amount of salaries and cost of construction charged to the parliamentary vote, and minus £99,674, the expenditure on private wires charged to capital.

TRUNK-LINE SYSTEM.—An Account, partly estimated, of Income and Expenditure for the Year ended March 31, 1907.

Trunk fees— *Income.*	£	£
Gross value for year ...	479,639	
Less commission paid to licensees for collection, etc. ...	19,897	
		459,742
Miscellaneous receipts...		779
Value of services rendered to Government departments without payment...		240
		£460,761
Expenditure.		£
Maintenance of trunk-line system ...		77,130
Salaries, wages, etc., of staff, including provision for pensions of established staff ...		136,679
Rent, rates, fuel, and light, including estimated rental value of premises already belonging to the Department...		12,900
Miscellaneous expenses (stationery, travelling, etc.)...		8,353
Balance available towards meeting depreciation, interest, etc. (*vide* footnote) ...		225,699
		£460,761

The estimated amount required to provide for depreciation of plant, inclusive of spare wires, is £104,496, and interest at 3 per cent. on the capital expenditure of £3,729,000 is £111,870, making together £216,366. The capital expenditure is the sum of £3,376,252 shown in Appendix N, plus £352,748, the amount of salaries and cost of construction charged to the parliamentary vote.

With regard to the opening of telephone exchanges, the report contains the following information:

During the year Post Office telephone exchanges were opened in the provinces at the following places: Armagh, Aylsham, Bedale, Buckingham, Bungay, Caputh, Chorley Wood, Cookstown, Coxley (Wells), Dipton (Consett), Diss, Dungannon, Dunkeld, Dunmow, East Kirkby, Eden Bridge, Eye, Girvan, Glastonbury, Greystoke, Halesworth, Harleston, Haverhill, Horncastle, Hunstanton, Killarney, Lanchester, Langham (Oakham), Ledbury, Lindfield, Liskeard, Long Sutton, Ludlow, Newbridge-on-Wye, Newport Pagnell, Olney, Omagh, Osborne House (Isle of Wight), Otterburn, Pitlochry, Port Erroll, Ramsey, Sandiway, Shardlow (Derby), Shepton Mallet, Somerby (Oakham), South Brent (Devon), Stobo (Peebleshire), Stony Stratford, Street (Somerset), Sutton Bridge, Wells, Winslow, Wolverton, Woodhall Spa, Wymondham. Besides these 56 exchanges, 23 public call offices connected with the Post Office trunk-line system were opened at places where the number of prospective subscribers was not sufficient to warrant the opening of exchanges. In the districts of Melton Mowbray, Chipping Norton, Malton, and Bourne it has been possible to give a telephone service restricted to the local area by utilising the wires erected for the transmission of telegrams—which are not numerous—between the central town and the post offices of surrounding villages. The growing use made of such rural call-office systems shows that the additional facilities thus afforded are appreciated.

As stated in the last report, the postal reforms announced by the Chancellor of the Exchequer last year in the Budget speech included the introduction of more liberal terms for the extension of the telephone system to outlying places under guarantee. Whereas formerly the guarantors of telephone extensions were required to bear the whole of any loss incurred, two-thirds of it is now borne by the State. The telephone has thus been brought within the reach of many fruit-growing and agricultural districts, and it is hoped that some of the guaranteed call offices will in time develop into small exchanges.

TRAMWAY ORDERS, SESSION 1907.

The following is the report by the Board of Trade of their proceedings under the Tramways Act, 1870, during the session of 1907.

The number of applications made to the Board of Trade in December, 1906, for provisional orders under the Tramways Act, 1870, was five—viz., Audenshaw Urban District Council, Huddersfield Corporation, Leeds Corporation, Taunton (Extension), West Ham Corporation. Four of the applications included power to construct new or extension tramways, the remaining one—viz., Audenshaw—

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being to revive and extend powers which had expired. Except in the case of Taunton, the applications were by local authorities. The aggregate length of the proposed tramways was 3 miles 45 chains of double line and 2 miles 73 chains of single line, and the estimated cost was £77,894 Provisional orders were made in all the cases, and a Bill to confirm the orders was introduced into the House of Lords on May 1. The Taunton and the West Ham orders were petitioned against in the House of Lords by the National Telephone Company, Limited, and the Great Eastern Railway Company respectively, but the opposition in each case was withdrawn on amendments being agreed upon and inserted in those orders. A new clause was also inserted in all the orders, in a form agreed upon between the Postmaster General and the tramway representative bodies, empowering the Postmaster General to use the tramway posts of the promoters for the support of his telegraph wires. There was no opposition to any of the orders in the House of Commons. The Bill received the Royal assent on Aug. 2. The following table shows the number of orders made by the Board of Trade, under the Tramways Act, 1870, from the passing of that Act down to the present time:

	Tramway Orders.		
Year.	Applied for.	Made by Board of Trade.	Confirmed by Parliament.
1871	26	12	4
1872	18	16	10
1873	15	9	17
1874	10	6	6
1875	2	2	2
1876	7	6	6
1877	12	8	8
1878	25	17	15
1879	32	21	21
1880	35	28	27
1881	39	27	27
1882	27	23	21
1883	30	24	22
1884	24	18	18
1885	16	13	13
1886	20	14	13
1887	17	12	12
1888	14	13	13
1889	7	6	6
1890	13	11	11
1891	7	6	5
1892	10	8	4
1893	7	4	6
1894	8	6	6
1895	11	8	7
1896	15	11	11
1897	19	14	13
1898	15	11	11
1899	21	18	18
1900	36	32	32
1901	24	23	23
1902	18	12	12
1903	14	12	11
1904	15	13	13
1905	12	12	11
1906	7	6	6
1907	5	5	5
Total	633	487	466

APPOINTMENTS VACANT.

Tramways Manager, Wigan Corporation. Salary, £250 per annum.

Shift Engineer, Battersea Borough Council. Salary, £117 per annum. Applications by Sept. 26. See advertisement in last issue.

Assistant Engineer, to act as canvasser and agent to the Electricity Department, Hammersmith Borough Council. Salary, £2. 10s., rising by annual increments of 5s. to £3 per week. Applications to Mr. G. G. Bell, borough electrical engineer, 85, Fulham Palace-road, Hammersmith, W., by Sept. 20. See advertisement in last issue.

Assistant Electrical Engineer for the Harness and Saddlery Factory, Cawnpore, India. Pay to commence at 280 rupees per month, rising annually by 10 rupees per month to 320. On re-engagement 350 rupees per month (15 rupees = £1). Forms of application and further particulars can be obtained by writing to the Director-General of Stores, India Office, London, S.W., not later than Sept. 30. See advertisement.

Switchboard Attendant, Eccles Electricity Works. Wages, £1. 4s. per week. Applications to the Borough Electrical Engineer, Cawdor-street, Patricroft. See advertisement.

Representative for Newcastle-on-Tyne firm of cable manufacturers. Apply, Box T 75, office of this paper. See advertisement.

LEGAL INTELLIGENCE.

SEQUEL TO A STOCKPORT TRAMWAY COLLISION.

The adjourned case of John Astle against the Stockport Corporation was heard before his Honour Judge Reginald Brown, K.C., and a special jury at the county court, Stockport, on the 13th inst.

At the last sitting of the court the plaintiff's case was gone into, but the defendants' case had not been opened.

The facts briefly are that John Astle was driving his milk float out of Phillips-street, Shaw Heath, on May 2 last, when a Corporation tramcar coming from the Edgeley terminus dashed into his conveyance, and, it is alleged, caused him to sustain damages amounting to £58. 12s. 6d., for which amount plaintiff now sued the Corporation. The case against the defendants was that the car driver was driving at a furious speed and did not ring his gong to let anybody who might be coming from any of the by-streets know that the car was coming The plaintiff stated that he did not see the car coming, and that he was half-way over the metals before he noticed it, but then it was upon him, and he had no time to clear.

Mr. Chambers appeared for the insurance company and defended, whilst Mr. Potts represented the plaintiff.

Mr. Charles Sproson, traffic inspector to the Stockport Corporation, said that the distance between Edgeley terminus and Vernon Park was 2½ miles, which distance was supposed to be covered in 22½ minutes. There was no need to hurry on the date in question. The usual speed along Greek-street was 10 miles an hour, which was allowed by the Board of Trade as a limit on Greek-street and Castle-street. If Jackson (the driver) said he was going six or seven miles he would believe it. A car going at that speed on that section could pull up in 15 yards.

Mr. Chambers, for the defence, contended there was contributory negligence on plaintiff's part. The case, he said, would not have been in court if the Corporation had thought the claim was a reasonable one, and it was their duty, in the interests of the ratepayers, whom they represented, to see that claims like that were not paid recklessly.

Mr. Potts, on behalf of plaintiff, said that four independent witnesses had come forward to speak as to the rate at which the car was travelling, and in their opinion it was within the power and capacity of the driver of the car to have stopped the car within a very limited distance indeed, while he was in such a situation that he must have seen plaintiff's vehicle in time to have pulled up. Plaintiff was a careful driver of over 30 years' experience, and had never before met with an accident.

The Judge, addressing the jury, said that before they could give a verdict against the defendants they must be satisfied that the driver of the car was guilty of such negligence as to cause the collision. It was one of those things that might happen anywhere in narrow streets where trams ran for the convenience of the public, and it was for them, as they no doubt knew the place well, to take all the surrounding circumstances into consideration. If they thought the plaintiff had made out his case, then it was for them to award him such damages as they thought he was entitled to. If, on the other hand, they came to the conclusion that the driver of the car was driving at a moderate speed, and did all he could to avoid the accident, then it would be for the jury to give a verdict for the defendants. For his part he had never seen cars driving along the Stockport thoroughfares at from 14 to 16 miles an hour, because, as he had said, the streets were not as wide as in some thoroughfares along which trams ran, and therefore, greater care was exercised.

The jury gave a verdict for plaintiff, and awarded him £35 damages.

WIRELESS TELEGRAPHY STORY.

Felix Markfeldt, aged 42, described as an engineer, of Hetley-road, Shepherd's Bush, was charged on a warrant on the 12th inst. at the West London Police Court with obtaining, between August, 1906 and April, 1907, various sums of money, amounting to £150, by false pretences from Edmund Cutcliffe, a hotel hall porter, living at Black Lion-lane, Hammersmith.

The prosecutor stated that he first met the prisoner, whom he knew as Dr. Markfeldt, in May of last year. He told him that he had invented a microscope, but that owing to his position at the Admiralty he would be unable to own it or to conduct any business transactions other than his business with the Admiralty. He also said he was engaged by the Admiralty to conduct certain wireless telegraphy experiments, and that he would eventually obtain the position of Inspector-General of Wireless Telegraphy in the Admiralty. He suggested that Mrs. Ridley, the wife of the landlord of a public-house in Black Lion-lane, should be the owner of the invention, and that any profits accruing should be divided between her and his (the prisoner's) children. Witness thereupon advanced several sums amounting to £150, and had only been repaid 35s. The accused also showed him a document purporting to be an official paper from the Admiralty, and bearing the signature of the secretary to the comptroller, Mr. Frederick Brown. The paper purported to be an order from the Admiralty in respect of wireless telegraphy experiments, and the prisoner told witness he would appoint him as his private secretary at a salary of £500 a year. He also induced him to leave his situation as hall porter in order to hold himself in readiness to go off to assist him in the experiments. On two occasions witness went with the prisoner to the Admiralty and to the Trinity House, and then, getting dissatisfied, he made inquiries himself at the Admiralty, and, in consequence, communicated with the police.

Mr. Edward J. Tozer, staff clerk-in-charge of the comptroller's registry of the Admiralty, stated that, as far he knew, the prisoner had no connection with the Admiralty. The document produced was not an official Admiralty order, and the signature at the foot of the paper

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was not that of Mr. Frederick Brown, the secretary, who, as a matter of fact, had some months prior to the date of the document retired on a pension.

In answer to the clerk (Mr. Wilson), the accused said: "I am perfectly innocent. I had the money, but I never had any intention of not fulfilling my promises. I am hampered in giving evidence on my own behalf by an oath of secrecy in relation to my invention. I thought it was possible to have an audience of his Majesty the King, but they told me at Brixton Prison that it was not possible."

The MAGISTRATE: You may write to the King if you like. PRISONER (gratefully): Thank you very much, sir. The prisoner was then formally committed.

NOISY HALIFAX TRAMCARS.

At the Halifax Borough Police Court on the 13th inst. the noises caused by the passage of tramcars through the streets was the subject of comment by Mr. Alderman Whitaker, one of the justices. The criticism arose out of a summons for the brake nuisance. The defendant was John Greenwood, a driver employed in the stone trade. He pleaded guilty.

P.C. NELSON MITCHELL gave evidence that on Aug. 6 he saw the defendant in charge of three horses and a wagon laden with stone crossing St. James's-road. The brakes were screaming and making a great noise. Witness caught up with him in Northgate, and told him he would be reported. He said, "I can't help it. My brakes are red hot, and I have oiled them three or four times since I left Mount Tabor."

Alderman WHITAKER (to the constable): Don't you think you ought to have warned him?—WITNESS: I could not.

The MAYOR: He couldn't do without a brake if he had five or six tons of a load.

The CHIEF CONSTABLE observed that there was not much in the point about warnings. The man ought to have put oil or water on the brake more often.

Alderman WHITAKER said he had cautioned several drivers. (To the constable): Don't you think you might bring the Tramways Committee here?

The CHIEF CONSTABLE: I don't think so, sir.

Alderman WHITAKER: I have reported it to several constables.

The CHIEF CONSTABLE: I would rather you blamed me, sir, than the constable. I am responsible. The constables report cases in the ordinary way, and I direct these proceedings.

Alderman WHITAKER: Don't you think you ought to proceed against the Tramways Committee?

The CHIEF CONSTABLE: Tell me what for, sir, and we will.

Alderman WHITAKER: For the noise made by the trams.

The CHIEF CONSTABLE: If you will tell me where it is——

Alderman WHITAKER: I have spoken to the chairman of the Tramways Committee about it, and to several constables. The noise made by the tramways would not be tolerated if it were made by any private company.

The CHIEF CONSTABLE: If you will show me where they commit an offence we will take action. It is not because it is the Tramways Committee that they are excused. This is an offence of old standing. It is in cases of excessive noise that we issue summonses. Where there are mitigating circumstances we don't.

Alderman WHITAKER said he had been in shops in King Cross-street when it was impossible to hear what the shopman said or to give a message. That was through the noise made by passing tramcars. They were a perfect nuisance.

The case was dismissed with a caution.

COMPANIES' MEETINGS AND REPORTS.

DICK, KERR, AND CO.

The report of Dick, Kerr, and Co. for the year ended June 30 last, to be submitted at the meeting on the 24th inst., states that the profits amount to £80,475. Out of this has had to be paid debenture interest and trustees' fees, and there has been reserved the sum required to provide for the premium payable on the redemption of the present debenture stock. These items absorb £13,112, leaving £67,363, to which must be added the profits brought forward from last year—namely, £56,076—making a total of £123,440. The directors recommend a dividend of 10 per cent. on the ordinary shares, free of income tax, and to carry forward £79,140. The directors consider the result of the 12 months' trading very satisfactory, in view of the severe competition which has prevailed, the greatly increased cost of all raw materials, and the advance in cost of labour. The directors do not consider it necessary to make any further additions to reserves at the present time, and have, therefore, increased the amount carried forward by the balance of this year's profits, £23,063, making the total profits carried forward to next year £79,140.

OTTOMAN RAILWAY FROM SMYRNA TO AIDIN.

The report of the Ottoman Railway from Smyrna to Aidin for the half-year ended June 30 last, to be submitted at the meeting on the 24th inst., states that the receipts on revenue account amounted to £124,506, as compared with £104,707 in the corresponding period of 1906. The expenditure amounted to £56,018, as compared with £46,771, and the net profit amounted to £68,489, as compared with £57,936. After defraying all fixed charges for the half-year, the balance of net revenue, including the sum brought forward, amounts to £51,092, out of which the council recommend the payment of an interim dividend of 8s. per share on account of the year 1907, leaving £33,254 to be carried forward. The expenditure on construction of the pier and warehouses amounted to £10,441, and on additions to carriage and locomotive stock £16,934, which has been charged to capital account.

DIRECT WEST INDIA CABLE.

The report for the 12 months ended June 30 shows a net profit of £2 098. An interim dividend of 3 per cent. has been paid, and the directors now recommend a further similar payment, leaving a balance of £298 to be carried forward. The disastrous earthquake at Kingston (Jamaica) on Jan. 14 last caused the interruption of the Turks Island-Jamaica section until Feb. 23, and the Bermuda-Turks Island section was also interrupted from March 14 to April 7, probably caused by similar earth disturbances. The balance at credit of revenue account has been debited with £7,276 expended in repairs during the year, and credited with £298 surplus revenue of the past year, and now stands at £29,147.

HALIFAX AND BERMUDAS CABLE.

Net profits for the year ended June 30 amounted to £3,182. The directors recommend a further dividend of 2½ per cent, making 5 per cent. for the year, leaving £682 to be carried forward. For the first time after 16 years' uninterrupted working the Company's cable developed a fault, which last October had to be cut at the cost of £2,094. The business of the year was further adversely affected by the earthquake at Jamaica. The balance to credit of revenue account has been debited with the £2,094 expended in repairs and credited with £682 surplus revenue of the past year, and now stands at £16,598.

ALBY UNITED CARBIDE FACTORIES.

The first annual meeting was held on the 17th inst. at Winchester House, Old Broad-street. Mr. A. E. Barton, chairman of the Company, presided, and in moving the adoption of the report stated that the working expenses of the Company to Dec. 31 last resulted in a loss of £5,443. 16s. 5d, which, however, was nothing more than might have been anticipated in the early stages of such a concern. He stated that a large factory was being installed in Norway which when completed would be one of the finest up-to-date carbide factories in the world. After discussion the report was adopted.

NEW COMPANIES REGISTERED.

Selbach Industrial Motors.—Registered Sept. 10. Capital, £10,000 in £1 shares. Objects: as title. No initial public issue. Registered office: Bush-lane House, E.C.

Divisible Rim and Motor Tyre Syndicate.—Registered Sept. 5. Capital, £2,000 in £1 shares. Objects: to acquire a patent belonging to T. Dunn, and to carry on business indicated by title. No initial public issue. Registered without articles.

B.D.K. Co.—Registered Sept. 10. Capital, £26,525 (£25,000 £1 "A" preference shares, 5,500 1s. "B" preference shares, and 25,000 1s. ordinary shares). Objects: to adopt agreements with the Trans-Continental Construction and Contracts Corporation and with T. Kirkpatrick, to acquire and work railways, bridges, tramways, and roadways, etc. No initial public issue. Registered office: 46, Leadenhall-street, E.C.

Liens Registered.

Wick Motor Engineering Works and Garage, Limited, Hove. Lien registered Sept. 4 for £2,000 6 per cent. debentures. No trustees. Charged on the present and future assets.

Leicestershire and Warwickshire Electric Power Syndicate, Limited.—Issue on Sept. 5 of £100 6 per cent. debentures, part of series created July 9, 1907, to secure £5,000, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £650.

PERSONAL.

The Harrogate Town Council have increased the salary of Mr. F. W. Bruce, switchboard attendant, from 22s. 6d. to 25s. per week.

Mr. J. Newlands, deputy-controller of the chief telegraph office, St. Martin's-le-Grand, is about to leave for India to reorganise the telegraph system of that country.

We congratulate Mr. S. B. Haslam, of Messrs. Haslam and Schoutheil, engineers, of Cardiff, on the occasion of his marriage to Miss E. M. Riches, daughter of Mr. T. H. Riches, president of the Institution of Mechanical Engineers.

Thermit, Limited, have opened at 210A, Bow-road, E., a fully-equipped repair shop, where they are prepared to carry out repairs by means of their alumino-thermic welding process. Estimates for work and illustrated pamphlet will be forwarded free of charge upon application to the company, 27, Martin's-lane, Cannon-street, E.C.

We notice that in a recent competition promoted by the Simplex Conduit Co., and open to the whole electrical trade, Mr. James Plucknett, A.M.I.E.E., has been awarded the third prize for "new method of holding workshop flexible in wall plugs," as adopted at Messrs. Kench and Sons' Mills, Warwick. There were 15 prizes.

We are informed that on and after the 30th inst. the London office address of the Western Electric Co. will be Norfolk House, Victoria-

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embankment, W.C. We are also asked to note that whilst their Post Office telephone number will remain the same—viz., 2389, Central—the National Telephone number will from the 30th inst. be changed to Gerrard 5349.

On Friday afternoon last Mr. Alfred Mercer, mains superintendent to the borough of Gravesend electricity works, was the recipient of a handsome silver tea service, on the occasion of his wedding, which took place at Sidcup on the following day. The presentation was made in appropriate terms by the borough electrical engineer, Mr. C. F. McInnes, on behalf of the staff and employés of the works and public lighting department.

An interesting ceremony took place at Messrs. Stewart and Co.'s Bon-Accord Granite Works, Fraser-road, last week, when Mr. G. L. Smith, the inventor of the "Aero fire-alarm," was presented with a magnificent set of drawing instruments in a morocco case with the following inscription: "Presented to G. L. Smith by the firm and employes of Stewart and Co.—1907." Mr. Smith has been 17 years with the firm in the capacity of draughtsman, and now leaves to develop his invention in the various countries where it is patented.

An interesting ceremony took place at the Salford Corporation tramway offices on Monday last. The general manager, Mr. G. W. Holford, presented to Mr. J. W. Blakemore, the chief traffic clerk, a handsome oak clock bearing the following inscription: "Presented to Mr. J. W. Blakemore, by the general manager and staff, Salford Corporation tramways, on the occasion of his marriage, as a token of esteem and regard.—September, 1907." Mr. Holford also presented to Mr. Blakemore a pair of bronzes which had been subscribed for by the motormen and conductors on the Swinton and Pendlebury section, a flower stand from the ticket inspectors, and a pair of flower vases from the Deansgate timekeepers.

The annual outing of the Linolite Co. (works and office staffs) took place on Saturday last, the 14th inst., the party being accompanied by Mr. A. S. E. Ackermann (engineer to the company), his wife, and Mr. R. L. Matthews (assistant manager). This year it was in the form of a trip to Southend, where a most enjoyable day was spent by all. The party and their friends arrived at Southend at 10.15 a.m., when they broke up into groups, some preferring a walk and some playing various games and enjoying themselves generally. Dinner was provided at the Marlborough Hotel, after which a cricket match was played between the office staff and the works staff, the former beating the latter by 16 runs. A good tea was then partaken of, after which there were more walks and amusements, the party returning home by the 8.40 p.m. train.

OPENINGS FOR CONTRACTORS.

ABERDEEN—Improvements to station for Caledonian Railway Co.

ABERGARW—Eight houses. Mr. T. W. Jones.

ABERYSTWYTH—Electrification of Cliff railway.

ACOMB (YORK)—Twenty-eight houses. Builder, E. Ralton, Albemarle-road.

ALBURY—Extensions to the parish church. Architect, Mr. W. J. Parker, London.

ALDERTON—Opening of public telephone offices.

ALDINGTON—Completion of tower to parish church.

ALNWICK—Alterations and additions to mission hall at Togston-terrace. Mr. W. Burton.

AMBLE—New school for Education Committee.

AMBLESIDE—Erection of hospital for Urban District Council.

ANSTON—Two villas. Mr. F. Dennett.

ASHFORD—Construction of public convenience for Urban District Council (£390).

ASHTON—Electric plant at workhouse infirmary for Guardians.

AYR—Extension of tramways by Corporation.

BALLYMAHON—Scheme for labourers' cottages for Rural District Council (£27,736).

BALLYMORE—Erection of labourers' cottages for Rural District Council (£12,070).

BATH—Erection of Baptist church, Sunday school, etc. (£3,500).

BECKENHAM—Erection of church. Mr. G. F. Prynne.

BELFAST—Electrical lighting scheme. Engineers, Messrs. Miller and Wilson, Belfast.

BIRMINGHAM—Alterations to Queen's Head Hotel, Spring Hill.

BISHOPSTON—Parish hall for St. Michael's (£2,377).

BISLEY—Clubhouse at Bisley camp for Middlesex Rifle Association.

BLAENGARW—Stores; Mr. H. Morgan. Two houses; Mr. D. J. Davies, King-street.

BLAGDON—Church of St. Andrew to be rebuilt.

BOWDON—Erection of sheds at Council town yard.

BRISTOL—Extension of Corporation electricity undertaking (£34,600).

BROADSTAIRS—Bungalow, St. Mary's Home; Church Extension Association.

BRYN—Three houses. Mr. T. Richards.

BUCKIE—Villa in West Church-street. Mr. J. Murray.

BURGESS HILL—Building of vicarage (£2,250). Architect, Mr. W. J. Gibbon.

BURSCOUGH—Furnishing and fitting new Urban District Council offices.

BUXTON—Extension of Corporation electricity plant (£1,700).

CARDIFF—Construction of public convenience in Penarth-road for Corporation.

CARNARVON—Cable laying at Balaclava-road.

CASTLECOMER—Scheme for the erection of labourers' cottages for Rural District Council (£39,663).

CASTLE HEDINGHAM—Telephone to be introduced by Parish Council.

CATLEY BANK—Enlargement of Primitive Methodist Chapel. Messrs. Jones and Jackson, Hanley.

CHATHAM—Erection of Seamen's Institute (£2,500).

CHELTENHAM—Extensions of electricity mains for Town Council.

CHERTSEY—Erection of pavilion (£200). New schools (£13,398).

CHISELDON—Alteration of Oddfellows' Hall.

CLONAKILTY—Erection of labourers' dwellings for Rural District Council (£18,220).

CLOWN—Manse at Elmston-lane for Wesleyans.

CLUTTON—Alterations at the workhouse for the Guardians.

COOLE—Erection of labourers' dwellings for Rural District Council (£15,112).

COTTINGHAM—Dwelling-house at Springhead Hall; two houses in South-street; conversion of building into schoolroom.

COVENTRY—Extensions to the Midland Brewery and Leigh Mills.

COWDENBEATH—Erection of a mining school (£500).

CRESWELL—Primitive Methodist Chapel (£1,300).

CRIGGLESTONE—Proposed establishment of motor trains between Dewsbury and Cudworth.

CROMPTON—Additions to United Methodist Free Church.

CULLEN—Renovation of Council chamber.

DISLEY—Conservative club (£970).

DOVER—Two houses in Stanhope-road. Mr. W. S. Cadman.

DOWLAIS—Telephone installation at Great Western Railway Station.

DOWNPATRICK—Labourers' dwelling scheme for Rural District Council (£54,332).

DUBLIN—Extensions of Corporation electrical plant.

DUDLEY—New pattern electric lamps to be installed by Corporation.

DUNBAR—Residence for Major-General F. R. Wingate.

DUNDEE—Erection of villa, Elgin-street. J. Maclaren and Sons.

DUMBARTON—Erection of house for water foreman for the Corporation.

DUNFERMLINE—Electricity installation at St. Leonard's Works.

DUNGANNON—Scheme for artisans' dwellings for Rural District Council (£11,713).

DUNMOW—Restoration of the parish church.

FAILSWORTH—Alteration and additions to Council offices (£1,819).

FALKIRK—Erection of porter's lodge at fever hospital.

FAREHAM—Installation and telephones at clerk to Guardians' offices.

FERNDALE—Erection of swimming bath, hall, institute, and library. Architect, Mr. T. E. Richards, Pontypridd.

FINCHLEY—Enlargement of Baptist church at North Finchley.

FRINTON—Public convenience for Urban District Council (£600).

GLASGOW—Extensions to the Central and Buchanan-street Stations.

GOLCAR—Branch store and butcher's shop for the Co-operative Society. Architect, Mr. J. Berry, Huddersfield.

GOVAN—Extensions to the Corporation's electricity department (£2,601).

GOVER VALLEY—United Methodist Chapel (£300). Architect, Mr. J. Mutton, Charlestown.

GRIMSBY—Erection of public convenience for Town Council (£1,550).

HAMPTON—Porter's lodge at isolation hospital (£498).

HARPENDEN—House, shop, and slaughter-house, Station-road. Mr. H. Saisbury.

HAWARDEN—New hospital for Rural District Council (£1,200).

HEBBURN—Six dwelling-houses, Wellington-street. Mr. G. Gordon.

HECKMONDWIKE—Additions to Walkley Mills. Messrs. Blackburn, Tolson, and Co.

HIGHBRIDGE—Technical school for Somerset Education Committee (£800).

HINDLEY—Additions to engine-house for Urban District Council (£280).

HOOLE—Extensions to the Anglican schools.

HOVE—Fire brigade premises (£400).

HUDDERSFIELD—Erection of house and shop at Kingsmill-road. Architects, Messrs. Kirk and Sons.

HULL—Restoration of Holy Trinity Church. Messrs. Thompson and Son, Peterborough.

HUNSTANTON—Two houses and a shop, Victoria-avenue; Mr. J. W. Beeton. Two houses, York-avenue; Mr. Gosling.

INVERNESS—Choir stalls at St. Andrew's Cathedral.

KILSYTH—Equipment of higher grade school (£250).

KING'S LYNN—Provision and dust destructor at electricity works.

KNYPERSLEY—Erection of Council school for Staffordshire Education Committee.

LANGHOLM—Alteration to the academy for the School Board (£331).

LAURENCEKIRK—New station for the Caledonian Railway.

LEEK—Extensions to the Corporation electricity undertaking (£6,850).

LEIGHTON BUZZARD—Erection of public conveniences (£300). Purchase of Council offices (£744).

LEITON—Shed at Spar Mills; alteration to working-men's club sheds at Victoria Colliery.

LIMEHOUSE—Electrification of Messrs. C. and J. Webb's factory.

LINSLADE—House and shop, Wing-road. Mr. A. Atkins.

LINTHWAITE—Two villas, Western-road. J. Wimpenny and Co.

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LISBURN—New Methodist schools. Architect, Mr. J. M'Nally, Lisburn.

LLAITHDDU—Erection of school for Council Education Committee.

LLANHILLETH—Engine-shed for Great Western Railway.

LLANTWIT VARDRE—Erection of 21 cottages for Crown Building Club. Architects, Messrs. Evans and Williams, Pontypridd.

LOCHEE—Renovation of South-road Council school (£450).

LONDON, E.—Additions to Brunswick Hall, Whitechapel-road. Messrs. G. Baines and Son.

LONDON, N.—New theatre, Prah-road, Finsbury Park. Matcham and Co.

LONDON, N.W.—Motor garage, 28, St. John's Wood-road. Mr. H. C. Clarke.

LONDON, N.W.—Engine-room at the St. Pancras Corporation electricity station.

LONDON, N.W.—Two factory buildings, Cressy-road, Hampstead. Mr. F. S. Hammond.

LONDON, S.E.—Establishment at Arklow-road, Deptford, for manufacture of machinery.

LONDON, S.E.—Two dwelling-houses, Acorn-street, Camberwell. Messrs. Style and Winch.

LONDON, S.E.—Additions to Archbishop Sumner's Schools, Reedworth-street, Kennington. Mr. A. H. Teneson.

LONDON, S.E.—One-storey shops at Choumert-road, Peckham. Mr. W. O. Doulton.

LONDON, S.E. — One-storey shops, Rushey Green, Catford. Mr. Wilkinson.

LONDON, S.E.—Additions to St. Mary's Oratory, Sydenham-hill. Messrs. Johnson, Saul, and Co.

LONDON, S.E.—Additions to Blackheath High School for Girls, Wemyss-road. Mr. J. O. Smith.

LONDON, S.W.—Buildings on the western side of Brixton-hill. Messrs. Cush, Phillips, Walters, and Williams.

LONDON, S.W.—Baptist church, Lower Tooting. Messrs. J. Wills and Sons.

LONDON, S.W.—Mission hall, 113, New-road, Clapham. Mr. W. Dewes.

LONDON, S.W.—Blocks of flats at East Dulwich-road. Messrs. Rutherford and Brierson.

LONDON, S.W.—Erection of Baptist church, Tooting Junction (£6,400).

LONDON, W.—Erection of buildings in Uxbridge-road, Hammersmith. Mr. W. G. Ingram.

LYNMOUTH—Alteration of lifts at cliff railway.

MAESTEG—Shops and dwelling-houses. Architect, Mr. J. C. Rees, Neath.

MAIDSTONE—Renovation of operating theatre at Kent County Hospital (£300).

MAINDEE—Erection of Liberal club (£2,000). Messrs. King and Co., Newport.

MARGAM—Eleven houses in Broad-street; Mr. W. Jenkins. Six houses in Crown-street; Mr. E. Redmore. Six houses in Tanygroes-street; Messrs. Evans and Davies.

MELKSHAM—A villa in Sandridge-road for Mr. A. Hurn.

MENSTONE—Extension to the lunatic asylum.

MORLEY—Extensions to the Corporation electricity plant (£1,964).

MOUNTAIN ASH—Enlargement of railway subway for District Council (£2,200).

NENAGH—Erection of schools by the Board of Education.

NEWRY—Scheme for labourers' cottages for Rural District Council (£5,735).

OGMORE—Erection of public baths by Urban District Council.

OLDLAND—Erection of All Saints' Church (£3,700).

OSSETT—Proposed extensions of tramways from Dewsbury to Ossett.

POLLOKSHAWS—Public bath and fire station for Town Council.

PONTYCYMMER—Erection of school (£5,000). Mr. Davies, Cardiff.

POOLE—Six terrace houses, Croft-road; Messrs. Smart and Wyeth. Ten houses, Hamworthy-road; Carter and Co. Fifteen houses, New-road; Messrs. Smart and White.

PRESTEIGN—Alterations of Hertford-street Council School (£1,000).

RATHDRUM—Dispensary residence for Guardians.

RAVENSTHORPE—Cable laying and light installation. York Electric Power Co.

RHOS—Erection of chapel in Queen-street (£2,000). Mr. L. Davis, contractor.

ROMFORD—Board-room, offices, and waiting-room at the infirmary.

ROTHESAY—Extensions to the pier by the Harbour Trust (£10,000).

SALFORD—Erection of bakehouse at workhouse. Architect, Mr. H. Lord, Manchester.

SAFFRON WALDEN—Erection of artisans' dwellings for Rural District Council.

SALINE—Enlargement of public schools (£2,000). Mr. J. Houston, Dunfermline.

SEDGEFIELD—Alteration of Guardians' offices.

SHAW—Erection of a new mill.

SOLIHULL—Extensions of workhouse (£6,000).

SOMERSET BRIDGE.—The County Council are selecting a site for the erection of a Council school.

SOUTHAMPTON—Extension of municipal electric tramways to Royal Pier.

STALYBRIDGE—Electrical extensions for Tramway and Electricity Board.

STIRLING—Shops and dwelling-houses at Pelmont. Architect, Mr. J. Best, Wariston House, Edinburgh.

STORTHES HALL—Homestead and farm residence for Lunacy Commissioners (£8,500).

SUNDERLAND—Engineering laboratories for technical college (£10,000).

SWANSEA—Housing provision for 300 families for the Corporation.

SWINDON—Extension of mission hall, Bowling-street; Mr. H. Packham. Erection of temporary mission church; Mr. W. Masters.

TALYWAIN—Shop and warehouse for Abersychan Co-operative Society.

THORNTON—Bowling club pavilion at Cleveleys Park.

TIVERTON—Seven houses in Chapel-street; Mr. R. Sloman. Two houses, Canal-hill; Mr. J. Elliott. Farmhouse at Colcombe; Mr. I. Amory. New factory buildings, Leaf-street; Messrs. Heathcote and Co.

TOTNES—Erection of new infirmary for the Guardians.

TRURO—Erection of western towers and spires of cathedral (£20,000).

ULVERSTON—Villas at Hawkeshead; calf hall at Sawrey; and four houses at Allithwaite.

UPHOLLAND—Enlargement of Primitive Methodist chapel.

UPWEY—House at pumping station for Portland Urban District Council.

WARE—Telephones to be installed at Joint Hospital.

WARWICK—Construction of public convenience for Town Council (£350).

WATFORD—Extensions to public library for Urban District Council (£1,950).

WEBB—Primitive Methodist chapel (£1,600).

WEDNESBURY—Electricity plant for Corporation (£10,000).

WESTON-SUPER-MARE—Alteration at Central Council Schools (£165).

WEYMOUTH—Three houses at Greenhill; Mr. J. T. Whettam. Four villas in Ulleswater-crescent; Mr. J. Turner.

WHITEHAVEN—Two new villa houses to be erected at the top of Wellington-row for Mr. John Shackley, of Victoria-road.

WIDNES—New church of St. Mary. Architects, Messrs. Austin and Paley, Lancaster.

WIMBLEDON—Erection of Council school at Pelham-road (£15,428).

WISHAW—Provisional order promoted by Town Council for "free wiring."

WOKING—Erection of London and South-Western Railway Servants' Orphanage.

WOLVERHAMPTON—New church to be erected in Hilton-street, Springfields (£6,000). Architect, Mr. F. C. Beck.

WORKSWORTH—Additions to town hall for Urban District Council.

WORLE—Erection of Council schools for Somerset Education Committee.

YARDLEY—Election of new Council schools.

YARMOUTH—Corporation main extensions (£295).

CONTRACTS FOR ELECTRICAL SUPPLIES.

Paris.—Electric cables required for the Post and Telegraph Department, 103, Rue de Grenelle, Paris. Tenders by Sept. 30.

Brisbane.—The Postmaster-General invites tenders for telephones, cells, resistance coils, battery pole changers, operators' sets, etc. Tenders by Sept. 30.

Clacton.—The Urban District Council invite tenders for the supply of vulcanised bitumen distributing mains and service cables. Tenders to Mr. G. T. Lewis, clerk to the Council, by Oct. 2.

Norwich.—Tenders are invited for the annual supply of incandescent lamps for the Corporation Electricity Department. Particulars from the City Electrical Engineer. Tenders by Sept. 23.

Melbourne.—The Postmaster-General's Department invite tenders for 11 sets and a common-battery switchboard, and 3,000 subscribers telephones, etc., for the Windsor exchange. Tenders by Jan. 7.

London.—The London County Council invite tenders for three electrically-driven boiler feed pumps, each of 9,000 gallons per hour capacity, for the Greenwich tramway station. Tenders by Oct. 8.

Portrush (Ireland).—The Urban District Council invite tenders for a complete lighting installation by electricity or gas. Copies of specification can be seen at the Town Hall, Portrush. Tenders by Nov. 2.

West Ham.—The Corporation invite tenders for the supply and delivery for six months ending March 31, 1908, of indiarubber-covered wires and cables. Tenders to the Town Clerk by Oct. 3. See advertisement.

Peterborough.—The Electricity Committee of the Corporation invite tenders for providing and laying about 2,400 yards of feeder cables. Tenders to the City Electrical Engineer by Oct. 3. See advertisement.

Croydon.—The Council invite tenders for the supply and erection of an overhead runway at their electricity works, Factory-lane, Croydon. Tenders to Mr. F. C. Lloyd, town clerk, by Sept. 30. See advertisement.

Paris.—Pumping plant and electric dynamos and motors for the Municipal Waterworks Department. Estimate, £36,000. Particulars from the Canals and Waterways Department, Hotel de Ville, Paris. Tenders by Oct. 24.

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Dublin.—The Lighting Committee of the Corporation invite tenders for the supply of 500 alternating-current single-phase meters and 100 alternating-current three-phase meters. Tenders to the Secretary, 3, Cork-hill, Dublin, by Sept. 30. See advertisement in last issue.

Swinton and Pendlebury.—The Urban District Council invite tenders for the wiring, upon the hire-purchase system, of buildings for electric light. Tenders to the Chairman of the Electricity Committee, Council Offices, Swinton, Manchester, by Sept. 28. See advertisement in last issue.

Adelaide.—The Deputy Postmaster-General for Queensland invites tenders for a common battery switchboard and 3,000 subscribers' telephones. Specification No. 166. Particulars may be obtained from the Commonwealth Offices, 72, Victoria-street, London, S.W. Tenders by Jan. 8, 1908.

Stockport.—The Electricity Committee invite tenders for the supply of engine slack, delivered at the electricity works, Millgate, during a period of six or twelve months, at the discretion of the committee. Particulars from the Electrical Engineer at the works. Tenders by Sept. 26.

London, E.C.—Tenders are invited for the supply and delivery of a 600-kw. direct-current generator, as per specification to be seen at the Company's Offices, for the East Indian Railway. Specification, £1. 1s. Tenders to Mr. C. W. Young, secretary, Nicholas-lane, London, E.C., by Oct. 2.

Rangoon.—For pumping plant for Rangoon Municipality. Particulars, etc., of Messrs. Ogilvy, Gillanders, and Co., London agents to the Rangoon Municipality, Suncourt, 67, Cornhill, London, E.C., accompanied by a remittance of 10s., which will not be returned. Tenders to the Agents by Oct. 31.

Victoria.—The Deputy Postmaster-General at Melbourne invites tenders for the supply and delivery at Melbourne of 11 sections of a common-battery switchboard and 3,000 subscribers' telephones and other apparatus for telephone exchange, Windsor, in accordance with Victorian specification No. 148. Tenders by Jan. 7.

Keighley.—Tenders are invited for the supply of steam coal to the electricity works for six months commencing Dec. 1, 1907, for the Electricity Committee. Forms of tender may be obtained from the Borough Electrical Engineer, at the Electricity Offices, Coney-lane. Tenders to Mr. Wm. Bagshaw, town clerk, by Sept. 23.

Carlisle.—The Electricity Corporation invite tenders for the supply of 1,000 tons small washed steam coal. Tenders must be upon the form which can be obtained at the City Electrical Engineer's Office, and must be received by Mr. Charles D. Burnet, city electrical engineer, Corporation Electric Light and Power Station, Carlisle, by Sept. 23.

Dundee.—The Electricity Committee invite tenders for the supply of meters for period from Oct. 1, 1907, to April 30, 1908. Specification, etc., from Mr. H. Richardson, M.I.E.E., general manager, Electricity Works, Dudhope-crescent-road, Dundee. Tenders to Mr. W. H. Blyth Martin, clerk to the Corporation, City Chambers, Dundee, by Sept. 30.

Limerick.—The Electric Lighting Committee invite tenders for the supply and delivery at the electricity works of (*a*) machine-made washed anthracite peas or (*b*) machine-made anthracite nuts, for producer gas, for a period of six months—quantity 300 tons (approximately), to be delivered as required. Tenders to Mr. W. M. Nolan, town clerk, by Sept. 24.

Alexandria.—Tenders are invited for the following electrical equipment for the port of Alexandria: five large and seven small transshipping engines, six cranes of four tons, 36 cranes of two tons, 25 windlasses, various small plant and necessary accessories, and the construction and installation of a central power station. Particulars from M. le Directeur des Ports et Phares, Alexandria. Tenders by Nov. 1.

Hull.—Tenders are invited for the supply of unwashed slack and hard steam coal, required by the Electric Lighting Committee at their electricity works, Sculcoates-lane, for six or for twelve months, ending approximately May 12, 1908, or Nov. 12, 1908, respectively. Forms of tender may be obtained from the Electricity Office. Tenders to the Chairman of the Electric Lighting Committee, Town Hall, Hull, by Sept. 26.

Dundee.—The Corporation Electricity Department invite tenders for extra-tension armoured feeder cables laid direct in the ground, and low-tension armoured and low-tension paper-insulated, lead-covered feeder cables and distribution cables laid direct in the ground, and on the solid system in wood troughing. Particulars from the Engineer-in-Chief, Electricity Works, Dudhope-crescent-road. Tenders by Sept. 30.

New South Wales.—With reference to an announcement inviting tenders for the supply and construction complete of a pneumatic tube service to the General Post Office, Sydney, from the Pacific Cable Board's Office, Royal and Stock Exchanges, etc., the Postmaster-General for New South Wales give notice that the date for the receipt of such tenders has been extended from July 10 to 2.30 p.m. on Wednesday, Oct. 16 next.

Worthing.—The Corporation invite tenders for the supply and delivery at Worthing railway station, for the electricity works, of 600 tons of unscreened Durham (Holmside) coal and 300 tons of Welsh (through-and-through) coal, containing a minimum of 60 per cent. of large. Particulars from Mr. W. Verrall, town clerk, Municipal Offices, Worthing, by sending a stamped addressed foolscap envelope, and to whom tenders must be sent before Sept. 23.

Army Contracts.—Manufacturers who may wish to be invited to tender for army requirements should address the Secretary, War Office, by letter, stating the particular articles which they manufacture, and the names of at least two well-known firms or public bodies who have purchased from them and are in a position to certify as to the quality of their productions. The services of an intermediary are unnecessary in approaching the Department for this purpose. See advertisement.

Antwerp.—The Commercial Intelligence Branch of the Board of Trade have received from his Majesty's Consul-General at Antwerp a copy of a specification issued by the Municipal Authorities of that city calling for tenders for the installation of electric light in the Salle de Fêtes recently erected in the Place de Meir, Antwerp. A deposit of 8,000fr. (about £320) will be required to qualify any tender. Tenders to M. le Bourgmestre de la Ville, at the Hotel de Ville, Antwerp, by Oct. 17.

New South Wales.—Tenders will be received at the office of the Deputy Postmaster-General, Sydney, until 2 30 on Oct. 23 for supply and delivery of the following material at the Departmental Stores, Sydney: 11 tons galvanised iron wire, 400lb. per mile, as per specification No. 164; 1,600 large best white porcelain insulators, as per specification N.S.W. No. 17, and sealed pattern N.S.W. No. 5. Specifications, general conditions, and sealed patterns may be seen and tender forms obtained at the General Post Office, Sydney, Melbourne, Brisbane, and Adelaide.

Epworth (Axholme).—The Axholme Joint Railway Committee invite tenders for the construction of the Hatfield Moor extension light railway, about five miles long, commencing at Epworth Station, on their Axholme Joint Line, and terminating near the peat moss works. Plans may be seen and specification, etc., obtained on personal application at the office of Mr. W. J. Cudworth, Engineer's Office, North-Eastern Railway, York. Tenders to Mr. H. Marriott, secretary, Axholme Joint Railway, Lancashire and Yorkshire Railway Offices, Hunt's Bank, Manchester, by Sept. 28.

Maidstone.—Tenders are invited for four electrical motors and centrifugal pumps, each capable of delivering 150 cubic feet of sewage, and three electrical motors and centrifugal pumps at 225 cubic feet per minute, together with two motor-driven air injectors, two travelling cranes, switchboard, starting switches, workshop fittings, and other appliances and connections, including a complete electric light installation, for the sewage-disposal works. Plans, etc., and form of tender from Mr. G. R. Strachan, 9, Victoria-street, Westminster, London, on and after Sept. 3. Tenders by Oct. 1.

Gothenburg.—The Commercial Intelligence Branch of the Board of Trade are notified by his Majesty's Consul at Gothenburg that tenders are invited for supply of the electrical equipment for the Government power station at Trollhattan, comprising three electric generators for direct current, each of 350 kw.; one accumulator battery of 4,800 ampere-hours capacity; four three-phase generators, each of a maximum of 11,000 kilovolt-amperes; 12 transmitters, each of a maximum of 3,670 kilovolt-amperes; connections; regulators; and control tables. Sealed tenders, marked "Anbud a elektrisk utrustning for Statens kraftverk," should be sent to the Managing Director of the Royal Trollhattan Canal and Waterworks, Trollhattan, Sweden, by noon on Oct. 1 next. Tenders are binding until Jan. 1, 1908. Delivery is to be completed by Sept. 1, 1909. Further information may be obtained from the Managing Director, from whom a copy of the programme can be had against a deposit of 50 kronor, which will be returned on receipt of a tender in accordance with the programme.

RESULTS OF TENDERS.

Keighley.—The Corporation have accepted the tender of Johnson and Phillips for the supply of Paterson's vulcanised bitumen cable.

Grimsby.—The Electricity Committee have accepted the tender of Johnson and Phillips for the supply of cables for the next two years.

Derby.—The Electricity Department have placed an order with Johnson and Phillips for the supply of Paterson's vulcanised bitumen cable.

Aberdeen.—The Tramways Committee have accepted the tender of Hurst, Nelson, and Co., Motherwell, for the supply of six additional car top-deck covers at £148. 10s. per car.

St. Albans.—The North Metropolitan Electric Power Supply Co. have placed an order with the Brush Electrical Engineering Co. for two 150-kw. steam dynamos and accessories.

Bombay.—The Brush Electrical Engineering Co. have received an order from the Bombay Electric Supply and Tramways Co. for 50 single-type trucks, 25 car bodies, and 50 sets motor equipments.

Newcastle-on-Tyne.—The City Council have accepted the tender of Messrs. E. Allen and Co. for the construction of an electric tramway junction at Pilgrim-street and Market-street extension for £2,142. 10s.

London.—The Metropolitan Asylums Board have accepted the tender of Messrs. J. and F. May, 33, Whetstone-park, Lincoln's-inn-fields, W.C., for boilers and machinery for the North-Eastern Hospital for the sum of £6,985. 10s.

London.—The Metropolitan Asylums Board have received the following tenders for alterations to fire-alarms and telephones at the Gore Farm Hospital:

Electrical Engineering and Maintenance Co., 49, Lime-street, E.C. *	£175	0	0
Private Wire and Telephone Installation Co., 78, Queen-street, E.C.	226	0	0
J. Bryden and Sons, 90, Gloucester-road, S.W.	248	10	0
H. J. Galliers, Brighton	257	1	11
National Telephone Co., Maidstone	275	0	0
Speedy, Eynon, and Co., 3, Adelaide-street, W.C.	295	0	0
T. Potter and Sons, Putney Bridge Ironworks, S.W.	299	0	0
J. W. Gray and Son, 91, Leadenhall-street, E.C.	300	0	0
W. G. Cannon and Sons, 107, London-road	375	8	0
Watford Engineering Works, Watford	400	0	0

* Recommended for acceptance.

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Loch Leven.—The directors of the Loch Leven Water and Electric Power Co. have accepted the tender of Johnson and Phillips for the supply and erection of overhead transmission lines, including telephones, lighting, and traction, with aluminium cables.

Malvern.—We are informed that the contract for the electrically-driven compressors at the Link Mill, Malvern, has been secured by Walters and Co., Ocean-chambers, Birmingham, and includes motors manufactured by Rhodes Motors, Limited, of Doncaster, and air-compressors manufactured by Reavell and Co., of Ipswich.

Shipley (Yorks).—We are informed that Chas. Pullan, electrical engineer and contractor, Bradford, has secured the contract for the electric lighting of the Queen's Palace Theatre, Shipley, Yorks. The whole of the wiring in this building is going to be carried out in a screwed conduit system, and the supply taken from the Urban District Council mains.

BUSINESS NOTES.

TRACTION.

Dundee.—The Board of Trade has refused to interfere with the complaint made by the Dundee tramway employés that they cannot run up to the time-table.

Southampton.—The Council have decided to obtain parliamentary powers to extend the tramways to the Royal Pier, and also to separate the work of the Tramway Committee from the Electricity Committee.

Crigglestone.—At a meeting of tradesmen at Dewsbury on the 12th it was decided to write to the Crigglestone Colliery Co. in support of the suggested scheme of running motor trains for passengers between Dewsbury and Cudworth.

Madras Electric Tramways (1904).—The receipts for the fortnight ending Sept. 15, 1907, totalled Rs.18,221 against a total of Rs.14,751 for the corresponding period of 1906. The gross receipts since Jan. 1 were Rs.292,821 against Rs.242,960 for last year.

Ossett.—At a tradesmen's meeting at Dewsbury on the 12th a resolution was carried unanimously in favour of co-operating with the Dewsbury Corporation in their endeavours to have the tramway line laid from Dewsbury to Ossett with all possible speed.

Hampton.—The solicitors of the tramway company have written the Urban District Council stating that the necessary steps are being taken for the acquisition of the properties required for the widening of High-street, Hampton Hill, and that they would be communicating further as soon as possible.

Light Railways Act, 1896.—The Board of Trade have recently confirmed the following order made by the Light Railway Commissioners: Kent and East Sussex Light Railway (Further Borrowing Powers) Order, 1907, extending the borrowing powers of the Kent and East Sussex Light Railway Co.

Streatham.—The Streatham Chamber of Commerce and the ratepayers' association are sending a combined deputation to the London County Council to urge upon that body to extend the trams from the library to the county boundary at Norbury. The Council have agreed to receive the deputation on Oct. 30.

Milngavie.—At the last Town Council meeting the provost remarked that it was time the Council were doing something in connection with the proposed extension of tramways to Milngavie, in so far that they might know the public feeling in the burgh regarding same. The question was remitted to the Tramway Committee to go into this matter without further delay.

Birkenhead.—A tramcar accident occurred on the 14th in Borough-road, Birkenhead. It appears that a boy named John Trevor Jones, who resides in Brattan-road, was playing in the thoroughfare, when the front of an electric car caught him and knocked him down. He sustained injuries to the head and a severed artery. The ambulance conveyed him to the Wirral Children's Hospital.

St. Pancras.—Mr. C. H. F. Barrett, the town clerk, has received a letter from the London County Council, which has been referred to the Parliamentary Committee of the Borough Council, asking the latter body, in connection with the electrification of the tramways in Pentonville and Gray's-inn roads, to contribute towards the cost of making a road across the Metropolitan Railway, King's Cross, for all kinds of traffic.

Teddington.—A member of the Teddington District Council estimates that since the commencement of the running of trams in Teddington house property in the parish has depreciated in value to the extent of £30,000, and that the number of empty houses on the line of route represent a like amount. A notice is to be served on the tramway company calling upon them to abate the nuisance caused by the noise of the cars.

Heckmondwike.—The Council have decided to protest against the increased tram fares, and have expressed their willingness to join with any other authority for the purpose of getting them reduced. The Council are also protesting against the Midland Railway Co.'s proposed postponement of the construction of their line through the district, and are prepared to join with the Bradford Council in urging the company to proceed at once.

Leeds.—The Tramways Committee of the Corporation have decided to recommend that sanction be obtained for the borrowing of £40,000 for the construction of tramways in Otley-road from the Three Horse Shoes to Lawnswood, in East-street, and in South Accommodation-road. The committee, after consideration, resolved to visit the Farnley and Wortley districts in connection with the proposed extensions which were suggested at the last meeting of the City Council.

Stoke Newington.—A letter has been received by the Council from the Board of Trade stating, in reply to a complaint from the Borough Council, that they were not prepared to make any alteration in the regulations governing the speed of tramcars in the district. The Council have decided to again write to the Board pointing out that in their opinion the rate at which the electric cars were allowed to travel on Stamford-hill (16 miles an hour) is too high.

Proposed Largs and Skelmorlie Tramways.—The Northern District Committee of Ayrshire County Council have had before them a letter from Messrs. Keyden, Strang, and Co. in connection with a proposal to lay down tramways between Largs and Skelmorlie, and desiring an agreement with the committee before proceeding further with the matter. The meeting agreed to recommend several gentlemen to the Road Board with a view to having their full strength on the standing committee.

Edinburgh.—At a meeting of the Tramways Committee of Edinburgh Town Council it was agreed to recommend that the tramway company be asked to resume the early morning service of workmen's cars on the lines in the northern district of the city. On the motion of Councillor M'Michael, it was also agreed that the Town Council be recommended to take estimates for the whole of the work required to be done in connection with the cabling of the East Claremont-street route, with a view to having definite data for the calculation of the total cost.

Hackney.—The London County Council have written to the Borough Council intimating its intention to construct a single line of tramway from Essex road to Kingsland-road (*viâ* Englefield-road and Stamford-road), and from Kingsland High-street to Mare-street (*viâ* Ridley-road and Dalston-lane), together with a double line in Lea Bridge-road, between Cornthwaite-road and Lower Clapton-road. A proposal is also made for the widening of Lea Bridge-road in connection with the scheme, the necessity for which improvement has long been the subject of comment in the district.

South Shields.—The first serious tramcar accident at South Shields since the service was commenced by the Corporation a little over 12 months ago occurred on the 17th inst. No. 9 car was proceeding up Slake-terrace when it jumped the points and came into violent collision with car No. 25 going in the opposite direction. All the passengers were thrown from their seats and suffered from shock, but no one was badly injured. The cars were extensively damaged, the front ends being smashed in and the windows broken into splinters. All the passengers were able to walk home.

Monkstown.—A collision between tramcars occurred on the 14th at Monkstown, co. Dublin, under extraordinary circumstances. At the foot of the slope from De Vesci-terrace a collision occurred between a vehicle driven by a coachman and a tramcar. The tramcar came to a standstill, and in the commotion which arose while picking up the coachman, who was thrown from his seat, no one thought of warning the next approaching tramcar, with the result that another car came along and dashed into the stationary tramcar. A shower of glass was sent flying all round, and the driver's leg was severely cut.

Darlington.—At a special meeting of the Darlington Tramways Committee on the 17th, Councillor Crooks proposed a reversion to ½d. stages on cars. Councillor Wooler (chairman of committee) objected, and gave statistics comparing the period from Nov. 1 last year, when 1d. fares commenced, until Saturday last, with the period commencing Nov. 1, 1906, and ending Sept. 14 last year. During the 1d. fare period they had carried 550,000 fewer passengers, and taken over £78 more money in fares. Ultimately the proposal was adjourned until the next meeting, when the tramways manager will present a report on the subject.

Clacton-on-Sea and St. Osyth Light Railway.—The *London Gazette* states that the Light Railway Commissioners have submitted to the Board of Trade for confirmation under the Light Railways Act, 1896, an order reviving the powers granted and extending the periods limited by the Clacton-on-Sea and St. Osyth Light Railway Order, 1904, for the compulsory purchase of lands, and for the completion of the railway and works by that order authorised, and for other purposes. Any objections to the confirmation of the order should be addressed to the Assistant Secretary (Railway Department), Board of Trade, before Sept. 28.

Doncaster.—An inquest was held at Doncaster on the 13th respecting the death of Wm. Vickers, aged 93, an inmate of the Doncaster Workhouse, who was injured in a tramcar accident at the top of Hall Gate, Doncaster, on July 2. A party of aged inmates from the workhouse had been for a drive to Armthorpe Rectory, and were returning, when the wagonette was run into by a tramcar, Vickers and others being thrown out. Vickers's left leg was fractured. Dr. Willey, house surgeon at the infirmary, said the fractured bone had united, and Vickers had been suffering from general debility and congestion of the lungs. His death was probably due indirectly to the accident. The jury returned a verdict of "death from natural causes, accelerated by the accident."

Tooting.—A petition, extensively signed by the working classes of Tooting, has been submitted to the London County Council asking for an extension of the time of workmen's cars from 7.30 a.m. to 8.30 or 9 a.m., and pointing out the disadvantages of the present system, which means that those who have not to get to work until 9 a.m., or even later, to avail themselves of a workman's ticket have to leave Tooting-broadway by 7.30 at the latest, so that they are landed at the bridges soon after 8 o'clock. It also points out that the cars leaving Tooting between 7.30 and 9 a.m. are virtually empty, so that if the Council were to run cars, say, between 8 and 9 a.m. at an increase of 1d.—*i.e.*, 3d. for a return workman's ticket—which, in reality, would mean the saving of 3d., it would not only alleviate the suffering caused by their premature arrival, but would benefit the Council financially.

Pudsey.—A special meeting of the Town Council was held on the 13th, the chief business being the consideration of a draft agreement

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which had been forwarded by the Leeds Corporation with a view to the taking over of the Pudsey tramway powers. Leeds propose to construct a line from their terminus at Stanningley up Richardshawlane to the Pudsey Mechanics' Institute, and forward to Chapeltown, Pudsey. They agree to pay Pudsey the expenses incurred in obtaining the order. Upon the expiration of 35 years, or upon the expiration of any subsequent period of five years thereafter, Pudsey may purchase the tramways upon payment of a sum equivalent to the fair market value of the cars and permanent way, but without any allowance in respect of goodwill or loss of profits. The Council approved of the principle of the agreement, which was referred to a committee to arrange certain details.

Brighton.—Further consideration has been given by the Tramways Committee of the Brighton Corporation to the resolution, withdrawn at the last meeting, with reference to the proposed turning of the cars at the Royal Pavilion during the winter months. The committee again considered the engineer's report, which, briefly stated, meant about half the cars turning at the Pavilion and half at the Aquarium. The engineer (Mr. William Marsh) estimated that, after making allowance for all the cars turning at the Aquarium on Saturday and Sunday afternoons, this scheme would effect a saving during the 30 weeks of the winter service as follows: Lewes-road route, £258. 15s.; Ditchling-road route, £270; and Beaconsfield-road route, £274. 10s.—making a total of £803. 5s. The committee recommend the adoption of the report with the proviso that on Saturdays and Sundays cars travelling on all the routes turn at the Aquarium at the discretion of the engineer when the weather is favourable.

Tramway Men's Brotherhood.—Two successful meetings of the Cardiff Corporation tramway men were held at St. John's National Schoolroom, Queen-street, on Sunday, in connection with the St. Mark's Tramway Brotherhood of Great Britain. The Rev. Alick Henderson, vicar of St. John's, presided, and addresses were delivered to the men by the Rev. Dr. Darlington, Kensington, founder of the brotherhood; Conductor Doughty (London County Council tramways), London secretary; the Rev. D. Jenkins, St. Barnabas's, Grangetown; Mr. David (traffic manager of the Cardiff Corporation tramways), etc. It was decided to form a branch at Cardiff, and Conductor Attwell will act as secretary provisionally. Although only founded in 1904, there are already over 1,000 members. The Rev. D. Jenkins has also undertaken to keep in close touch with the branch, which, it should be explained, has no official connection with any trades' union, and confines its aim to the moral side of the tramwaymen's lives.

Halifax.—The revenue from the Halifax tramway system for the week ended Sept. 4 amounted to £1,721. 17s. 1d., or 11·61d. per car mile, compared with £444. 0s. 5d., or 10·02d. per car mile run, for the corresponding week of 1906. Thus £1,277. 16s. 8d. is the increase recorded, but this is easily explained when it is stated that the corresponding week of last year was the first week of the tram strike. The effect this struggle had upon the returns is also shown in another way. For example, the mileage run by the cars for the week ending Sept. 4 was 35,596, for the corresponding week last year the total was only 10,630, and this it will be remembered in spite of one day when there were no cars and days when there was only a limited service. The aggregate revenue since the beginning of the municipal year has been £38,339, as against £38,862 for the corresponding period, a decrease of £522. The total number of children's fares received this year has been 639,600, against 641,663, and of workmen's fares 15,123.

Eccles.—In regard to the agreement between Salford and Eccles as to Eccles supplying electrical energy for tramway traction, the following are the terms of the supplemental agreement entered into on July 31 last: (1) the Salford Corporation to provide and lay the feeder main, etc., for the sum of £1,838; (2) the Salford Corporation not to require any further feeder mains except on payment of an additional amount in respect of the provision and maintenance; (3) the supply of electrical energy to be deemed to have been duly given so long as a pressure of 500 volts is provided and maintained at the feeding point in Fielding-street; (4) the Salford Corporation in each year to pay for a minimum quantity of electrical energy of 500 000 units; (5) the demand at any one time not to be more than 11 four-motor equipment bogie cars, with a proviso that an additional sum is to be payable for an additional service which is to be provided after notice.

German Railways.—The electrification of the existing railways of Germany is proceeding steadily in many parts of the country. The Bavarian Minister of Railways will shortly introduce a Bill in the Bavarian Diet providing for the substitution of electric for steam traction on several lines, including one from Munich to Kochel, another from Munich to Mittenwald, and a third from Freilassung to Berchtesgaden, with an aggregate length of 150 miles. The Prussian State Railways Administration have decided to substitute electric for steam traction on all the Berlin suburban lines, and a beginning in this direction has already been made with the line to Südende. Entirely new electric railways for high-speed trains are projected on the Berlin-Hamburg and Berlin-Cologne Railways. Herr Rudolf Mayer, the engineer, publishes a statement that Germany will lead the world in the introduction of electric railways as England was the pioneer in regard to steam.

Twickenham.—At the last meeting of the District Council a letter was read from the secretary of the Light Railways Commission, with reference to the application which had been made to the Light Railway Commissioners for the above-named order, stating that the Commissioners, in accordance with the provisions of Sections 7 and 8 of the Light Railways Act, 1896, had settled such order, and that upon Aug. 6, 1907, it was submitted by them to the Board of Trade for confirmation. The order, as submitted to the Board of Trade for confirmation, extended the time for the compulsory purchase of the lands and the period for the completion of the works for the light railways comprised in the London United Tramways (Light Railways Extensions) Orders, 1904, for a further period of two years from Nov. 4, 1907. The order also contained provisions with respect to the use by the Postmaster-General for telegraphic purposes of any posts or standards erected in any street or road by the company, subject to the conditions set out in the order.

Liverpool.—A sensational tramway accident, by which several persons were more or less seriously injured, occurred in Liverpool early on the morning of the 14th. About half-past six, as a car was proceeding up the steep portion of Prescot-street, the driver lost control, and first slowly and then with increasing momentum the vehicle glided backwards down hill. The passengers early took alarm, and some jumping off infected the others with panic, and in a very few seconds all of them made for the door and jumped. Other passengers were not, however, so fortunate. A Mrs. Pugh, of Hereford, who was going to Highfield-road, Old Swan, to take a daughter home who has been on a visit, sustained a scalp wound and suffered from shock. P.C. 224B, who was of some assistance to the shaken ones, kindly saw the lady to the address given above. A man, whose name is John Moore, was taken to the Royal Infirmary. He appeared to be quite unnerved at the occurrence, and could not remember his address. The driver (David Roberts) and the conductor escaped unhurt.

Aberdeen.—The Aberdeen Corporation tramway traffic returns for the week ending Wednesday last show that the total receipts amounted to £1,584. 18s. 4d.—a decrease of £144. 2s. 6½d. compared with the corresponding period last year, in which, however, the autumn holiday occurred. The receipts per car mile averaged 12·3d., as against 13d. The total number of passengers carried was 365,280, a decrease of 31,255, the number carried over the various routes being as follows: Woodside, 64,494; Mannofield, 36,552; Bridges, 66,169; Bayview, 27,751; Ferryhill, 18,231; Circular, 64,949; Torry, 30,498; Bathing Station, 25,872; Suburban—Woodside, 18,151; Mannofield, 12,613. The number of luggage tickets issued was 727; parcels delivery tickets, 128; while the value of the composition tickets sold was £60. 14s. The allowances to the Suburban Tramway Co. were £34. 12s. 0½d., as against £34. 15s. 3½d. The receipts from June 1, the beginning of the financial year, amount to £23,422. 12s. 2d., a decrease of £445. 19s. 2d. compared with the corresponding period last year.

Portsmouth.—At the last meeting of the Council an important report was submitted by the Tramways Committee, as follows: "Your committee have had under consideration several extensions of the tramway system in the borough which have been from time to time suggested, and they recommend that a tramway be laid along Goldsmith-avenue to a point opposite the White House public-house, and from thence through Eastney-road, joining the existing tramway at the present terminus at Eastney, and in connection with the foregoing a tramway forming a junction with the existing tramway in Highland-road and passing through Festing-road and joining the existing tramway at the Canoe Lake. The estimated cost of these works is: for the line commencing at Fratton Bridge and passing along Goldsmith-avenue to a point opposite the White House public-house, £14,407; from the point through Eastney-road to the Eastney terminus, £8,368. 16s.; and from Highland-road through Festing-road to the existing tramways at the Canoe Lake, £11,100, the total amount being £33,875. 16s.

Newcastle.—A meeting of the Tramway Committee of Newcastle Corporation was held on the 12th inst., at which a deputation of tramway employés waited on the committee on behalf of their colleagues generally for permission to form a brass band. Mr. Howe, who was the spokesman, intimated that some time ago a number of the tramway men agreed to form a brass band. The general manager (Mr. Hatton) was waited on, and he readily gave his consent to a band being formed. Communication was made with several brass band instrument makers as to the cost of the necessary instruments, and it was decided, subject to the approval of the Tramways Committee, to ask for public subscriptions, believing the appeal would be liberally responded to. It should be borne in mind that tramway men, owing to their peculiar hours, were unable to enter into the sports and pastimes of ordinary working-men. It was, therefore, thought that they must cater for themselves, and one way of doing so was the formation of such band. The deputation not only hoped the committee would give their consent to the proposed undertaking and allow them to obtain public subscriptions, but also grant a subscription from the tramway funds. The deputation were informed that the matter would receive careful consideration. After some consideration the committee agreed to give permission for the formation of the band, and to render all assistance possible.

Luton.—It was expected that a commencement with the laying of the track in connection with the Luton tramways would have been made in September. It is unlikely, however, that a start will now be possible before the early part of October. As soon as the rails arrive the "first sod," so to speak, in connection with the laying of the tramways will be cut. So far as present arrangements go, the work will probably be commenced either in the New Bedford-road or in Dunstable-road. A little while ago it was confidently predicted the trams would be running by Christmas; now the middle of February or the beginning of March is the date named. Most likely it will be later still. Progress, however, is being made in some directions. The type of car which will be used has, for instance, been finally decided upon. It will consist of an ordinary double-deck car seating 54 persons (22 inside and 32 outside). The inside passengers will sit with their backs to the windows, and the outside passengers will sit on seats with reversible backs. The inside seats will be of oak slats. The Tramways Committee visited Dartford on Wednesday, and as a result of this visit the type of car referred to above was decided upon. The chairman of the committee (Councillor Osborne) was accompanied by the mayor, the electrical engineer, and the borough surveyor. The chairman and some members of the Dartford Urban Council met the Luton contingent. The former spoke very highly of the way in which the construction of the tramways was carried out at Dartford by

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Messrs. J. G. White and Co. On the return journey Luton representatives had a look in at the London County Council car depôt, New Cross, where they saw much that was interesting and instructive.

LIGHTING AND GENERAL

Globe Telegraph and Trust Co.—A quarterly interim dividend of 2s. per share is announced.

Upholland.—The Council have appointed a committee to consider the lighting of the district by electricity.

Castle Hedingham.—The Parish Council have resolved to take steps to have the telephone introduced into the village.

Fareham.—The Board of Guardians have decided to install a telephone in the clerk's office in connection with the National Telephone Co.'s system.

Lepton.—The District Council have agreed to affix the seal of the Council to the counterpart agreement with Mr. T. W. Broadbent to erect electric wire poles.

Sao Paulo Tramway, Light, and Power Co.—The Sao Paulo Tramway, Light, and Power Co. have declared a quarterly dividend of 2 per cent. on the capital stock.

Sheffield.—The Electricity Committee have been empowered by the Corporation to bring up the cost of extending the public street electric light to High-street and Fargate.

Leek.—The Urban District Council have decided to make application to the Local Government Board for sanction to the borrowing of £6,850 for electric light extensions.

King's Lynn.—The borough surveyor has been instructed, in conjunction with the electrical engineer, to report upon the provision of a refuse destructor for the borough.

Ashton.—The Board of Guardians have decided to lay down a plant for generating electricity for lighting the workhouse hospital. The machinery is expected to cost about £2,000.

Ogmore and Garw.—At a meeting of the Urban District Council plans for the Ogmore Valley Electric Light Co.'s new electric station in Llewellyn-street, Ogmore Vale, were passed.

Alderton.—On the 11th a telegraph office and public telephone call office was opened at the post office. The advantages are much appreciated by the residents in and near the village.

Marlborough.—The Board of Trade have granted an extension until the end of the year as the period within which the Marlborough electric light undertakers may make the deposit of £250 required by the order.

Notice of Dividend.—The *London Gazette* announces that a supplementary dividend of 2s. in the £ has been declared in the estate of G. A. Benton, electrical engineer, Hatherton House, Shareshill, Stafford.

Berwick.—The Lighting Committee are considering the question of the authority's contract with the Urban Electric Supply Co., and the committee are expected to be able to report on the subject at the next meeting of the Council.

Bursiem.—The report of the electrical engineer shows that the number of units generated in August was 22,145 compared with 22,598 in the previous month, and that the number of 8-c.p. lamps in use, exclusive of street-lighting, was 9,281 compared with 9,098.

Partnership.—The *London Gazette* states that the partnership between H. Lewarne and E. J. Swift, carrying on business as electrical and motor engineers at St. John-street and Parkside, Coventry, under the style of the Victoria Garage and Electrical Co., has been dissolved by mutual consent.

Orders for Oil and Waste-Saving Machinery.—Mr. Chas. Pullen, of Cardiff, has received orders for the above from Messrs. Guest, Keen, and Nettlefolds; the Ebbw Vale Steel, Iron, and Coal Co.; Lochets Merthyr Collieries; the borough of Newport electrical department, etc.

Dunfermline.—A large new electric installation has been introduced into the extensive St. Leonard's Works. It is calculated that the Corporation stand to lose anything up to £500 or £600, which represented the company's annual gas bill. The electricity will be generated on the premises.

Chile.—Official consent has been given to the construction of a railway from Osorno to Puerto Moult at an estimated cost of £830,500. A decree has also been published authorising the expenditure of about £122,500 for machinery, electric light installation, and construction work by the General Director of the State Railways.

Hemel Hempstead.—The Finance and General Purposes Committee have recommended the Council to refuse their consent to the proposed application by the Chesham Electric Light and Power Co. for a provisional order to authorise the supply of electricity within the borough of Hemel Hempstead. The Council have agreed.

Eastern Telegraph Co.—The directors of the Eastern Telegraph Co. announce a dividend at the rate of 3½ per cent. per annum, less income tax, on the preference stock for the quarter ending 30th inst., and the second quarterly interim dividend of 1¼ per cent. on the ordinary stock, free of income tax, for the year ending Dec. 31, 1907.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to allow the following securities to be quoted in the official list: American Telephone and Telegraph Co.'s 158,661,800dol. capital stock in shares of 100dol. each; Sumatra Para Rubber Plantation's 50,000 shares of £1 each, fully paid, Nos. 1 to 50,000.

General Electric Co.—An incorrect report appeared in the daily papers this week to the effect that there had been a serious fire in the Union-street works of the above company. The fact is there was no fire whatever in these works, but at a store in a railway arch adjoining. The damage done was trifling, and will not in any way interfere with the normal dispatch of goods.

Cheltenham.—As the result of an interview held by the committee appointed by the Cheltenham subscribers with the district manager of the National Telephone Co., it has been announced that the company have given an assurance to the present subscribers that no alteration would be made in the charges for the use of existing lines, but that new lines and new subscribers would be taken under the system of measured calls.

Woking.—The Highways Committee have recommended the Council to request the Telephone Co. to place underground the wires in the Star Hill and Heathside roads, and that they be given notice to remove the poles in these roads at the expiration of six months. The committee also recommended that when the wires in any road exceeded 20 in number, the company should be asked to lay them underground. The report was adopted.

Wireless Telegraphy.—Proposals have been submitted to the San Francisco police authorities for the establishment of a novel telephone service for the force. By the proposed system wireless telegraphy would be employed, and each policeman would act as a station. The receiver would be in his helmet, and a call would ring a bell in his pocket. The authorities are assured that the scheme is quite feasible, but they have not yet decided to adopt it.

Yardley.—After negotiations extending over 12 months, in the earlier stages of which the Shropshire, Worcestershire, and Staffordshire Electric Power Co. and the Birmingham Corporation were approached respecting terms for the supply of electricity to the district, the Yardley Rural District Council at a meeting on the 12th accepted terms from the City of Birmingham Tramways Co., under which they will work their own electric light order.

Electrocuted in a Mine.—William Herbert Edwards, aged 15, of Chadsmoor, near Cannock, was electrocuted while at work at the Littletown Collieries, Huntingdon, Cannock Chase, on the 13th inst. He was attending to an electric motor down a mine, and came in contact with a live wire, which passed 500 volts through his body, killing him instantly. Deceased's father, an engine-winder, had the melancholy task of drawing the body to the surface.

York.—At a meeting of the Electricity Committee of the City Council on the 17th a suggestion was made by the electrical engineer that a central position should be obtained in the city for the display of electrical apparatus and fitting. The committee considered the matter carefully, having regard to the fact that it was a serious question for those who were engaged in electrical work, and eventually a sub-committee was appointed to consider the suggestion.

Swinton.—At a meeting of the Tramways and Electricity Committee the clerk read a letter from Mr. Miller stating that it had been necessary to obtain apparatus for testing meters and for insulation testing on consumers' premises. The prices quoted were as follows: Century testing set, £18. 10s., less 20 per cent.; Evershed Megger set, £25, less 15 per cent. As the instruments were urgently required Mr. Miller had ventured to place the order for them. The Council approved the action.

Ince.—At the last Council meeting a letter was read from the Postmaster-General asking permission to place an underground telegraphic line along the north side of Manchester-road, Wigan, from the boundary at Birkett Bank to the Hindley urban district boundary; also along the west side of Stopforth-street the erection of a pole and two stays. He agreed to make good any damage done in the work. Permission was given on condition that the pole was placed in a position approved by the surveyor.

Ware.—The matron having reported to the Joint Hospital Board that the electric bells of the hospital had again failed, the question arose as to the provision of telephonic communication between the wards at the hospital. The medical superintendent said he thought there should be communication between the administrative block and the diphtheria and scarlet-fever blocks. After discussion it was decided to establish telephonic communication between the hospital and the diphtheria block as a trial.

Buxton.—Upon the report of the engineer, the Corporation have decided to apply to the Local Government Board for sanction to the borrowing of £1,700 for additional machinery, etc., as follows: a 280-kw. steam dynamo, including delivery and erection, £1,150; switchboard panel, £30; foundations, including new ones for removal of booster, £100; steam-piping, valves, covering, etc., £200; cable to connect new machinery to board, £15; meter for new set, £15; house service meters, 50 at 50s., £125; contingencies, £65.

Glasgow.—The Telephone Committee of the Corporation are considering the best means of meeting a deficiency of from £15,000 to £17,000 which has arisen in connection with the telephone department. The sum represents the difference between the expenditure in respect of the undertaking made by the Corporation and the price received from the Postmaster-General when the system was acquired by the Government. It is understood that the deficiency can only be met by taxation, but as this could be spread over a number of years the annual rate per £1 would be insignificant.

Kilmarnock.—A discussion took place at the last meeting of the Town Council with regard to the position of affairs in connection with the electrical undertaking. With the view of effecting economies in management, the Electric Committee recommended that the staff should be rearranged, but the general manager be retained at his present salary of £380. Several members contended that the system was extravagantly managed, while the others held that the staff could not be reduced without impairing its efficiency. The committee's report was referred back for further consideration.

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Hammersmith.—At the Board of Guardians' meeting Messrs. Enright, the electrical engineers, wrote forwarding a copy of certificate granted by them to Messrs. Fryer and Co. as to the completion of their contract; also a letter giving particulars of further deductions from Messrs. Fryer's account. As to the "flex" fittings, about which so much was heard at the recent inquiry, they said that the substitution of tubular fittings would cost £700 extra, just the amount which the flex fittings cost. Had the tubular system been installed in the first place they would have accused of extravagance.

Dundee Harbour Board.—Sub-committees of Dundee Harbour Trust have had under consideration questions affecting the new electric station and the crane proposed to be erected at the Caledon shipyard. It was reported that the ground plans for the electric station had been arranged, and that the conveyance of the ground had been completed. A sketch was submitted showing the kind of crane the Caledon Shipbuilding Co. propose to erect on their jetty for fitting-out purposes. Objections were stated to it, and it was arranged that the engineer should have a consultation with members of the firm and report.

Thornbury.—Conditionally upon applications being received from a sufficient number of subscribers, the National Telephone Co. contemplate the opening of an exchange at Thornbury, Bradford. Complaint has been made that under the new regulations subscribers have to pay mileage on their wires a charge which amounts to £2 or £2. 10s. per instrument. With an exchange at Thornbury this charge would be escaped, and the company have intimated their willingness to establish an exchange provided that the number of subscribers warrants it. It is stated that the recent adoption of a lower rate for residences has already resulted in a considerable expansion of the company's business.

Ravensthorpe.—A commencement has been made, in accordance with the electric lighting order, for supplying the district within the prescribed area. The contractor is getting out the foundations for the sub-station, and the Yorkshire Electric Power Co. within the next few weeks will be laying their cable to the station. It is expected that Messrs. Garnett, of Bradford, will shortly start with the laying of the cable on the north side of Huddersfield-road from the Pioneers' Store towards Shepley Bridge, crossing over the roadway near Bradbury-street. The Yorkshire Electric Power Co. have given notice of their intention to lay a cable to the District Council sub-station now being built at the entrance to the park.

Twickenham.—At the last meeting of the District Council a memorial was presented, signed by 106 residents in the neighbourhood of the electric light works, complaining of the noise made by some of the machinery there. It was stated that night workers complained that their rest in the day was disturbed, and that it was disquieting and bad for health. The complaint had reference to the smaller machinery connected with the exhaust pipe. The petition had only been signed by people who lived there before the works were established. People who had gone there since were reckoned to have had the nuisance self-inflicted, else a great many more would have signed. The noise could be remedied, but that it was, as usual, a question of cost. The matter was referred to the Health Committee.

Limehouse.—The electric plant installed at Messrs. C. and J. Webb's factory, the contract consisting of the installation of 11 direct-current 480-volt motors, driving sewing, button-holing and bar-tacking machines for the manufacture of uniforms, etc., has just been carried out by the Electrical Engineering and Maintenance Co., of 49, Lime-street, E.C., in conjunction with Messrs. Jones's Sewing Machine Co., who contracted for the mechanical equipment and transmitters. The apparatus is of the very highest class, and the work has been carried out to the specification and under the personal supervision of Mr. T. Kerr-Jones, of 11, Victoria-street, S.W., the company's consulting engineer. It is in accordance with the new Home Office factory regulations. The adoption of electric driving has enabled the speed of the machines to be raised to three times the old value, and the perfectly steady running obtained has been found of great advantage. In consequence of the speeding up, the output of the factory has been enormously increased. Power is taken from the Stepney Borough Council's mains at 1d. per unit.

Wednesbury.—A Local Government Board inquiry in connection with the electricity undertaking was concluded on the 11th at the town hall by Mr. H. R. Hooper. The inquiry was into an application of the Corporation for sanction to borrow £10,000 for the purposes of laying down a complete plant for the generation of electricity. The town clerk explained that the Corporation considered the time had come when they should have their own electricity undertaking. They were at present taking their power from the Midland Power Co., but the mains belonged to the Corporation, and they now only had to install their own plant. Mr. Hayward, on behalf of the Midland Power Co., strongly opposed the application, urging that it would not pay the Corporation to generate their own electricity, and he further pointed out that in that case the present agreement between the company and the Corporation would be liable to be determined. The result of that would be that there would be three concerns which would have the power to supply electricity within the borough of Wednesbury—the Corporation, the Midland Power Co., and the Mond Gas Co. After a prolonged hearing, the inspector was accorded a vote of thanks.

Loughborough Exhibition.—An interesting exhibition of electrical appliances, lamps, etc., is being held at Loughborough, in Leicestershire, and is attracting a great deal of local attention. The Edison and Swan United Electric Light Co., of 35-37, Queen-street, E.C., write to say that, although they have not taken a stand there, they are showing in operation four of their new 10-ampere size white flame Ediswan-Carbone lamps, as well as two of their new enclosed arc, the "Radiant," which is also one of the white light type, although not a flame arc. In connection with the remarks made at a recent meeting of gas engineers by Mr. J. H. Canning, of Newport, in which he stated that flame arcs threw off poisonous fumes, became corroded by the volatilised salts condensing on the mechanism, burned costly carbons, and emitted a light of unpleasant hue, thus making four definite charges, the Ediswan Co. inform us, in reply, that their Ediswan-Carbone white flame type throw off no poisonous fumes, do not corrode, burn pure carbons of inexpensive nature, and give a light the spectrum of which is exactly similar to daylight. Obviously, Mr. Canning ought to visit the Ediswan showrooms and become acquainted with the latest thing in flame arcs.

Dowlais.—For some considerable time now the Dowlais Chamber of Trade have been urging upon the three railway companies which run into the town the great desirability, as a matter of convenience to the trading community and business men generally, that their respective goods stations should be connected by telephone. The Dowlais district served by the companies is very scattered, extending to Gellifaelog and Penydarren, so that a call in person or by messenger to inquire concerning the dispatch, arrival, delivery, or miscarriage of goods—perishable and otherwise—necessitated often a great loss of time when other means might be employed. As the outcome of the representations of the chamber, the Great Western Railway Co. have acceded to the request, and Mr. Henry Aldridge, Cardiff (district goods manager), in a letter received on Thursday, says: "I am pleased to be able to inform you it has been agreed for telephonic communication to be established with the Dowlais Station, Caeharris, and arrangements will be made for this to be done as early as possible." This concession will give widespread satisfaction, and it only now remains for the chamber to persist in their petition to the London and North-Western and Brecon and Merthyr Railway Companies, and prevail upon them to fall into line.

Dudley.—At the Town Council meeting, Councillor T. W. Tanfield moved that the Lighting Committee be asked to report to the Council on the best means of improving the lighting of the streets. His object, he said, was to improve the appearance of the town, and also to properly advertise the electrical undertaking and make it a success. In the Market-place the light at present was mostly diffused over the roofs of the buildings; in the main roads the light was given in patch-work. Either they ought to remove the electric light from the streets altogether or make it more efficient. He thought, however, that a thoroughly good system of electric lighting could be introduced at a slightly increased cost, and had expert opinion that the present arc lamps were not only obsolete in pattern, but nearly worn out. He advocated the adoption throughout the main thoroughfares of lamps of the class of which a specimen was now in use near the bank in the Market-place. The cost of the improvement he estimated at £90 a year, and he asked for the earliest attention to be given to the Stourbridge-road. Councillor T. Williams seconded, complaining of the frequency with which individual lamps were extinguished. Councillo E C. Theedam agreed that the committee should consider how an improvement might be effected, but thought it might be left to them to recommend a scheme. The motion was carried.

Morley.—The electricity department of the Corporation continues about stationary in respect of its deficit. This year the expenditure is £3,524. 7s. 11d., and the income £2.558. 2s. 9d., the deficit after transfer to the sinking fund being £966. 5s. 2d., whilst last year the expenditure was £3,367. 12s. 5d., the receipts were £2,411. 2s. 6d., and the deficit £956. 9s. 10½d. The cost of coal and cartage was £402. 0s. 4d.; oil, waste, water, etc., £105. 12s.; wages at the works, £308. 7s.; repairs to buildings, £11. 9s.; repairs to machinery, £101. 12s. 6d.; cost of distribution of electricity, £70. 12s. 2d.; attendance and renewal of public lamps, £101. 14s. 6d.; rents, rates, and taxes, £88. 8s; management, salaries of engineer, etc., £314. 1s. 11d.; insurance, lamps. sold, and work done on consumers' premises, £50. 8s. 7d. These items amount to a total of £1,554. 6s., but in addition there are—interest on loans, £986. 4s. 2d.; bank interest, £185. 17s.; and payment to sinking fund. £798. 0s. 9d., which brings the total expenditure, as stated, to £3,524. 7s. 11d. There was received by sale of current, after allowing discount, £1.894 12s. 3d., as compared with £1,768. 18s. 7d. last year, and other sources of income were—public lamps, £355; meter rentals, £103. 15s. 1d.; repairs of apparatus, repayment for wiring customers' premises and work done, etc., £54. 15s. 5d.; steam supplied to the baths, £150. The capital expended amounts to £29,060. 16s. 8½d., and the outstanding loans to £26 800.

Southampton.—At the last meeting of the Town Council the Electricity and Tramways Committee reported that the manager recorded that a serious accident occurred at the electricity works, Western Shore, during the afternoon on Bank Holiday, caused through their supply of condensing water being practically exhausted, due to having neap tides and a contrary wind, which kept the water low in the river. This had occurred several times before without serious accident. On this occasion, fortunately, there was no loss of life through the damaged pipes cracking instead of bursting. If the pipes in question had burst, the heavy pieces which would have been thrown about the engine-room would, of course, have killed anybody they happened to strike. He had reported to the committee several times before the danger they were running, and was sorry to say that what he foresaw had taken place, and he must ask them to give him permission to immediately complete the scheme of cooling troughs on the embankment, which had been deferred from time to time. Further, when the land outside the embankment was reclaimed, it would be necessaary to approach the Estates Committee to grant an additional strip, some 25ft. wide, so that extensions of the cooling troughs would be made possible as the station increased. He could not yet give the total cost of repairing the damage caused, but it would be a very considerable sum. The accident resulted in a delay to the tramway traffic of nearly 20 minutes, and that delay was minimised through the prompt action taken by the two engineers in charge and the engine driver who was on duty at the time. He thought something ought to be done as a mark of appreciation of

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their efforts, for the way they got the supply going under trying circumstances was exceptionally smart. It was resolved to refer the matter to the Electricity Sub-Committee, and also the subject of compensating the men, with power to act up to £10. The report was adopted.

Weymouth.—The borough electrical engineer has presented the following report to the Street and Works Committee: "In response to your request I herewith submit for your consideration a scheme whereby a more efficient and economical lighting of the borough may be anticipated. At the present time the public lighting (electric) is confined to 48 arc lamps, each equipped with one arc lamp and two incandescent lamps, 261 pillars or brackets, equipped thus: four each with four tantalum lamps, 24 each with two tantalum lamps, 15 each with one one-ampere Nernst lamp, 211 each with one ½-ampere Nernst lamp, seven each with one ¼-ampere Nernst. The clock tower with nine incandescent lamps. You paid for the year ending March 31, 1907, £1,907. 10s. 5d. under the existing scale of charge—*i.e.*, 3d. per unit for arc lamps and incandescents, and 3½d. per unit for Nernst and tantalum lamps. For the quarter ending June 30, 1907, the amount of electricity used on public lighting is considerably in excess of that used in the corresponding quarter last year, so that your expenditure for the current year is likely to amount to more than the figure given above (£1,907. 10s. 5d.). It would seem that if a fixed charge were made per lamp per annum you would be freed from the anxiety of estimating a variable expenditure for public lighting, and I have looked into the question with this in view. The scheme outlined below has been submitted to the Electricity Committee, and I am empowered by them to present the same for consideration. The proposals are as follows: (1) That the remaining 233 Nernst lamps be replaced by metallic-filament lamps, two of the latter for each of the former. This would give a greater gross illuminating power than at present. (2) That the existing incandescent lamps on the arc posts and in the clock tower be replaced by metallic-filament lamps, the number in the tower being reduced to five. An illumination of nearly double that now existing would be assured in the case of the arc posts. (3) That a uniform charge per annum be made as follows: for each arc post (arc lamp and two metallic filament), £16; for each pillar or bracket, £4; for the clock tower, £10; and that these charges be retrospective—*i.e.*, as and from March 31, 1907. (4) That, as a cost of over £100 will be incurred in making the necessary alterations, such cost be equally divided between the two committees. (5) That, whenever practicable, existing gas lamps be converted to electricity, so that as the mains are extended the public lighting (electric) is also extended. By so doing the cost of working will be lessened and further reduction made possible. (6) That the charges be reduced in March, 1908, per arc lamp to £15. 10s. per annum. If further reductions can be then made by the Electricity Committee in the cost of the other lamps, the Street Committee to have the benefit. In this way your expenditure for the current year will be (instead of, say, £2,000): 48 arc lamps at £16, £768; 261 pillars at £4, £1,044; clock tower at £10, £10—total, £1,882; proportion of cost, say £50—total cost to Street Committee, £1,872. The cost for the same number of lamps in the year 1908-9 would be reduced to a maximum of £1,800, and it is quite possible that an even less figure than this might be obtained. I would suggest that if this basis be accepted, the scale of charges per lamp might be revised after March in each year, as then the Electricity Committee would be in a position to estimate any reduction in cost of generation, etc. The time of lighting up to be half an hour after sunset, and for extinguishing half an hour before sunrise in the winter and one hour before sunrise in the summer. This will give a total number of burning hours of 3,844 per annum." The committee recommended the Council to adopt the report, and it has been agreed to.

PROVISIONAL PATENTS, 1907.

SEPT. 9.

20061. Electrical self-controlling pendulum. Walter Samuel Steljes, 6, Princess May-road, Stoke Newington, London.

20068. Improvements relating to electrical switches. John William Huntington, 9, Tempest Hey, Liverpool.

20095. Improvements in protective devices for alternating electric current circuits. Kenelm Edgcumbe and Edgar Isaac Everett, Collindale Works, Hendon, London.

20096. New or improved alarm device for electric tramcars. Johannes Stober, 53, Grabenstrasse, Essen-on-the-Ruhr, Germany.

20110. Improvements in switch and circuit breakers for high-potential circuits. Joseph Nelson Kelman, 18, Southampton-buildings, London.

20119. Improvements in transmitters for wireless telegraphy. Guglielmo Marconi and Marconi's Wireless Telegraph Company, Limited, 24, Southampton-buildings, London.

20128. Improvements relating to electric connections for multiple wireless telegraphy. Simon Eisenstein, 7, Southampton-buildings, London. (Complete specification.)

SEPT. 10.

20193. Improvements in and relating to tremblers for induction coils. Charles Anthony Vandervell, 1, Queen Victoria-street, London.

20201. Improvements in or relating to means for rotating or training searchlight projectors and for like purposes. Siemens Bros. Dynamo Works, Limited, and Ernest Akehurst Holmes, 139, Queen Victoria-street, London. (Complete specification.)

20202. Improvements in or relating to rotary converters. Siemens Bros. Dynamo Works, Limited, 139, Queen Victoria-street, London. (Siemens-Schuckertwerke, G. m. b. H., Germany.) (Complete specification.)

20203. Improvements in or relating to boosting arrangements for polyphase-current systems. Siemens Bros. Dynamo Works, Limited, 139, Queen Victoria-street, London. (Siemens-Schuckertwerke, G. m. b. H., Germany.) (Complete specification.)

20223. Improvements relating to the manufacture of filaments for electric incandescent lamps. "Z" Electric Lamp Syndicate, Limited, 111, Hatton garden, London. (Communicated from abroad.)

20226. Improvements in and relating to electromagnetic devices. Allgemeine Elektricitäts Ges., 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Sept. 12, 1906, being date of application in Germany.) (Complete specification.)

20227. Improvements in and in the manufacture of refractory bodies. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

20228. Improved method of and means for obtaining and manufacturing (?) constant temperatures. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

20229. Improvements in motor starters and regulating rheostats. Allgemeine Elektricitäts Ges., 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Sept. 12, 1906, being date of application in Germany.) (Complete specification.)

SEPT. 11.

20246. Improvements in or relating to electric motors, dynamos, and the like. Robert Hacking, Harry Hill, and Henry Walker Hill, 2, Church-gate, Nottingham.

20261. Contact breaker and placing of the condenser on a high-tension arc light magneto ignition, used for motorcars. August Lutz, 59, Glengall-road, Kilburn, London.

20300. Improvements in and relating to electric traction systems and apparatus therefor. Allgemeine Elektricitäts Ges., 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Sept. 12, 1906, being date of application in Germany.) (Complete specification.)

SEPT. 12.

20325. Improvements in or in connection with electrically-driven travelling pulley blocks. Sidney Harper Heywood, 3, Brown-street, Market-street, Manchester.

20332. Improvements relating to controllers and starting switches for electric motors. Veritys, Limited, and Arthur Edgar Gott, 11, Burlington-chambers, New-street, Birmingham.

20341. Improved wire connector for switchboards and the like. Wilhelm Multhauf, 61, Planufer, Berlin, Germany. (Complete specification.)

20347. Improvements in or relating to trembler induction coils. Stanley James Watson and George Herbert Smith, 306, High Holborn, London.

20348. Improved system or method of wiring multiple trembler induction coils. Stanley James Watson and George Herbert Smith, 306, High Holborn, London.

20361. Improvements in tremblers of induction coils. Boultbee Brooks and Frank Herbert Alston, 24, Temple-row, Birmingham.

20362. Improvements in or relating to electric accumulators. Boultbee Brooks and Frank Herbert Alston, 24, Temple-row, Birmingham.

20380. Improved electrical clock. Ferdinand Schneider, 116, High Holborn, London. (Complete specification.)

20397. Improvements in rheostatic electric controlling switches. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

20398. Improvements in and relating to coils for electrical use. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

SEPT. 13.

8173A. Improvements in and relating to inductor alternators. John Lewis Milton, 18, Southampton-buildings, London. (Date applied for under Rule 5 of the Patents Rules, 1905, April 8, 1907.) (Complete specification.)

20399. Improved liquid switch for the control of electric motors and other electric circuits. George Joseph Philpott and George Herbert Alderton, 41, Hamilton-road, Brighton.

20441. Improvements in vapour-electric apparatus. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

20451. Improved terminal connection for electric wires. Charles Mark Antonio Culverhouse and Frederick Victor Culverhouse, 321 High Holborn, London.

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20460. Improvements in or connected with vibrating electric contacts. John Andrew Jones Haslop, 40, Chancery-lane, London.

SEPT. 14.

20471. Improvements in or in connection with apparatus for electrically lighting miners' safety lamps. John Charles Best, 30, Park-row, Leeds.

20491. Improved electrode for secondary batteries. Eduard Heymann, 116, High Holborn, London. (Complete specification.)

20495. Improved means for governing the speed of alternating-current commutator machines. Henry Charles Edward Jacoby, 21, Finsbury-pavement, London.

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Oct. 3.)

1906.

18490. Systems of electric motor control. British Thomson-Houston Company. (General Electric Company.)

19951B. Plates and connectors for electric batteries. Sefton Jones. (Decker Electrical Manufacturing Company.) (Date applied for under Rule 5, Patents Rules, 1905, Sept. 7, 1906.)

20182. Electric burglar alarm systems. Prevette.

20234. Electric insulator stalks. Bloxam. (Goffin.)

20294. Electric incandescence lamps suitable for theatrical, decorative, and other purposes. Crawshaw and Affleck.

20464. Control of electric motors. British Thomson-Houston Company. (General Electric Company.)

21703. Dynamos for ignition purposes on motorcars. Fitch.

22221. Dynamo-electric machines. British Thomson-Houston Company. (General Electric Company.)

22700. Interlocking mechanism for enclosed electrical switches with removable contact plugs. Cox.

22808. Electric heaters. Leitner.

23011. Devices for controlling electric circuits, especially applicable to the control of electric motors. British Thomson-Houston Company. (General Electric Company.)

23107. Systems of electric distribution. British Thomson-Houston Company. (General Electric Company.)

23563. Dynamo-electric machines, more especially applicable to the regulation of said machines. British Thomson-Houston Company. (General Electric Company.)

23696. Signal systems for railways and the like. British Thomson-Houston Company. (General Electric Company.)

23742. Electrical time switches. Venner and Griesbach.

24995. Starting devices for electric motors. Kallmann.

25289. Method of electrical regulation. Bijur.

25770. Tremblers of induction coils. Electric Ignition Company and Hall.

28922. Intercommunication telephones and switches therefor. Bell.

29406. Electric contact devices. Kent. (Date applied for under International Convention, Dec. 26, 1905.)

1907.

28. Caps for electric lamps of variable luminosity. Harrison.

725. Electric measuring instruments. Nalder and Nalder Bros. and Thompson.

2019. Electric door contact for alarm bells and the like. Zinth.

3778. Electrically-operated vibrating plate sounders. Siemens Bros. and Co. (Siemens und Halske Akt.-Ges.)

3938. Manufacture of incandescent lamps with wolfram incandescent bodies. Consortium für Elektrochemische Industrie Ges. (Date applied for under International Convention, Feb. 21, 1906.)

4292. Electric switches. Electric and Ordnance Accessories Company, Hall, and Garner.

4340. Magnetic compasses. Laube.

4578. Apparatus for controlling electric currents. De Bremaecker.

4712. Signalling by electromagnetic waves. Fessenden.

4799. Wireless telegraphy. Poulsen.

5351. Receiving apparatus for wireless telegraphy. Pierce. (Date applied for under International Convention, March 16, 1906.)

5999. Electric alarm thermometer. Walther. (Date applied for under International Convention, Nov. 12, 1906.)

7637. Filaments for incandescent electric lamps. Lake. (Parker Clark Electric Company.)

8727. Method of telegraphically transmitting photographs and the like, and system therefor. Korn.

10518. Magnet boxes and armatures of magnets therein. Lanning.

13278. Electric circuit breaker. Larsson. (Date applied for under International Convention, June 7, 1906.)

16582. Controlling switches for electric trains. Siemens-Schuckertwerke Ges. (Date applied for under International Convention, July 28, 1906.)

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.

Name.	Amount paid.		Last price.
	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	—	½-⅝
—— Ord., 1 125,000	1	..	½-¼
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	5/32 9/32
British Aluminium Co., Ordinary, 2,001-40,000	5	..	4¾-5¼
—— 7 per cent. Cum. Pref., 1-40,000	5	..	5-5⅛
—— "A" 6 per cent. Cum. Pref., 1-20 000	5	..	4¾-5¼
—— 4 per cent. Funding Certificates, 1-20,000	5	..	3⅞ 4¼
—— 5 per cent. 1st Mort Deb. Stock, Red.	100	..	100-103
—— 5½ per cent Loch Leven Deb (Reg.), Red., 1-3,000	100	..	96-99
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6½ 7 xd
—— 6 per cent. Cum. Pref., 1-100,000	5	—	5⅞-6⅛
—— 4½ per cent. Mortgage Debentures	100	—	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	85 87
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	3	..	1-1½
—— 4 per cent. Mortgage Debenture Stock	100	—	60 65
Brush Electrical Engineering, Ordinary, Nos. 1-106,751	2	—	⅛-⅜
—— Non. Cum., 5 per cent. Pref.	2	—	⅛-1⅛
—— 4½ per cent. 1st Debenture Stock	100	—	85-86
—— 4½ per cent. 2nd Debenture Stock	100	—	68-71
Callender's Cable, Debentures	100	—	106-107½
—— Ordinary	5	—	9½-10⅜
—— 5 per cent. Pref.	5	..	5½-5⅝
Consolidated Electrical Co., Ordinary, 1-110,000	1	..	7/16-9/16
Crompton and Co.	5	..	1 13/16-2 1/16
—— 5 per cent. Debentures	100	—	86-99
Dick, Kerr, and Co., Ordinary, 1 260,000	1	..	1⅛-1⅜
—— 6 per cent. Cum. Pref., 1-305,000	1	..	1-1⅛
—— 4½ per cent. Debenture Stock, Red.	100	..	101-104
Edison and Swan United, "A" Shares, 1-99,261	3	..	1 1/16-1 5/16
—— "A" Shares, 01-017,139	5	—	2½-2⅝
—— 5 per cent. Debentures	100	—	84-92
—— 4 per cent. Deb. Stock, Red.	100	..	83 85
Electric Construction, Nos. 1 to 112,100	2	—	¼-⅜
—— 7 per cent. Cumulative Pref.	2	—	1⅛ 1⅜
—— 4 per cent. Perp. 1st Mort Deb.	100	—	77-81
Electrolytic Alkali Co., Ordinary, 1-202,218	1	..	¼-⅜
Ferranti Limited, 6 per cent. 1st Mort. Deb. Stock, Red.	100	..	—
General Electric Company (1900), 5 per cent. Cum. Pref.	10	—	8 8½
—— 4 per cent. 1st Mort. Deb. Stock	100	—	92-96
W. T. Henley's Telegraph Works, Ordinary	5	—	11½-12½
—— 4½ per cent. Preference	5	—	5-5⅛
—— 4½ per cent. Debentures	100	..	105½ 107½
India Rubber, Gutta Percha, and Telegraph Works	10	—	13¼ 14¼
—— 4 per cent. Debentures	100	—	97-99
National Electric Construction Co., 1-170,000	1	..	27/32-31/32
Parker, Thos., Limited, Ordinary	10	—	10-10½
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5	..	3½-4
Telegraph Construction and Maintenance	12	—	31-33
—— 5 per cent. Bonds	100	—	99½ 02½
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	..	9½-9⅝

Electric Lighting and Supply.—

Name.	Amount paid.		Last price.
	£		£
Adelaide Electric Supply Co., 6 p. c. Cum. Pref., 1-10,000	5	..	4½-5
Bournemouth and Poole, Ordinary	10	—	9⅜ 9⅝
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	—	9⅜ 10⅛
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	—	9½ 10⅜
—— 4½ per cent. Debenture Stock, Red.	100	—	99 102
Bromley (Kent) Electric Light and Power Co.	5	—	4⅜ 4½
—— 4½ per cent. 1st Debenture Stock, Red.	100	—	98 100
Brompton and Kensington, Ordinary	5	—	7½ 8¼
—— 7 per cent. Preference	5	—	7½ 8¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	—	6⅜ 7⅜
—— Nos. 80,001-100,000	4	—	6½ 7½
Cambridge Electric Supply Company, £10 Ord.	8	—	12⅝-13⅜
Canadian General Electric Co., Common Shares	$100	..	117-121
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	—	99 102
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	—	3½ 4
—— 4½ per cent. Cum. Pref., 1-80,000	5	—	3½ 4
—— 4 per cent. Debenture Stock, Red.	100	—	98 99
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	—	3⅜ 3⅝
—— ditto (1905) 40,001-80,000	5	—	3-4 xd
Chelsea Electricity Supply	5	—	3½ 4½
—— 4½ per cent. Debentures	100	—	103-105
Chicago Edison Co., 1st Mt. 5 p. c. 30-yr. Gld. Bds., Red., 1-1,200	$1000	..	96-99 xd
City of London, Ordinary	10	—	9- 0
—— 6 per cent. Cumulative Pref.	10	—	10½-11½
—— 5 per cent. Debenture Stock	100	—	122-126
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	—	97-100
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1,653	50	—	50-53
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100	..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-70,000	5	..	4½-5
—— 5 per cent. Preference, 1-50,000	5	..	4½-5
County of London Electric Supply, Ordinary	10	—	6⅞-7⅜
—— 6 per cent. Cum. Pref.	10	—	10-11
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100	—	106-109
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	—	94-97
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5	—	½-1
—— 6 per cent. Cum. Pref.	5	—	1½-2
—— 4½ per cent. First Mort. Deb	100	—	76-81
Electrical Development Co. of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, 10,751-15,75[illegible]	—	..	74½-76½ p.c.
Electric Lt. & Traction Co of Aust., 6 p.c Cm Pf., 1 30,000	5	—	2½-2⅝
5 per cent Debenture Stock Red	100	—	85½ 89½
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red.	100	—	94-96
Folkestone Electric Supply, Ord. Nos. 1-10,000	5	—	4⅜-5½
—— 4½ per cent. First Deb. Stock, Red.	100	—	96-99
Hove Electric Lighting, Ord., 1-13,000	5	—	6⅜-7½
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100	—	102-105
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk. Red.	100	—	94-97
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	—	—
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5	—	8½-9½
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	—	94-97
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9⅜-10½
London Electric, Ordinary	3	—	1⅜-1⅝
—— 6 per cent. Pref.	5	—	4¼-4⅞
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	88-92

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Name.	Amount paid. £		Last price £
Madras Electric Supply Corporation, 5 per cent. Construction Deb. Stock., Red. (Prov. Certs.), all paid	100	.	94-97
Metropolitan Ordinary, 100,001-300,000	5	..	4⅜ 5⅛
—— 4½ per cent. First Mortgage Debenture Stock	100	..	105 107
—— 4½ per cent. Cum. Pref.	5	..	4⅜ 5⅛
—— 3½ per cent. Mortgage Debenture, Red.	100	..	87 89
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds. 1935, C 1-1,000 ($100), D 1-5,000 ($500), M 1-4,400 ($1,000	—	..	72-74 p.c
Mexican Light and Power Co., Capital Stock	$100	..	94 96
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14,000 ($1,000)	—	..	81-83½
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	..	85-86
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,000	5	..	6¼ 6⅜
—— do., 57,001-75,000	5	..	6¼ 6⅜
—— do., 75,001-87,500 (issued at £2 prem., 10s. paid)	5	..	6¼ 6⅜
—— 5 per cent. Pref., 1-57,000	5	..	5 5⅛
—— do., 75,001-87,500 (issued at 10s. prem., 4s. paid)	5	..	5-5⅛
Notting Hill Electric Lighting	10	..	11 12
—— 7 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	..	5 5 7
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	..	5⅛ 6⅛ ad
—— 5 per cent. Debenture Stock	100	..	95 97
River Plate Electricity Co., Ord., 1-119,687 & 120,501-120,507	1	..	⅛ ⅜
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	..	⅛ ⅛
—— 4 per cent. Debenture Stock, Red.	100	..	85-88
Rosario Electric Co., 6 per cent. Cum Pref., 1-20,000	5	..	5-5⅛
—— 6 per cent. Cum. 2nd Pref., 1-15,000	5	..	5-5⅛
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	.	96 98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	—	..	99 101 p.c.
Smithfield Markets Electric Supply, Ord. 1-12,000	5	..	⅛-1⅛
—— 4 per cent. Debenture Stock	100	..	7 75
South London, Ordinary	5	..	1⅛ ⅛
South Metropolitan Belgrave Light and Power, Ord.	1	..	⅛ ⅜
—— 7 per cent. Cum. Pref.	1	..	1-1⅛
—— 4½ per cent. 1st Mort. Deb.	100	..	100-103
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	7 8⅜
—— 7 per cent. Pref.	5	..	6⅜ 7⅜
—— 3½ per cent. Deb.	100	..	86 91
Urban Electric Supply Co., Ordinary, 8-30-007	5	..	1⅛ 2⅛
—— 5 per cent. Cumulative Preference, 50,001-60,000	5	..	4 5
Westminster, Ordinary	5	..	8⅛ 9⅛
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	..	5-5⅛

Electric Tramways.—

Name.	Amount paid. £		Last price. £
Anglo-Argentine, 5½ per cent. Cum. Pref., 1-260,007	5	..	5 15/16 6 3/16
—— Ord.	5	..	8⅛ 8⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100	..	101 104
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	..	102-105
Barcelona Tramways, Ord., 1-20,000	10	..	—
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	..	—
—— 5 per cent. Deb., Red., 1-600	100	..	—
—— 4½ per cent. Red. Deb. Stock	100	..	—
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,000	1	..	⅜ ½
—— 5 per cent. Cum. Pref. Shares, 1-59,364	1	..	27/32-31/32
Birmingham and Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100	..	94-97
Blackpool and Fleetwood Tramroad	10	..	13⅜ 13⅝
Bombay Elec. Supply & Trams. Co., 6 per cent. Cum. Pref.	8	..	7⅛-8
—— 4½ per cent. Deb Stock, Red.	100	..	94-96
Brisbane Tramway Invest., Ord., 1-75,000	5	..	4¼ 4⅜
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	..	4⅝-5⅛
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	..	96 100
British Columbia Electric Railway Co., Ord. Def.	100	..	107-112
—— Ord. Pref.	100	..	111-115
—— 5 per cent. Cum. Perpetual Pref. Stock	100	..	104-107
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	..	100 103
—— 4½ per cent. Vancouver Power Deb.	100	..	102 104
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	..	2⅛ 2⅜
—— 6 per cent. Cm. Pf., 30,001-60,000	10	..	6⅛ 6⅜
—— 5 per cent. Perpetual Debenture Stock	100	..	100 103
—— 4½ per cent. 2nd Deb. Stock	100	..	78 81
Brown's Ayres and Belgrano Trams.	5	..	4⅜ 4⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	..	4⅜ 4⅝
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	4⅜ 4⅝
—— 5 per cent. Deb. Stock, Red.	100	..	105-115
—— Prov. Cert., all paid	100	..	100 103
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100	..	92-97
Buenos Ayres Gl. Nat. Trams Co., 5½ per cent. Pref. Deb. Bonds, Red., 1-1,500	100	..	99- 03
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	..	100-105
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red	100	..	91-94
Calcutta Tramways, 1-105,000	5	..	7¼ 7⅜
—— 105,001-137,510	5	..	5 5⅛
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	102 106
Cape Electric Tramways, Nos. 1-480,000	1	..	5/16 7/16
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	..	4¼ 4⅜
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100	..	98 101
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	..	5¼-5⅜
—— 4 per cent. Deb. Stock, Red. 1985	100	..	97 101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	90	..	94 98
Cork Electric Tramway and Lighting Co., Ordinary	10	..	13 14
—— 6 per cent. Cum. Pref.	10	..	12⅜ 12⅝
—— 4 per cent. Debentures	100	..	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	..	3- 4
—— 6 per cent. Pref., Nos. within 1-60,000	10	..	12⅜ 13⅜
—— 5 per cent. Mort. Debs., 1-3,000 Red.	100	..	93 97
Hastings and Dist Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100	..	98-101
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6,957	$1,000	..	82 87
Imperial Tramways, Ordinary	all	..	18-19
—— 6 per cent. Cum. Pref.	all	..	14-14½
—— 4½ per cent. Deb. Stock	100	..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5	..	1 1⅛
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	66 71
Kalgoorlie Electric Tramways, 1-250,000	1	..	5/32-5/32
—— 5 per cent. "A" Deb. Stock	100	..	89-93
—— 6 per cent. "B" Deb. Stock	100	..	78-82
Kidderminster and District Lighting and Traction, Pref.	5	..	9⅜-10⅛
Lancashire United Tramways Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	..	94-97
—— £296,500 2nd Mort. Deb Stock	—	..	—
—— £83,330 Deferred Deb. Stock (all fully paid)	—	..	—
Lisbon Electric Tramways Limited, Ord., Nos. 1-594,188	1	..	1-1⅛
—— 6 per cent. Cum. Pref., Nos. 1-425,553	1	..	1-1⅛
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100	..	95 98
London United Trys. (1901), 5 per cent. Cum. Pref.	10	..	7⅜ 8⅜
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	82 86
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Red.	100	..	96-9

Name.	Amount paid. £		Last price £
Manila Elec. R. R. and Lghtg. Corp., 5 p.c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000	..	90-92
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,625 and 23,436-25,000	5	..	4⅝-5⅛
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	97-100
Metropolitan Elec. Trams., Defd., 1,000,001-1,214,000	1	..	3/32 5/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	..	27 32-31 32
—— 4½ per cent. Deb. Stock, Red.	100	..	84 87
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	—	..	79-81 p.c.
Milwaukee Electric Rail and Light, 5 per cent. Con. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	..	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., (1922	100	..	101-103
New General Traction, 6 per cent. Cum. Pref., 1-10,000	5	..	⅜-⅝
34,001-74,000	10	..	⅛ ⅜
Oldham, Ashton, and Hyde Tramway, Ordinary	10	..	8⅜-9
—— 5 per cent. Cum. Pref.	100	..	100 104
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mtg. Deb.	1	..	5/16-9/16
Potteries Electric Traction, Ordinary, 1-545,000	1	..	⅛ ⅜
—— 5 per cent. Cum. Pref., 300,001-345,000	100	..	85-88
—— 4½ per cent. Debenture Stock	10	..	4⅜-5
Provincial Tramways Co., Ordinary, 1-24,912	10	..	10⅛-11⅛
—— 6 per cent Cum. Pref., 1-50,000	5	..	5⅛-5⅜
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-30,000	100	..	97-99
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	115-120
Sao Paulo Tramway Light, and Power Co.	$100	..	82-84 p.c.
—— 5 per cent. 1st Mort. Deb., Red 1929 1-11,000	$500	..	5/16-7/16
South Metropolitan Electric Tramways and Lighting Co., 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1	..	⅛-⅛
—— 4 per cent. Deb. Stock, Red. 1940	100	..	80-84
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs., Red., 1-1,600	100	..	84-88
Yorkshire (West Riding) Elec. Tram. Co., Ord., 70,001-100,000	5	..	1-1⅛
—— 6 per cent. Cum. Pref., 1-46,261	5	..	3⅛-3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	87-90

Electric Railways.—

Name	Amount paid. £		Last price £
Central London, Ordinary	100	..	87 89
—— 4 per cent. Pref.	100	..	89-91
—— " " deferred	100	..	51-53
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	..	102-105
City and South London, Consolidated Ordinary	100	..	45-47
—— 4 per cent. Debenture Stock	100	..	102-105
—— 5 per cent. Pref. Stock '91	100	..	115-118
—— " " " " '96	100	..	113-116
—— " " " " '01	100	..	113-116
—— " " " " '03	100	..	108-111
Liverpool Overhead, 5 per cent. Pref.	10	..	10-10⅛
—— Ordinary, 1-50,000	10	..	3⅜-4⅛
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	..	94-96
Underground Electric Railways of London, 5 per cent. Profit-sharing Secured Notes	—	..	55 58

Telegraphs and Telephones.—

Name.	Amount paid. £		Last price. £
Amazon Telegraph Co., 1-25,000	10	..	3-3⅛
—— 5 per cent. Debs., Red., within 1-1,069	100	..	85-88
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000	$1,000	..	90-92
Anglo-American Telegraph Co., Ordinary	100	..	60-63
—— 6 per cent Preferred Ordinary	100	...	104½-105½
—— Deferred Ordinary	100	...	17⅜ 18½
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort Deb. Stock, Red.	100	...	93-102
Chili Telephone Co., 1-44,000	5	...	6⅜-7⅛
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100	...	91½-92½
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	...	6½-7⅛
—— 10 per cent. Preference, 1-6,000	10	...	15⅜-16⅜
Direct Spanish Telegraph Co., Ordinary	5	...	3⅜-3⅝
—— 10 per cent. Cum Preference	5	...	9-9½
—— 4½ per cent. Debs., 1-600	50	...	98-101
Direct United States Cable Co.	20	...	14⅛-14⅜
Direct West India Cable Co., 4½ per cent. Debs., Reg. within 1-1,200, Red.	100	...	100-102
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100	...	97½-100½
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8,000, 1913	25	...	100 102
Eastern Extension, Australasia and China, 1-300,000	10	...	11⅜-12⅛
—— 4 per cent Mort. Deb. Stock, Perp.	100	...	102-104
Eastern Telegraph Co., Ordinary Stock	100	...	132-137
—— 3½ per cent. Preference Stock	100	...	86-88
—— 4 per cent. Mortgage Debenture Stock	100	...	103-105
Great Northern Telegraph Co. (of Copenhagen)	10	...	34-36
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1,200, Red.	100	...	100-102
Indo-European Telegraph Co.	25	...	55-57
Marconi's Wireless Telegraph Co., 1-256,127	1	...	⅜-½
—— 256,128-384,190	1	...	⅜-½
Monte Video Telephone Co., Ordinary, 1-72,680	1	..	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492	—	...	1-1
National Telephone, Preferred	100	...	104-108
—— Deferred Stock	100	..	105½-107½
—— 6 per cent. Cum. First Pref.	10	..	11-13
—— 6 per cent. Cum. Second Pref.	10	..	10-12
—— 5 per cent. Non. Cum. Third Pref.	5	..	4⅛-4½
—— 3½ per cent. Deb. Stock, Red.	100	..	86-88
—— 4 per cent Deb. Stock, Red.	100	..	101-103
Oriental Telephone and Electric Company	1	..	⅜-⅞
—— 6 per cent. Cum. Pref.	1	..	13/16-15/16
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100	...	97-100
United River Plate Tele. Co., Ordinary, 1-100,000	5	...	7-8
—— 5 per cent. Cum. Pref., 1-40,000	5	...	5-5⅛
—— 5 per cent. Debenture Stock, Red.	100	...	—
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	...	98-101
West African Telegraph Co.	10	...	10-10½
West Coast of America, 1-30,000 and 53,001-53,008	2½	...	14-15
—— 4 p.c. Debs., 1-1,500, Guar. by Western Telegraph	100	...	97-100
West India and Panama Telegraph Co., Ordinary	10	...	7/16 9/16
—— 6 per cent. Cum 1st Preference	10	...	7⅛-7⅜
—— 6 per cent. Cum. 2nd Preference	10	...	6⅛-6⅜
—— 5 per cent. Debs., Red., 1-800	100	...	99-102
Western Telegraph Co., 1-207,930	10	...	12⅛-12⅜
—— 4 per cent. Debenture Stock, Red.	100	...	100-103

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open		Accounts for past year.							Cost per car mile.
	Ending	1907.	1906	Week.	Current year.	1907.	1906.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Passenger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Sept 11	1,881	1,723	- 144	—	25½	25	May 31	64,071	15,530,351	1,379,723	0 98	11·14	2,512	6·45
Ayr Corporation	,, 14	324	329	- 5	—	8	8	,, 15	14,228	3 316,380	353,945	1	9·71	1,830	5·16
Baker Street and Waterloo Ry.	,, 14	2 155	1,610	+ 615	+ 10 240	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 15	1,1 6	1,045	+ 71	- 4:0	3553	3553	March 31	55,025	11,145,531	1,309 903	1·18	10·08	2,338b	6·03
Birmingham Corporation	,, 14	5 274	—	—	—	56	—	,, 31	17,173	4,709,768	266,526	·86	14·5	8 866	—
Blackburn Corporation	,, 11	1,430	1,189	+ 241	+ 1,412	21	21	,, 25	48,875	8,661,720	986,953	1·35	11·29	2,036	7·44
Blackpool Corporation	,, 12	2 780	2 099	+ 681	- 2 074	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	,, 14	1,575	1,257	+ 3 9	- 1,055	16½	6½	Dec. 31	31,846	2,525,677	579,264	3·28	13 19	—	7·27
Bolton Corporation	,, 15	2 381	2,096	+ 285	+ 3 138	42	40	March 31	95 766	20,205 196	2,161,130	1·13	10·63	2 394	6·14
Bournemouth Corporation	,, 11	2,351	2,234	+ 118	+ 676	17·41	16 82	,, 31	55,276	11,058,288	1,121,623	1·32	11·83	3 226	7·19
Bradford Corporation	,, 14	4,865	4 519	+ 346	+ 630	95	95	,, 31	230,085	47 1 8,000	5,053,392	1·172	10 ·27	2,396	—
Brighton Corporation	,, 15	1,167	1,140	+ 27	- 2,724	9½	9½	,, 31	60,339	11 321,160	1,152,828	1·06	10·48	2,914·8	8·0·4
Bristol Tramway Company	,, 12	5 512	5 580	- 38	—	51½	51½	Dec. 31	259 799	55,312,373	6 127,135	—	—	—	—
Burnley Corporation	,, 14	1,554	1 195	+ 359	—	40	40	March 31	87,942	11,092,704	1,197,772	1·31	11·61	5,388	8·17
Burton Corporation	,, 12	281	288	- 7	- 371	8½	8½	,, 31	17 950	3,678,269	454,082	1·07	9·21	2,068	6·76
Cardiff Corporation	—	—	—	—	—	32 62	32·26	,, 31	112,209	24,134,363	2,770,049	1·12	9·72	3,782	9·44
Carlisle Tramways Company	,, 7	193	229	- 36	- 605	8·5	8·5	Dec 31	10 713	2,935 002	359,756	—	7 14	—	5.18
Central London Railway	,, 14	4,163	5,871	- 1,203	- 7,056	6	6	,, 31	347,588	4,675,547	1,281,214	1·86	65·10	57,931	35·80
Charing X, Euston, & Hamp. Ry.	,, 14	2,455	—	—	—	8	—	—	—	—	—	—	—		—
City and South London Railway	,, 15	3,144	2 997	+ 147	+ 6,434	6½	6½	,, 31	—	—	—	—	—		—
Colchester Corporation	May 8	195	195	—	—	8	8	March 31	10,788	2 457,653	220,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	Sept. 12	535	556	- 31	- 770	15½	15½	Dec 31	24,895	5,814,376	882,256	1·01	6·64	—	4·69
Croydon Corporation	,, 13	1 562	—	—	—	12 c	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 13	335	301	+ 35	- 17	7 23	7·23	March 3	—	—	—	—			
Dover Corporation	,, 14	232	238	- 15	- 9.0	4½	4½	,, 31	11 250	2 853,200	284,343	·94	9·49	2,500	
Dublin and Lucan Electric Ry.	,, 13	160	143	+ 17	+ 126h	6½	6½	Dec 31	6 358	402,611	110,738	3·79	13·78	942	7 33
Dublin U.T.	,, 15	7 381	5,367	+2,014	+ 18 464	48½	48½	,, 31	267,489	50,050,949	7,077,372	1·18	9·07	691	5·55
Dundee City Tramways	,, 11	1,217	1,164	+ 53	+ 411	23	23	May 15	59 154	13 086 396	1,005 911	·906	11·96	2,180	7·42
East Ham Corporation	,, 14	967	925	+ 34	- 442	14	14	March 31	38,652	3,689,658	863,816	·64	10 18	2 994	6 79
Glasgow Corporation	,, 14	18,741	17,727	+ 1,017	+ 4 038h	79½	73½	May 31	756 490	195,767,519	17,946 595	—	10·12	—	—
Gloucester Corporation	July 10	278	304	- 26	—	15	15	March 31	15,465	3,902,077	563,595	·60	6·58	999	5·32
G.N., Piccadilly, and Brompton	Sept 14	3 805	—	—	—	9	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	37	37	,, 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 14	1 765	1,505	+ 160	+ 1,874	35	35	,, 31	62,938	12 838,150	1,665,262	1·24	9·71	1,923	—
Hull Corporation	,, 14	2,418	2,279	+ 139	+ 2,954	26	26	,, 31	112,651	27,104,921	2,910,688	1	9 29	—	—
Ilford Corporation	—	—	—	—	—	10½	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 11	151	147	+ 3	+ 165	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	11,586	3,626,656	419,800	·727	6 62	1,480	5·22
Lancashire United Tramways	,, 11	1,536	1,038	+ 498	+ 1 844	39½	28	—	—	—	—	—	—	—	—
Leeds Corporation	,, 14	7,011	6 495	+ 5 6	+ 6,212	89½	89½	March 25	298,233	64,223 666	7,121,038	1 10	10·02	351	—
Leicester Corporation	,, 14	2,264	2 213	+ 51	—	42	42	Dec. 31	26,011	12 039,252	1,229,507	1	9·79	—	4 82
Liverpool Corporation	,, 7	11,267	11 3·8	81	+ 6 813	104	104	,, 31	547 625	116,642 663	12.166 419	—	—	—	—
Liverpool Overhead Railway	,, 15	1,540	1,433	+ 107	+ 1,135h	6 65	6 65	June 30	81,302	11 171,865	1,024,275	—	—	—	—
London County Council	Aug. 31	31 917	26,568	+5,349	+108 471	93	98	—	—	—	—	—	—	—	—
Lowestoft Corporation	—	—	—	—	—	6	6	Sept. 30	14,511	3,128,857	359,435	1 08	9 68	2 630	6·48
Maidstone Corporation	—	—	—	—	—	2	2	March 31	4,740	850 121	112,227	1 33	10 13	2,370	
Manchester Corporation	Sept 14	15,787	14 240	+1,657	+ 26 534	149	119	,, 31	631,966	125,900 875	14,123,124	1 19	10 73	4,289	6 99
Metropolitan District Railway	,, 16	6,981	7 377	- 396	+ 65	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 15	14,661	14 450	+ 211	+ 1,641	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 14	193	147	+ 76	+ 67	2½	2½	,, 31	6 159	1,992,647	206,358	82	7 14	2,239	—
Newcastle-on-Tyne Corporation	,, 14	4 055	4,020	+ 35	+ 399	50	50	,, 31	197 849	45,76 934	4,326,152	1 07	0 98	3,957	7·0
Newport (Mon.) Corporation	June 29	639	628	+ 11	+ 1,197	15½	15½	,, 31	30.356	7 252 535	783 435	—	9 29	—	6·4
Oldham Corporation	—	—	—	—	—	34	34	,, 25	65 553	15,465,245	1,504,740	1 16	10 45	1,885	—
Portsmouth Corporation	May 25	2,330	1 578	+ 752	+ 632	23½	28½	,, 31	95,702	19 625,329	197,499	1·17	11 63	—	—
Reading Corporation	Sept. 12	692	719	- 28	- 704	33½	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	11·29	21·29	,, 31	14,881	2 837,110	386,547	1·24	9·24	1,102	7 92
Rotherham Corporation	—	—	—	—	—	9½	9½	,, 31	25 554	5 251,472	593,054	1 07	9 53	2,612	7·49
Salford Corporation	,, 15	4 8 4	4,105	+ 4·8	+ 2 983	70¾	70¾	,, 31	214.111	39 213 560	4,894,590	1 28	10 29	—	—
Scarborough Tramways Co.	—	—	—	—	—	4½	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 15	5 620	5,243	+ 387	+ 5 963	35½	35½	,, 25	240.5 5	63 962 283	,049,899	903	9 543	3,653	6 477
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,365	9 294,771	1,108,369	1·27	11·02	—	7·83
Southend-on-Sea Corporation	,, 11	513	596	+ 17	- 3 8	9	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	,, 31	39,550	6,766,031	1,027 730	—	9 23	—	4 75
Sunderland Corporation	,, 15	1,479	1,385	+ 85	- 462	20	20	,, 31	64,858	15 364 463	1 495,785	1·004	10·36	—	6·37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	4,937	1,315,757	102,761	0·87	11 53	1,371	—
Torquay Tramways	Sept 12	320	—	—	—	5 16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 14	952	852	+ 100	+ 438	13 68	13·43	,, 31	43,607	7,995,451	862,12	9·27	12·14	3,132	7·89
Warrington Corporation	—	—	—	—	—	9	9	,, 31	17,0 7	4 418 225	4 3 363	—	9 85	—	6·33
West Ham Corporation	,, 12	2,412	2,339	+ 73	+ 1,173	14·7	14 7	,, 31	—	15,773 742	1,237,165	—	—	—	—
Wolverhampton Corporation	,, 11	332	321	+ 3	+ 251	20	20	,, 31	41,905	8 847,066	950,338	—	10 583	2,062	6·15

f And 98 miles of interlacing track. g Train mile. h Per mile of single track. c Miles of route. k Half-year's figures. l Double track.

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NOTES.

Radium.—A Swiss paper is responsible for an interesting statement as to the discovery of radium deposits in the Simplon Tunnel. It is said that Prof. Joly, while making a geological examination of the stones, debris and strata extracted from the centre of the Simplon Tunnel, discovered deposits of radium richer than any yet met with in Europe. Should the presence of this substance be confirmed by the later researches which Prof. Joly is to make, it may give some explanation of the abnormal heat experienced during the construction of the tunnel.

Transatlantic Wireless Telegrams.—Mr. Marconi, who arrived in New York on Monday last, told an interviewer that he intended to remain in the States until wireless communication with Europe had been established on a commercial basis. He is reported to have said that all obstacles had been finally overcome, and that when the preliminary trials, which would be held during the next three weeks, were finished, the Transatlantic service would be thrown open for regular business. It is noteworthy that the cable companies intend to reduce their rates as soon as the transoceanic wireless system is in operation.

Wireless Telegraphy on the Pacific. — The *Electrical World* states that arrangements have been completed whereby the U.S. War and Navy Departments will co-operate in the maintenance of wireless communication between Nome, St. Michael, Seattle, and San Francisco. The signal corps of the army already has wireless stations at Nome and St. Michael, and next year will establish a station at Fort Gibbon. The latter station will be capable of communication with the navy wireless station to be erected at Valdez. The navy already has stations at Sitka and 800 miles from Valdez, at Tatoosh Island, about 100 miles from Sitka, and at North Head, Table Bluff, and Cape Blanco. The distance between the three latter stations varies from 175 to 300 miles. Stations are to be established by the army this autumn at Fairbanks and Circle City, and a land line is to be built from Tacoma to McCurdy. The War and Navy Departments have suffered considerable inconvenience since the telegraphists' strike began, and the utility of wireless telegraphy is becoming better appreciated. The army cableship "Burnside" is now in Alaskan waters making cable repairs. The cable between Sitka and Valdez may be diverted to Montague Island and pieces spliced in at that place at Katalla, which may become a railroad terminus.

American Patent Infringement.—The United States Circuit Court for the district of New Jersey has just filed an opinion in the suit of the Westinghouse Electric and Manufacturing Company, Pittsburg, against the Prudential Insurance Company of America, charging the latter with the infringement of the Nolan patent No. 582,481 in the generator manufactured by the Bullock Electric Manufacturing Company, of Cincinnati, O. The Nolan patent relates to a very simple, inexpensive, and efficient means of fastening together the laminæ of the cores of electrical machines and to the casting by which they are supported, and whereby the armature can be readily taken apart and put together. The laminæ are clamped between a cylindrical flange at one end of the casting and a ring fitting over the other end of the casting. This ring is held in place by a small fastening ring interposed between it and a small shoulder on the casting. A shoulder is provided upon the outer face of the clamping ring for holding the small ring from flying outward. This is generally termed the spring-ring method of clamping armature laminæ Judge Lanning held that claims 2 and 4 of the Nolan patent were valid, and covered the construction found in the Bullock generator used by the Prudential Company, the construction being a substantial copy of that shown in the Nolan patent and that used by the Westinghouse Company.

Stutterheim Lighting.—New countries require new conditions, and it is interesting to note how often in matters of business undeveloped countries have to find some substitutes for coins of the realm. Thus, when the Canadian Pacific was made the company took in payment, or as an inducement to build the line, a considerable portion of the undeveloped land opened out by the railway. Now we notice, from a cutting of the *East London Dispatch*, that the township of Stutterheim is adopting somewhat similar proceedings. This town is about 50 miles from East London, South Africa, and is at the eastern base of the Amatola Mountains, in the midst of a rich pastural district. The notice is to the effect that the Council of Stutterheim intend applying to his Excellency the Governor for permission to lease for a term of not more than 21 years certain pieces of commonage land, the rent of same to be applied to paying the interest on a loan of £3,000, to be raised for the purpose of installing the electric light in the town of Stutterheim. Our readers will hardly be interested in the description of boundaries of the six pieces of land which are to be let, but the total area of the same is over 900 acres. Unless objections were lodged to this procedure, the land in question will guarantee the electric lighting of the rest of the township. The Town Council of Uitenhage have accepted the offer of the Bellad Ellis Company to lay down at their own cost a plant to light the streets by electricity for £825 per annum; the Council to have the right of purchase at a future date. Private consumers are to be supplied at a fixed rate. Uitenhage is about 20 miles from Port Elizabeth, and has a population of about 7,000. The railway workshops are situated in the town, and employ over 500 men when in full work.

London and the Surface-Contact System.—The London County Council's intention to electrify that portion of their tramway system between Bow Bridge and Commercial-road, in the borough of Stepney, on the "G.-B." surface-contact system is not to be allowed to be given effect to without the neighbouring authorities owning tramways having a say in the matter. Among these there exists the opinion that in the event of the London County Council taking action as proposed a most serious obstacle would be placed in the way of through running over this portion of the London system and the extra-metropolitan tramway systems of West Ham, East Ham, Leyton, Walthamstow, Ilford, and Barking, by reason of the fact that, London having already installed the conduit system on the portion of their Aldgate and Bow line west of Commercial-road, any cars running over the various tramway systems must be electrically equipped for the conduit, "G.-B. contact," and trolley system. But the cost of so fitting the cars should be a comparatively small one, and should not constitute an obstacle in the way of intercommunication. Moreover, the London County Council were practically forced into adopting the surface contact system through the persistent refusal of the Stepney Borough Council to agree to the adoption of the overhead trolley system within their area, and also owing to the physical difficulty of installing the conduit system in Bow-road and Mile End-road by reason of the close proximity of the crown of the tunnels of the Whitechapel and Bow Railway to the surface of these roads. The local authorities seem ever on the lookout for an opportunity of making the passing of many of the London County Council schemes a

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difficult matter, but in their opposition to the surface-contact system there is neither wisdom nor reason.

Lighting in Portuguese West Africa.—Angola, one of the most important of Portugal's possessions in West Africa, promises to become an important field for the exploitation of the electrical engineer, especially for lighting, for the principal towns are contemplating the introduction of electricity. A concession was granted in 1906 to an Italian engineer for the lighting of Benguella, Catumbella, and Lobito with electricity. The number of lamps for the respective towns were fixed at 1,000, 300, and 100 for the first year, for which payment was to be made at the rate of £2. 15s. 6d. per lamp, the municipalities retaining the right to increase or decrease the number after the expiration of that period. The vice-consul at Benguella reports that a British syndicate has taken over the concession. The motive power is to be derived from the Catumbella River at a point four miles above the town of that name. The British consul writes that Loanda is at present badly lit by petroleum lamps, and that the municipality are negotiating in Paris for a loan to cover the cost of electrical installation. It is proposed to place the order for the necessary plant with a Paris firm of electrical engineers in the event of the loan being granted. The present primitive arrangements for lighting the town have been in existence since 1900, when the gas company suspended operations in view of the unexpected rise in the price of coal and the refusal of the municipality to allow a corresponding rise in the rates of payment stipulated in the contract. The municipality paid at the rate of 9s. 8½d. per 1,000 cubic feet, whereas the company estimated that gas could not be produced at a profit under 15s. 1½d. per 1,000 cubic feet with a daily consumption of three tons of coal at £2. 5s. per ton.

Rubber.—A new company has just been formed to acquire from the Karak Rubber Syndicate 2,000 acres of land in the Bentong district of the State of Pahang, which have held on a lease in perpetuity from the Resident-General of the Federated Malay States. The company propose to develop the property by planting 1,000 acres with rubber (Hevea Braziliensis) during the next three years. One hundred acres have been felled and will be planted by the end of the current year, and it is proposed to complete the 1,000 acres by annual extensions of 300 acres during the years 1908, 1909, and 1910, which will leave a reserve of 1,000 acres of virgin forest land. The expenditure incurred in connection with the 100 acres now in progress of planting will be met by the company. Endeavours are also being made to revive the rubber industry of Angola in Portuguese West Africa by the introduction of systematic methods of planting, and the creation of experimental stations for the production of plants and seeds for distribution throughout the vast rubber-growing districts. The Government have secured the services of Mr. John Gossweiler, an expert botanist from Kew Gardens, whose report on his interesting and extensive researches will, it is expected, shortly be published. His investigations have been conducted over a great area, extending as far inland as the reaches of the Zambezi He apparently succeeded in cultivating root rubber along the River Kuiriri-Longa and other places corresponding in climatical and physical conditions. In districts that differ in point of climate, etc., from that of the rubber region, it is believed that better results will be obtained by planting Ceara, Pará, and Lagos silk rubber trees. The vast inland regions lying between the River Cuevi east wards to Lake Mussumbo and the Barotze country, and extending northwards from the Cubango region into Lunda, the Kassai basin, and the Congo Free State, are covered with root rubber. With regard to the extent of cultivation, mention is made in an official report published some time ago of an area of no less than 494,228,000 acres over which the root rubber plant extends, and the fabulous figure of 1,000,000 metric tons is given as its possible yield.

Educating the Consumer.—The golden days, when the man who grumbles at the meter is no more, are not yet with us. Probably 25 per cent. of the worry of an average central station engineer's existence is due to the batch of letters, with all their panopoly of passionate phraseology, which meets him day by day shortly after he has sent out his accounts Complaints that the supply authority is a swindler, that they must have put a pound or two on, that the meter (variously spelt metre, meater, and meeter) has gone wrong, that they don't know their business, that the electricity is running to waste, and so on *ad nauseam*, make life a misery at quarter days. And after painful investigation most of the charges are proved to be trumpery and might have been avoided if the consumer had known how to read his meter. It is a curious thing that a man who will regard the indications of a gas meter with perfect confidence, has a rooted distrust of the electric indicator. A little education is wanted, and perhaps as good a one as any was adopted by the manager of a small American town rejoicing in the name of Wichita. An exhibition was in course of operation in the town, and in this show was fitted up a meter without a case, so connected up that its working could be exactly seen. Various numbers of lamps were switched into and out of circuit by an attendant, who also stood ready to explain how a meter is made, how it works and how it is read. In addition to this meter was installed a working model having four dial faces, each 12in. in diameter, the units dial at the right hand making about three revolutions per minute. The method of reading the dials was explained by a large sign in big letters so worded that anyone could understand the method of reading, even without the help of the attendant. To draw attention to the whole exhibit an Americanism of the usual rather alarming type was displayed "People who read their meters don't kick on bills." The idea is distinctly a good one, and, shorn of its translantic colouring, should be worthy of adoption by central station men who ar inclined to develop baldness as the result of consumers' complaints We are indebted to our contemporary, *Selling Electricity*, for the hint.

French Regulations for the use of Electric Power.—The application of the new regulations regarding the use of electric power in France is not unlike the English regulations, which immediately preceded them, inasmuch as both sets refer especially to medium pressures. But the general intention of the French regulations is that installations should be protected in proportion to the maximum normal potential existing between the conductors and the earth. These installations are divided into the following classes, in accordance with such potential: (1) direct-current installations, where the maximum normal potential between the conductors and the earth does not exceed 600 volts; (2) alternating-current installations, where the maximum effective potential between the conductors and the earth does not exceed 150 volts; (3) installations with potentials respectively higher than those above mentioned. It is principally with the third class that the new regulations deal. In such cases the stationary and conducting parts not traversed by the current must be electrically connected with the earth or must be electrically insulated from the ground. In the latter case the machines are to be so arranged that it is impossible to touch at the same time the machine and any conducting body fixed to

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the ground. The grounding and electrical insulation must always be kept in good condition. When an electrical machine or apparatus is in a place serving at the same time for some other purpose, it must be fenced off or otherwise rendered inaccessible to those not in charge, and a notice of the existing danger is to be posted up. Uncovered electrical machines, incandescent lamps not doubly covered, arc lamps, or other appliances giving off sparks are prohibited in workshops containing explosive substances, or in those where detonating gas or any inflammable dust may be produced, unless they are provided with a covering insulating them from the atmosphere. The ventilation of places intended for accumulators must be sufficient to insure the escape of gases liberated. Exposed conductors or other electrical appliances are not to be allowed within reach of the workmen's hands in places where the floor or the walls are of a very conductive nature, by reason of saline deposits resulting from the work carried on or of damp.

Australian Telephone Rates.—There has recently been a sweeping reduction made in the charges for trunk telephone messages in Australia, as the figures below indicate. The new scheme of rates is as follows: up to 15 miles, new rates 2d. for first three minutes and 2d. for every additional three minutes, old rates 4d. for first three minutes and 3d. for every additional three minutes; over 15 and up to 20 miles, new rates 3d. and 3d., old rates 6d. and 4d.; 20 to 25 miles, new rates 4d. and 3d., old rates 6d and 4d.; 25 to 50 miles, new rates 8d. and 6d., old rates 10d. and 6d.; 50 to 75 miles, new rates 1s. and 9d., old rates 1s. 2d. and 9d.; 75 to 100 miles, new rates 1s. 4d. and 1s., old rates 1s. 6d. and 1s.; 100 to 150 miles, new rates 1s. 10d. and 1s. 4d., old rates 2s 2d. and 1s. 5d.; 150 to 200 miles, new rates 2s. 4d. and 1s. 9d., old rates 2s. 10d. and 1s. 10d.; 200 to 250 miles, new rates 2s. 10d. and 2s. 1d., old rates 3s. 6d. and 2s. 4d.; 250 to 300 miles, new rates 3s. 4d. and 2s. 6d, old rates 4s. 2d. and 2s. 9d.; 300 to 350 miles, new rates 3s. 10d. and 2s. 10d., old rates 4s. 10d. and 3s. 2d.; 350 to 400 miles, new rates 4s. 4d. and 3s. 3d. The Postmaster-General, Mr. Mauger, at the suggestion of his predecessor, Mr. Chapman, has reduced the rates on the Melbourne-Sydney trunk telephone line from 6s. to 5s. for conversations in the daytime, and to 2s. 6d. for those after 8 p.m. The present intention is to let these rates stand for three months, and if the effect should be to encourage a further reduction, to then adopt a still lower schedule. If the expansion of business under this popularising method of management should be very considerable, a new line will be constructed next year. The above reductions have resulted in a marked increase in the daily number of telephone conversations between Melbourne and Sydney. Mr. John Hesketh, the chief electrical engineer attached to the Central Postal Administration, has informed the Postmaster-General that, in consequence of the completion of certain technical apparatus, it is now possible to use the new telephone line for duplex telegraphic work This means that when the wire is in full use, a telegraphic message from Sydney to Melbourne, a telegraphic message from Melbourne to Sydney, and a telephonic conversation may pass over the line at the same time

New South Wales Tramways.—The report of the Chief Commissioner of the New South Wales Railways and Tramways for the year ended June 30, 1907, is to be commended as a lucid statement of the position of the undertakings owned and worked by the Goverment. The net results may be considered eminently satisfactory, as the surplus on the working of the railways and tramways rose from £440,940 in 1906 to £659,916 in 1907. But our readers will be more interested in the working of the tramways alone (which are largely electrified), and the following excerpts from the report will show what success has attended such working. The number of miles open on June 30 last was 128¾. The total capital expenditure on lines open for traffic to June 30 was £3,669,524. The total earnings amounted to £908,701, as compared with £851,483 last year, being an improvement of £57,218, or 6·72 per cent. The total expenditure on revenue account amounted to £727,947, as compared with £665,083 for the previous year, an increase of £62,864, or 9·45 per cent. The percentage of expenditure to receipts is 80·11 per cent, as compared with 78·11 per cent. last year. The net result, after providing for all working expenses and £131,793 interest on the capital invested, is a surplus of £48,961, as compared with £55,960 last year. The earnings per tram mile are 1s. 1d., compared with 1s. 0½d. in 1906; the working expenses are 10½d. for the preceding year, thus the return per tram mile (after paying working expenses) is 2½d., compared with 2¾d. for 1906. The total output from the Ultimo power-house for the year was 38,343,573 kilowatt-hours, of which the alternate-current supply was 23,756,284 kilowatt-hours, and the direct-current 14,587,289 kilowatt-hours. A sub-station has been equipped at the new railway station, Sydney, for lighting the station premises, consisting of two kilowatt three-phase transformers, a storage battery and booster, with switchboard and auxiliary apparatus. This sub-station is also equipped as a tramway traction sub-station with three 450-kw. convertor units and switchboard apparatus, the current being supplied by a separate pair of high-tension cables from Ultimo. In connection with the Belmore sub-station, new lines of ducts have been laid for carrying underground feeder cables. Mr. O. W. Brain, the electrical engineer, certifies that the whole of the electric plant, apparatus, and workshops of the railways and tramways, and the tramway rolling-stock and other works under his charge have during the past year been maintained in good working order and repair.

Alternate-Current Series Motors.—In the discussion on a paper read recently before the Verband Deutscher Elektrotechniker Dr. Behn-Eschenburg gave some interesting details of the large alternate-current commutator motors made by the Maschinenfabrik Oerlikon. The locomotives working since 1905 on the Seebach-Wettingen line are fitted with motors for 250 h.p. (one-hour rating) running at 650 r.p.m. and 15 ~, and attaining a speed of 25 miles an hour. These were the first motors provided with Dr. Behn-Eschenburg's patented compensating arrangement for producing a phase displaced cross field. The rotors had originally 96 open slots, and were fitted with resistances between the winding and the commutator. When tested on the line, even with a perfect sine wave supply, it was found that the teeth introduced high frequency fluctuations into the current and thence into the 15,000-volt supply. These had a very disturbing effect on the neighbouring telephone lines, and in order to prevent the effect new rotors with closed slanting slots were introduced. At the same time the commutator resistances were omitted. As a result the high-frequency fluctuation practically disappeared, whilst the commutation remained as satisfactory as with the original rotors. This commutation is, in fact, exceptionally good, both when starting and when running, with the ordinary tractive efforts up to 5,500lb. per motor. The commutators remain smooth and free from copper or carbon dust, and the carbon brushes show extremely little wear. The light railway from Locarno to Bignasco is fitted with 60-h.p. Oerlikon series motors, and in these again the commutator resistances are omitted. On the other hand,

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in some large 500-h.p. series motors for 37½ miles per hour, now under construction at Oerlikon, it has been thought advisable to employ commutator resistances, in spite of the comparatively low short-circuit voltage. These motors, like the 250-h.p. ones, have ordinary salient poles, with simple removable coils for both main and auxiliary poles, and the armature compensation is accomplished by short-circuited windings built with the magnet frame. By so arranging the magnet dimensions that the poles become highly saturated by any overload in current, the short-circuit voltage introduced by transformer action is automatically kept within practicable limits. The writer mentions that, in his experience, both in factory tests and in practical operation, flashing over from brush to brush, such as sometimes occurs with direct-current motors, has never occurred with these alternate-current motors, and he considers this a point distinctly in favour of all alternating motors.

Post Office Telephones and Finance. — Under another heading is noted the telegraph portion of the post office business for the year 1906-7. The remarks of Mr. Sydney Buxton on the growth of the telephone business are of special interest in view of the preparations that are being made to take over the business of the National Telephone Company in 1911. Besides the extensions in London, large additions have been made to the post office trunk and provincial systems, and arrangements have been made for local intercommunication between subscribers to the Post Office and National Telephone exchanges respectively. Although no one can say exactly what the terms of purchase will amount to, the parties are working amicably to make the transfer as smooth as possible. In pursuance of this policy, it is stated that after considerable discussion with the company a scale of rates was adopted for the intercommunication on May 1. These rates are based on the principle of a measured service, which the Postmaster-General states "is the same which has long been in use for the supply of water, gas, and electric light. It has been adopted almost universally in the United States, where it has led to an enormous increase in the number of telephones in use, and the same principle is becoming generally recognised in the principle countries in Europe." Mr. Buxton adds: "The amalgamation of the systems of the Post Office and National Telephone Company which is to take place in 1911 is being kept steadily in view. I am providing for the company on rental terms, in both the Metropolitan and Provincial areas, an increasingly large number of wires, which will be available for immediate use as part of the post office system when the transfer is effected." The general results of the working of the post office are reported on as follows: "The postal revenue of the year, including the value of services rendered to other departments, was £17,361,042, an increase of £297,019 on that of the previous year. The net profit was thus £5,071,255, or £143,756 less than last year. The telegraph and telephone revenue of the year, including the value of services rendered to other departments, was £4,369,230, an increase of £217,850; and the telegraph and telephone expenditure was £5,021,285, an increase of £129,086 upon the previous year. The net deficit on working the telegraphs was thus £652,055, or £88,764 less than last year. The net revenue from the postal and telegraph services combined was £4,419,200. If the interest on the capital expended on the purchase of the telegraphs—£10,867,644—be taken into account, the net profit was £4,147,509, or £54,992 less than last year. These figures are, necessarily, partly estimated." It is obvious that in the telegraph branch, reforms are needed in order to place matters on a sound financial basis. It is therefore satisfactory to read that Mr. Buxton is considering whether means can be devised for showing the financial results of the telephone and telegraph services more clearly and fully.

Foreign Trade Returns.—The trade returns for August will be closely examined to see whether the reaction that is already to be noticed in Germany and America has yet set in here. While there are some signs of fluctuation in the rate of increase in the import returns, there are no indications of declension in the volume of exports, though it should be borne in mind that exports are probably the last to feel the effects of lessened trade activity, because they represent, to a very large extent, the fulfilment of contracts made during a period of pressure. Details as to the movements of electrical commodities should prove of interest. The sum total of imports of telegraph cables and apparatus for July amounted to £104,245, an increase of £2,319, or 2·2 per cent., compared with the same month of the preceding year. The total imports for eight months (1907) amounted to £844,386, an increase of £74,546, or 9·6 per cent. compared with 1906. Under the heading of articles wholly or mainly manufactured, we find that of wire (including telegraph and telephone wire) 4,313 tons, valued at £52,066, were imported in August, compared with 4,047 tons, valued at £41,460, in the same month of the preceding year. The imports for the eight months 1907 and 1906 amounted respectively to 41,937 tons valued at £447,607, and 39,988 tons valued at £407,735. Electrical machinery (of all kinds) was imported last month to the extent of 778 tons, valued at £55,818, compared with 780 tons, valued at £61,128, in August, 1906. The value of the 5,012 tons of electrical machinery imported for the eight months of this year is returned as £393,344, compared with £390,369, which was the value of the 4,829 tons imported last year. Turning now to exports, we find that under the heading of telegraph cables and electrical apparatus, there was a decline during the past month of £429,911, or 73·2 per cent. compared with August, 1906, the figures for the past month being £156,669. The export for the eight months of the year has likewise declined by £388,226 or 21·3 per cent., to £1,426,454 Both in quantity and value does the export of wire (including telegraph and telephone wire) show an increase last month, the figures, 4,879 tons valued at £88,602, comparing favourably with 3,988 tons valued at £65,589. The export of this commodity for the eight months of this year has thus been brought up to 35,222 tons and to £642,954 in value, compared with which we have the amount of £504,107, representing a value of 29,193 tons for the first eight months last year. The export of all kinds of electrical machinery also shows a big advance, the figures for last month being 1,346 tons, for which a value of £97,008 is returned, compared with 755 tons and £59,411. For the eight months the following figures are given 1907—quantity 8,834 tons, value £645,715; 1906—7,855 tons, value £559,734. The exports of electrical goods, etc. (not including machinery), of foreign and colonial origin last month reached a value of £13,566 compared with £9,418, bringing the total figures for the eight months up to £99,418 against £63,722 last year. The volume of trade as recorded in the foregoing figures appears satisfactory, but as we have pointed out on several occasions already, statistics are not a reliable guide to the state of trade in this country, especially at this moment.

Electrical Haulage in Mines.—The increasing adoption of electricity for mining purposes in Europe and America, and the satisfactory and economical results with which its adoption is attended, must eventually effect its use in this country, despite the conservatism of mine managers. The fact that a country like Belgium, for

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instance, whose output of coal is but small in comparison to that of the United Kingdom, and the physical features of whose coal zones are peculiarly difficult for the work of producing coal, should go in largely for improved electrical apparatus is a testimony to the superiority and economy of that class of apparatus in the work of coal production, especially when we remember that the neighbouring coal-fields of Germany (and, in a lesser degree, those of the United Kingdom) lie very close, and that as there is no fiscal barrier to obstruct the free entry of coal into the country, the price of that commodity must be kept at the cheapest possible level. Sir C. Hertslet, in a report to the Foreign Office on the coalmining industry of Belgium, writes that "some of the mines of the country have adopted electricity as the sole motive force for extraction, pumping, and ventilation, and what are regarded as satisfactory and economical results have been obtained." The question of electric *versus* steam engines is one which has been much discussed in technical circles in this country and elsewhere, and although it is likely to remain in an indefinite state for some time to come, there can be no doubt as to the superiority of the electrically driven machine where local conditions are favourable. It is of interest to follow Sir C. Hertslet's remarks, which, on the whole, are favourable to electric machinery, and bring to light the greater simplicity of its manipulation. He cites the following instance: "One of the events most liable to cause accidents in mines is the possibility of the machinist failing to stop the cage at the exact moment. This is met in a certain measure by the provisions which compel mine owners to have a second machinist when shifts of workmen are going up or down the shaft, but a momentary aberration or indisposition of the machinist at a critical moment might be the cause of a terrible accident before the second man could stop the machinery. In working steam-engines the attention of the operator is divided between several control levers, whereas one of the greatest advantages of the electrical machine in this connection is that only one main controlling lever is required. In addition, on the one electric machine which I have seen at work in Belgium, a safety contrivance was attached which, in the event of the machinist omitting to stop the cage on its upward or downward course, automatically brings the starting lever to the zero position and stops the cage." In the report there is given a copy of the most recent law respecting the lighting of mines and of the lamps authorised to be used for this purpose. Among the latter may be mentioned the Wolf lamp, used in the mines of the Mariemont and Bascoup Company, which is one of the largest and best administered mining companies in Belgium. This is a benzine lamp fitted with an automatic relighter, and, in addition, possesses the advantage of automatically locking after it has been filled and screwed together, so that it is impossible for the workers in the mines to open it, as this can only be done by means of an electromagnet specially used for the purpose. Belgian experience shows no insuperable difficulty in the use of electricity in mining, the advantages of which only need be persistently urged to receive the recognition of mine managers. With the attention that is now being given by electrical engineers to perfecting machinery the future should see an undeniable extension of the application of electricity to mining in this country as well as in others.

A Year at the Post Office.—The Postmaster-General has just issued his latest annual report, a document which, perhaps, surpasses in interest any of the preceding ones. No exceptional circumstances are necessary to render the Postmaster's department one of importance to electrical engineers, for at any time it constitutes one of the best customers of the electrical profession. But two features distinguish the past year from its forerunners. One of these is the ratification by the Government of the Radio-telegraphic Convention framed by the Berlin Conference (an action which is likely to have an important effect upon the future of wireless telegraphy), and the passing of the Telegraph (Money) Act, which sanctions an expenditure of £6,000,000. During the year the telegraph has been extended to 227 offices in country districts and in the areas of the larger towns. Guarantees have been given for 158 of these new telegraph offices—69 by local authorities and 89 by private persons. Under the announcement of last year the guarantee for telegraphs was, except in certain exceptionally costly cases, reduced from a half to one-third of the loss. There are now in the United Kingdom 10,587 telegraph offices at post offices, and 2,406 at railway stations and other public places. The extension to Edinburgh of the underground line between London and Glasgow has been taken in hand on the Edinburgh side. Permanent cable has been provided for the important spur line from Manchester to Leeds. Good progress has been made with the construction of the underground line from London to the landing places of the submarine cables in the West of England. At the end of the financial year pipes had been laid as far as Bristol, and the cable had been drawn into them to within four miles of Bath. Among the works to to be undertaken if possible before the end of the present financial year the Postmaster-General mentions the following: (1) the completion of the western underground line as far as Exeter; (2) the provision of a new cable between Warrington and Liverpool; (3) the construction of a line between Newcastle and Durham to connect eventually with the main underground system by way of Leeds and Manchester; (4) the extension, from the Glasgow side, of the line which will eventually complete the underground system between London and Edinburgh. In his remarks upon wireless telegraphy the Postmaster-General observes that the Act of 1904, by which it was made illegal to instal or work wireless telegraph apparatus within the United Kingdom or its territorial waters without a license from the Post-master-General, was passed for a term of two years only. It was, however, extended to December, 1909, by an Act of last year, and steps have been taken for the renewal of the licenses granted under the Act of 1904 for the period covered by the new Act, except where experiments licensed under the former Act have since been abandoned. During the year, the report states, there has been received 45 new applications for licences, of which 36 were required for experimental purposes only. The latter have all been granted, but some of the other applications have been held over pending the consideration of the whole question of the use of wireless telegraphy in the United Kingdom for commercial communication with ships. This question turns largely on that of the ratification by his Majesty's Government of the International Radiotelegraphic Convention formulated by the International Conference which met at Berlin in October and November last. The position is again touched upon in the report, but as it has been quite recently dealt with fully in the columns of this journal, it is needless to dwell further thereon. It is of interest, however, to mention that the Post Office continued during the year to collect and deliver the Marconi Company's telegrams to and from ships at sea under the arrangements settled in 1904. The total number of outward telegrams dealt with during the year was 1,140, as compared with 558 in 1905-6, and of inward telegrams 15,853 as compared with 11,094. It remains to be added that the telegraphs have always been worked at a loss, and the year 1906-7 was no exception to the rule.

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MUNICIPAL TRAMWAYS ASSOCIATION.

Annual Conference.

The sixth annual conference of the Municipal Tramways Association, which opened in Manchester on Wednesday morning, will be continued until to-day (Friday). Some 300 delegates, comprising members of municipal tramway committees, tramway managers, and officials, were in attendance, and the conference was strengthened by the presence of representatives from the Municipal Electrical Association, the Tramways and Light Railways Association, and the Tramway Officials' Association. Mr. J. M. M'Elroy, general manager of the Manchester Corporation tramways, is the president for the year. At the opening of the conference the Lord Mayor (Mr. J. Harrop) was present, accompanied by Mr. Alderman Wainwright and Mr. Alderman Bowes (chairman and deputy-chairman of the Manchester Tramways Committee), and the two first-named gentlemen extended a hearty welcome to the association on behalf of the Tramways Committee and the Corporation of Manchester. Alderman Sir Joseph Baxter Ellis (Newcastle) proposed, and Mr. Alderman Dunsford (Southampton) seconded a vote of thanks to the Lord Mayor for receiving the guests.

The conference then commenced the business of the session, and Mr. M'Elroy took the chair and delivered his presidential address, which was as follows:

Presidential Address.

BY J. M. McELROY, GENERAL MANAGER, MANCHESTER CORPORATION TRAMWAYS.

In opening this, the sixth annual conference, I must congratulate the members on the association's continued prosperity and usefulness. From small beginnings—from a preliminary meeting held in this city, at which only eight persons were present—the association has grown into the important and influential body we find it to-day. Its membership includes representatives of practically all the municipal tramway authorities in the kingdom—authorities whose combined undertakings represent a total capital outlay of something like 40 millions sterling. The necessity for the existence of such an association was felt long before it came into existence. The rapid growth of the municipal movement, the new conditions which arose through the introduction of electric traction, the obligations and restrictions which were imposed upon tramway undertakers by the Legislature, the serious responsibilities which the municipalities themselves felt towards their ratepayers, whose credit they had pledged for large sums of money—all these things pointed to the advantages to be gained by combination, by the establishment of an association for the safeguarding of the many interests common to the whole of the municipalities—to the perhaps still greater advantages to be gained by the interchange of views and experiences on matters more or less technical—on construction, equipment, and operation of tramways—these considerations led, as they obviously would do, to the formation of the Municipal Tramways Association, and I venture to think that no association has ever proved of greater value to its members, nor displayed greater vigilance in looking after the general interests of the various authorities it claims to represent. The success which has so far attended the municipalisation of tramways in this country has to some extent silenced a large number of those who are opposed to the principle of municipal ownership, but we have still from time to time to face strong criticism from certain quarters—not all of which is disinterested.

The alleged evils arising out of what is called "municipal trading" have been presented in many forms by writers whose qualifications for the task have varied considerably, but I do not think it can justly be denied that practically all the writers on this subject—the well-informed and the ill-informed—have failed to present their case with that freedom from bias which is necessary in dealing with a problem of this character. Moderation of language has not always been one of their strong points, and as an instance of this I submit the following extract from a recent publication on "The Dangers of Municipal Trading": "Such trading with the public credit, whether State or municipal, must of necessity lead to stupendous financial liabilities, add to the burden of the rates, weaken municipal credit, bring about inequality of taxation, interfere with the natural laws of trade, check industrial and scientific progress, stop invention, discourage individual effort, destroy foreign trade, establish an army of officials, breed corruption, create an aristocracy of labour, demoralise the voter, and ultimately make socialistic communities of towns and cities." An indictment couched in language of this kind is apt to produce a smile of incredulity on the face of the average citizen of to-day who can show in some of the large cities concrete examples of "municipal trading" in the shape of well-equipped up-to-date tramway systems, providing excellent means of transit at cheap fares, paying over large sums of money in relief of the rates, and at the same time maintaining the undertakings in sound financial condition by making adequate provision for depreciation and renewals, and, in addition to that, paying off the borrowed moneys by means of the sinking funds so that the next generation will have handed over to them fully-equipped tramway systems efficiently maintained and entirely free from debt

On the other hand, it may perhaps with some justice be contended that the advocates of "municipal enterprise"—as many prefer to term it—in presenting their case have "placed all the best things in the window," and have failed to a large extent to meet many of the objections raised by their opponents, or even to admit that there are difficulties and dangers inseparable from municipal operation even under the best conditions prevailing to day. To put the matter briefly, it would not be far from the truth to state that the case *pro* and *con.* has been presented from extreme standpoints, and that a fair and impartial account of municipal ownership and operation in the light of actual experience has yet to be written. Possibly some day one of the members of this association when he gets a little leisure—a rare commodity among those engaged in the tramway business—may see his way to undertake this task. When the question of the introduction of tramways into this country was first brought before the legislature—now some 40 years ago—it was not to be expected that they would permit private promoters to obtain rights and concessions enabling them to use the public streets and to set up huge monopolies in such enterprises as tramways—which affect the comfort, convenience, and health of the public—without imposing proper conditions safeguarding the public interests in every reasonable way. And, further, it was not to be expected that the safeguards were likely to err on the side of leniency towards the promoters, having regard to the experience which the local authorities had undergone in purchasing and taking over the undertakings from the old gas and water companies, in respect of which exorbitant prices had to be paid.

The Tramways Act of 1870—the general Act which authorised the construction of tramways—has been pointed to by the anti-municipal traders as an Act which, perhaps more than any other, had the effect of "strangling" an industry which it was the aim of its framers simply to regulate and control. The language used by many writers who have criticised this Act has been exceedingly strong. They have stated that it "destroyed private initiative" and "paralysed" the tramway industry in this country. Any Act of the Legislature which cripples an industry, especially such an industry as the tramway industry, in which the interests of the public are so much bound up, would be hard to justify; but if the "crippling" were shown to be simply "regulating" the industry, with the object of ultimately directing it into the channel of complete public ownership and control, there are many who would say that the end justified the means.

The celebrated forty-third section of the Tramways Act—the "crippling" section—which enabled local authorities to purchase from private companies at the end of 21 years, is especially interesting to us in Manchester, because it was at the suggestion of Sir Joseph Heron, our then town clerk, that the terms of purchase were made clear—namely, that the price was to be "the then value of the tramway (exclusive of any allowance from past or future profits of the undertaking, or any compensation for compulsory sale, or other consideration whatso-

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ever)." The words in brackets were inserted at Sir Joseph Heron's suggestion, acting on behalf of certain local authorities, and Sir Joseph, in his evidence, said that the words were proposed by him in order to put it beyond doubt that goodwill was to be excluded from the valuation—to use his exact phrase, "to prevent it being a matter of controversy." Notwithstanding this precaution taken in the drafting of the section, it did not prevent certain companies from attempting to drag in goodwill in their valuation when the time came for purchase, and the matter had ultimately to be settled through the Law Courts. It even went as far as the House of Lords It is the limited period of this concession—21 years—added to what has been incorrectly described as the "scrap iron" purchase price, which the anti-municipal traders point to as having the effect of "strangling" the tramway industry, and in illustration of this they point out that for many years, particularly during the last years of the companies' *regimé*, tramway enterprise was practically at a standstill in this country, and our tram-travelling public were compelled to put up with horse or steam haulage, with rolling-stock, track, and equipment generally in a moribund state, whilst in American and Continental cities the public were enjoying the improved means of transit which resulted from the introduction of electric traction.

No doubt these contentions are to some extent true, but the municipal advocates would point out that it was better to forego immediate benefits, and to put up for the time being with the slower and less convenient means of transit, if the effect of such action or inaction on their part resulted in ultimate municipal ownership of the undertakings and the development of the same along such lines as would best meet the requirements of the public and the interests of the ratepayers. The municipal trader who takes up this position points to the fact that in practically all the cities and towns in the kingdom the tramways have now been taken over and are operated by the municipalities, and that the benefits accruing to the travelling public, the ratepayers, and the tramway employés have been enormous. He also points out that, speaking generally, the construction, equipment, and organisation of the municipal service will bear favourable comparison with any other tramway undertakings in any part of the world. Further, he is able to show that whilst in other countries—where unlimited concessions were granted to private enterprise, and where few restrictions were imposed for safeguarding the public interest—it is true that they enjoyed in earlier years the advantages of electric traction when we were putting up with what the Americans call "back numbers" in the shape of horse and steam cars, yet we are now able to indicate to our friends abroad how since then we have forged ahead—how by the very Legislature which it is alleged "strangled" the industry nearly all the larger tramway systems of the country have been directed into the channel of public ownership, whereas unrestricted private enterprise abroad has led to the creation of huge monopolies with well watered stock, and with undertakings certainly not up to the high standard of efficiency to be found in many cities in this country.

The purchase clause in the Tramways Act of 1870 has not been the only act of the Legislature which, in the opinion of the anti-municipal traders, has retarded the development of tramways in this country. There is another, and, in the opinion of many persons, a more serious act which has prevented tramway extension, and that is the Standing Order of the House of Lords and also of the House of Commons which places upon tramway promoters the obligation of obtaining the consent of the local or road authority before they can proceed with the promotion of Private Bills in Parliament authorising the construction of tramways. That local authorities have in a number of instances prevented tramway development by exercising their veto under the Standing Orders cannot be questioned. That they have imposed, or attempted to impose, onerous conditions on tramway promoters before giving their consent is undeniable. Matters have in some cases gone so far under this head as to cause the promoters in their irritation to describe the action of the local authorities as nothing more nor less than levying "blackmail." In recent years the effect of this Standing Order has been felt by some of the larger municipalities themselves. Their tramway systems are now spreading into the suburban districts, and the refusal of the local authorities to give their consent for the construction of new lines—except, perhaps, under conditions financially impossible—is apt to be a serious barrier to tramway development. For ordinary purposes of local government—for street paving, cleansing, lighting, and things of that kind—the fixing of artificial boundaries for administrative purposes may be beneficial, but when public transit in concerned the fixing of these artificial boundaries beyond which the public may not pass without the consent of the local administrators, and then possibly only by the payment of "toll" in the shape of onerous conditions, is a matter calling for serious consideration, inasmuch as it may retard progress by preventing the spreading of the population from the central to the suburban districts and the relieving of the congested city areas, so necessary from a public health point of view

In tramway matters America has taught us many lessons. We certainly reaped the benefit of her pioneer work in electric traction. During my recent visit to the States I found we had little or nothing further to learn from them on matters connected with construction, equipment, and operation generally, but we have a very important lesson yet to learn in the way their populations are spread by the energetic manner in which the tramways are extended into districts absolutely unbuilt upon. There the tramway precedes the population. They do not wait until a district grows before they provide transit facilities. The facilities are provided first. And we must remember that these facilities are provided by private companies working for their selfish ends—the benefit of their shareholders. This is a lesson which the municipalities of this country would do well to bear in mind. It is a strong point made by the the anti-municipalisers on the other side.

The pleasant picture which the municipal trader is fond of exhibiting showing the success which has so far attended municipal enterprise has, like most good things, another side to it which must not be overlooked. It is this side that his opponent wishes the public to carefully examine, because it directs attention to the risks and dangers under municipal control. That there are real difficulties and dangers must be admitted by those whose intimate connection with the management of large undertakings enables them to speak with authority. The constant demand and pressure from the public for greater concessions is an undoubted source of danger. In the tramway business the margin of profit per passenger is so small that any ill-considered scheme involving reduction of fares is likely, by a stroke of the pen, to turn a handsome profit into a huge loss. The demands for contract tickets—another name for cheaper fares—one mile ½d. stages, increased services on "thin" routes, special fares and privileges for certain classes of the community, all these proposals are constantly being made by those who speak with freedom unfettered by responsibility. Then, again, the anti-municipal trader points to the danger of the large and increasing number of municipal employés and the political influences which may possibly affect the engaging and control of such employés, and the consequent risk of slack and inefficient service to the public.

So far, speaking generally, all these risks and dangers have been recognised and met by tramways committees, who have disregarded sectional interests, and looked to the general welfare of the undertakings they control; and as regards the employés, it is well recognised that the engaging and control of the men is a matter entirely for the manager, unfettered by any political or other influence whatever. Bearing upon this subject, the experience of Australia is interesting. Australia is probably the most democratic of all countries. There the railways and tramways are operated by the State. The entire control and management of the undertaking is placed in the hands of salaried commissioners, who are clothed with full powers to carry on the business. The object of the Australian Legislature in giving the commissioners such wide powers was to remove all possibility of political influence in the management of the undertakings.

Another danger, and a very serious one, in connection

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with municipal trading concerns is the strong tendency when the rates are high and on the increase for members of corporations to look to the trading departments for relief in the shape of increased amounts to be handed over in aid of the rates. In the case of tramways, instances can no doubt be found where "profits" have been paid over in relief of rates which ought to have been retained by the undertakings if proper regard had been had for their financial stability. Those of us who have had experience of the great wear and tear which is taking place on the track and equipment generally feel that the question of depreciation is one which should be seriously faced by the municipalities. In some of the larger cities they are erring on the side of great caution in connection with this matter. In addition to paying off the loan debt by means of the sinking fund, they are making very liberal provision for depreciation and renewals. In other cities and towns they are relying on the sinking fund, supplemented by additional provision, to meet the full depreciation. In other places they are relying solely on the sinking fund. If the loan period synchronised with the "life" of the asset, especially the track, there would be little to say against the sinking fund being regarded as proper provision for depreciation; but we know that the track will be worn out long before the loan is repaid, and this is, therefore, a matter calling for serious attention on the part of the municipalities.

The American Commission which visited this country last year to investigate and report upon the question of municipal ownership has recently published its report. This report is interesting and valuable, inasmuch as it is signed by men of many shades of opinion who have approached the question from many standpoints, some of whom, no doubt, commenced their investigations with a distinct bias against public ownership. After drawing attention to the difference in the social and political conditions which characterise the two countries—Britain and America—the report goes on to say: "First, we wish to emphasise the fact that the public utilities studied are so constituted that it is impossible for them to be regulated by competition. Therefore, they must be controlled and regulated by the Government, or they must be left to do as they please, or they must be operated by the public. There is no other course. None of us is in favour of leaving them to their own will, and the question is whether it is better to regulate or to operate. There are no particular reasons why the financial results from private or public operation should be different if the conditions are the same. In each case it is a question of the proper man in charge of the business and of local conditions. We are of the opinion that a public utility which concerns the health of the citizens should not be left to individuals, where the temptation of profit might produce disastrous results, and, therefore, it is our judgment that undertakings in which the sanitary motive largely enters should be operated by the public. We have come to the conclusion that municipal ownership of public utilities should not be extended to revenue-producing industries which do not involve the public health, the public safety, public transportation, or the permanent occupation of public streets or grounds, and that municipal operation should not be undertaken solely for profit."

In so far as tramways are concerned, this is a distinct verdict in favour of the principle of municipal ownership; and coming from a country where they have long been distrustful of any interference by the State with private enterprise, where individual effort has been held to be the only safeguard of progress, the verdict is all the more gratifying to those who have advocated municipalisation on this side. Having arrived at these general conclusions, the commission naturally turned their minds to the conditions under which private enterprise controls these "public utilities" in their country, and in the case of tramways they find in a great many instances that interminable franchises have been granted—a far cry from the 21 years' concessions which were granted under our Tramways Act of 1870, and which "strangled" the industry here. Here lies the difficulty, and under this head they report: "We are also of the opinion that all future grants to private companies for the construction and operation of public utilities should be terminable after a certain fixed period, and that meanwhile cities should have the right to purchase the property for operation, lease, or sale, paying its fair value." "Paying its fair value"—including goodwill. Any city in the States determining to take over and municipalise its tramways is "up against a big proposition," as they say over there. Sir Joseph Heron's phrase, "the then value, exclusive of any allowance for past or future profits"—would have been useful words to the American municipalities had they been inserted in the franchise grants.

On the general question of management and freedom from political influence the report says: "Our investigations teach us that no municipal operation is likely to be highly successful that does not provide for (1) an executive manager with full responsibility holding his position during good behaviour; (2) exclusion of political influence and personal favouritism from the management of the undertaking."

The report speaks in praise of the excellence of the municipal government of this country: "We wish to bring to your consideration the danger here in the United States of turning over these public utilities to the present government of some of our cities. Some we know are well governed, and the situation on the whole seems to be improving, but they are not up to the government of British cities. We found in England and Scotland a high type of municipal government, which is the result of many years of struggle and improvement. Business men seem to take a pride in serving as city councillors or aldermen, and the Government of such cities as Glasgow, Manchester, Birmingham, and others includes many of the best citizens of the city. These conditions are distinctly favourable to municipal operation."

The success of any undertaking, municipal or private, depends upon the men who are placed in command—the men who direct and control it. Given public men with high ideals of municipal government, with broad and comprehensive views, with business experience—given well trained public-spirited officials, men of integrity, tact, and good judgment—the municipal movement in this country will continue its prosperous career, and will justify the conclusions long ago arrived at—namely, that all those undertakings which are in the nature of necessities, monopolies, and require the use of the public streets, should be owned and operated by the municipalities in the interests of the ratepayers and the public generally.

At the conclusion of the address, Mr. J. B. Hamilton (Leeds) proposed, and Mr. J. Aldworth seconded, a vote of thanks to Mr. M'Elroy, which the meeting cordially adopted.

Long Wheel-Base Trucks.

BY R. L. ACLAND, M.I.E.E, TRAMWAYS MANAGER, CHESTERFIELD CORPORATION TRAMWAYS.

As an introduction I would like to state that these few remarks were put together and handed to the Hon. Secretary some four weeks ago, since which time, in order to be able to lay before this association as much information as possible, and to obtain confirmation or otherwise of my own opinion, I have visited several Continental cities, and having only returned on Friday last from Buda Pest, I have been unable to put these into print, and must therefore apologise for the few additions I have found necessary to make.

At the spring meeting of the Municipal Tramways Association the relative qualities of cars mounted on double bogies and single short wheel-base trucks were advocated respectively by Messrs. Mozley and Dalrymple, and many valuable expressions of opinion were elicited from other tramway experts on this subject, but little was said as to the merits of the third alternative—namely, the long wheel-base single truck—which, in the opinion of the author, is superior to either of the older types, and, further, he considers that before long it will be very much more largely adopted in this country, as is already being done in Germany, where its advantages have been realised as compared with the short wheel-base trucks previously in use, particularly in Nuremburg, Vienna, and Budapest,

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where cars with wheel centres varying from 8ft. 2in. to 11ft. 10in. are being used.

The standard single-truck double-deck car as used in this country, carrying from 50 to 56 passengers (22 inside and the remainder on the top deck) leaves nothing to be desired from the traffic manager's point of view, as it is a size which can be loaded and unloaded rapidly, provided an efficient stairway to the top deck is used, and not one of the inconvenient and awkward arrangements known as the "reverse" staircase which causes the inside and outside passengers to struggle as to who is to get on or off first, and, further, a single conductor can easily manage to collect all his fares with a mixed complement of long and short stage passengers on board; a high average speed with stops can be maintained; and with a top-deck cover this is an ideal car for all weathers. From the engineering point of view, however, to run a self-propelled vehicle weighing with a full load of passengers and top-deck cover about 12 tons, spread over a length of some 30ft. on a wheel base not exceeding 6ft. 6in., at speeds up to 16 miles per hour, is certainly very contrary to what has been found from experience to give the best results on other forms of rolling-stock.

This type is a legacy from the old horse-car days, when very much smaller and lighter cars mounted on short wheel base trucks were used in order to take as much work as possible off the long-suffering animals when dragging them round fairly sharp curves; but with the rapid development of electric traction, and the quick change that was made on some of the old horse systems it was only considered necessary to use a similar truck of stronger build which would carry the motors and other equipment, the wheel base remaining the same as before. This was all very well with the smaller type of electric cars first used, or when the old horse-car body was simply mounted on the heavier bogie, but car bodies began to grow and extend lengthways, and it would seem only reasonable to expect that the wheel-base should have been increased in something like proportion, which has, however, not been the case. The result of this unequal growth of body and wheel-base can now be seen on many systems, where cars are running with bent backs and drooping platforms, caused by excessive overhang and pull on the brake chain fixed to the extreme end of same; the trucks also are strained and thrown out of square, for a car of this type when running on a straight track at high speed, in addition to pitching heavily, oscillates from side to side, due to the unevenness of the rail and other causes, the ends of the platforms describing part of a circle about the truck as a centre, with the result that the wheels are constantly running askew in the grooves in either direction, whereby heavy wear and tear takes place on the flanges, which are worn into all sorts of extraordinary shapes by having to guide the car under such severe conditions, and the constant slipping and grinding of the tyres must help to wear the rail head into a corrugated surface, and it would seem to an increased degree when steel-tyred wheels are used instead of chilled iron.

When a car runs through a pair of points at the entrance of a loop, the whole mass has to be set revolving in one direction, and immediately afterwards in the opposite direction by reason of the short S curve, for which work an abnormal force has to be applied to the wheel flange in order to steer the car round the curve and to draw it out of the line of its momentum into a new direction, both of which are increased in proportion to the overhang of the body. These conditions are worse the shorter the radii of the points, and, further, when a runaway car of this type approaches a simple curve at high speed, the flanges have not the same chance to give the car the necessary steering force to get it safely round the curve, and to overcome its momentum travelling in a straight line, as they would if the wheel-base was longer, and the leverage of the unsupported portion of the car body upon them thus reduced.

I find that in nearly all Continental cities it is a practice to lay the outer rail on curves with a very shallow groove, so that the outer wheels of the car in rounding the curve are running on the flanges, by which means an additional superelevation is given to the car, and, further, the flange friction is greatly reduced on all types of trucks, and with those that have a flexible base it ensures that the axle is moved out of square radially to the curve, as it is only the check of the inner rail which offers a resistance to the passage of the wheel. Rail joints, when they begin to go, as all mechanical joints will do, get most unmercifully pounded, for a car that is pitching heavily endways will often have very much more than half the weight on one pair of wheels, when they drop into the bad place. In passing, it is of interest to note that on the Continent the types of rail joints in use are nearly all variations of what is known as the Dicker joint, and the latest type now being used entirely in Berlin and Vienna appears to be a very good one. This is given as one of the chief reasons why the European cities above-mentioned have so largely adopted the long wheel-base truck, the majority of the track being in a somewhat shaky condition. This statement, which has been published, is incorrect, as I consider from personal inspection that the track in these three towns is as good as any I have seen, considering the very large amount of traffic that is dealt with.

The bogie car is in the author's opinion only suitable for interurban transit, or in large towns where both types of cars are used, when they are useful for loading up at crush hours with the long distance or "through" passengers, but to continually stop and start a car carrying between 80 and 90 passengers for the accommodation of general traffic is certainly not heading towards the greatest economy, for the average speed is considerably less, time-keeping not so good, and the likelihood of all fares being collected is reduced, as compared with the use of two small cars on the same service. A further result of discrimination in car functions on a large system as outlined above, is that the comfort of the passenger and loading speed capacity will be in proportion to the length of the journey, for the small short stage city car with fore and aft seats provides ample space for standing room facilities for rapid loading and moderate comforts, as compared with the bogie car, which, with comfortable cross seats, centre aisles, and minimum of standing accommodation, offers an attractive method of transit to the long-stage or interurban passenger as compared with the higher speed and varying comfort of a competing railroad.

From an engineering point of view the bogie car is a considerable improvement on the single-truck type, as the wear and tear on the car body is not as great, nor are such violent strains imposed upon the truck frames, wheel flanges, and track, but still the oscillation of the bogies upon their respective centres, with the consequent skewing of the wheels in the grooves, will give the same conditions conducive to flange wear, rail corrugation, etc, as those belonging to the short wheel-base truck, but in a less degree, for the bogie truck is not acted on by any direct force tending to throw it out of square, and to set itself in line with the track has only to overcome the direct downward pressure of the car body upon the centre of the bolster.

When most tramway lines were operated with steam locos and trailers mounted on bogies corrugation was practically unknown, for the cars were being hauled, and not self-propelled, and the steam locos which did the hauling had a wheel base proportional to their overall length, and further, they were held practically square in the rail grooves by the weight of the trailer. A locomotive type of crank axle on the driving wheels, hitched up to the trailing wheels by means of coupling rods, gave practically an even turning moment on all four wheels, which making therefore the same number of revolutions would tend to keep all the tyres the same diameter, and also reduce the slip when accelerating and rounding curves, whereas with two motors running independently, and gear driving on to the extreme end of each axle, torsional strains are set up on the axles themselves, cross strains on the trucks, and cross-corner wear on the tyre flanges, with a consequent extra wear and tear on the track which did not exist before. This argument is supported by experience on steam railroads, where a comparatively small amount of corrugation has so far been found when the train is hauled by a single locomotive in front, but with the advent of electric traction and multiple-unit system with numerous driving wheels on four-wheel bogies dispersed throughout the

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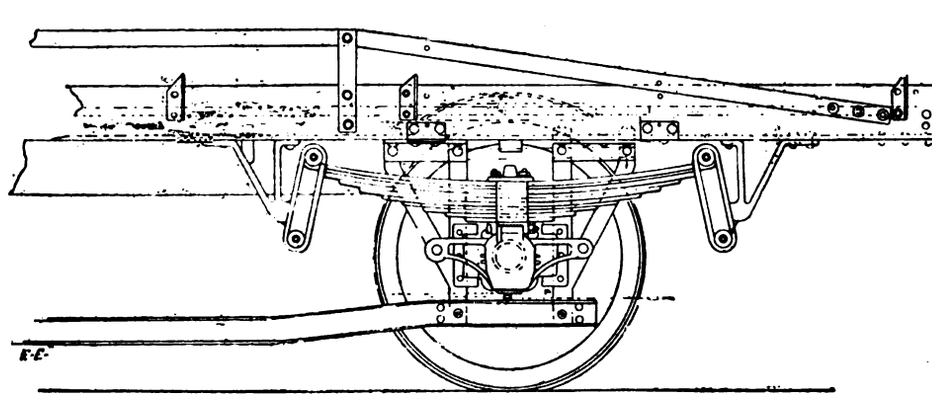
length of the train, corrugation has developed largely, also wheel-flange and rail-head wear, owing apparently to the insufficient length of wheel base in proportion to the rail gauge as pointed out recently in the *Tramway and Railway World*.

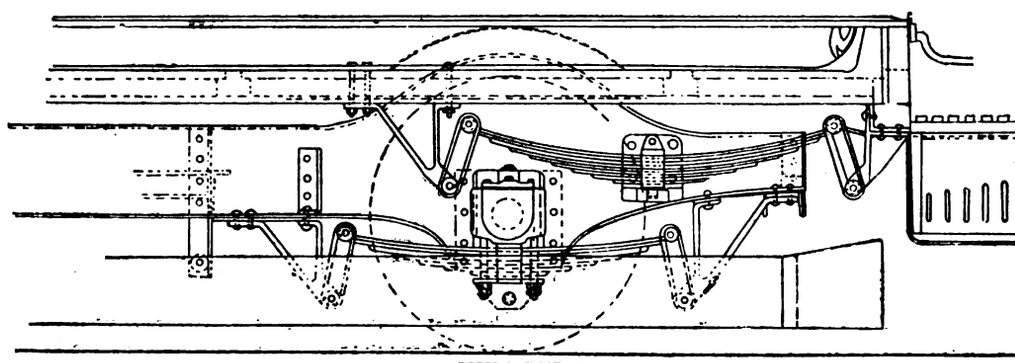
Some steam railroads are adopting six-wheel bogies on main line rolling-stock, and it would be interesting to know whether this increased wheel base or the use of coupling rods connecting the driving wheels would tend to reduce these troubles. In 1904 when advising the Corporation as to the type of truck to adopt on the Chesterfield tramways, the author held the same opinion of the faults existing in the bogie and short wheel-base trucks as he has endeavoured to lay before you to-day. He wanted the standard two-deck body mounted on a single truck with a long wheel base, and recommended the adoption of the only one at that time on the market, certainly not without some misgivings, for while the advantages were very apparent, the disadvantages would only develop in working, and no other Corporation had at that time adopted them from whose experience any information could be obtained. The result, however, of nearly three years' working with this type of truck has clearly demonstrated that a car mounted on a long wheel base gives the most comfortable riding owing to the great reduction of pitching and side oscillation; the body is also held in line, being supported practically throughout its length, and can in consequence be of lighter construction; the strain on body, truck, and track when running through points or round curves is largely reduced, and no case of derailment has occurred on this system unless through an obstruction on the track, and not a single axle has been broken.



VIENNA.

The long wheel-base trucks mostly in use in this country are called "radial" trucks—a better name would be "flexible" trucks, because they do not radiate in the geometrical sense of the word, and the author considers that in designing these the necessity for a minimum amount of flange friction on short radius curves has been made too much of, with the result that the trucks have been rendered unsuitable for high speed on a straight track. On all these cars the tractive force is applied at the centre of the truck frame through king pins, which are fixed only a short distance to the front and rear of the diagonal centre of same instead of at the axles, and the inner truck carrying the motors and brake gear, together with the axes, are free to move about these pins as centres subject to the controlling effect of springs or inclined planes, the result of which is that any end oscillation of the body and main frame, or tendency of the trailing motor to do more work than the leading motor will move the king pins off the central line of the track and put both axles out of square with the rails, in which position they will often remain with disastrous results to the tyre flanges. To get over this latter trouble a link suspension with gravity control has been recently put on the market, and is being tried on several lines, which certainly seems to fulfil its claims in this respect; but with such a delicate method of hanging the car body, the axles are more likely to be constantly slightly deflected, with the result that while the flange wear may be reduced, the constant grinding slip on the railhead will be increased.

Experiments are also being made with locking the inner trucks completely, and thus using an 8ft. 6in. rigid wheel base, and on one line having curves of 40ft. radius, cars with chilled wheels have been running successfully for some time, with much better results in the way of wheel-flange wear than when the axles were free to move, and, it is stated, without any appreciable increase of wear of the check rail on curves. The author is also experimenting in the same direction at Chesterfield, using a special V-shaped flange on the wheels, as designed for the above-mentioned tramway, and is inclined to think that this will be the ultimate form of the long wheel-base truck, with wheel centres spaced from 8ft. 6in. to 10ft. This is also the opinion of all Continental tramway engineers and builders of trucks whom I have had the pleasure of meeting during the last few weeks, and to whom I would like to express my thanks for their courtesy in placing every possible information at my disposal. The result of their experience may be thus summarised. They must have a long-bodied car with large platforms, on both of which eight or ten passengers are carried. They have tried the double-bogie car and find them to be too heavy, and both first cost and maintenance are too high. Cars with two single-axle swivel trucks have been tried, and while suitable for curves are most unsuitable for the straight track, owing to the tendency of the axles to remain out of square with a consequent excessive wear on the flanges. The practice has now settled down to the single four-wheel truck with a practically rigid wheel base of from 9ft. to 12ft., having a clearance between the axle box and horn cheek varying from 2mm. to 12mm, the axle being maintained in a central position on the straight track by link suspension of various designs, two of which are shown on the diagram,



NURNBERG.

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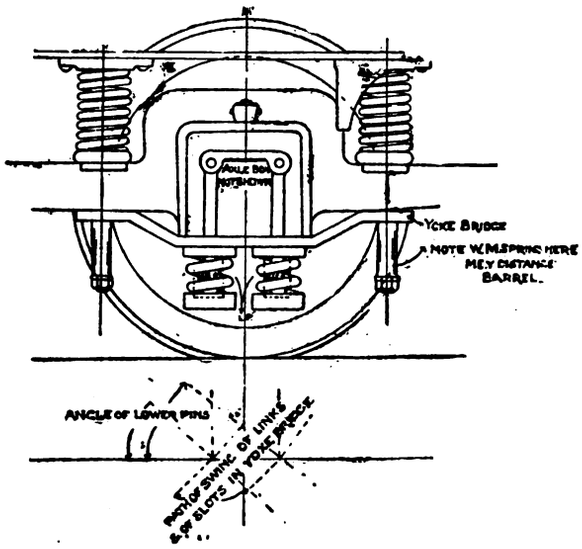
in conjunction with the Warner flexible suspension mentioned above. There are numerous important details of design in connection with the long-wheel base truck, all of which appear to have had the most careful consideration, but time does not permit of them being dealt with in this paper

No industry in modern times has attained such huge proportions in a few years as has been the case with electric traction in this country; every town wanted to be equipped at once, in order to be up-to-date; with the consequence that there has been no time for one line to carefully investigate the results of faulty designs on the forerunners, to improve on these and benefit thereby. One of the fallacies that has grown and flourished under these conditions in the past, was that tramway trucks could only be built in America, because it has been easier for tramway engineers simply to specify a certain make of American truck already in use, rather than to seek out the good and bad points of these, to design an improved one, and have it built in this country, so that details could be discussed with the makers. We can turn out some of the finest locomotives and rolling stock in the world, so that surely we are capable of building a good tramway truck, and more of the leading firms would give this all-important matter their attention provided tramway authorities are prepared to pay a reasonable price for a good article.



WARNER.

The rush of constructing new lines is over for a while, and now is the time for engineers to carefully consider what improvements can be made in truck design, as many of those running at present are not only knocking themselves to pieces but the track also. One of the chief results of such investigation will be, in the author's opinion, a greatly extended use of the long wheel-base truck.

DISCUSSION.

Mr. R. C. BULLOUGH, of Colchester, said that the author in his paper advocated several changes which would seem to reverse principles established in this country. A long-base car was all very well on a straight line, but it would not go round some curves. He could not understand how the cars advocated could get round the curves unless the axles were on flexible supports.

Mr. P. FISHER, of Dundee, asked how the author had arrived at his conclusions as to the relative amount of corrugation caused by steel-tyres and chilled-iron tyres respectively.

Mr. H. MOZLEY, of Burnley, gave a few details of a new car being tried at Burnley, which was put on the lines on the 10th inst. It was 37ft. 10in. long, and weighed 11 tons 14cwt. With a two-motor equipment it saved 3 tons 6cwt. of the weight of a similar car with four motors. There were only two axles, placed 18ft. apart. Each axle was carried on a bogie pivoted above the centre of the axle. It was claimed that this arrangement had very many advantages (10 in all). On each axle there was a differential gear. Results of the trials of this car were yet to come before the committee, but they were so far satisfactory.

Alderman SMITH, of Liverpool, defended the reverse staircase on tramcars. They had carried 700 million passengers on cars so designed, and he questioned the author's experience on the subject.

Mr. HILL, of Birmingham, gave details of his experience obtained under Mr. Baker. They had 150 radial trucks, and had had to correct for the tendency for these trucks to set themselves out of the square. With increased wheel bases, either there must be some flexibility in the axle support or else the grooves must be wider on the curves. For the six months from Jan. 1 to July 1 this year their cost of repairs to trucks had been as follows: 20 maximum traction trucks, £5. 6s. each; 150 radial trucks, £1. 16s. each; 100 rigid 6ft. wheel base trucks, 17s. each. It was only fair to state that the maximum traction trucks were 3½ years old while the others were new, and hence the cost of upkeep was not a fair average. It would certainly go up with age. The wheels with steel tyres ran for 20,000 miles before being turned up, and had a life of over 5,000 miles for ¼in. wear in diameter.

Mr. JAMES DALRYMPLE, of Glasgow, said they had decided in favour of longer wheel bases and were trying radial-axle trucks. He asked if the author had heard at Nuremberg that the long wheel base cars there had so damaged the track that it all had to be relaid?

Mr. MOFFAT, of Rugby, had had 8ft. 6in. wheel-base cars running since 1904. They could run 35,000 miles before turning up the wheels, and the tyres had a life of 55,000 miles. With bogie trucks the life was from 75,000 to 80,000 miles. He advocated long bogie single-deck cars.

Mr. ACLAND, in reply, said it was not the rigid axles at Nuremburg that had caused the excessive wear referred to, but the cars in which the axle supports were flexible. He quite agreed that with the long wheel base the wear on the curves would increase, but held that there would be such a reduction in the wear of the straight rails as to warrant the change.

Staff Organisation.

BY JAMES DALRYMPLE, GENERAL MANAGER, GLASGOW CORPORATION TRAMWAYS.

In considering this question I have had very great difficulty in deciding on a definite scheme of staff organisation to suit all municipal undertakings. Indeed, I consider it quite impossible to lay down a scheme that could be applied universally. I think there is no other municipal undertaking in which such a variety of systems has been adopted as in tramways; in fact, in speaking to the various tramway managers in regard to this matter it is scarcely possible to find two municipal tramway undertakings that are exactly alike in the organisation of the tramway staff. There are various reasons for this diversity. In the first place, the size of the municipal tramway undertakings in this country varies very much, and you can easily understand that a system of staff organisation that might be suitable for a large undertaking with an annual revenue of a million, could not be adopted on a system with a revenue of a few thousands.

Then, again, on systems of much the same size, a great deal depends on the way in which the undertaking was originally organised. In a great many cases, the last officer to be appointed for the new undertaking was the tramways manager; all the work in connection with the new department having been allocated to various officers of the Corporation before the man who was to be held responsible for the success of the new venture had a word to say on the matter. For instance, it was arranged that the power should be purchased from another department, and the price to be charged was fixed; again, the work of making new lines and the renewing and repairing of old lines was given into the care of another department of the Corporation, and, further, all arrangements in regard to the keeping of the books and accounts of the tramways department were fixed in such a way as to take it entirely out of the control of the tramways manager. I have said that there must necessarily be a difference between the staff organisation of a large and of a small undertaking, but I contend that no matter how large or how small the undertaking may be, the tramways manager should have full control, not only of the revenue-earning staff, but also of all expenditure, and should have every facility for keeping himself in touch with all branches of expenditure, although the actual work, in some instances, may not be carried out by his own staff.

Now, you may ask me the question: What would you consider the ideal organisation for a municipal tramways undertaking? In the first place, I should say that in every case the manager should have full control. In a large undertaking the manager should have under him three

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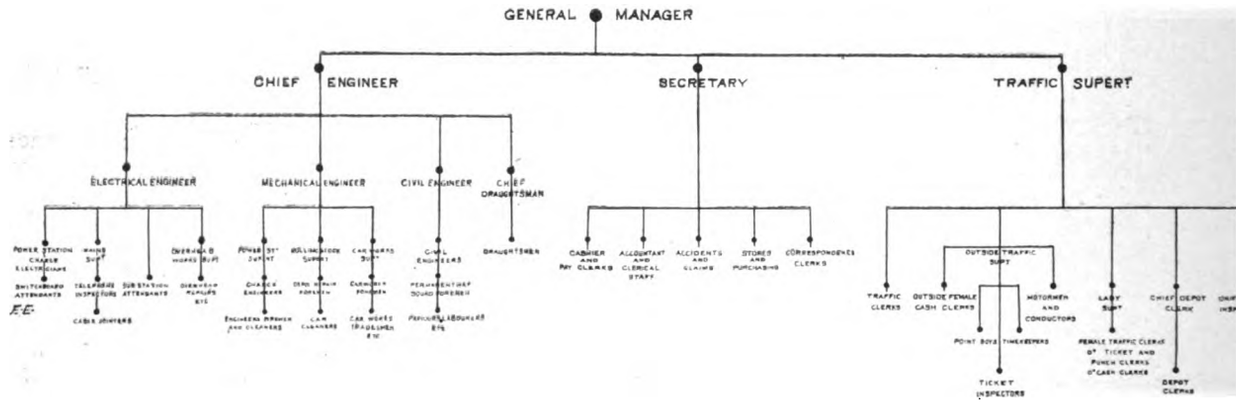
heads of departments—viz., an engineer, a traffic superintendent, and a secretary. It very frequently occurs that a tramways manager requires to arrange his work according to the men he may have at his disposal. For instance, instead of having one chief engineer in charge of the whole engineering departments, he may have a mechanical engineer, an electrical engineer, and a civil engineer, all independent of each other and directly responsible to himself. I am assuming, however, that the chief engineer has had an electrical, mechanical, and civil engineering training. Under this chief engineer, therefore, there will be in my ideal undertaking an electrical assistant, a mechanical assistant, a civil engineering assistant, and a chief draughtsman. Under the electrical engineer there would naturally fall all electrical work at the power station, sub-stations, cables, telephones, overhead equipment, etc. Under the mechanical engineer would naturally fall the power-station staff, car building and repairing staff at the workshops, and the care of the cars at the car-sheds. Under the civil engineer would come all the staff engaged in the construction and maintenance of the track. The chief draughtsman would require to work under the chief engineer in the preparation of plans, and, possibly, the care of buildings. The traffic superintendent would be directly responsible to the general manager, and would have control of the whole traffic staff, including inspectors, timekeepers, motormen and conductors, clerical staff in the traffic office and depôts, ticket and cash clerks, etc. Then the secretary would have general charge over the office staff, including the accountants, cashiers, pay clerks, stores



clerks, purchasing clerks, correspondence clerks, etc. This allocation of duties would embrace all the work of the tramways department, except the work caused by accident claims, which might be either put under the traffic superintendent or under the secretarial staff.

Of course, the organisation of the smaller undertakings must differ very widely from the above. In a small tramways undertaking, the manager very often has to be mechanical engineer, electrical engineer, and traffic superintendent all rolled in one. Then the question arises, Should the tramways department have their own power station? For all large undertakings I should certainly say there should be a separate tramways power station. For a smaller undertaking I should certainly say that the tramways department should purchase its power from the electric light undertaking where there is such a department under the municipality. Another question which has frequently been discussed is: Should the tramways manager have control over the track in regard to the making of extensions and renewals and repair work? I should say it would be a very small undertaking indeed in which it would be necessary to have this work carried out by another department of the corporation. The maintenance of the track is a very important part of a tramways undertaking, and it would not do to have this work carried out by someone not under the control of the tramways manager. I should say that in cases where this work is carried out by the borough surveyor, all work should be done at the order and to the satisfaction of the tramways manager. In regard to traffic work, I do not think there is much doubt in the minds of any of the managers how this work should be carried out.

Another question which I should perhaps touch upon is the accounting work. How much or little of this should be under the charge of the tramways manager? I think it is a matter of very little consequence how, or by whom, this work is done if the tramways manager can get every information, not only regarding his revenue, but also regarding every department of expenditure, whenever he wishes it. It is ridiculous to suggest that in commercial undertakings, where every item of revenue and expenditure must be carefully watched from day to day, that the man who is held responsible should only get such information as another officer of the corporation chooses to give him.

In large undertakings a thoroughly competent accounting staff is absolutely necessary, and it would be waste and folly to have the accounting work carried on in another department of the corporation, because, if this were done, it would simply mean that, if the tramway manager is to be kept thoroughly informed, the books and accounts must be kept in duplicate. In the smaller undertakings, it may not be necessary to keep an accounting staff in the tramway office, but I should say that, where there is no accounting staff under the tramways manager, the borough accountant should be in a position to give to him every possible information which he may wish. The borough accountant is, of course, the chief financial officer of the Corporation. He should take every means which he may consider necessary to audit the books of the tramways department, and to satisfy himself that all the financial transactions are correctly carried through, but I think it would be against the interests of the tramways department to allow any red-tape methods to stand between the tramways manager and the information he should have regarding the finances of his department from day to day or from week to week.

I trust that these remarks will be sufficient to introduce a useful discussion on the subject of "Staff Organisation."

At the general meeting on Thursday, Mr. J. Aldworth, tramway manager, Nottingham, was elected president for ensuing year. The following are the new members of council: Messrs. H. Mozley, Burnley; Jas. Dalrymple, Glasgow; C. J. Spencer, Bradford; and Peter Fisher, Dundee. Mr. H. G. Blain, West Ham, has been elected auditor.

It is likely that next year both the Incorporated Municipal Electrical Association and the Municipal Tramways Association will meet in Nottingham, both having elected presidents from that town.

(To be continued.)

ENGINEERING AND MACHINERY EXHIBITION.

The Engineering and Machinery Exhibition which opened at Olympia, London, on the 19th inst., and which remains open until Oct. 19, is somewhat limited in character; but as far as it goes it serves a most useful purpose in bringing together and focussing attention upon some of the more important of the recent developments in engineering. Captious critics may complain that the exhibition inadequately conveys an idea of modern practice in heavy engineering, or that the exhibits do not sufficiently repre-

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sent the extent of the various branches of engineering. These critics, however, should endeavour to form some estimate of the great extent of the multifarious industries which constitute separate domains in the vast realms of engineering and machinery (many of which are of sufficient importance to warrant the holding of separate exhibitions), and the impossibility of holding such a comprehensive exhibition within the confines of Olympia would at once become apparent. Moreover, if the great and far reaching advances made in engineering are to be seen in their true perspective, it is to the huge immovable works that have been executed in this country, in America, in Egypt, and elsewhere, or to the docks and vessels afloat, that attention must be directed, rather than to the examples to be seen at an exhibition, which, after all, show us but the means by which the greatest and most ingenious works are accomplished. Nevertheless, visitors to the Olympia Exhibition will note that at few stalls is to be seen machinery in motion—a defect which detracts somewhat from the educational value of the exhibition. The educational functions of an exhibition are of the greatest importance, and we hope to see at future displays that greater attention has been paid to the educational section, which shall comprise exhibits of the various parts of machines in common use.

The absence of classification renders the official catalogue of second-rate importance, either as a means of enabling us to group the exhibits or as a guide to visitors to the show. But a fact which must impress itself upon the mind of the visitor who has wandered round the stalls is the evidence afforded by numerous examples of the extended application of electricity to industrial purposes. Of purely electrical exhibits there are few, but on all hands are to be seen applications of electrical driving to machine tools, either through the means of belting, chain driven, or spur gearing.

Among prime movers, we notice exhibits from several well-known makers, chiefly of gas-engines. Messrs. Crossley Bros., Limited (Stand 266) show one of their "U.E." high speed electric lighting gas-engines, which will develop 49 e.h.p. as a maximum on town's gas, and 39 e.h.p. as a maximum on suction gas. This engine, coupled to a dynamo, and obtaining its supply of gas from a No. 3 suction gas plant, is used for lighting Messrs. Crossley's stand. Messrs. E. S. Hindley and Sons, of Bourton, Dorset, and 11, Queen Victoria-street, London, E.C., are showing (at Stands Nos. 233 and 248) some interesting specimens of their high-class gas and steam engines, including a "Hindley" vertical high-speed gas engine, direct-coupled to continuous-current dynamo, 15 kw., 200 volts at 600 revolutions, combined with one No. 3 "Hindley" suction gas-producer plant; also a vertical high-speed steam-engine, cylinder 7in. diameter by 7in. stroke, direct-coupled to continuous-current dynamo, 17½ kw., 200 volts, 450 revolutions. A gas-engine direct-coupled to a dynamo, and driven by suction gas, which is eminently suitable for the electric lighting of country residences, is shown by the National Gas Engine Company, Limited, of Ashton-under-Lyne The number of residences that are lighted through the means of isolated plants is by no means few, and the plant that is now available for this purpose bears evidence of great improvement. In this respect, attention must needs be called to the 5-h.p. De Laval steam turbine dynamo which Messrs. Greenwood and Batley, Limited, of the Albion Works, Armley-road, Leeds, are showing. This small but compact set takes up very little floor space, an important feature considering that it is commonly employed for the lighting of boats. Messrs. Reavell and Co., Limited, have on view a 5/3 D engine for electric lighting or fan driving, suitable for any pressure up to 140lb. per square inch, and developing 14 b.h.p. at this pressure. Another of their exhibits which may be singled out is their two-stage, water-jacketed, quadruplex compressor, with a direct-coupled motor by the General Electric Company of 45 b.h.p. The capacity of the machine is 230 c.f., running at 315 r.p.m. Especial interest attaches to the stand (Nos. 92 and 105) of Messrs. W. H. Allen, Son, and Co., Limited, of the Queen's Engineering Works, Bedford, both from the point of view of size and variety of exhibits. The first feature that meets the eye is a three-crank, three-cylinder, compound vertical enclosed high-speed engine, fitted throughout with a system of forced lubrication and suitable for dynamo driving in connection with electric lighting and transmission of power. The engine on view is capable of developing 300 b.h.p. at 450 r.p.m., and is suitable for steam pressure from 100lb. to 200lb. per square inch, condensing, or non condensing. The engine is fitted with valves of the piston type, and is so designed that it is impossible for oil to pass up into the cylinders or water into the crank chamber. The whole of the working parts are of Siemens-Martin steel, and all bearings are lined with white metal. A sensitive governor of the centrifugal type is fitted to the end of the crank-shaft and connected to the throttle valve. The engine is fitted with a valveless oil pump of simple design, fitted in the crank chamber and driven from the H. P. eccentric, oil being pumped continuously under pressure through all the bearings. Other engines similar in their details to the foregoing, but differing in size, are also shown. Messrs. Willans and Robinson, Limited, Rugby, at their stand (Nos. 29 and 32) are not showing types of their engines, but merely spare parts cast by their "Eatonia" process. Corresponding samples cast in the ordinary way clearly impress one with the advantages of the "Eatonia" process. A 17 b.h.p. gas-engine and suction plant coupled to a Lancashire dynamo by flexible coupling is shown by Messrs. Richard Hornsby and Sons, Limited, of Grantham and Stockport. The unique feature of the engine is in the design of the valves, which are all in sight, and can be easily got at without taking anything to pieces. The engine draws in the gas as it is required from the generator, and when the engine is not running there is no gas being made, and none is ever under pressure.

Dynamo and motor manufacturers are not much in evidence at Olympia, while some of those who, like the Phœnix Dynamo Manufacturing Company, Limited, of Thornbury Works, Bradford, Yorks, have stands are content with showing electrically-driven tools only. The range of sizes of patent laminated type, constant-speed, electric motors, and the J.-L., new design, three-phase motor showing by the Johnson-Lundell Electric Traction Company, Limited, of Southall, Middlesex, will not fail to attract many visitors to Stands Nos. 20 and 41. A special feature of the laminated type of motor is the fact that it requires so little space and at the same time combines many valuable properties. The armature winding is of the formed-coil type, each coil before being laid in its respective slot being thoroughly vacuum dried and then impregnated with a high grade of insulating compound, after which it is baked for a number of hours At each end of the armature is a fan-shaped casting, which circulates a steady breeze through the commutator and out through the air spaces provided in each end of the coils. The commutator is built up on an open spider. In order to effectively and economically collect the current and minimise the commutating spark the J.-L. Company employ a double brush. Messrs. Clarke, Chapman, and Co., Limited, Gateshead-on-Tyne, have on view an 8in. by 8in. diameter cylinder open-type engine coupled to a multipolar dynamo, capable of giving an output of 100 volts, 180 amperes, at 300 revolutions. This and another set represent this firm's display of electric generating plant. A 24in. and a 30in. projector are shown by the same makers. These projectors are of the horizontal automatic-feed type, which may be operated by hand, with lense. The mirrors are of standard parabolic type, made of glass and silvered, with protected backs.

In a later issue of this journal we will deal with other salient features of the exhibition, which is noteworthy for the varied and extensive display of tools, illustrating, at the same time, the adaptability of the electric drive. By that time we hope that all the work in connection with the exhibition will have been completed, and that exhibitors will have filled their stands with the models which they intend to display, thus enabling a truer estimate of the extent and importance of the exhibition to be formed. When we mention that nearly 100 firms who were not exhibiting last year are now present, and that many of those who were represented last year are now introducing new machines of the latest designs in engineering appliances, it will be evident at once that there is much to interest those who are directly or indirectly connected with the engineering industry. There is one aspect of the exhibition which

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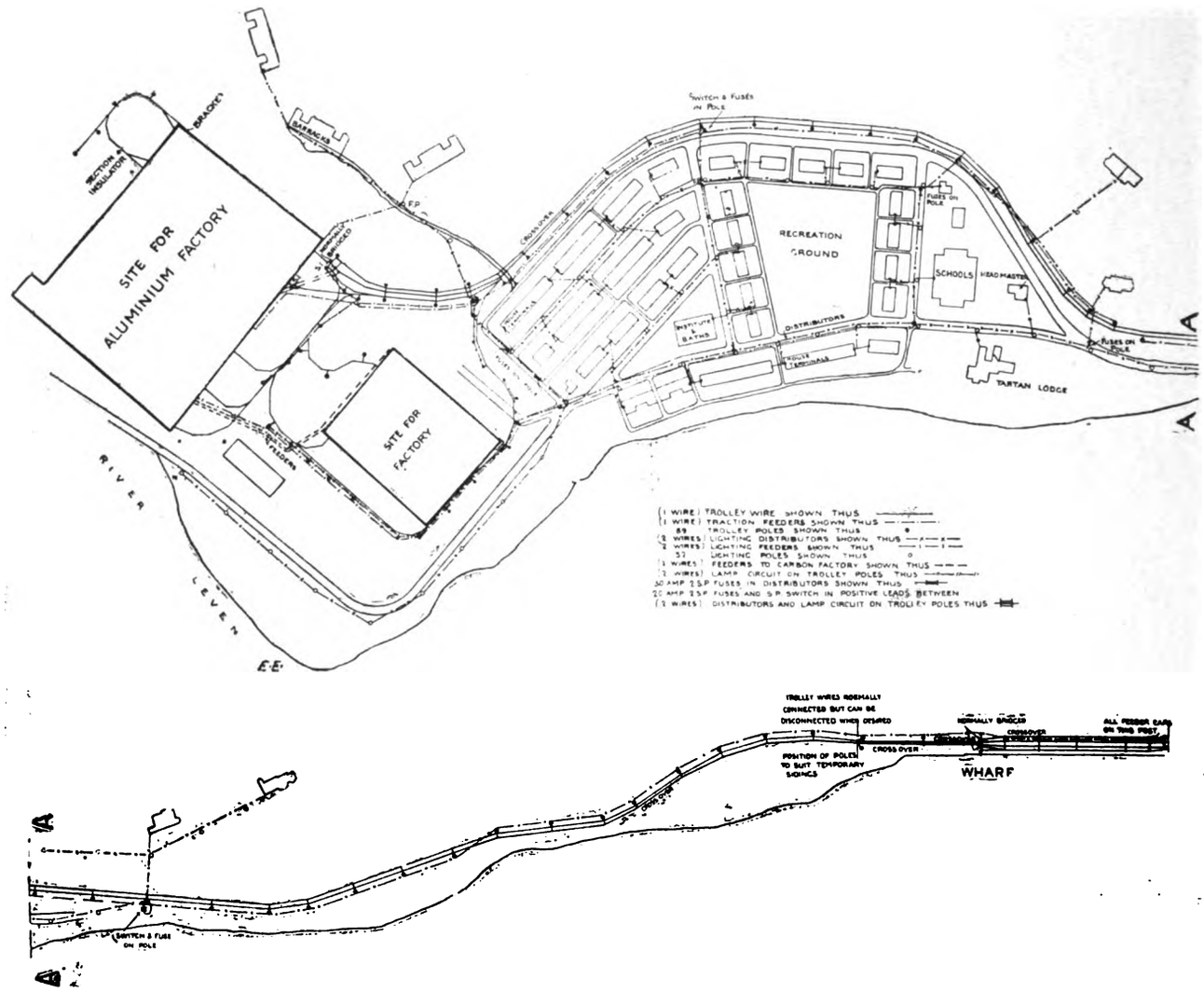
appeals strongly to all, and that is its benevolent object. As the result of the last exhibition a grant of £500 was made to the funds of the various benevolent institutions connected with engineering associations, and it is hoped that the present exhibition will be so successful as to enable an even larger sum to be available for the same purpose.

ALUMINIUM CABLES FOR THE LOCH LEVEN POWER COMPANY.

In our last week's issue we announced that Messrs. Johnson and Phillips had secured the contract for the supply of a quantity of aluminium cables to the Loch Leven Water and Electric Power Company. Through the courtesy of the consulting engineers to the company, Messrs. Kennedy and Jenkin, we are now able to give a few details as to the extent to which aluminium cables are being used in connection with this scheme. The block plan of the works reproduced herewith shows the general arrangement. Owing to the position of the works a tramway about 1¼ miles long is needed to bring materials from the wharf on the river to the power-house. Again, the company have to build all the houses required for the staff and workmen, and these are arranged as shown on the plan. The trolley wire for these tramways will be of copper, but the main and return feeders will be of aluminium. These involve some 500 yards of aluminium cable, and about 2,000 yards beyond this will be used in connection with the lighting of the tramway route, which will be carried out from the poles. For the lighting of the model village which is being erected for the workmen the whole of the feeders and distributors will be of aluminium. This section of the contract includes delivery and erection complete of all the lighting distributors and house service mains required for the electrical energy between the switchboard in the power-house and the several houses and buildings in the village or near by. As will be seen from the plan, three pairs of feeders are to be run from the terminals on the lighting switchboard to the system of overhead distributors, which are arranged as three separate circuits connected together through fuses placed on the poles. From the distributors house service leads are to be run to insulators to be fixed on each building, close to the house service fuse box. The working pressure between the positive and negative lighting 'bus bars is 250 volts, direct current. The feeders and distributing mains are connected on the two-wire system, and are to be insulated from earth throughout, as neither pole will be permanently earthed.

To show the quantities involved, there are some 3,700 yards of aluminium feeders needed for the scheme, 4,300 yards of distributors, and 1,200 yards of house service Messrs. Kennedy and Jenkin specify that all aluminium used in the stranded cables and other conductors is to have a conductivity of not less than 61 per cent. of the standard


SITE FOR ALUMINIUM FACTORY
SITE FOR FACTORY
RECREATION GROUND
SCHOOLS
HEAD MASTER
TARTAN LODGE
RIVER
LEVEN
SWITCH & FUSES ON POLE
SECTION INSULATOR
BRACKET
BARRACKS
CROSS OVER
FUSES ON POLE
INSTITUTE BATHS
DISTRIBUTORS
HOUSE TERMINALS
(1 WIRE) TROLLEY WIRE SHOWN THUS
(1 WIRE) TRACTION FEEDERS SHOWN THUS
59 TROLLEY POLES SHOWN THUS
(2 WIRES) LIGHTING DISTRIBUTORS SHOWN THUS
(2 WIRES) LIGHTING FEEDERS SHOWN THUS
52 LIGHTING POLES SHOWN THUS
(1 WIRE) FEEDERS TO CARBON FACTORY SHOWN THUS
(2 WIRES) LAMP CIRCUIT ON TROLLEY POLES THUS
50 AMP TSP FUSES IN DISTRIBUTORS SHOWN THUS
20 AMP TSP FUSES AND S.P. SWITCH IN POSITIVE LEADS BETWEEN
(2 WIRES) DISTRIBUTORS AND LAMP CIRCUIT ON TROLLEY POLES THUS
TROLLEY WIRES NORMALLY CONNECTED BUT CAN BE DISCONNECTED WHEN DESIRED
NORMALLY BONDED
CROSSOVER
ALL FEEDER CABLES ON THIS POST
POSITION OF POLES TO SUIT TEMPORARY SIDINGS
CROSS OVER
WHARF
SWITCH & FUSE ON POLE

adopted by the Engineering Standards Committee for hard-drawn high-conductivity commercial copper. The tensile strength of the aluminium used in the stranded cables and other conductors is to be not less than 11 tons per square inch, with an extension of not less than 4 per cent in 5in. The finished cables are to have the following sectional areas:

Aluminium cables.	Sectional area in square inches.	Number of strands and diameter of each strand in inches
Traction feeders, returns	0·196	37/·085
Earth cable from lightning arresters	0·100	19/·085
Lighting feeders to village	0·196	37/·085
,, barracks	0·100	19/·085
Feeders to factory	0·899	169/·085
Distributors	0·196	37/·085
Railway lighting	0·037	7/·083
House services	0.016	1/·144

Tests will be conducted to prove that this strength is obtained. As regards the joint, it is specified that all

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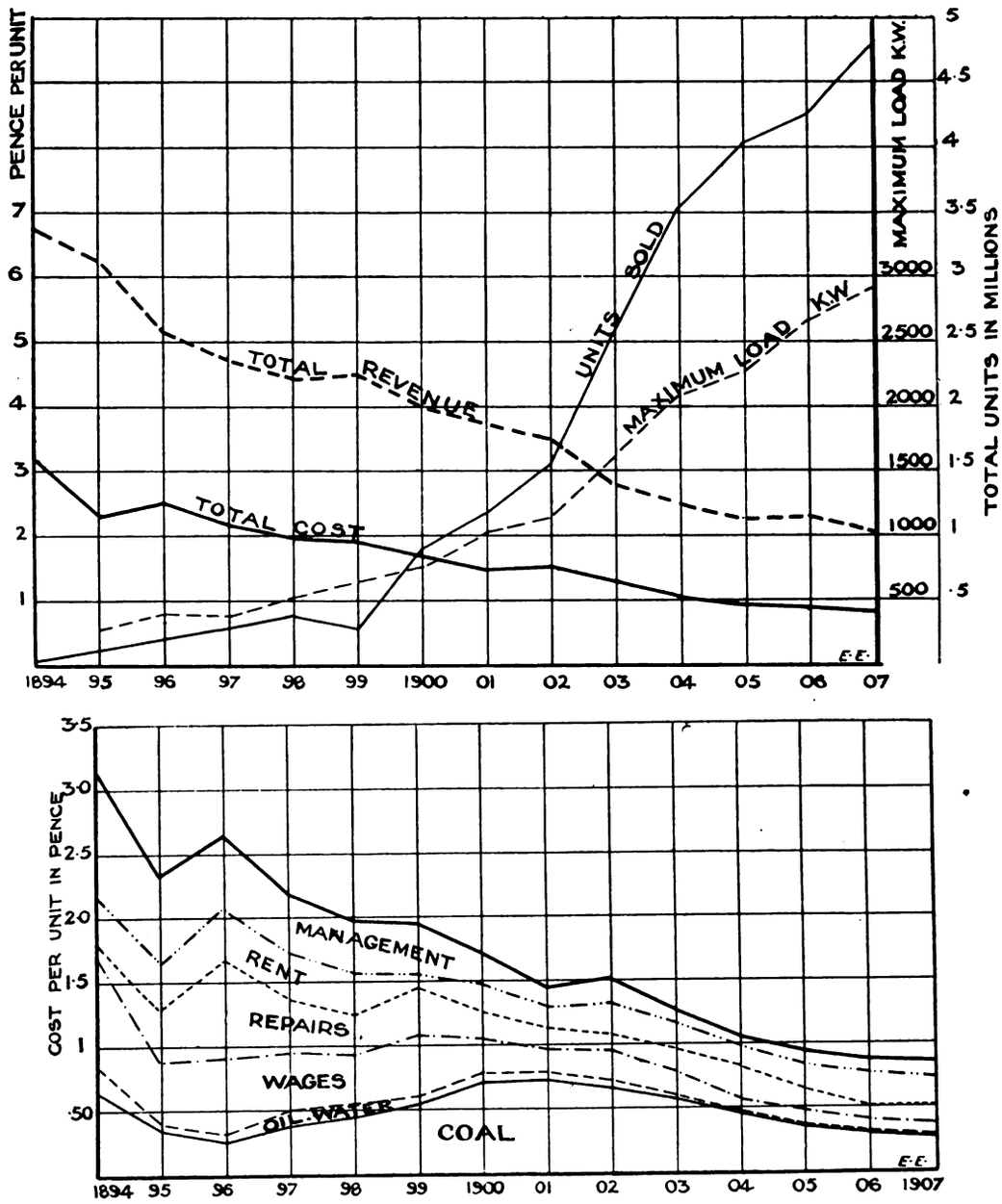
permanent joints between aluminium conductors are to be welded, the ends of the wires being butted together and enclosed in an approved metal mould into which molten aluminium is poured. After the mould is removed the joint is to be cleaned up and any roughness filed off. The joints between the feeders and distributors and at points where the distributors may require to be disconnected are to be formed by aluminium thimbles bolted together, and the thimbles are to be welded to the ends of the wires as described above.

When this installation is completed it will be the most extensive one using aluminium cables in the United Kingdom, and it will be interesting to inspect. With the wide fluctuations in the brass and copper it is difficult to tell when aluminium is or is not a more economical material to use It might be mentioned that Johnson and Phillips are getting the wire from the British Aluminium Co., who are connected with the Loch Leven Power Co.



ABERDEEN ELECTRICITY WORKS.

We referred in our issue of a fortnight ago to the progress made at the Aberdeen electricity works under the able management of Mr. Alex. Bell. The following is a report for the past year, together with curves showing the progress of the undertaking since its inception. Owing to the size of our paper we have only published the schedule for the past six years instead of for the whole period. The pleasant feature in this schedule is that of the growth of power; thus at Aberdeen the power and tramway units now outnumber those sold for lighting. One is apt to look at this rather too much from the central station point of view, and to forget that while the power units help the station a cheap power supply is of the greatest value to a town like Aberdeen. Mr. Bell's report reads:

Gentlemen,—I beg to present my annual report upon the working and progress of the electricity department for the year ended July 31, 1907.

General.—Proposals will shortly be put before you for the extension of the permanent buildings to avoid any further expenditure of money on temporary erections, etc., when the next extension of plant takes place. The parliamentary Bill promoted by the Town Council for extension of the electricity area, to coincide with the existing gas area, received the Royal assent on the 21st inst. Besides increasing our area so as to include the parishes of Oldmachar, Newhills, Dyce, Peterculter, and Nigg, powers have been obtained under this Bill to supply "in bulk," also to provide and hire motors, etc., and various clauses, usually incorporated with recent electricity Bills, have been obtained, all of which are expected to be of value to the department. The average number of staff on the books of the department during the year was 116.

Consumers.—The Great North of Scotland Railway Company completed their change over to our mains early in the year, and in addition electrically lighted Kitty-brewster and Waterloo Stations. The new theatre and the new post office were coupled up in December and January

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SCHEDULE A.—PARTICULARS OF UNDERTAKING.

Reference No.	—	One year to July 31, 1902.	One year to July 31, 1903.	One year to July 31, 1904.	One year to July 31, 1905.	One year to July 31, 1906.	One year to July 31, 1907.
1	Public arc lamps—number installed, including harbour arcs	235	281	289	296	304	306
2	Ditto—equivalent in 33-watt lamps	3,746	4,461	4,597	4,730	4,863	4,896
3	Private arc lamps—number installed	235	350	422	508	542	673
4	Ditto—equivalent in 33-watt lamps	4,342	6,220	7,711	9,321	9,920	12,349
5	Motors—number hired out	126	184	235	277	311	350
6	Ditto—(hired out), horse power	395½	593	768	886¼	1,058¾	1,194¼
7	Ditto—(private), number	95	118	173	198	213	248
8	Ditto—(ditto), horse-power	436	566	951	1,130	1,234	2,094½
9	Ditto—total horse-power connected	831	1,159	1,719	2,016¼	2,292¾	3,288¾
10	Ditto—total equivalent in 33-watt lamps	22,383	31,155	46,070	54,833	63,019	89,622
11	Heating—total equivalent in 33-watt lamps	1,153	1,540	1,789	2,632	3,856	4,299
12	Lighting—total equivalent in 33-watt lamps	69,849	83,151	93,934	101,461	111,099	124,043
13	Total connections—equivalent in 33-watt lamps (not including tramways)	101,473	126,327	154,000	172,977	192,757	235,209
14	Consumers connected—number	950	1,159	1,349	1,498	1,633	1,742
15	Capacity of machinery in kilowatts	2,440	2,440	2,814	3,390	3,810	3,860
16	Maximum load in kilowatts (including tramways)	1,183	1,682	2,080	2,295	2,633	2,912
17	Load factor	14·92 %	17·49 %	19·42 %	20·24 %	18·56 %	18·79 %
18	Miles of distributing cable laid	17·95	21·13	24·68	26·57	28·84	29·84
19	Ditto feeder ditto (length of one outer)	8·15	9·08	11·16	10·58	13·21	13·55
20	Ditto arc lighting ditto (length of single cable)	—	—	—	12·09	12·39	12·67
21	Ditto tramway feeder ditto (length of + and − feeders)	24·41	24·64	29·75	29·75	29·75	29·75
22	Total mileage of cable laid	—	—	—	78·99	84·19	85·81
23	Units sold to private consumers (lighting)	841,530	999,752	1,193,339	1,246,630	1,292,144	1,601,980
	Ditto ditto (power)	137,486	275,038	388,570	462,382	572,184	851,886
24	Ditto for public lighting	186,058	217,212	258,803	255,540	249,681	269,191
25	Ditto for tramways (Corporation)	381,495	1,085,306	1,686,653	1,960,548	2,000,143	1,922,388
	Ditto ditto (suburban)	—	—	11,661	144,831	166,096	149,062
26	Total units sold during year	1,546,569	2,577,308	3,539,026	4,069,831	4,280,248	4,794,507
27	Ditto generated during year	1,859,812	2,987,487	4,158,141	4,899,050	4,945,198	5,540,120
28	Pounds of coal and other fuel per unit sold	10·24	9·20	6·79	5·78	5·47	4 87

SCHEDULE B.—ANALYSIS OF COSTS IN PENCE PER UNIT SOLD.

Reference No.	—	One year to July 31, 1902.	One year to July 31, 1903.	One year to July 31, 1904.	One year to July 31, 1905.	One year to July 31, 1906.	One year to July 31, 1907.
29	Coal or other fuel, including cartages, etc.	·66	·55	·43	·35	·29	·27
30	Oil, waste, water, and stores	·06	·06	·03	·03	·02	·02
31	Wages	·22	·18	·12	·10	·10	·09
32	Repairs and maintenance	·16	·18	·23	·14	·10	·13
33	Works costs, including 29, 30, 31, and 32	1·10	·97	·81	·62	·51	·51
34	Rent, rates, and taxes	·22	·17	·17	·21	·27	·26
35	Management, salaries, insurance, etc.	·19	·13	·09	·09	·08	·07
36	Total costs	1·51	1·27	1·07	·92	·86	·84
37	Redemption of capital (sinking fund)	·35	·32	·27	·29	·30	·27
38	Interest on capital	·74	·53	·50	·45	·44	·41
39	Depreciation	·50	·47	·43	·40	·42	·40
40	Reserve	·42	·16	·24	·16	·22	·10
41	Profit (placed to reserve and depreciation)	·92	·63	·67	·56	·64	·50
42	Revenue from sale of current	3·43	2·69	2·49	2·20	2·22	2·00
43	Revenue from other sources	·09	·06	·03	·02	·03	·02
44	Total revenue	3·52	2·75	2·52	2·22	2·25	2·02

respectively, and the Rubislaw Quarries have, since the spring of the year, been entirely operated electrically. Schedule A shows that satisfactory progress is being made with power consumers. Owing to the university quatercentenary celebrations, the department was called upon to undertake a large amount of exterior illumination work. Coloured lamps to the number of 4,860 were erected in Union-street and on the town house alone, and two searchlights were fitted up. Many private consumers used electricity for exterior illuminations in connection with these celebrations. Additional lighting was required in all the public buildings used for meetings and entertainments during the week, and at all these functions the department had a man in attendance to cope with any trouble that might arise due to temporary wires and fittings. The Strathcona Hall was fitted with 814 lamps. I have pleasure in testifying to the satisfactory manner in which the staff carried out this additional work at a time of considerable pressure.

Mains.—Extensions of mains have given an additional frontage of supply of ·984 of a mile. Expenditure on repairs to the existing distributing system is greater this year, being approximately £140 above the average for the last three years. The Town Council has recently sanctioned the replacing of copper-strip culverts in Union-street section by cables, which, it is expected, will reduce our expenditure on repairs in the future. In my last report I was able to record immunity from breakdown for a period of 24 months on end of any section of the distributing system through cable failure. Two interruptions of supply, to sections only, have occurred during the year under review. On Aug. 7, 1906, Broad-street and King-street sections were without supply for an hour and a half, due to a failure in a triple concentric cable in Justice-street, and on May 21, 1907, Market-street section was cut off for 15 minutes due to culvert explosion in Union-street.

Station Plant.—A 390-kw. set, originally in the Cotton-street works, has been moved from the main engine-room to the temporary engine-room to allow of the installation of the 750-kw. set now on order. A 50-kw. set, also from Cotton-street works, has been compounded and erected in the main engine-room to deal with the early morning car load. A reversible booster for storage battery will be erected in the course of the next few weeks. Renewals to storage battery have been carried out this year, 20 cells being replated throughout and 20 fitted with new positive plates. As already reported to the committee, the renewal of plates will form an additional expenditure for the next

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two or three years. This expenditure has been borne out of revenue Boiler and feed pipe repairs have been heavier this year than usual. All station plant is in an efficient condition.

Output, Costs, etc.—The output for private lighting consumers is 309,836 units and for power consumers 279,702 units in excess of last year; 10,574 units were sold for exterior illumination during the university celebration week, 2,591 being for private consumers; as a special rate of 1½d. per unit was charged for this lighting, the department benefited by this load to the amount of £55 only; 131 private arc lamps and two public arc lamps have been added during the year. The most gratifying increase is that of motors; it will be noted that we have added 996 h.p. during the 12 months. Reductions have been made in our costs per unit sold under headings 29 and 31 in Schedule B—namely, for coal and wages. An increase in item No. 32 (repairs and maintenance) has, however, counterbalanced this reduction, and the works costs remain the same as last year—namely, ·51d. The total costs are down ·02d., and the average price obtained per unit for all classes of supply has fallen from 2·22d. to 2d. The reduction of prices last year has affected our revenue this year to the amount of £4,179.

Recommendations as to Charges.—As the committee are already aware, we have placed contracts for coal for our financial year ending July 31 next, and, due to enhanced prices, this item of our expenditure is estimated to be raised by some £2,200. The department is also committed to an expenditure of some £8,000 on the renewals of the feeder and distributor system in Union-street. Under these circumstances, I have no hesitation in recommending that the existing charges for electricity supply for all purposes remain the same for the ensuing 12 months.—I am, gentlemen, your obedient servant,

(Signed) J. ALEX. BELL.

WANTED—A TELEPHONE. HOW I GOT IT.

BY ONE O FIVE.

The following article cut from an Australian paper has been sent us by a friend, and, unfortunately, the name of the newspaper has not been included. It reminds us that when we installed the telephone the first entry in the official directory was useless for two reasons, as both name and address were incorrect. The *Electrical Engineer*, 139-140, Salisbury-court, E.C., was changed into *Electric Engineer*, Salisbury House, E.C. The Australian skit reads:

"Numbers of householders who are desirous of installing a telephone are deterred by ignorance of the departmental regulations and the fear of red tape. The procedure is really so simple that a few notes, forestalling the efforts of the proposed Post Office publicity department, may prove of interest to intending subscribers.

"The first step is to write to the Deputy P.M.G., stating the position of the premises, and asking particulars of the fees payable. By return post you will receive a printed card (Form X.O., 982), stating that your letter has been duly received and is having attention. This card is sent by the office boy, and has no real bearing on the subsequent proceedings.

"After this effort the department takes a brief rest to recover its strength, and then plunges into a series of abstruse calculations over a period of some weeks. The result of this mountain in labour is an absurdly inadequate mouse, in the shape of a circular (Form C.B, 67), informing you that your telephone will cost you £5 per annum for a maximum of 2,000 originating calls. If this startling example of departmental omniscience does not overpower you you may write to the D.P.M G., accepting his offer, and instructing him to proceed with the work.

"Within 10 days, or thereabouts, you will receive another circular (Form C., 1,546), requesting you to sign the attached agreement and pay 12 months' rent in advance. Having done this you may safely take a holiday.

"After an interval of, say, a month, it is as well to write to the D.P.M.G., pointing out that you have only a lease of the premises, and are, therefore, anxious to have the telephone as soon as is convenient. You will receive no reply to this (Form XY., 1,273, being out of print), but a few weeks later a very civil-spoken young man will present a half-gallon 'billy' at your back door, and request a little hot water for breakfast. If you direct attention to the size of the billy the man will point out two of his mates who are sitting on your roof and two others standing in an expectant attitude in your back garden, a sixth man will be found standing at the head of a linesman's handcart out in the right-of-way. The men on the roof are discussing where they will fix your telephone wire, while the men in the garden are waiting to catch them in case they roll off. This tends to show the perfection of the organisation which exists in all great Government departments.

"If the weather keeps fine the necessary wires will soon be connected, and nothing then remains but to obtain the telephone instrument. After waiting, say, two or three weeks without result, you should write to the daily papers, directing attention to the facts, and signing yourself 'Disgusted Taxpayer.' On the day following the insertion of your letter the 'official explanation' (Form XO., 73) will appear in a prominent position in the news columns. The explanation will set out that the Postal department is not to blame, since it ordered seven telephone instruments in 1904, but the demand has been so great that these have already been used. It will further explain that tenders are being called for 10 additional instruments, and arrangements are being made for prompt delivery. Again, it will state that all applications are dealt with strictly in order of priority, and as soon as the 1,196 back orders are completed 'Disgusted Taxpayer's' application will receive immediate consideration.

"The same day's evening paper will contain an interview with the Minister concerned, who will express regret that 'Disgusted Taxpayer' did not write direct to the department under his own name. The Minister will add that he is completely reorganising the department, and, although only nine months in office, he has already had two telegraph-poles repainted and a piece of orange peel picked off the steps of the G P.O. The interview will conclude with a statement that the Minister has 'called for a report.' This is a most arduous and dangerous undertaking, which cannot be safely attempted by anyone drawing less than £2,000 a year, with prospects of £200 increase.

"As the result of the publicity given to your case by the Press, a telephone instrument will be sent out to your house, and you must then act with the utmost circumspection if you would avoid disaster. Foolish people with no knowledge of departmental methods are apt to directly address the instrument-fitter, saying, 'I want the telephone placed here in the hall.' This, however, is a fatal mistake. The best way is to suggest, with due diffidence, that the telephone should be placed under the kitchen sink. The fitter will say that is impossible, and express his intention of putting it over the drawing-room mantelpiece. At this stage, with a little tact and a violently-expressed preference for the sink, you will succeed in having the instrument set up in the hall, where you wanted it.

"Your troubles are now over, and at the modest charge of £5 per annum, in advance, you have a piece of furniture which is an ornament to any house. In the event of your ever desiring to use your new telephone, you should first read the instructions most carefully, and, if you are connected to a suburban exchange, it is always as well to drop a postcard to the manager the day before you ring up. Attention to this little point will ensure the prompt attendance of an operator when you do ring, and you will then learn without unnecessary loss of time that the number you want is engaged.

"Three months, or thereabouts, after the telephone is installed your name (incorrectly spelt and with someone else's initials) will be duly inserted in the official 'Telephone Directory,' and earth will hold no further joys in store.

"It will be seen from this that installing a telephone is a perfectly simple operation, and, if due regard is paid to the hints here given, the whole thing can be fixed up within the year."

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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MUNICIPAL TRAMWAYS.

At the annual conference of the Municipal Tramways Association opened by the Lord Mayor at Manchester on Wednesday the presidential address dealt largely with the above subject. As Mr. J. M. M'Elroy states, there has been much written for and against the municipalisation of tramways. In the Tramways Act of 1870 it was provided that municipal authorities could acquire the tramways in their area after twenty-one years. In other words, if tramways were proved to be a real need and a profitable venture, they could be purchased without goodwill after the lapse of twenty-one years. No one disputes that they are a necessity, and their financial possibilities are attested by the keen fight made by company promoters against municipal ownership. It is too late in the day to fight over again the question as to how much we have lost in past years by the drag of the municipal veto, as much leeway has been made up. In some ways we may still be behind the States, but not in the tramway equipments of large towns. As Mr. M'Elroy states:

"In tramway matters, America has taught us many lessons. We certainly reaped the benefit of her pioneer work in electric traction. During my recent visit to the States I found we had little or nothing further to learn from them on matters connected with construction, equipment, and operation generally, but we *have* a very important lesson yet to learn in the way their populations are spread by the energetic manner in which the tramways are extended into districts absolutely unbuilt upon. There the tramway *precedes* the population. They do not wait until a district grows before they provide transit facilities. The facilities are provided first. And we must remember that these facilities are provided by private companies working for their selfish ends—the benefit of their shareholders. This is a lesson which the municipalities of this country would do well to bear in mind. It is a strong point made by the anti-municipalisers on the other side."

The tramways so built are used to exploit building sites and new residential areas, and this is not the proper sphere of a municipality, especially when the areas exploited are outside the boundaries of the tramway authority. From the remarks in the address as to the present effect of this local veto, it is clear that it now hampers local authorities quite as much as it has done companies in the past. The London County Council has found this to be the case, and so have many of the large towns. It shows, as we have often done in other matters, that the present municipal areas are too often unnatural and impede progress. The question is one which should be actively taken up, and some power given to the Board of Trade to dispense with the consent of an objecting authority under certain conditions. We will conclude our article by an extract from the report of the United States of America commission which investigated municipal working in this country and paid our authorities the compliment to state that: "We wish to bring to your consideration the danger here in the United States of turning over these public utilities to the present government of some of our cities. Some we know are well-governed, and the situation on the whole seems to be improving, but they are not up to the government of British cities. We found in England and Scotland a high type of municipal government, which is the result of many years of struggle and improvement. Business men seem to take a pride in serving as city councillors or aldermen, and the government of such cities as Glasgow, Manchester, Birmingham, and others, includes many of the best citizens of the city. These conditions are distinctly favourable to municipal operation."

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SMOKE NUISANCE.

It is always well to look at a difficulty from different points of view, and to many central-station engineers the smoke inspector has been a much bigger nuisance than the smoke. The engineer knows that his chimneys do produce at times a certain amount of smoke, but that this is exceedingly small compared to that issuing from the large number of private-house chimneys around. Complaints and summonses for smoke nuisances have to be attended to, and the time spent in trying to convince untechnical magistrates of the facts of the case is far from remunerative to the undertaking represented. The paper we reproduce elsewhere of Mr. William Nicholson, the chief smoke inspector of Sheffield, is a valuable one, and will repay careful reading. The most curious point is that he is satisfied with the present condition of the atmosphere in Sheffield as being so much better than it was fifteen years ago. We feel sure that if Mr. Nicholson with his standards of smoke nuisance could be sub-divided and distributed to act as smoke inspectors in other towns we should not find many complaints of smoke nuisance. We quite agree with him that much can be done to reduce the volume of smoke issuing from factory chimneys, and that it will pay the owner of the factory to make such changes as will reduce his coal bill and the smoke at the same time. It is, however, the private house chimney which is the largest offender, and here we are afraid that only a great increase in the cost of fuel will serve to remedy the present conditions, and to force householders to use economical stoves giving perfect combustion.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE LENTZ ENGINE.

SIR,—We notice in your issue of to-day's date that you illustrate a Lentz compound-tandem engine. We should esteem it a favour if you would kindly inform your readers in your next issue that we have the sole license from Mr. Hugo Lentz, of Berlin, for Great Britain, to manufacture his positive drop-valve shortened compound-tandem engine (as per your illustration), ordinary compound-tandem, coupled-compound, and also vertical engines—in fact, every description of stationary engine. We also have the sole license for the manufacture of the Lentz patent metallic packing.—Yours, etc.,

DAVEY, PAXMAN, AND CO., LIMITED.

Colchester, Sept. 20, 1907.

[Messrs. Davey, Paxman, and Co., Limited, also inform us that they have a large number of engines on order at the present moment, including five 500-kw. sets and four 250-kw. sets for one order, and, amongst others, a 1,200.h.p. engine for the City and South London Railway Company.—ED., *E. E.*]

RE QUESTION No. 992.

SIR,—Allow me to express my thanks for "M.'s" letter in your issue of Sept. 13.

I quite agree that "An ounce of practice is worth a pound of theory," but should not have thought, under these conditions, that the voltage produced by the self-induction of machine would have been sufficient to prevent any damage being done.

It would be rather interesting to know exactly how the machines described by "M." behaved, the type of circuit breaker employed, and the length of time which elapsed before the machines were again running normally, as 100 per cent. overload is rather a severe test to last any great time.—Yours, etc.,

A. I.

REVIEWS.

Hydraulics. S. DUNKERLEY, D.Sc., M.I.C.E., M.I.M.E., Professor of Civil and Mechanical Engineering in the University of Manchester and Director of the Whitworth Laboratories. In two volumes. Longmans, Green, and Co., 39, Paternoster-row, E.C. 10s. 6d. net.

The subject-matter of this book treats of hydraulics and hydraulic machinery. The notes, which form the foundation of the book, were written at the Royal Naval College, Greenwich. The lectures given on hydraulic machinery, and also on the resistance and propulsion of ships, were a very important part of the course for engineers and contractors. The first volume deals with the former subject; a second volume will treat of the latter. Included in the contents are the following: first chapter—the flow of a perfect fluid; second chapter—fluid friction; third chapter—pressure machines; fourth chapter—reciprocating pumps; fifth chapter—turbines; and in sixth chapter—centrifugal pumps. In the first part of each chapter the theoretical considerations are fully discussed; and in the second part numerous illustrations of machines have been given; a number of numerical examples being added at the end of the book. The chief features of the present volume are: full details of the hydraulic gun brake as applied in his Majesty's ships; Prof. Osborne Reynolds's four-stage turbine has been discussed and results of trials given; full details, with sectional drawings, of Prof. Osborne Reynolds's "hydraulic brake" and "four-stage centrifugal pump."

THE USE OF THE SYNCHRONOUS MOTOR AS PHASE COMPENSATOR.*

BY R. E. HELLMUND.

The possibility of running a synchronous motor with leading current naturally suggests the use, where possible, of such motors on lines which supply a large inductive load, in order to compensate for the wattless currents thus caused. There is no doubt such an arrangement is advantageous when the power station is at one end of a long line, while the energy consumers are at the other end.

Consider now the case (Case I.A) in which a power of 1,000 kw. is to be transmitted a distance of about five miles. The nature of the power consumers may be such that 500 kw. is taken by a large synchronous motor, while the rest of the power is supplied to induction motors. The combined effect of the induction motors and their transformers may be such that a lagging current with a power factor of 70·7 per cent. results. In order to reduce the line current to a minimum, the synchronous motor will have to be operated with a leading current of the same power factor if it is direct connected to the line. The rating of the synchronous motor required is then approximately given by the load it will carry divided by the power factor, and will, therefore, be $\frac{500}{\cdot 707} = 707$ k.v.a. The capacity of the alternators at the power station should be

$$\frac{1{,}000}{\cdot 80 \times \cdot 90} = 1{,}390 \text{ k.v.a.}$$

if the efficiency of the consuming plant is assumed to be 80 per cent. and that of the line 90 per cent. If under these assumptions the potential at the consuming plant is 6,000 volts, the wire required for the transmission line will be 0 B & S., and its weight will be 25,000lb. The main parts of the transmission system will have the following ratings:

Generators	1,390 k.v.a.
Synchronous motor	707 k.v.a.
Induction motors	500 kw.
Total in machine investment	2,597 kw.
Total amount of line copper	25,000lb.

This is assuming that the size and cost of the induction motors is about proportional to their output in kilowatts, which is approximately the case.

Consider now the case (Case I.B) in which the same power is to be transmitted, but that all power is used by induction motors, and that the induction motors have an average

* Extracted from the *Electrical Review* of New York.

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power factor of 70·7 per cent. The rating of the alternator should then be $\frac{1,000}{\cdot 80 \times \cdot 90 \times \cdot 707} = 1,965$ k.v.a., the same efficiencies as before being assumed. The wire required for the transmission is now No. 00 B. & S., and its weight will be 33,000lb. The main parts of the transmission system will be :

Generators	1,965 k.v.a.
Induction motors	1,000 kw.
Total capacity in machine investment	2,965 kw.
Total amount of line copper	33,000lb.

If we compare this with Case I.A, we find that, assuming the same efficiencies, we may save $2,965 - 2,597 = 368$ kw. in machine investment, and $33,000 - 25,000 = 8,000$lb. of copper by means of the synchronous motor. The amount of capital investment that may be saved in this way by the use of synchronous motors has caused a number of engineers to assume that the use of synchronous motors is advantageous in all cases, and to choose them so that their use is not at all advantageous or only so in a limited way

Consider, for instance, a case (Case II.A) in which, again, 1,000 kw. must be transmitted as before, but where only 100 kw. of the load are suitable to be driven by a synchronous motor, while the remaining 900 kw. must be induction motor load. If other conditions are as before, the total induction motor current will be

$$\frac{900}{\cdot 80 \times \cdot 707 \times 6,000 \times 1 \cdot 73} = 153 \text{ amperes,}$$

and the wattless current will be 108 amperes. The watt current of the synchronous motor will be

$$\frac{100}{\cdot 80 \times 6,000 \times 1 \cdot 73} = 12 \text{ amperes.}$$

If now the synchronous motor is, as frequently done, designed to take care of the total wattless current of the induction motor load, its total current will have to be

$$\sqrt{12^2 + 108^2} = 114 \text{ amperes,}$$

and it will run with a power factor of

$$\frac{12}{114} = \cdot 105.$$

Its rating will, therefore, have to be

$$\frac{100}{\cdot 105} = \cdot 955.$$

The generator will have to have a capacity of 1,390 k.v.a., as in Case I.A, and the weight of the transmission copper will also be the same. The main parts of the transmission system will be :

Generators	1,390 k.v.a.
Synchronous motor	955 k.v.a.
Induction motors	900 k.v.a.
Total in machine investment	3,245 kw.
Total amount of line copper	25,000lb.

Now compare this with Case I.B, in which no synchronous motors have been used. We see that although 8,000lb. of line copper may be saved by the use of the synchronous motor, this apparent advantage must be paid for with an additional machine investment of $3,245 - 2,965 = 280$ kw., and it is obvious that in this case the instalment of the synchronous motor is hardly advisable. Some advantage might be secured for Case II.B by using a synchronous motor if the power factor be about 70·7. Such a motor would compensate a wattless current of

$$\sqrt{\left(\frac{\cdot 707}{12}\right)^2 - 12^2} = 12 \text{ amperes.}$$

Then the line would have to carry $108 + 12 = 120$ amperes watt current and $108 - 12 = 96$ amperes wattless current and 153 amperes total current. The wire required for the line would be No. 00 B. & S. and its weight 33,000lb. The capacity of the alternator should be

$$153 \times 6,600 \times 1 \cdot 73 = 1,750 \text{ k.v.a.}$$

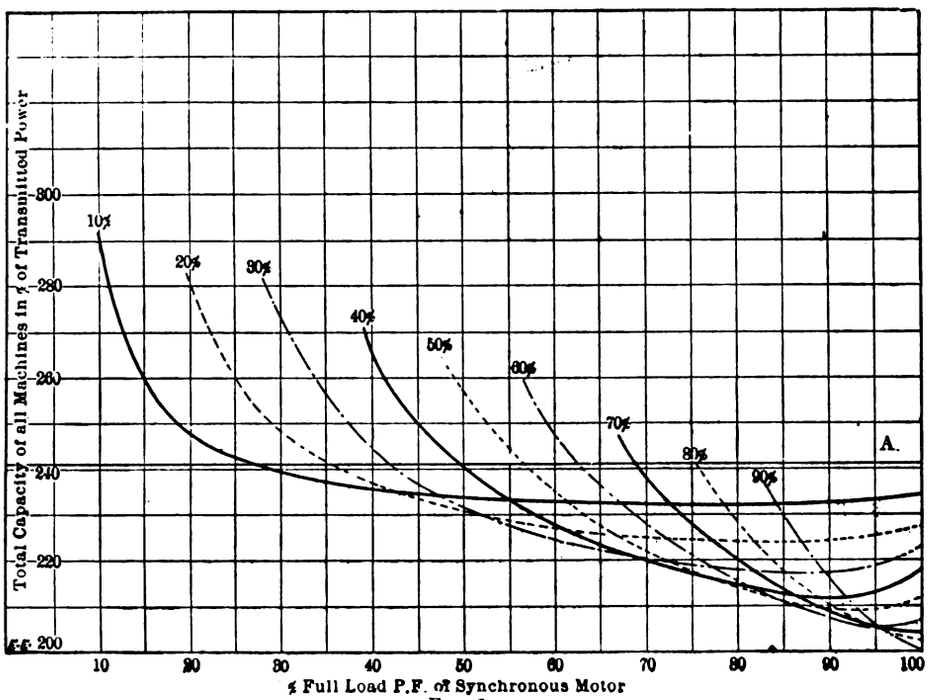

FIG 1.

and that of the synchronous motor

$$\frac{100}{\cdot 707} = 142 \text{ k.v.a.}$$

The main parts of the transmission system will, therefore, be :

Generators	1,750 k.v.a.
Synchronous motor	142 k.v.a.
Induction motors	900 k.v.a.
Total in machine investment	2,792 kw.
Total amount of line copper	30,000lb.

If this be compared with Case I.B, it is seen that $2,965 - 2,792 = 173$ kw. in machine investment have been saved by the use of the synchronous motor running with 70·7 power factor. This Case II B shows that some advantage may be secured by using synchronous motors, even if the load which can be taken care of by the motors is only a small percentage of the total load, but that it is necessary to consider the conditions carefully in order to make the right choice of the synchronous motor, and that it is not always advantageous fully to compensate the wattless current in the line and generators.

The question then is for what full-load power factor should the synchronous motor and the alternator be installed in each particular case, in order to obtain a minimum cost for a certain condition. It is obvious that conditions in

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practice change too much to make it possible to give a general rule. However, in the following it is endeavoured to discuss a series of cases covering the condition which occur most frequently in practice and from which it will be possible to draw some general conclusions. In all the instances given, it will be assumed that the power factor for the inductive load is 70·7, this being a value which represents a fair average for plants with induction motors, and being at the same time convenient for calculation, since it gives watt current and wattless current of equal amplitude. The curves in Fig. 1 give the total machine ratings which are required in per cent. of the power to be transmitted as a function of the full-load power factor, for which the synchronous motor is chosen. The curve for 10 per cent., for instance, gives these values under the assumption that 10 per cent. of the total load may be taken by synchronous motors; the curve marked 20 per cent. is calculated under the assumption that 20 per cent. of the total load may be synchronous motor load, etc. The straight line A gives the total required machine capacity under the assumption that only induction motors are used. It will be noticed that all curves given reach a minimum value of the total machine capacity for a certain power factor of the synchronous motor. This value, however, is not necessarily the point for which the minimum capital investment may be obtained. It may be that the nature of the transmission is such that the generators run with a much lower speed than the motors, and that, therefore, the price per unit of generator capacity is much higher than that of the motors, and *vice versâ*. Of course, if this is the case it should be taken into consideration. Besides this, the cost of the line copper and that of the transformers, if such are used between the generator and synchronous motors, should be taken into consideration. This can be done in a comparatively simple way. We know that the weight and cost of the line copper is proportional to the generator capacity; the same is true in regard to the transformers at the generator station and all other transformers which are used for the inductive load and the synchronous motors at the same time. If a transformer be used for the synchronous motor only, its capacity and cost are proportional to the size of the synchronous motor. We may, therefore, make a distinction between a group, A, of apparatus and materials the cost of which is proportional to the output of the generators in kilovolt-amperes, and another group, B, of apparatus the cost of which is proportional to the full-load output of the synchronous motor divided by the full-load power factor of the same. In any problem of the kind under consideration, the first thing to do is to find out approximately the total cost of the apparatus in group A per kilovolt-ampere of generator output, and the total cost of the apparatus in group B per kilowatt output of the synchronous motor divided by its power factor. This is comparatively simple, since the approximate size and the speed of the machines is mostly given from the beginning. After this the following coefficient may be found:

$$C = \frac{\text{cost of group A per unit}}{\text{cost of group B per unit}}.$$

The following table will give approximately the most favourable values of full-load power factor for which the synchronous motor should be chosen:

Synchronous motor load in per cent. of total.	Coefficient C. 2	1·75	1·5	1·25	1	·75	·50
10	·30	·40	·60	·65	·75	·80	·90
20	·50	·60	·65	·80	·90	·90	·90
30	·70	·70	·80	·90	·90	·90	·90
40	·90	·90	·90	·90	·90	·95	·95
50	·90	·90	·90	·90	·90	·95	1
60	·90	·90	·90	·95	·95	1	1
70	·95	·95	·95	·95	1	1	1
80	1	1	1	1	1	1	1
90	1	1	1	1	1	1	1
100	1	1	1	1	1	1	1

In using this table it will be well to keep in mind that the choice of a power factor slightly differing from those given in the table does not change the cost of the plant much. This may be seen from Fig. 1, which not only gives the machine capacities, but also the cost for C = 1. It will be seen that all the curves are very flat near the minimum value. If, therefore, special reasons arise which make it desirable to have the generators as large as possible, this may be done without much additional expense by choosing the synchronous motor power factor somewhat lower as given in the table and *vice versâ*.

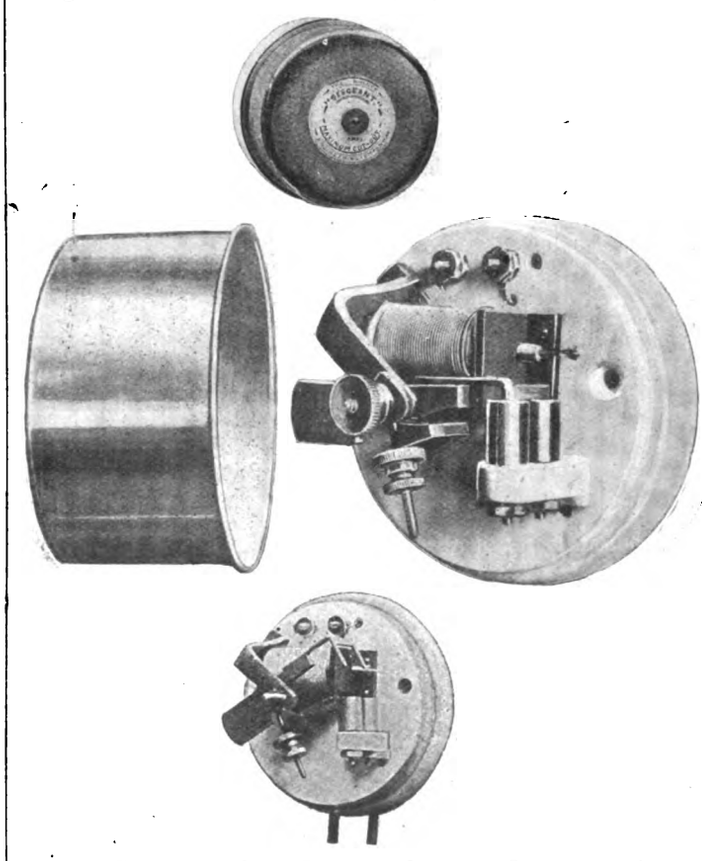
After the power factor for the synchronous motor has been chosen the exact capacity and cost of the various parts may easily be determined. Then, as a rule, it is advisable to figure also the cost of the plant under the assumption that induction motors are used in place of the synchronous motor. In a good many cases, especially where the capacity of the synchronous motor can be only a small percentage of the total capacity of the plant, it will be seen but little can be saved by the use of the synchronous motor, especially if the more expensive starting devices required are taken into consideration. Even though a small amount may be saved by using synchronous motors in many cases, it is not advisable to use them if the much simpler and safer way of starting and operating induction motors be given the consideration it deserves.

In some cases the use of a synchronous motor may be advantageous for the operation of the system on account of its tendency to improve the potential regulation. If, for instance, a sudden increase of the inductive load decreases the potential of the alternator, the synchronous motor will draw automatically a larger wattless current, which has a tendency to increase the alternator potential. The drop of the alternator will, therefore, be smaller than it would if no synchronous motor were on the line. In the same way a synchronous motor counteracts a rise of potential. As another advantage of the synchronous motor may be mentioned its constant speed feature, which, however, is of practical value only in certain cases.

Of course, the exactness of the conclusions drawn from the above considerations may be largely affected by special conditions, but for ordinary situations they will give quickly a general idea of what machines should be chosen.

THE "SERGEANT."

A novel device which is largely used abroad and is being introduced into this country by the Warner Engineering Company, of 11, Dartmouth-street, Queen Anne's-gate, S.W., and known as the "Sergeant," is illustrated herewith. In this apparatus a bridge piece spans two



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mercury cups, and this bridge piece by a simple arrangement of an electromagnet is raised out of the cups whenever the current passing through the magnet exceeds a defined limit. The difference between this apparatus and the similar well-known form of cut-out is, that while with the latter the interruption is maintained as long as the excess of current, in the "Sergeant" the magnet is in series with the break, and no sooner has the break taken place than the bridge-piece drops and remakes the circuit. It will thus be seen that the bridge-piece jumps up and down when there is an excess of current, giving a rapid series of interruptions without such a complete break of the circuit as an ordinary fuse would give.

The principal use to which the "Sergeant" is being put is to limit the use of current in workmen's dwellings, the idea being to wire a workman's dwelling for four or six lamps, and without the use of meters to limit the supply to two or three lamps alight at any instant. It is claimed by the makers that by substituting a "Sergeant" for a meter costing several pounds and expensive to maintain, four 8-c.p. lamps, limited to two alight at one time, can be supplied in a small office or dwelling for 6d. per week, the consumers finding their own lamps. Many other uses naturally suggest themselves for this compact piece of apparatus, and the claim of the makers that by its use every supply engineer can add 20 per cent. of small consumers to his roll seems justified. The base is of glazed porcelain, while the whole is of first-class workmanship, and so arranged that when covered by the complete metallic shield it may be sealed with the supply company's seal, so as to render tampering practically impossible.

PRACTICAL SMOKE ABATEMENT.*

BY WM. NICHOLSON.

The smoke nuisance unlike many nuisances is practically inodorous, silent, is not a fad or fancy but a flagrant fact, and can be seen and felt daily. It has been with us since the introduction of coal, centuries ago. When coal was introduced into London there was a very popular and powerful protest against its use, for the people then declared that smoke was prejudicial to health. The pronouncement of that fact was prophetic, in the absence of positive proof. Its use was prohibited, for a period, during the sittings of Parliament. Its cost made it a luxury possessed only by the comparatively few. Then the damage done was small, but rapidly its value was realised; as a fuel, it had no rival, and its use became general both for trade and domestic purposes. There was with the increased use the increased nuisance, the people were almost smothered with smoke: they protested and protested and at last prevailed. In 1819 a select committee was appointed to inquire into the question, and the result was practically nothing. Another was appointed in 1843 (24 years, a rather long interval), another in 1845, and a report in 1846. The Towns' Improvement Clauses Act came into existence in 1847, and 14 large towns in England proceeded under it *re* the consumption of smoke; in 1855 another report, and in 1866 a letter was addressed to large towns *re* the question of smoke.

In 1875 (nine years later) the Public Health Act was passed, and since then a very long interval of 32 years, and heaven alone knows when the Government will take action again to stop unnecessary smoke. If the nuisance then demanded drastic measures when in comparative infancy, are not measures now needed a thousand times more drastic? The nuisance is national, as proved by the coal consumption in this country of 150,000,000 tons annually, 50,000,000 of which might be saved (says the Royal Commission on Coal Supplies) if a sensible and scientific system were adopted in the burning of the said fuel. If we take the United Kingdom with its (about) 20 millions of chimneys, each pouring out volumes of smoke of a larger or lesser degree, we have a very inadequate conception of the extent of atmospheric poisoning by these acres of crape, which consist of millions of tons of dirt, and the Public Health Act gives power to compel owners of furnaces and fireplaces to prevent these emissions as far as practicable, and even greater power, for smoke emitted of a given quantity is a nuisance, and the court has power to make an order to abate nuisances whether practicable or not. This legal aspect we will look at later. For 15 years after the passing of the 1875 Act it was a dead letter as far as smoke was concerned, the health authorities refusing for various reasons to use the power given them, the chief probably being that they were not the greatest sufferers, being able to leave the nuisance in the evening, and live in districts not smoky. The greatest sufferers from air pollution are the poor people who are compelled to live in the districts where the large works are situated. They are continually in an envelope of smoke, very little sunshine, showers of dirt, and the women in these districts some of them slavishly struggle on against the dirt demon until they find it hopeless to conquer. They give up in despair, and no wonder. Then follows demoralisation of an incredible kind, disease, and dirt. The poor people's health should be considered, for it is their wealth, their only capital, or stock-in-trade. Better housing, food, clothing, education, and a thousand other things are absolutely necessary, but are not one whit more important than pure air for the physical, intellectual, and moral well-being of the people. The marvel is that the poorer classes of the women of England, who are the greatest sufferers and are responsible for the cleanliness of the home, have remained silent and slaves to the dirt demon so long. But the day is not far distant, or it ought not to be, when there will step out of the smoke-laden streets real suffragettes—women who have suffered long enough— who will march to Westminster and demand from the Legislature, not a vote, but a stoppage of this wholesale atmospheric vitiation; and if this is to be accomplished, women will have to play an important part, for men in general are most apathetic in the matter. In fact, they glory in and love a good smoke—if not coal, tobacco.

In June of this year a leading London paper said: "We know few greater benefactors of the community than Sir W. B. Richmond. He is a great artist, but he has a greater title than his art to our gratitude He has for years fought a wrestling battle against the smoke evil in London, and we wish others would join him with equal enthusiasm in this great crusade against one of the worst and unnecessary evils of our London life." I am sure we one and all most warmly welcome Sir W. B. Richmond amongst us at this congress, greatly appreciate the good work he has done, are pleased to hear his wise words, and heartily join him and his association and kindred associations in such a laudable crusade. Sheffield has won a world-wide reputation for many things, but specially for its steel and smoke. With reference to the latter it was true 18 years ago, for the city was almost full of smoke, and the people almost smothered by it. A number of gentlemen who were determined to put an end to this state of things, led by the late Sir W. C. Leng, editor of the *Sheffield Daily Telegraph*, formed a smoke abatement association, which did excellent work. The result was the appointment of additional smoke inspectors by the Corporation, the most drastic steps being taken to stop the smoke without interfering with the trade, and Sheffield to-day does not occupy the premier position for smoke Such public service rendered by gentleman who are not compelled to live in smoky districts deserves admiration, but the time has now arrived when there ought not to be any necessity for such service. The said association is now non existent, because the Sheffield Corporation is doing its duty on this question—in fact, some think it is doing a little more. With the object of inducing other responsible authorities to do likewise, I purpose considering the question from the practical point of view—viz: coal smoke, the effects, the cost, practical abatement, smoke from boilers, furnaces, fireplaces, smoke law, and its amendment and administration.

Coal Smoke.—Smoke is the sooty exhalations that escape from burning materials into the atmosphere, and is matter undoubtedly in the wrong place, the proper place being the furnace. Coal smoke is coal converted from the solid carbon to the gaseous state The colours are black, brown, grey, and various other colours, according to the treatment of the

* Abridgement of paper read before the Llandudno conference of the Sanitary Inspectors' Association by the Chief Smoke Inspector of Sheffield.

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fuel in the furnace; it is waste heat, and the result of incomplete combustion. To prevent the formation of smoke the furnace temperature must be about 1,000deg. C., at which oxygen combines with carbon and with hydrogen. The oxygen in the air supplied should be brought into the closest possible contact with the fuel, both as coal and as gases from the coal. The air supplied should be sufficient (about 15lb. to each pound of coal) to convert carbon and oxidisable carbon compounds to carbon dioxide. This is a complicated process, as coal is a variable mixture of substances, which have to be gasified and reduced to a free state of division before oxygen highly diluted with nitrogen can combine with them. One pound of coal uniting with the oxygen to form carbon dioxide (CO_2) liberates, in round figures, 14,650 B.Th.U., which is practically perfect combustion. But when the said conditions do not exist and smoke is formed—viz, carbon monoxide (CO)—then only 4,400 units are utilised, which is an abnormal waste of heat. The number of solid particles of carbon, smuts, soot, etc., determine the density of the smoke, and the duration of its emission depends on the amount of fuel which the fire is fed with in excess of the necessary air to oxidise it. It is most advisable to have an automatic (CO_2) recorder if coal combustion and smoke prevention is to be carried on with economy. The chemistry and physics of combustion is a very big and difficult subject, and to deal with it in detail is entirely outside the scope of this paper.

Effects of Smoke.—The clouds of coal smoke which cover our cities and towns produce millions of tons of vitiated air, as analyses of the atmosphere have positively proved. In Manchester during a three days' fog there was deposited on every square mile 1½cwt. of sulphuric acid and 13cwt. of smuts, but in Chelsea, under like conditions, the deposits were eight times as much. This seems almost incredible, but analysis would prove that other cities, and even London, were no better, except Sheffield, which city repented in sackcloth and ashes a few years ago, and reformed. It shuts out sunlight, which is a most benign influence in human life, for without it a man is fitted for treason, stratagem, or anything else. It is the father of at least 30 per cent. of the fogs, and these deleterious gases must be breathed, unless we take the advice given by a man to his wife who complained of pain when she breathed, and he said to her, "Well, don't breathe, love"—and he might mean it. We must breathe it, and our medical men (whom we warmly welcome in this crusade) say "that the lungs of city men, instead of being of a pinky colour, are black; and not on the surface only, but down to the depths." The International Committee on Physical Deterioration say, "It plays a great part in undermining the national health." The London County Council have decided to open an out-of-door school in the country for the weakly children, which is a most commendable step, for the smoky, sunless atmosphere contributes largely to infant and adult mortality. The deluge of dirt produces depression, leads to drink, demoralisation, disease, and death; does incalculable harm to plant life, disfigures, defaces, and damages property, and everything else it comes in contact with.

Cost of Smoke.—Smoke slays thousands of people annually, for as far back as 1880 in London during a fog the death-rate rose in one week from 27 to 48 per 1,000. The cost in health is beyond calculation, and the monetary cost in damage done, artificial lighting, etc., totals up to many millions, and this enormous national annual bill of costs would be wiped out if the smokemakers were compelled to take steps to utilise their fuel instead of emitting it into the atmosphere.

Practical Smoke Abatement.—A lady lecturer on smoke abatement (like some ladies possessing a little more presumption than practicability) said "that smoke was an abominable nuisance, and all of it ought to be stopped," specially emphasising the *all of it*. I said "to stop smoke was an easy and very simple thing to do, by putting out the fires; but I was afraid the remedy would be a thousand times worse than the disease." The heaven-born idea amused the audience, but the lady lecturer looked angry. The policy of procedure must not be persecution but practicability, then there will be no reasonable reason for any one to complain. The furnaces and fireplaces must be constructed on the best-known principle, for the practically complete consumption of the combustibles used therein, and to answer the purpose for which they are intended. The fuel used must be of the most suitable kind. The most practical and economical smoke-preventing appliances ought to be adopted, and the said furnaces and fireplaces worked on the most scientific system. The utilisation of the best known means for the abatement of smoke is the most practicable and profitable policy, and if the ideal is not reached it will have to be considered satisfactory until some better method is devised which will be nearer the ideal, for there is no finality even to smoke abatement.

Boiler Smoke.—When an earnest crusade against boiler smoke was commenced the attackers, though few in number, had proved by practical tests the non-necessity of black smoke emissions. They were met with very fierce opposition, and it was said (and verily believed by many), that if the excessive smoke were stopped the result would be stoppage and ruination of trade. The issuing of dense volumes of smoke for 20, 40, or more minutes in 60, from chimneys serving boilers only has ceased in many instances, and trade has not been hindered but helped. To-day all experts are agreed on the non-practical necessity for boiler smoke, under normal or ordinary working conditions, because there are so many methods by which it can be prevented, and to make it is a great waste of fuel.

What is the Cause?—A chimney serving six boilers the other week emitted 100 minutes of continuous black smoke, and feeding the fires too quickly was the cause. It may be caused by shortness of boiler power, necessitating forcing of the fires, insufficient draught (the result of small flues and a low chimney), bad fuel, or even good if too little or too much air is admitted into the furnace, low temperature, dirty fires, stokers leaving the boilers to do other work, their wilful and wicked misuse of excellent appliances, and a score of other things, sometimes the fault of the employer, and at others the employé.

What is the Cure?—Ample boiler power is absolutely essential. The draught, either natural, forced, or induced, must be sufficient to produce the combustion temperature, alternate side firing, lightly, or coked at the front of the furnace, then pushed backwards, the necessary air admitted at the proper time and place, and the fires clean. Also it is very necessary to have an intelligent and experienced stoker, for to stoke smokelessly is without doubt a great art. The German Government (who are frequently to the front) in 1902 decided that £4,000 should be spent on lectures and courses of instruction at the technical schools on how to prevent smoke. A superintendent was appointed to give practical lessons to firemen, and, when unable to attend the courses because of distance, then instructors visited the works to demonstrate practical prevention. This a most commendable and practical policy to pursue, and one well worthy of our own and other Governments to follow. Daily experience with firemen plainly points out the great necessity for a theoretical and thorough practical training in the many and important matters connected with the combustion of coal and the prevention of smoke. If such instruction were obtainable, and firemen's certificates of efficiency were awarded, there would very shortly be in existence an army of skilled scientific stokers, whose services would be worth much more money than they now receive, and they would play no little part in smoke abatement. There always has been, and there is to-day, a great difficulty in getting hold of the ideal stoker, and as a natural result mechanism has come to the help of man (and in many instances superseded him) to supply these deficiencies and derelictions of duty. The smoke-preventing and economic value of the many and various kinds of appliances are so well known, their value having been proved for years, that it is only necessary for me to mention a few, and their simplicity and utility will be recognised by an inspection of the diagrams. There is the "Bennis automatic machine stoker," the "Underfeed (London) stoker," the "Economic coaling appliance specially adapted for loco-type boilers," the "Horsfall forced-draught furnace and smoke preventer," the "Gregory's smoke preventer and steam generator," the "Cochran system for the utilisation of waste gases and the prevention of smoke," the "Schwartz-

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kopff coal-dust firing apparatus," and "Green's modern economiser." Machine stoking, as innumerable tests have proved, is a more reliable, perfect, and economical smoke preventer than hand firing. There is a saving of from 10 to 20 per cent., because the fires are fed regularly and lightly. The necessary amount of air is admitted to the furnace, hence complete combustion, no smoke, and greater boiler efficiency.

Great Gain.—Messrs. J. Crossland and Sons, Limited, Warrington, some years ago were frequently fined for emitting black smoke, which, with the enormous waste of fuel, proved very costly. They created a department to deal with smoke prevention, water purification, and economy of fuel, and the result is chimneys practically smokeless, 1,000 tons less coal consumed weekly, and a saving of £25,000 annually. This firm have, like many others solved the problem of how to burn large quantities of common bituminous slack with no smoke, and the results appear incredible to the unpractical person. For additional facts and figures *re* the advantages of smoke-preventing appliances, etc., see "Smoke Abatement," published by C. Griffin and Co, Limited, Strand, London.

Smoke from Metallurgical Furnaces —Metallurgical furnaces are distinctly different from boiler furnaces. The latter are for the generation of steam, and the former for reheating, annealing, and melting of metals. The smoke nuisance is bad enough from boilers but worse, if possible, from furnaces, for some of the furnace chimneys will emit black smoke almost continuously. No action has been taken for its abatement, only in a few exceptional cases, which we will look at shortly. It is universally stated that to stop furnace smoke would stop trade; such action would be pure persecution, and there is no legal power to do it. We have proved in a number of instances that there is no necessity for at least 80 per cent. of the smoke made; to stop it would not be persecution but profitable to the smoke maker, and the Public Health Act does give power to proceed against even unnecessary furnace smoke. The time has now arrived to commence a most determined crusade against furnace smoke, pursuing the same practical policy that has been pursued against boiler smoke, and very shortly the furnaee smoke fallacy will be exploded.

Furnaces and Boilers.—Where a few chimneys, from 100ft. to 200ft. high, serve boilers and furnaces, exemption is always claimed for excessive smoke emissions on account of the furnaces. The furnaces have been fired according to special instructions, no excessive smoke has been made, and when proceeded against for excessive smoke the court has been satisfied of the non-necessity of the smoke complained of, and have convicted, and the said conviction has been upheld when appealed against.

Reheating Furnaces.—Sheffield being one of the heavy workshops of the world possesses all sorts and sizes of reheating furnaces. They are used for rehcating steel, for pressing, forging, rolling, and all sorts of purposes. Many of the large furnaces are fired by gas, hence smokelessly and economically. But the great majority are most carelessly and senselessly fired with coal, by anyone (man or boy) told to by the furnaceman in charge; and prevention of smoke is never considered, in fact they make a thick smoke to prove they have put on a good fire. Frequently four times more coal is put into the furnace than there is any necessity for. The firing-hole door is made up to prevent air entering the furnace, and the natural result is often 20 minutes of continuous smoke. Mr. A was induced to put a man in charge of three large furnaces, whose duty it was to stoke only. The furnaces were fired lightly, they got more work out of them, less coal was consumed, and no black smoke was emitted. If suitable appliances were adopted and ordinary care used in the working of the said furnaces, the smoke and economical results would be as satisfactory as from boilers.

Smoke from Private Dwelling-Houses.—The smoke from the chimneys of private dwelling-houses (whether little or much) is exempt under the Public Health Act, 1875. The amount of smoke made by each domestic fire is very small compared with each furnace, yet in the aggregate the quantity of smoke emitted from the millions of domestic chimneys is enormous, and is an appalling nuisance. There is neither rhyme nor reason in its exemption, for there would be no injustice done to anybody if the owners were compelled, like owners of other fireplaces, to do all that was practicable to prevent the emission of unnecessary smoke. By adopting the best grate, using the most suitable or smokeless fuel, the substitution of gas, or electricity, or anything else as the circumstances required, the smoke pall from domestic grates would be considerably less, and it is only reasonable to demand the legal power to stop it.

Smoke Law and its Amendment.—The Public Health Act, 1875, Section 91, Sub-Section 7, says: "Any fireplace or furnace which does not, as far as practicable, consume the smoke arising from the combustible used therein, and which is used for working engines by steam, or in any mill, factory, dye-house, brewery, bakehouse, or gaswork, or in any manufacturing or trade process whatsoever, and any chimney (not being the chimney of a private dwelling-house) sending forth black smoke in such quantity as to be a nuisance, shall be deemed to be nuisances, liable to be dealt with summarily in manner provided by this Act. That where a person is summoned before any court in respect of a nuisance arising from a fireplace or furnace which does not consume the smoke arising from the combustible used in such fireplace or furnace, the court shall hold that no nuisance is created within the meaning of this Act, and dismiss the complaint if it is satisfied that such fireplace or furnace is constructed in such manner as to consume as far as practicable, having regard to the nature of the manufacture or trade, all smoke arising therefrom, and that such fireplace or furnace has been carefully attended to by the person having the charge thereof."

(To be concluded.)

PERSONAL.

Sir Norman Lockyer has been appointed chairman of the British Science Section of the Franco-British Exhibition.

Mr. A. H. Stanley has been appointed general manager of the Metropolitan District Railway Co., in place of Mr. Collinson, who has resigned.

Mr. A. C. Bostel, of Manchester, has been appointed junior assistant engineer in the business development department of the Birmingham Corporation electricity works.

The Midland Electric Light and Power Co. have appointed Mr. P. Olver, in succession to Mr. F. W. Jones, as engineer and manager of the Leamington station of the company.

We regret to announce the death, at Samaden, Ober Engadine, of Dr. Paul Schoop, Ph.D., of Nuremberg, well known to members of the electrical profession in Switzerland and Germany.

We are informed that on the 28th inst. Messrs. F. W. Smith and Co., electrical and mechanical engineers, of Salford, will remove to larger and more convenient premises at 12, Tib-lane, Cross-street, Manchester.

We are informed that Messrs. Brecknell, Munro, and Rogers are opening new offices in London at Finsbury-pavement House, E C., on the 27th inst., under the management of Mr. E. M. Munro, M.I.M.E., M.I.E.E.

Mr. H. White, who has been a pupil at the electricity works, Kilmacolm, Renfrewshire, for the last three years, has been placed on the staff, and Mr. James Brown, the chief engineer, has been instructed to advertise for another pupil.

Mr. J. W. Button, A.R.C.S., A.M.I.M.E., has been appointed head of the engineering department of the Technical College, Battersea, in place of Mr. W. E M. Curnock, M.Sc., B.E., A.M.I.M.E., who has been appointed head of the engineering department at the Battersea Polytechnic, London.

Messrs. Mawdsley's, Limited, Zone Works, Dursley, inform us that they have appointed the following gentlemen as their agents: for Lancashire and district, Mr. D. C. Bate, 40, Brazennose-street, Manchester (telephone 5602, telegrams "Zonal"); for the West of Scotland, Messrs. D. M. Malloch and Co., 50, Wellington-street, Glasgow (telephone 2175, telegrams "Cryselco").

Mr. F. J. Rynd has resigned his position as manager of the South Wales office of the Electrical Co., in order to join Mr. C. P. Sparker, of Moorgate-court, Moorgate-street, E.C., as assistant in his consulting business. Mr. Rynd has been with the Electrical Co. for the last four years, joining them in 1903 as outside superintending engineer, in this capacity has had charge of all their installations in this country.

In the annual competition for the City fire shield, presented by the Corporation of London, held at the Guildhall on Saturday, the Robertson fire brigade lost possession of this shield. Twenty brigades competed, and the Robertson brigade were placed third, only one or two seconds dividing the first three brigades. In the competition for the fire brigade championship the Robertson brigade held a clear lead of 12 seconds, and in the concluding event, which is to take place on Oct. 19, it is anticipated that the Robertson brigade will still retain the championship.

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COMPANIES' MEETINGS AND REPORTS.

SWANSEA IMPROVEMENTS AND TRAMWAYS.

The report of the Swansea Improvements and Tramways Co. for the half-year ended June 30 last, to be presented to the meeting on the 30th inst., states that the gross receipts of the tramway undertaking have amounted to £22,317, an increase of £613 upon the corresponding period of last year, and the expenses to £18,575, an increase of £63. Expenses include debenture and other interest and the amount payable to the Swansea Corporation in respect of the tramways and light railways leased from the Corporation. The profit on the half-year's working is £3,742, which, added to the balance of £2,000 brought forward, makes a total of £5,742 at credit of profit and loss account. The directors recommend that there be placed to reserve and depreciation fund £1,000, to dividend on 984 preference shares at the rate of 6 per cent. per annum £295, and on 4,016 preference shares at the rate of 5 per cent. per annum £1,004, leaving to be carried forward £3,442. The net loss on the improvements undertaking for the half-year amounts to £255, after allowing £302 for accrued interest on mortgages.

SHAWINIGAN WATER AND POWER.

The directors of the Shawinigan Water and Power Co. announce the declaration of a dividend for the quarter ending 30th inst. at the rate of 4 per cent. per annum on the common stock. The earnings for August were 52,675dol., being an annual rate of revenue of 632,100dol. This revenue will soon be considerably augmented by the operation of several new important contracts for the sale of power. A contract for a total of 3,250 h.p. at 19dol. per horse-power was recently closed with a substantial Montreal manufacturing concern, the proceeds of which will be entirely net revenue, as the Company will not be involved in any additional expense thereby, and notification has been received from the vice president of the conclusion of a further contract for an additional 2,000 h.p. to the Montreal Light, Heat, and Power Co. This will make a total of 18,000 h.p. delivered over the island of Montreal, for which the Company will be receiving over 275,000dol. per year.

ELECTRICAL SECURITIES TRUST.

The report of the Electrical Securities Trust, Limited, to be presented to the statutory meeting in Edinburgh on Oct. 1, states that the total number of shares allotted is 52,085, of which 51,578 are allotted as fully paid—namely, 10,000 have been allotted to the nominees of the Alliance Trust Co., in consideration for its underwriting an issue of £100,000 of first mortgage debentures; 38,078 have been allotted to Bruce Peebles and Co., as part consideration for certain securities transferred by it to the Company; 2,000 have been allotted to the Electric Conversion Syndicate, Limited, as part consideration for certain securities transferred by it to the Company; and 1,500 have been allotted to Arthur Elliott, of 4, Swanage-road, Southend-on-Sea, as consideration for certain securities transferred by him to the Company. There has been paid in cash on each of the remaining 507 shares £1, making the total amount of the cash received by the Company in respect of the shares issued wholly for cash £507. The estimated amount of preliminary expenses, exclusive of underwriting commission, is £3,000.

DICK, KERR, AND CO.

The ordinary general meeting of the shareholders of Dick, Kerr, and Co. was held in London on Tuesday, Mr. John Kerr, chairman of the Company, presiding.

In moving the adoption of the report and accounts, the CHAIRMAN said the net profits amounted to £80,475, or £5,878 less than last year's. Taking the experience of other concerns of a somewhat similar nature into account, he thought they might rejoice that their position had been so well maintained. The directors were prepared to take their part in the struggle to hold their own, and would strongly deprecate ruthless cutting of prices. Apart from competition, the great advance in the cost of raw material, and especially of copper, of which they bought a large amount, was a matter of considerable importance. As their reserve amounted to £216,000, it had been decided to make no addition to it this year, but to increase the amount carried forward by £23,063, making the total carried forward £79,140. The directors, while safeguarding the debenture holders and preference shareholders, had thus strengthened the position of the ordinary shareholders. The chairman remarked that though the Board of Trade returns would give the impression that this country was in a state of boundless prosperity, and it was true some producers and traders had done well, most people would perceive that the margin of profit was less than when the Board of Trade figures were of a more modest character.

Mr. C T. CAYLER seconded, and the report and accounts were adopted without comment.

A dividend of 6 per cent. on the preference shares and 10 per cent. on the ordinary was declared.

UNITED ELECTRIC CAR.

The annual meeting of the United Electric Car Co. was held at Preston on the 19th inst., Mr. George Richardson, chairman of the Company, presiding.

In moving the adoption of the report, the CHAIRMAN said that the directors considered the result of the 12 month's trading very satisfactory, in view of the severe competition, the greatly increased cost of all raw materials, and the advance in the cost of labour, for with a greatly reduced production compared with the previous year they had made a profit of nearly £7,000 more. Another feature on which the directors might congratulate themselves was the bank balance. Twelve months ago the Company owed the bank £9,374, but now they had a credit balance of £6,506. With respect to the Hadley and Manchester works, they had leased the former at a fair rental for three years. The Trafford Park works were unlet, and the directors were doing all they could to secure a tenant or purchaser. As to the policy of absorbing the two places, the fact remained that two very formidable competitors no longer existed, and the absorption had made it possible for them to show a better net result for the past year on a decreased production. For several months past orders had been scarce, but the directors had obtained a fair share of them. At the moment there was something of a stagnation in electric traction, but they trusted that as many schemes of electrical and railway development matured and monetary conditions were more favourable there would be more work for the Company.

The report was adopted.

NEW COMPANIES REGISTERED.

Karak Rubber Co.—Registered Sept. 19. Capital, £50,000 in £1 shares. Objects: to acquire lands in the Malay Peninsula, India, Ceylon, the East Indies, or adjacent parts of Asia, to grow, prepare for market, and deal in indiarubber and other products, etc.

Peruvian Rubber Co., Limited.—Registered Sept. 6 by Ashurst Morris Crisp and Co., 17, Throgmorton-avenue, E.C. Capital, £250,000 in £1 shares. Objects: to acquire a concession for the construction of an inland road, 120 miles long, from Phara, province of Sandia, to a point navigable by steamer on the Tambopata River, granted to M. Forga and Sons, and transferred with the consent of the Peruvian Government to La Compania Gomera Villamayo, Limitada, of Arequipa, Peru; to complete the construction of the said road (on which completion the company will be entitled to select, subject to the approval of the said Government, titles to grants in perpetuity of 420,000 acres of land); to immediately acquire about 80,000 acres of rubber-bearing forest land on the said river, now held on lease from the Government of Peru at a royalty of about 4s. per 100lb. of rubber extracted, apart from customs duties, the leasehold merging into personal ownership under the aforesaid concession; and to carry on the business of cultivators of and dealers in rubber, tobacco, and other produce, etc.

Liens Registered, etc.

Cleveland and Durham Electric Power, Limited.—Deed of indemnity and security registered Aug. 31, to secure an amount not exceeding £5,000. Charged on all the property, present and future, except the uncalled capital.

Lumb Electrical Bleaching Co., Limited, Edenfield, near Manchester.—Lien registered Sept. 18, for £1,775 6 per cent. second debentures, part of £15,000. Amount previously issued, £13,225. No trustees. Charged on the assets (excluding the uncalled capital), subject to £15,000 5 per cent. first debentures.

National Electric Construction Co., Limited, Westminster, S.W.—Particulars required by Sub-Section 4, Section 14, of the Companies' Act, 1900, registered Sept. 2, relating to a series of debentures for £75,000. Trustees: L. B. Schlesinger and R. Williams. Secured by a specific charge on certain debentures and shares held in various companies; also on a sinking fund policy effected with the Legal and General Life Assurance Society for £75,000, and by a floating charge on the undertaking and all the other assets, present and future.

APPOINTMENTS VACANT.

Premium Pupil, Kilmalcolm Electric Lighting Co. Particulars from Mr. James Brown, electrical engineer, Electricity Works, Kilmalcolm, Renfrewshire. See advertisement.

Switchboard Attendant, Eccles Electricity Works. Wages, £1. 4s. per week. Applications to the Borough Electrical Engineer, Cawdor-street, Patricroft. See advertisement in last issue.

Jointer for H.M. Dockyard, Sheerness. Wages 34s. to 42s. per week, with overtime. Applications to the Electrical Engineer's Department, H.M. Dockyard, Sheerness, by Oct. 7. See advertisement.

Assistant Electrical Engineer for the Harness and Saddlery Factory, Cawnpore, India. Pay to commence at 280 rupees per month, rising annually by 10 rupees per month to 320. On re-engagement 350 rupees per month (15 rupees = £1). Forms of application and further particulars can be obtained by writing to the Director-General of Stores, India Office, London, S.W., not later than Sept. 30. See advertisement in last issue.

FORTHCOMING EVENTS.

Civil and Mechanical Engineers' Society.—Thursday, Oct. 3, at 8 p.m., at Caxton Hall, Westminster, presidential address by Mr. W. N. Twelvetrees.

Society of Engineers.—Monday, Oct. 7, at 7.30 p.m., at Royal United Service Institution, Whitehall, meeting.

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OPENINGS FOR CONTRACTORS.

ACTON—Branch library in connection with Railway Mission Hall.
ABERTILLERY—Electric light undertaking by Corporation (£10,000).
ABERYSTWYTH—Erection of 25 workmen's dwellings by Council (£4,500).
ALVERDISCOTT—Erection of Wesleyan Methodist chapel and school.
ANDOVER—Three houses at Newton Stacey. Messrs. Pink and Arnold.
ANNFIELD PLAIN—Coach-house, Syke View; Mr. E. Mackinlay. Dwelling-houses, Flint-hill; Mr. T. Laverick.
ARGOED—Erection of mission hall and reading-room. Architect, Mr. H. D. Blessley, 22, Trinity-street, Cardiff.
ASHBOURNE—Erection of grammar school.
ASHBY-DE-LA-ZOUCH—Enlargement of Grammar School. Architects, Messrs. Barrow, Cliff, and Alcock, Town Hall-chambers, Loughborough.
ATHLONE—Erection of labourers' cottages for Rural District Council (£20,349).
BALLYSHANNON—Council is considering an electrical lighting and power scheme.
BANGOR—Extension of the workhouse infirmary for Guardians.
BARDEN—Erection of Wesleyan chapel (£450).
BETHNAL GREEN—Alterations and additions to the workhouse for the Guardians (£3,000).
BINGLEY—Additions to houses in Marlborough-terrace; Mr. Thomas Ecroyd. Coach-houses, Heyworth-road; Mr. J. Brooksbank. Filter at Goit Stock Mill; Messrs. T. Acked and Son.
BIRDWELL—Two houses for Mr. J. Matthewman. Architect, Mr. A. Whittaker, Barnsley.
BOLLINGTON—New church at Bollington Cross. Architect, Mr. F. B. Oakley, Manchester (£2,500).
BRIDGWATER—Extension to the Town Hall and Municipal-buildings.
BRIERFIELD—New Council school. Mr. T. Pickles, Luddendenfoot (£11,000).
BRISTOL—New hall, church of St. Michael's and All Angels. Architect, Mr. H. Smith.
BRYNAMMAN—Parish Council considering lighting scheme.
BURY—Extensions to Roath Conservative Club; erection of Catholic school in Market-street.
CAERLEON—Home for waifs and strays (£2,100).
CANTERBURY—Erection of General Post Office.
CARDIFF—Erection of lunatic asylum (£50,500).
CARRICK-ON-SUIR—Erection of labourers' cottages for Rural District Council (£17,514).
CASTLEDON—Erection of mill for the Hay's Doubling Co.
CHISLETON—Alteration of Odd Fellows' hall. Architect, Mr. R. J. Beswick, 10, Victoria-road, Swindon.
CHISWICK—Secondary school for Education Committee.
CHURWELL—A large woollen mill is to be erected.
CLIFTON—Two blocks at the Asylum. Architect, Mr. J. H. F. Jones, York.
CLYDEBANK—Erection of model lodging house accommodating 440.
CLYDEBANK—Six houses, Montrose-street; Mr. P. Orr. Erection of hall for Clydebank Burgh band.
COLCHESTER—Pavilion at Castle Park for Council (£600).
CORSHAM—Erection of villa residence. Architect, Mr. W. H. Bromley, Pickwick-road.
CREWE—Erection of secondary school £17,726).
DARLASTON—Renovation of Wesleyan Chapel (£200).
DEAN FOREST—Erection of Primitive Methodist church (£3,000).
DOWNHOUSE—Dwelling-house for Mr. L. Philp. Architect, Mr. L. Scantlebury, Callington.
DROMIN—Additions and improvements to parish church. Architect, Mr. J. C. Brennan.
DUBLIN—Supply of electricity meters for Corporation.
DUDLEY—Printing works and offices for the *Dudley Herald*. Architect, Mr. W. Wright.
DUNDEE—New school at Dens-road. Architect, Mr. Langlands.
DUNSTABLE—Erection of new school for Education Committee (£3,310).
EDINBURGH—Ten villas, Willowbrae-road; A. Miller. Two houses, Weekfield-place; Mr. G. Wood. Police station at Torphichen-place.
EDMONTON—Provisions of bath rooms at workhouse. Board of Guardians.
ERITH—Extension to the Sanatorium for Urban District Council.
FALLIN—Erection of church (£2,000).
FLEETWOOD—Erection of free library for Council.
FLINTSHIRE—Erection of county hospital for County Council (£1,200).
GLASGOW—Erection of Infirmary block. Architect, Mr. J. Miller, 15, Blythswood-square.
GORLESTON—Repairs to Odd Fellows' hall, High-street. Mr. G. A. Woods, 91, Lower Cliff-road.
GREAT HARWOOD—New central premises for the Co-operative Society. Architect, Mr. F. J. Parkinson.
GREENOCK—Extension of Eagle Foundry. Messrs. Rankin and Blackmore.
GOSPORT—Erection of soldiers' quarters at Fort Monkton,
GUISBOROUGH—Urban District Council are considering lighting scheme.
HALTWHISTLE—Erection of a church hall, classroom, and caretaker's-room; Mr. J. M. Clark.
HAM—New board-room for Guardians (£520).
HAMILTON—Public library (£15,000).
HANTS—Erection of reception station and mortuary at Bordon Camp.
HASLINGDEN—Extensions to the secondary schools for Town Council (£6,500).
HERTFORD—New municipal offices for Corporation (£3,550).
HESTON AND ISLEWORTH—Erection of school for Urban District Council.
HETTON—Four houses at Colliery Hotel; nine houses, Houghton-road. Mr. J. Storey.
HEYWOOD—Erection of Council school. Architect, Mr. H. C. Anderson.
HIGHGATE—Elementary school, St. Joseph's Retreat.
HITHER GREEN—Free public library. Mr. H. Hopton, Catford (£4,500).
HORNSEY—Erection of workmen's dwellings by Borough Council (£39,690).
HUDDERSFIELD—Wesleyan Sunday school, Gledholt. Architect, Mr. W. Cooper (£5,500). House and shop, King's Mill-road. Architects, Messrs. John Kirk and Sons.
KEIGHLEY—Extensions to Council electricity undertaking (£667).
KELSALL—Erection of elementary school proposed.
KENDAL—Erection of library for Corporation.
KETTERING—Extension of electricity undertaking (£3,500).
KILKENNY—Erection of cottages for Urban District Council.
KIRKCALDY—Sanatorium, Den-o-Dunnikier. Borough surveyor, Mr. J. Lumsden.
KIRKHAM—Erection of elementary school proposed.
LANCASTER—Houses at Chapel-lane; Mr. Wilcock. Six houses at Silverdale; Mr. W. J. Edmundson.
LEEDS—Alterations at vicarage. Messrs. Mosley, 6, Wormald-row.
LEICESTER—Alterations at cottage homes by Guardians (£250).
LEIGH—Library building to be erected by Education Committee.
LEISTON—Erection of Council school, East Suffolk County Education Committee.
LETTERKENNY—Erection of labourers' cottages for Rural District Council (£15,600).
LEVENSHULME—Erection of a new church of St. Mark.
LEWISHAM—Erection of tramways electricity sub-station for London County Council. Architect's department, 13, Charing Cross, S.W.
LISTOWEL—New chancel, side chapels, and aisles to Catholic church. Architects, Messrs. Ashlyn and Coalmen, 7, Dawson-street, Dublin.
LIVERPOOL—Technical institute to be erected in Aigburth-road (£12,400).
LLANELLY—Three houses in Bygin-road; Mr. W. J. Hopkins. Three houses in Tunnel-road, 20 houses in Temple-street, 10 houses in Temple-terrace; Mr. D. Harries.
LOCHGELLY—Additions and improvements at the North British Railway Co. station.
LONDON, E.—Erection of branch post office at Aldgate for Commissioners H.M. Works.
LONDON, W.—Extensions of public lighting by Hammersmith Council (£11,145).
LONDONDERRY—Electrical fitting of municipal technical school.
LONG EATON—Extension to Corporation Electricity Works (£10,000).
LONGSIGHT—A new church is to be erected (£10,000).
LUDLOW—Installation of telephone service.
LUTON—Dwelling-house, Moor Path; Mr. F. White. Six houses, Ashburnham; Mr. W. Frost.
LUTON—Extensions to Corporation tramway system (£65,000).
MAESTEG—Dwelling-houses and shops. Architect, Mr. J. C. Rees, Neath.
MAIDSTONE—Supply of motors for Corporation.
MARYLEBONE—Shops, residential flats, and hotel, Wigmore-street. Architects, Messrs. Boehmer and Gibbs.
MERTHYR—Erection of overhead wires by the Electric Supply Co.
MERTHYR VALE—Five houses. Architect, Mr. A. S. Cameron, Glanant-street, Aberdare.
MIDDLETON—Erection of new cotton mill in Oldham-road.
MONMOUTH—Council are about to extend electricity business.
MORAR—Additions to Station Hotel. Architects, Messrs. L. and J. Falkener, Fort William.
MORECOMBE.—Erection of art school proposed by Corporation.
MORLEY—Extensions to Laneside Mills. Architects, Messrs. Buttery and Birds, Queen-street.
NELSON—Cotton weaving-shed for Messrs. Holden Bros.
NEWCASTLE—Extensions to electric lighting.
NORWICH—Additional accommodation at Isolation Hospital for Town Council (£4,000).
OLDHAM—New theatre, Bottom-o-th-Moor. Mr. H. A. Turner.
PENTREBACH—Erection of new school for Merthyr Education Committee.
PERTH—Erection of Guildhall for Corporation.

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PORTLAND—Five houses, Refane. Messrs. Wakeham.

PORTRUSH—Electric light installation for Urban District Council. Mr. J. Woodside, Ocean-buildings, Belfast.

PORTSMOUTH—Erection of pavilion.

RADCLIFFE—New town hall.

READING—Special school to be erected for Council.

ROCHESTER—Mission church for sailors (£4,000).

ROSCRAE—Erection of labourers' cottages for Rural District Council (£13,650).

ROYTON—A church is to be erected.

RUGBY—Additions to repository, Castle-street; Mr. A. Bill. Two houses, Craven-road; Mr. W. Cox. Two houses, Manor-road, Mr. A. J. Shillitoe. Extensions to drawing office, Victoria Works; Messrs. Willans and Robinson.

ST. ANNE'S—Erection of Council school

ST. DAVID'S—Erection of hotel for Great Western Railway Co.

ST. NEOTS—Renovation of Wesleyan Methodist chapel. Mr. J. H. Davey, Greenbank-road, Liskeard.

ST. THOMAS—Alterations at workhouse for Guardians (£600).

SALFORD—Extension to Union Workhouse. Architect, Mr. H. Lord, 42, Deansgate, Manchester.

SCOTSWOOD—Twelve houses for Blaydon Co-operative Society.

SHALLELAGH—Erection of labourers' cottages for Rural District Council (£10,389).

SHELFIELD—Erection of Council school; Staffordshire Education Committee.

SHORT HEATH—Alterations to Council Schools; erection of new school, Staffordshire Education Committee.

SINCLAIRTOWN—New passenger and goods station for N.B. Railway.

SNIZORT—Erection of manse, United Free Church of Scotland.

SNODLAND—New paper mills. Messrs. Townsend, Hook, and Co.

SOMERSET—Erection of school for County Council.

SOUTHEND—Erection of kiosks, conveniences, refreshment rooms, offices, and station buildings at the pier.

SPARKBROOK—Congregational mission church (£2,850).

SPRINGWELL—Erection of workmen's club and manager's house. Messrs. Liddle and Browne, Prudential-buildings, Moseley-street, Newcastle.

STEEPLE LANGFORD—Alterations to East End Inn. Architect, Messrs. J. Harding and Son.

STIRLING—Erection of slaughter-house for Corporation.

STOCKPORT—School in connection with St. Mary's Roman Catholic Church.

STOKE ON-TRENT—Bakery and shops for Silverdale Co-operative Society; five houses, Argyle-street; Mr. B. James. 14 houses, Stone-road; Mr. G. L. Jones. Additions to manufactory, Boothen Old-road; Messrs. Barrett and Co.

SUTTON COLDFIELD—Public library proposed.

SYKEHOUSE—Public elementary school, West Riding County Council. Architect, Mr. V. Edwards.

TATTENHALL—Erection of elementary school proposed.

TEDDINGTON—School in connection with Baptist Church (£4,300).

TENFIELD—Enlargement of Roman Catholic schools.

TENDRING—Alterations to workhouse laundry.

TIGHNABRUAICH—Provisional order for electric supply to be obtained.

TOWN END—Dwelling-house and shop, Golcar. Architect, Mr. J. Ainley, Chapel-street, Slaithwaite.

TRAWDEN—New Council schools. Architect, Lancashire County Council (£9,000).

TRIM—Erection of labourers' cottages for Rural District Council (£67,317).

TUNBRIDGE WELLS—Extensions to Corporation electricity undertaking (£9,600).

TUNSTALL—Erection of elementary school. Architect, Mr. A. B. Wood, Town Hall.

TYNEMOUTH—Installing public clocks by Council (£5,000).

WALTHAM—Enlargement of hospital. Architect, Mr. H. Tooley (£4,100).

WARRINGTON—Labour home for Ragged School Mission.

WELLHOUSE—Stores for the Slaithwaite Equitable Industrial Society. Architect, Mr. J. Berry, 3, Market-place, Huddersfield.

WEMBLEY—Two houses, District-road; Mr. G. C. Clifton. Two houses, District-road; Mr. A. J. Churchman. Ten houses, Lancelot-road; Mr. A. Ecclestone. 33, St. Anne's-road; Mr. A. Ecclestone. Two houses, Dagmar-avenue; Mr. G. Poole. Six houses, Ealing-road; Messrs. Moody and Lucas.

WEXFORD—Provisional order for electric lighting is to be applied for.

WHITCHURCH—Erection of market by Corporation (£1,200).

WHITEHALL—Erection of school at Rose Green (£17,000).

WOLVERHAMPTON—Welsh Presbyterian church in Bath-road (£1,900).

WORKINGTON—Erection of technical college and secondary school (£5,000).

WORKSOP—Extensions of public lighting by Corporation (£1,700).

Melbourne.—The Postmaster-General invites tenders for the supply of 6,000 dry cells. Particulars from the Commonwealth Offices, 72, Victoria-street, Westminster. Tenders by Nov. 12.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Antwerp.—The Municipality invite tenders for one 30-ton electric crane. Deposit £280. Tenders by Nov. 12.

Antwerp.—Tenders are invited by the Municipality for lighting by electricity of the Place de Meir Hall. Tenders by Oct. 18.

Paris.—Electric cables required for the Post and Telegraph Department, 103, Rue de Grenelle, Paris. Tenders by Sept. 30.

Spain.—Concession of Seville telephones. Particulars from the Post and Telegraph Department, 10, Cerretas, Madrid. Tenders by Oct. 17.

Sydney.—The Postmaster-General invites tenders for hard-drawn copper wire, copper binding tape, insulators, and cross-arms. Tenders by Oct. 30.

London, S.E.—The London County Council invite tenders for the erection of a tramways electricity sub-station at Lewisham, S.E. Tenders by Oct. 8.

St. Peter's (Kent).—The Isle of Thanet Electric Tramways and Lighting Company invite tenders for the annual supply of stores. Tenders by Oct. 1.

Sydney.—Additions and extensions to equipment of existing common battery system for the Postmaster-General's Department. Tenders by Oct. 9.

Clacton.—The Urban District Council invite tenders for the supply of vulcanised bitumen distributing mains and service cables. Tenders to Mr. G. T. Lewis, clerk to the Council, by Oct. 2.

Melbourne.—The Postmaster-General's Department invite tenders for 11 sets and a common-battery switchboard, and 3,000 subscribers telephones, etc., for the Windsor exchange. Tenders by Jan. 7.

Napier (New Zealand).—The Town Council invite tenders for lighting and power plant and an electric tramway equipment. Particulars from Mr. F. Bowen, town clerk. Tenders by Dec. 31.

London.—The London County Council invite tenders for three electrically-driven boiler feed pumps, each of 9,000 gallons per hour capacity, for the Greenwich tramway station. Tenders by Oct. 8.

Melbourne (Victoria).—D.C. and A.C. meters for the Melbourne Corporation. Specifications from Messrs. McIlwraith, McEacharn, and Co., Billiter-square-buildings, London, E.C. Tenders by Oct. 4.

Portrush (Ireland).—The Urban District Council invite tenders for a complete lighting installation by electricity or gas. Copies of specification can be seen at the Town Hall, Portrush. Tenders by Nov. 2.

Sydney.—The Postmaster-General invites tenders for the supply of wire insulators, fittings, etc. Particulars from the Commonwealth Offices, 72, Victoria-street, Westminster, London, S.W. Tenders by Nov. 6.

Willesden.—The Urban District Council invite tenders for seven 50-kw. static transformers for the Electricity Department. Particulars from the Electrical Engineer, Salusbury-road, Kilburn, N.W. Tenders by Sept. 30.

Paris.—Pumping plant and electric dynamos and motors for the Municipal Waterworks Department. Estimate, £36,000. Particulars from the Canals and Waterways Department, Hotel de Ville, Paris. Tenders by Oct. 24.

West Ham.—The Corporation invite tenders for the supply and delivery for six months ending March 31, 1908, of indiarubber-covered wires and cables. Tenders to the Town Clerk by Oct. 3. See advertisement in last issue.

Peterborough.—The Electricity Committee of the Corporation invite tenders for providing and laying about 2,400 yards of feeder cables. Tenders to the City Electrical Engineer by Oct. 3. See advertisement in last issue.

Croydon.—The Council invite tenders for the supply and erection of an overhead runway at their electricity works, Factory-lane, Croydon. Tenders to Mr. F. C. Lloyd, town clerk, by Sept. 30. See advertisement in last issue.

Dublin.—The Lighting Committee of the Corporation invite tenders for the supply of 500 alternating-current single-phase meters and 100 alternating-current three-phase meters. Tenders to the Secretary, 3, Cork-hill, Dublin, by Sept. 30.

Hammersmith.—The Borough Council invite tenders for the supply of (1) extra high-tension concentric feeder cable, (2) extra high-tension three core cable, and (3) joint-boxes, etc. Tenders to the Town Clerk by Oct. 2. See advertisement.

Tunbridge Wells.—Tenders are invited by the Corporation for the supply, delivery, and erection of the work in connection with the installation of a 500-kw. turbo-alternator, condenser, and pipework in sections. Tenders by Nov. 1. See advertisement.

Adelaide.—The Deputy Postmaster-General for Queensland invites tenders for a common battery switchboard and 3,000 subscribers' telephones. Specification No. 166. Particulars may be obtained from the Commonwealth Offices, 72, Victoria-street, London, S.W. Tenders by Jan. 8, 1908.

London, E.C.—Tenders are invited for the supply and delivery of a 600-kw. direct-current generator, as per specification to be seen at the Company's Offices, for the East Indian Railway. Specification, £1. 1s. Tenders to Mr. C. W. Young, secretary, Nicholas-lane, London, E.C., by Oct. 2.

Rangoon.—For pumping plant for Rangoon Municipality. Particulars, etc., of Messrs. Ogilvy, Gillanders, and Co., London agents to the Rangoon Municipality, Suncourt, 67, Cornhill, London, E.C., accompanied by a remittance of 10s., which will not be returned. Tenders to the Agents by Oct. 31.

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Victoria.—The Deputy Postmaster-General at Melbourne invites tenders for the supply and delivery at Melbourne of 11 sections of a common-battery switchboard and 3,000 subscribers' telephones and other apparatus for telephone exchange, Windsor, in accordance with Victorian specification No. 148. Tenders by Jan. 7.

Bradford.—The Guardians invite tenders for the general maintenance of the electric wiring installation, telephones, bells, etc., at the union hospital, Horton-lane, Bradford. Deposit £1. 1s. (which will be refunded on receipt of a bona fide tender. Tenders to Mr. G. M. Crowther, clerk to Guardians, 22, Manor-row, Bradford, by Oct. 5.

Dundee.—The Electricity Committee invite tenders for the supply of meters for period from Oct. 1, 1907, to April 30, 1908. Specification, etc., from Mr. H. Richardson, M.I.E.E., general manager, Electricity Works, Dudhope-crescent-road, Dundee. Tenders to Mr. W. H. Blyth Martin, clerk to the Corporation, City Chambers, Dundee, by Sept. 30.

Manchester.—Tenders are invited for the supply of special (permanent way) track work, for the Tramways Committee. Specifications, etc., from Mr. J. M. M'Elroy, general manager, Tramways Department, 55, Piccadilly, Manchester, on deposit of £2. 2s., which will be returned on receipt of a bona fide tender. Tenders to the Chairman of the Tramways Committee, 55, Piccadilly, Manchester, by Oct. 8.

Alexandria.—Tenders are invited for the following electrical equipment for the port of Alexandria: five large and seven small transshipping engines, six cranes of four tons, 36 cranes of two tons, 25 windlasses, various small plant and necessary accessories, and the construction and installation of a central power station. Particulars from M. le Directeur des Ports et Phares, Alexandria. Tenders by Nov. 1.

Dundee.—The Corporation Electricity Department invite tenders for extra-tension armoured feeder cables laid direct in the ground, and low-tension armoured and low-tension paper-insulated, lead-covered feeder cables and distribution cables laid direct in the ground, and on the solid system in wood troughing. Particulars from the Engineer-in-Chief, Electricity Works, Dudhope-crescent-road. Tenders by Sept. 30.

New South Wales.—With reference to an announcement inviting tenders for the supply and construction complete of a pneumatic tube service to the General Post Office, Sydney, from the Pacific Cable Board's Office, Royal and Stock Exchanges, etc., the Postmaster-General for New South Wales give notice that the date for the receipt of such tenders has been extended from July 10 to 2.30 p.m. on Wednesday, Oct. 16 next.

Londonderry.—Tenders will be received by Mr. J. A. Williams, secretary, Technical Instruction Committee, Savings Bank, Londonderry, up to 3 p.m. on Oct. 11 for wiring and fitting the new Municipal Technical School, Londonderry, for electric light, etc., according to plans, specification, and schedules, copies of which may be obtained from the architect, Mr. E. J. Toye, 20, Great James-street, Londonderry, on deposit of £2. 2s. returnable on receipt of bona fide tender.

Antwerp.—The Commercial Intelligence Branch of the Board of Trade have received from his Majesty's Consul-General at Antwerp a copy of a specification issued by the Municipal Authorities of that city calling for tenders for the installation of electric light in the Salle de Fêtes recently erected in the Place de Meir, Antwerp. A deposit of 8,000fr. (about £320) will be required to qualify any tender. Tenders to M. le Bourgmestre de la Ville, at the Hotel de Ville, Antwerp, by Oct. 17.

Copenhagen.—The Commercial Intelligence Branch of the Board of Trade are informed by his Majesty's Consul at Copenhagen that tenders are invited for the supply of four dynamos to the Odense electrical works. Tenders must be in writing and must reach the Stad-ingeniorens Kontor, Odense, before 1 p.m. on Oct. 7. Copies of the specifications and conditions relating to the above contracts may be seen by British manufacturers at the offices of the Commercial Intelligence Branch, 73, Basinghall-street, London, E.C.

New South Wales.—Tenders will be received at the office of the Deputy Postmaster-General, Sydney, until 2.30 on Oct. 23 for supply and delivery of the following material at the Departmental Stores, Sydney: 11 tons galvanised iron wire, 400lb. per mile, as per specification No. 164; 1,600 large best white porcelain insulators, as per specification N.S.W. No. 17, and sealed pattern N.S.W. No. 5. Specifications, general conditions, and sealed patterns may be seen and tender forms obtained at the General Post Office, Sydney, Melbourne, Brisbane, and Adelaide.

London, W.—The Metropolitan Railway Co. invite tenders for the supply of general stores during 12 months ending Oct 31, 1908, including copper, brass, spelter, antimony, zinc, tinplates, etc., crucibles, and plumbago; electric wires, cables, lamps, carbons, fuses, ebonite, battery jars, zincs, etc.; indiarubber, asbestos packings, tapes, belting, waterproof coats, etc.; signal and telegraph ironwork, insulators, galvanised pulleys, switch-boxes, etc.; English and foreign timber, also telegraph poles and wire casings. Tenders to Mr. R. H. Selbie, secretary, 32, Westbourne-terrace, London, W., by Oct. 7.

Maidstone.—Tenders are invited for four electrical motors and centrifugal pumps, each capable of delivering 150 cubic feet of sewage, and three electrical motors and centrifugal pumps at 225 cubic feet per minute, together with two motor-driven air injectors, two travelling cranes, switchboard, starting switches, workshop fittings, and other appliances and connections, including a complete electric light installation, for the sewage-disposal works. Plans, etc., and form of tender from Mr. G. R. Strachan, 9, Victoria-street, Westminster, London, on and after Sept. 3. Tenders by Oct. 1.

Gothenburg.—The Commercial Intelligence Branch of the Board of Trade are notified by his Majesty's Consul at Gothenburg that tenders are invited for supply of the electrical equipment for the Government power station at Trollhattan, comprising three electric generators for direct current, each of 350 kw.; one accumulator battery of 4,800 ampere-hours capacity; four three-phase generators, each of a maximum of 11,000 kilovolt-amperes; 12 transmitters, each of a maximum of 3,670 kilovolt-amperes; connections; regulators; and control tables. Sealed tenders, marked "Anbud a elektrisk utrustning for Statens kraftverk," should be sent to the Managing Director of the Royal Trollhattan Canal and Waterworks, Trollhattan, Sweden, by noon on Oct. 1 next. Tenders are binding until Jan. 1, 1908. Delivery is to be completed by Sept. 1, 1909. Further information may be obtained from the Managing Director, from whom a copy of the programme can be had against a deposit of 50 kronor, which will be returned on receipt of a tender in accordance with the programme.

RESULTS OF TENDERS.

Falkirk.—The Town Council have accepted the tender of J. E. Cuthbertson and Co. for the supply of telephones for the burgh hospital.

Bradford.—Mr. C. Pullan, 52, King's-arcade, Bradford, has obtained the order to install electric light throughout the Muff Field Schools, Bradford.

Blackburn.—The tender of the Wigan Coal and Iron Co., Church-street, has been accepted for the supply and delivery of steam coal for nine months, for the Electricity Committee.

Stoke-on-Trent.—The tender of the Florence Colliery Co., for the supply of washed beans to the electricity works for the ensuing six months, at 11s. 6d. per ton, is recommended for acceptance.

Torquay.—The tender of the Main Colliery Co., Neath Abbey, Neath, has been accepted for the supply of 1,500 to 2,500 tons of smokeless thro' steam coal, for the Electric Lighting Committee.

Hackney.—The Public Libraries Committee report that the tender of Messrs. F. C. Hoskins and Co., 4, Tufton-street, S.W., amounting to £266. 14s. for the installation of electric light to the Central Public Library, is the lowest.

Finchley.—The Electricity Committee have accepted the tender of Messrs. J. P. Hall and Sons, of Peterborough, for the condensing plant at the generating station for £1,258, subject to the Local Government Board giving their sanction for the needful loan.

Croydon.—The following tenders have been accepted by the Corporation: Oliver Arc Lamp, Limited, Woolwich, for approximately 100 flame arc lamps; General Electric Co., London, approximately 100 transformers; London Electric Firm, Croydon, lowering gear (approximately 100).

BUSINESS NOTES.

TRACTION.

Geneva Tramways Co.—The traffic receipts for the month of August amounted to 239,474fr., an increase on the same month of 1906 of 15,670fr.

Falkirk.—The Falkirk and District Tramway Co. has intimated the terms on which they will allow the Council to fix 12 nameplates on the tramway poles in Camelon and Bainsford. The matter has been remitted to Judge Flannigan and the burgh engineer.

Tramway-car Wedding.—Jack Adams, the oldest Northampton tramway-car driver, and his bride were driven to church on Monday last in an electric tramway car, lent by the Corporation, and decorated from trolley pole to wheels with flowers and bunting. Drivers and conductors in uniform formed an escort.

Middlesbrough.—Many months ago, in response to appeals from the Middlesbrough Corporation, the tramways company promised to give the running of cars on the Parliament-road route a month's trial. Summer has gone by without that promise being redeemed, but now it is stated that a service is to be inaugurated in a few weeks time.

Newport.—The Newport Tramway Committee have considered the question of extending the Corporation-road route line as far as the Transporter Bridge, and have instructed the manager to report on the question as well as on proposed turnouts in Rodney-parade to meet the excursion steamers, and the doubling of the Stowhill line from Charles-street to the Westgate.

Croydon.—On Sunday morning last the tramway employés of Croydon were to have held their first church parade, having been invited to St. Philips, Norbury, by the curate-in-charge (the Rev. J. H. Crickmer). However, owing to the fine weather and consequent demands of the public necessitating the running of every available tramcar from both depôts, the event had to be postponed.

Wallington.—The South Metropolitan Tramways Co. have notified that, in accordance with the recommendation of the Board of Trade inspector, they propose carrying out a slight alteration to the road level at Park-lane corner, Wallington, on the Croydon and Sutton line of tramways. It was there that a tramcar overturned last Easter Monday, causing two deaths and injury to about 40 passengers.

Electrification on the North-Eastern Railway.—A start has been made by the North-Eastern Railway Co. with the electrification of the branch line between Newcastle and South Shields, workmen having commenced operations at the Gateshead end of the high-level bridge in laying Barton limestone. This stone is a non-conductor, and is now laid throughout the Newcastle and Tynemouth branch to Monkseaton.

Through Tramcar Service between Bradford and Leeds.—The tramcar that has been fitted by the Bradford Tramways Committee with the extensible axle inaugurated the permanent through service between Bradford and Leeds on Monday. At present the service is only such as this car can maintain, but the tramway autho-

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rities of the two cities have under consideration the equipment of cars for an adequate through service.

Brighton.—Acting upon a report from the engineer, the municipal Tramways Committee have decided to abandon the compromise in regard to the increased fares, and to adhere to a scale based upon the charge of 1d. per mile, with 1½d. rates for distances beyond. On the Dyke-road route a new 1½d. fare is to be arranged, the distance being from a halt called The Fountain to Dyke-road Drive. The other routes affected are Ditchling-road and Beaconfield-road. The statistics show that since the compromise has been in force there has been a considerable falling off in the traffic.

New York.—Receivers have been appointed for the New York City Railroad Co. on the joint application of the creditors and officials. The application was made to Judge Lacomb in the Circuit Court. The New York City Railroad Co. is the operating company of nearly all the surface and street railroads in the boroughs, Manhattan Island, and New York City. Its stock is held by the Metropolitan Securities Co. It in turn leases the property to the Metropolitan Street Railway Co., guaranteeing certain dividends on the stock of the latter, which lately the Metropolitan has not earned.

Hampshire.—The Southampton Council are considering reports dealing with the financial results of two of the chief Corporation trading undertakings. The electrical tramways, which are owned and worked by the Corporation, show an increase of receipts on the year to Sept. 11 of £790. 15s.; but in the report as to the public baths, also owned by the Corporation, the manager reports that owing to the unfavourable weather this season, there has been a decrease of 13,559 in the number of bathers using the open-air bath, representing a diminution of £120. 8s. 8½d. in the receipts.

Rio de Janeiro Light and Power Co.—The British Empire Trust, the London agents of this company, have received the following cable: "The Municipal Council of Rio have formally approved and ratified the contract for the unification of the tramways, and have settled all outstanding matters definitely. We have obtained ll that we desired, including extensions of the period of the concessions, moderate taxes, fixed the entire period, and many valuable facilities for operating the company; also have secured the right to build extensions in suburbs with monopoly within the zones similar to present lines."

Wallsend.—An accident by which a horse was killed occurred on the North-Eastern Railway near Wallsend on the 24th. The Tynemouth express electric train, which left Newcastle at 12·2, ran into a horse and cart which were crossing the line. The horse was hurled to one side and instantly killed, whilst the cart was thrown on to the up line, and the bags of cement with which it was loaded were scattered in all directions. The current was at once turned off by the signalman at the adjoining cabin. Although the front of the motor-box of the train was smashed to pieces, the motorman escaped with a fews cuts on his hand from the broken glass. The driver of the cart luckily escaped unhurt.

Coatbridge.—A joint meeting has been held of the Town Councils of Coatbridge and Airdrie in order to confer as to what steps it might be thought expedient to take, in regard to the increase in the fares which are now being charged by the Airdrie and Coatbridge Tramways Co., towards approaching the company for the purpose of having the fares reduced or revised. After discussing the matter, it was unanimously agreed, before approaching the Board of Trade in the matter and with the view of a friendly settlement being come to, if possible, to ask a meeting in Coatbridge with the directors of the company or someone authorised to represent them, and the town clerk of Coatbridge was instructed to write the company requesting this.

Swansea.—At the County Council meeting the Streets Committee reported that it was advised by the town clerk that it was not competent for the tramways company or the Corporation to lay a double line of rails in High-street without first obtaining an Act of Parliament or a provisional order. He suggested that a conference might with advantage be held between representatives of the Corporation and the tramways company, in order that a way might be found by which the difficulty would be overcome if the Corporation would insist in obtaining the powers to lay a double line, and the tramways company contributes its proportion towards the paving of the street. It was decided that the chairman and vice-chairman of the committee confer with the managing director of the tramways company on the subject.

Finsbury.—At the last meeting of the Council, Councillor Beard, speaking on the question of the electric tramway speed, said the Council were asked to sanction a speed limit of 16 miles an hour. Such a speed, in his opinion, was not dangerous to life and limb. Some of the railways did not convey their passengers so fast as that. The councillor then illustrated the danger of trams running at such a speed between Provost-street and the Angel, and Penton-street and the Angel, and other short distances. Alderman Tripp said it was not so dangerous as had been pictured by the last speaker. Certain parts of the tram track were only to be traversed at a rate of four and eight miles an hour, and it was only where the road was wide and quite safe for fast travelling that the speed of 16 miles an hour was asked for. The Council agreed with the speed asked for.

Kilmarnock.—The Town Council of Kilmarnock at a special meeting had under discussion the question of management expenses in connection with the electric station and tramway cars. The Electric Committee brought in a report with recommendations to effect a saving of £227, which included a reduction of £80 in the salary of the general manager, a reduction of £10 in the salary of the traffic manager, and dispensing with one inspector, while the post of assistant engineer, presently vacant, was not to be filled up. The report, so far as it concerned the general manager, was adopted by 12 votes to 8, the minority voting for a salary of £260. The general manager's salary will now be £300 instead of £380. Satisfaction was expressed with the general manager's services, but the Council felt bound to effect some economy in management expenses owing to the loss on the tramway cars. The other portion of the report was remitted back to the committee for further consideration.

Lewisham.—At the last meeting of the Borough Council particulars were laid before the Council of the tramway scheme of the London County Council for the Sydenham district. The Council Departmental Committee reported that the Improvements Committee had considered the widening of Sydenham-hill and London-road in connection with the proposal to construct tramways to the Crystal Palace, commencing with the County Council's authorised tramway in London-road and running up Sydenham-hill to the Crystal Palace-parade. The General Purposes Committee of the Borough Council submitted a report and stated that the proposed tramways would not prove advantageous to their borough. They were also informed that the proposal did not meet with the approval of residents of Sydenham and Forest Hill. On the recommendation of the committee the Council declined to give the consent required by the Standing Orders of the House of Commons prior to the introduction of a Bill for the construction of tramways.

Kingstown.—The Council have adopted the following resolution: "This Council views with alarm the number of serious tramway accidents which have occurred recently within this urban district. The Council, as the road authority of the district responsible for the safe condition of the streets and highways of the urban district for public traffic—except the tramroad, the obligation to make and maintain which is, by law, placed upon the tramway company—is of opinion that by reason of the slippery condition of said tramroad, same is not in the safe condition for public traffic as the law requires The Council is furthermore of opinion that if more attention were paid by the company to their obligations to the public in this respect, and as imposed upon them by law, and if the cars of the company were driven at a slower speed through certain parts of the urban district, some of the recent accidents might have been avoided. That a copy of this resolution be forwarded to the directors of the tramway company."

Derby.—The Tramways Committee of the Derby Town Council has received a memorial from the inhabitants of Friar-gate, complaining of the annoyance and inconvenience they are being subjected to by the slow progress made in the construction of the electric trams along Ashbourne-road. The memorial is as follows: "Sir,—We, the undersigned tradesmen and residents of Friar-gate, beg to draw your attention to the great inconvenience culminating in serious loss of trade through the unreasonable and deplorable delay in completing the electric tramways in Friar-gate. We are prepared to suffer to a reasonable extent, such being inseparable from an undertaking of this kind, but we have come to the conclusion that further delay cannot be justified, as it is practically ruining the businesses in this part of the town, and unless strong steps are at once taken to expedite matters we shall have no other alternative but to make an appeal to the law courts for compensation. Hoping we shall not have to proceed to this extreme measure, we beg to subscribe ourselves."

Handsworth.—At the last Council meeting the Tramways Committee reported that it had been found impracticable to arrange for the running of a through service of cars from Birmingham through Aston to the Perry Bar terminus of the Birchfield tramways. Some time ago the City of Birmingham Tramways Co. were asked whether they were willing to enter into an arrangement with Birmingham to run to the Perry Bar terminus at a through fare of 2d, to be divided on the basis of the route mileage between the Corporation of Birmingham, the company as lessees of the Aston Manor Tramways, and the Handsworth Council, and they were advised that such an arrangement would result in a considerable increase in the receipts, and be a great convenience to the public, also that Birmingham was willing to agree to the arrangement. The company refused to agree to a through fare of 2d. An interview took place on the 2nd ult., between Mr. J. A. Lycett, the company's managing director, and a sub-committee, but the terms Mr. Lycett then offered were such as the committee could not recommend the Council to agree to.

Ayr.—Mr. W. Grant, the manager of the Ayr Corporation tramways, in his fifth annual report, states that the total capital expenditure to May 15 last was £79,974, and the amount of the sinking fund is £1,363. There has been set aside for depreciation and renewals the sum of £9,935, there is a reserve fund of £5,000 and the sum of £1,140 has been transferred in aid of the burgh general assessment. The total revenue for the year under review was £15,285, compared with £15 467 for the previous year. The traffic receipts for the year amounted to £14 672, compared with £14.732, while the receipts per car mile worked out at 9·23d., against 9 50d. for the previous year. The total number of passengers carried during the year was 3,603,789, being an increase of 52,251 passengers. There had been a considerable falling off in the long distance passengers, due to the stoppage of the workmen to and from Alloway in connection with the Carrick Railway. The total number of miles run by the cars during the year was 378,864, an increase of 6,822 miles, and the electrical energy consumed amounted to 375,436 units, or ·99 unit per car mile.

Chester.—At a recent meeting of the Chester Tramways Committee, on consideration of the resolutions of the committee of July 12, 1907, the tramways manager reported that, calculating roughly, if the car service is suspended on Sundays up to 2 p.m., it will involve a loss of £120 a year, £100 of this being for the loss of traffic on the Saltney route. He thought, however, that if the change were made there would be increased traffic in the afternoons, which would in some measure compensate for the loss. The decrease in wages per mile on the Saltney route would be 6d., and on the Boughton route 11d. He also submitted a table showing the income and expenditure in connection with the service on Sunday mornings and afternoons. It was resolved that the consideration of the subject be deferred to the next meeting of the committee, and that the manager be instructed to submit a further report as to income and revenue, and the effect upon

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the convenience of the general public by the running of two instead of three cars up to 2 p.m., and an analysis of the profits of the cars between the hours of 11 a.m. and 12 noon and 12 noon and 1 p.m. on Sundays.

Luton.—The Board of Trade have sanctioned the borrowing by the Corporation of a sum of £65,000, repayable within 27 years, for the purposes of the Luton electric tramways. The Tramways Committee met on Sept. 11 and reported that they had visited the Dartford electric tramway scheme and inspected the cars running. Representatives of Messrs. J. G. White and Co. and the District Council met the committee and explained fully the details of the cars and the manner in which the same were constructed. Subject to certain additions and improvements of a minor character, which were suggested and explained by the engineers, the committee approved the style of car and gave instructions for placing the necessary orders in connection with the Luton tramways. A visit was subsequently paid, on the return journey, to the depôt of the London County Council system at New Cross, where valuable information was obtained as to the various types of cars running on that system and as to the working of the same. In moving the adoption of the report, Mr. Osborne remarked that it dealt exclusively with the selection made by the committee of the type of the car to be used on the Luton system. From the London County Council car depôt, which was the largest in the world, the committee received a lot of valuable information.

Pontypridd.—At the last meeting of the Council committee for electrical purposes, Councillor David Williams, referring to the crush on the workmen's cars on the Rhondda route, said a better system of taking fares was required. He understood the fares were being collected sometimes without any tickets issued. Councillor T. J. Thomas complained of the over-crowded state of the cars. The condition of things was scandalous, and the Council would have a rude awakening some day. Councillor James Roberts, J.P., said on a certain occasion he and a few colleagues waited for a car, but when it arrived it was simply packed. "They were inside and outside," said Mr. Roberts, "top and bottom, and the conductor hanging outside." The manager said the congestion of traffic occurred when men were proceeding to work and upon leaving work. They must not lose sight of the fact that their returns showed that they dealt with 8,500 workmen in a day, and the crush was only for a couple of hours. The percentage of persons who did not pay their fares must be very small. Things were much better than they had been, and he hoped for continued improvement. He was considering the advisability of recommending the purchasing of slot machines for the issuing of tickets at the junctions where the workmen boarded the cars. The matter was left in the hands of the engineer.

Bury.—The gross receipts from all sections of the Bury tramways have been as follows: April 1 to Aug. 11, 1907, inclusive, £21,157. 13s. 6½d.; for four weeks ending Sept. 8, £4,876. 2s. 2d.—£26,033. 15s. 8½d. Bury sections: Average receipts per week for the last four weeks, £859. 0s. 4d.; average per week since April 1, 1907 (23 weeks), £781. 16s.; total receipts since April 1, £17,981. 7s. 3d. The average number of passengers carried per week has been as follows: ordinary, at 2½d. 17,523, at 2d. 8,838, at 1½d. 18,150, at 1d. 80,947—125,458; workpeople carried at single fare for the double journey, 17,667—total, 143,125. Radcliffe sections: Average net receipts for the last four weeks, £187. 18s. 8d.; average per week since April 1, 1907 (23 weeks), £184. 17s. 3d.; total net receipts since April 1. £4,251. 16s. 7½d. The average number of passengers carried per week has been as follows: ordinary, at 2½d. 3,465, at 2d. 3,673, at 1½d. 4,008, at 1d. 31,780—42,326; workpeople carried at single fare for the double journey, 8,199 — total, 50,525. Heywood sections: Average per week for the last four weeks, £155. 11s. 1d.; average per week since April 1, 1907, £149. 11s. 3d.; total receipts since April 1, £3,433. 8s. 8d.; during the corresponding four weeks of the previous year the average receipts per week were £153. 5s. 7d. The average number of passengers carried per week has been as follows: ordinary, at 4d. 208, at 3d. 5,736, at 2½d. 4,108, at 2d. 3,646, at 1½d. 1,821, at 1d. 8,975—24,492; workpeople carried at single fare for the double journey, 5,677—total, 30,169.

York.—A meeting of the Tramway Committee of the Corporation has been held for the purpose of considering steps to be taken in regard to the provision of electric tramways for the city. The proceedings, which were not very largely attended, were ultimately adjourned, no decision being arrived at. The meeting lasted for two hours, and the matter was fully discussed. The principal point under consideration was as to the policy to be pursued in regard to municipalisation, and no agreement was arrived at on this head. The topic proved a controversial one, the committee being divided in their views. Eventually, in view of the fact that there was not a large attendance, the meeting was adjourned to Wednesday evening next. It was agreed to make no communication to the Press. The Tramways Committee of the York Corporation have unanimously resolved to recommend the City Council to apply to the Board of Trade in November for a light railway order or a provisional order authorising the City Council to make, lay down, and construct, or to lease for the purpose of an electric tramway system, four routes, from the railway station, as a centre, to the city boundary at Fulford, Tadcaster-road, Acomb-road, and Haxby-road respectively. It was also unanimously resolved that before exercising any of these powers a poll of the citizens shall be taken to determine whether the Corporation shall work the tramways or lease the same to a company. It will be remembered that the Corporation entered into an agreement with the York Tramway Co. to purchase the existing horse-car system, with the view to the substitution of an electric system, and the company will continue to work the old system until the Corporation are ready to take it over.

Manchester.—The Manchester Tramways Committee will, in the course of a week or two, bring into operation the alteration in fares and in other matters which have been asked for by passengers on various routes and agreed to by the Council. In the case of workmen, at the present time all cars that run before seven o'clock in the morning are classed as workmen's cars, and in these cases the following reductions have been made in the fares: ordinary 1½d. and 2d. fares are reduced to 1d.; ordinary 2½d. and 3d. fares are reduced to 1½d.; ordinary 3½d. and 4d. fares are reduced to 2d. The committee have arranged for passengers travelling before seven o'clock in the morning to get return tickets at the reduced rate. This will do away with the necessity of running workmen's cars in the evenings. The committee are also experimenting with regard to long-distance fares, and they have selected the Middleton route for the purpose. The present fare is 3½d., and it has been decided to reduce it to 3d. With regard to school children of not more than 15 years of age, the committee have decided that they shall be enabled to travel the double journey at single fares. In order to provide against fraud, forms of application will have to be provided and tickets issued in accordance with a scheme settled by the committee. The committee have declined to issue contract tickets. In this matter they have been guided by Mr. M'Elroy, who says: "It is the almost unanimous opinion of both municipal and company owned undertakings that contract tickets are undesirable and practically unworkable on tramway systems." An accident that resulted in several passengers being injured occurred to a Manchester tramcar on the Middleton route on Saturday evening last. The car, in which there were about a dozen persons, left the line near some fixed points at the end of Dane-street, between Middleton and Middleton Junction, and ran on to the footway. It then bumped into the wall of St. Michael's churchyard. The passengers were thrown from their seats, and when they alighted four or five complained of injuries. The cause of the accident is not known.

LIGHTING AND GENERAL.

Southend.—The Town Council are about to spend nearly £21,000 upon their electric light works.

Shoreditch.—The Council have decided to rewire the Hoxton Baths at an estimated cost of £102. 10s.

Bromley (Kent) Electric Light and Power Co.—The directors announce an interim dividend of 2 per cent.

Ravensworth.—A telegraph office and telephone exchange has been opened to meet the requirements of the parishioners.

Dundalk.—The Council have under consideration the establishment of a municipal electric lighting scheme for the town.

American Telephone and Telegraph Co.—The American Telephone and Telegraph Co. has declared a quarterly dividend of 2 per cent.

Fulham.—The Borough Council are about to apply to the London County Council for sanction to the borrowing of £2,330 for purposes of electric lighting.

Long Eaton.—The Council have resolved to apply to the Local Government Board for permission to borrow £10,000 for the extension of electricity works.

Plomesgate.—The Rural District Council have granted the request of the Postmaster-General to construct a telegraph line from the main road to Benhall Bridge.

Monmouth.—The Local Government Board will hold an inquiry on Oct. 3 into the application of the Council for sanction to a loan for electric lighting purposes.

Lees.—At the last meeting of the Council a letter was read from the Local Government Board stating that the Lees Electric Lighting Order, 1902, had been revoked.

Ludlow.—The Rural District Council have granted an application to lay a new overhead telephone service from Long-lane, Hammond's Green, Newington, Craven Arms.

Telephony and Trains.—A telephone has been successfully worked on an express in America. Communication was kept up with the central exchanges at both termini.

Tunbridge Wells.—A Local Government Board inquiry is to be held on Oct. 8 into the Council's application for permission to borrow £9,600 for electric lighting purposes.

Abertillery.—A Local Government Board inquiry is to be held on Oct. 2 into the application of the Council for sanction to borrow £10,000 for electric lighting purposes.

Bristol.—The Local Government Board will hold an inquiry on Oct. 1 into the Corporation's application for sanction to a loan of £34,600 for the electricity undertaking.

Kingston.—At the last Council meeting the electricity accounts for the year were presented, which showed a surplus of £6,000 after setting aside a considerable sum for depreciation.

Hammersmith.—The Council have decided to make application to the Local Government Board for sanction to the borrowing of £11,145 for extensions to the electricity undertaking.

Direct Spanish Telegraph Co.—The directors announce an interim dividend at the rate of 4 per cent. per annum, free of income tax, on the ordinary shares for the half-year ended June 30 last.

General Electric Sports.—The eleventh annual athletic sports of the General Electric Co., Salford, was held at Belle Vue Gardens on Saturday last. For 14 events there were at least 500 entries.

Battersea.—The number of applicants for the use of electricity for the quarter ended Sept. 17 totalled 1,042, and the electrical energy generated amounted to an equivalent of 75,605 8-c.p. lamps.

Merthyr.—The Electric Supply Co. have applied to the Council for permission to fix overhead wires along the roads to Dowlais for the new electric lamps. A sub-committee are to consider the matter.

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York.—The Higher Education Sub-Committee of the York Education Authority have decided to make a grant of £50 to the Railway Institute in connection with the equipment of their engineering and electrical department.

Wexford.—The London firm of Messrs. Foote and Milne has notified the Corporation of its intention of applying for a provisional order in December next, for the purpose of supplying electrical power in Wexford and district.

Mechanical Stokers Opposed.—The Colchester Trades and Labour Council have passed a resolution protesting against the expenditure of over £1,000 by the Town Council for mechanical stokers in the electric light station.

Ballyshannon (co. Donegal).—This town is presently interested in an electrical lighting and power scheme, the consideration of which is in the hands of a committee. The motive power is ready to hand in the famous Assaroe Falls on the Erne.

Belfast.—At the weekly meeting of the Electrical and Tramway Committee on the 16th inst. a delay in the delivery of the steam-turbine plant was reported by the city electrical engineer, and he was instructed to communicate with the firm.

Alloa.—The town clerk has been instructed to communicate with the National Telephone Co. with reference to the charge for putting in the telephone at the slaughter-house, and asking that the charge should be on the same lines as the other municipal departments.

Kilmacolm (Renfrewshire).—During the past summer 30 new houses have been coupled to the electricity supply and five additional street lamps added. Mains have been laid in all new streets formed recently. Consideration of additional plant is under consideration.

Lyme Regis.—A communication has been received by the Town Council from the Postmaster-General intimating that, if 25 residents rented circuits at stipulated rates, the authorities would be prepared to favour a proposal to connect the town by telephone with Bridport.

Anglo-Argentine Tramways Co.—The directors have declared an interim dividend to June 30 last of 4s. per share on the ordinary shares (which under the recent special resolutions become second preference shares), being at the rate of 8 per cent. per annum, free of income tax.

The Telegraph Strike in America.—The Western Union Telegraph Co. announces that telegrams for all important points east of Pittsburg and north of Washington are no longer subject to delay. This indicates the extent of the recovery in the telegraph service from the effects of the strike.

Light as a Bait.—A novel fishing invention has been patented by Mr. B. Asholck, a noted American angler. The contrivance consists of an electric light bulb suspended just below the float, and the inventor claims that the light attracts the fish for 50 yards around. In his first experiment he caught 82 fish in two hours.

Woking Electric Supply Co.—The directors of this company notify that an interim dividend at the rate of 5 per cent. per annum on the ordinary shares has been declared for the half-year ended June 30 last. This is the first dividend paid on the ordinary shares, and points to satisfactory progress in the company's revenue.

Kensington.—In order to take electricity in bulk from the generating station of the Kensington and Notting Hill Electric Lighting Companies, the Hammersmith Borough Council are seeking permission from the Kensington Corporation to lay 200 yards of four-way 3in. Sykes conduit along the roadway on the south side of the Kensington depôt.

Clitheroe.—At their last meeting the Council were asked to support the Town Council of Leamington in protesting against the proposed new rates of the Telephone Company. In reply it was stated by the company that the protest was based on a misconception. The rates would not be increased, the new rates were only for new subscribers.

Keighley.—At the next meeting of the Council the Electricity Committee will recommend that a feeder cable be laid from the electricity works to the top of Dalton-lane, at an estimated cost of £650; that 35 yards of cable be laid in Greengate road, at an estimated cost of £17, to supply electricity to the premises of Messrs. Samuel Fearnside and Sons.

Houghton-le-Spring.—At the last meeting of the Education Committee a letter was read from Mr. Kirkup that the cost of a meter at the installation of the electric light at the West Merrington Schools would be £5 if the committee decided to buy outright, together with £3 for fixing, a total of £8, or a rental of 5s. per quarter, and the cost of fixing. It was decided to recommend the purchase of the meter outright.

Partnerships.—According to the *London Gazette* the partnership between W. Mackie, E. J. Glyn, and A. R. M. Lockwood, carrying on business as electrical engineers at 122 and 124, Golden-lane, London, has been dissolved by mutual consent.—The partnership between W. J. Crawford and E. Draper, mechanical and electrical engineers, Alma Works, Alma-street, Sheffield, has been dissolved by mutual consent.

Cherbourg.—The Minister of Marine has authorised the port of Cherbourg to open a credit of £40,000 for the establishment of electrical works, to provide the motor power required for lighting the workshops of the arsenal and for charging the accumulators of submarines. The works will be the first of their kind, and similar works will be erected at other ports if the results obtained at Cherbourg are satisfactory.

Edinburgh.—The town Council at the last meeting discussed a recommendation from the Electric Lighting Committee that the price of current to ordinary consumers for private lighting be reduced from 3d. to 2¾d. per unit as from October, 1907. The convener thought an eighth would be quite sufficient. It was agreed by 20 votes to 16 to allow the rate to stand as at present.

Olympia Exhibition.—In connection with the engineering and machinery exhibition which is now in progress at the Olympia, a number of interesting, scientific, and popular lectures have been arranged, and last Wednesday evening Mr. J. W. C. Haldane recounted to a crowded audience the growth of the battleship, from mining the ore to the fully-equipped fighting ship. The lecture was profusely illustrated by lantern slides.

Oldham.—At the meeting of the Corporation Electricity Committee the engineer reported that the number of lamps connected to date was: arc, 615; incandescent, 23,041; motors, etc., 338; equivalent lamps of 8 c.p., 101,088; showing an increase during the fortnight of: arc, 19; incandescent, 92; motors, etc., 1; equivalent lamps of 8 c.p., 672; and making a total of: arc, 634; incandescent, 23,133; motors, etc., 339; equivalent lamps of 8 c.p., 101,760.

Liquidations.—The *London Gazette* announces that the City of Wellington Electric Light and Power Co. has been wound up voluntarily, and Mr. H. E. Salt appointed liquidator.—A general meeting of the Severn Electric Launch Co. will be held at the offices of the company, Stourport, on Oct. 21, at 3 p.m., for the purpose of receiving the liquidator's report, showing the manner in which the winding-up has been conducted and the property disposed of.

Leicester.—The Electric Lighting Committee report that the accounts of the electric lighting undertaking have been submitted, from which it will be seen that the result of the working of this department for the half-year ending June 30 last is a net profit, after paying interest on the capital of the undertaking, of £5,946. 19s. 9d. Out of this has been paid £3,343. 16s. 10d., the half-year's amount of sinking fund, leaving a balance of £2,603. 2s. 11d.

Stoke-on-Trent.—The monthly report of the Corporation electrical engineer shows that during the months of July and August 35,700 units had been supplied, an increase on the corresponding period of last year of 90 per cent., and that the number of consumers now on the books was 306, representing a total of 25,270 8-c.p. lamps. The provisional order authorising the Council to supply electrical energy within the area of the Fenton Urban District Council has been confirmed.

Beckenham.—A Local Government Board inquiry was held at the Council Offices on the 25th inst. by Mr. C. E. Ducat into the application of the Council for sanction to borrow £1,000 for enlarging the dust destructor at the electric lighting station. Mr. J. S. Best, assistant surveyor, stated that the refuse of the district had so increased that the destructor was much overcharged. It was proposed to add two cells to the existing three, and increase the capacity of the destructor by 20 tons per day.

Morley.—The Ampiere Electrical Engineering Works in Commercial-street, Morley, were completely destroyed by fire on the 20th inst. The fire orginated on the ground floor of the building, and before the Corporation fire brigade arrived the whole of the building was ablaze. Within a very short time the upper floor and roof collapsed, and the destruction of machinery and electrical stock was complete. Nothing remains but the outer walls and a heap of debris. The cause of the fire is unknown.

Heswall.—The result of the poll of the ratepayers of Heswell in regard to the proposed scheme of electric lighting of the village by a private company was announced last night at the meeting of the Parish Council, the figure being 273 in favour of the scheme and 228 against it. There were 45 who declined to vote, and 76 papers were not sent in. The Council decided that their solicitors shall now confer with the solicitors of the promoters with a view to drawing up an agreement, to be approved of by the Council.

Mansfield.—At the last Town Council meeting a sub-committee was appointed to consider the question of taking electricity to Pleasley Hill. The consideration of the application of the electrical engineer for an increase in salary was deferred for six months. It was reported that the General Purposes Committee had acceded to the request of the Leamington Town Council to urge upon the National Telephone Co. the desirability of resuming their former charges in preference to the new schedule of rates recently adopted.

Victoria Falls Power.—The Victoria Falls Power Co. have received advices that the electrical power stations at Germiston and Brakpan, on the Rand, purchased respectively from the General Electric Power Co. and Rand Central Electric Works, are now supplying power to their utmost capacity, and that it has been found necessary to enlarge the capacity of the Germiston station pending the erection of the new central generating station of 24,000 h.p. capacity, the machinery for which is in an advanced stage of construction.

Wisbech.—At the last meeting of the Town Council the deed of transfer under the Wisbech electric lighting provisional orders to the Wisbech Electric Light and Power Co. was sealed. It was pointed out that the company undertook within six months from the date of that transfer to lay down plant and installation and everthing else connected with it. An agreement with the Wisbech Lighting Co. for the street-lighting for the year ending July 31 was passed. The prices are £3. 6s. per ordinary lamp and £3. 10s. per incandescent lamp, less 5 per cent. discount.

St. Helens.—A disastrous fire broke out on the 26th at the plate glass factory of Messrs. Pilkington Bros., St. Helens. It originated in the boiler-house and extended to the dynamo-room, both buildings being quickly ablaze from end to end. Owing to the dynamo being wrecked the works were plunged into darkness except for the glare of the flames. The town fire organisation, assisted by Messrs. Pilkington's two brigades, succeeded in preventing the fire spreading to the adjoining warehouses and grinding sheds, in which there were huge

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stores of glass and valuable machinery. The damage is estimated at many thousands.

Pontypridd.—Satisfactory increases were shown in the receipts for the electrical undertakings of the Council. At the Corporation Committee the engineer (Mr. Teasdell) reported that the receipts from the generating station for the past month amounted to £477. 14s. 7d., as compared with £383. 6s. 2d. for the corresponding period of last year. Expenditure had decreased, representing a difference of £40 in the month's wages. The tramway department returns were: Cilfynydd and Treforest route, £727. 1s. 5d., as against £676. 5s. 4d.; new Rhondda route, £324. 8s. 1½d., representing a total of 256,678 passengers carried.

Watford.—At the last meeting of the Council the electrical engineer reported that the net number of consumers connected to the system to date is 542. The clerk reported that he had received an estimate from the Watford Gas Co. to light certain streets on the Monmouth House Estate and the Cassiobridge Estate, and that he had furnished copies of the same to the surveyor and the electrical engineer, who were preparing complete estimates for lighting by gas and electricity respectively. The committee decided to refer the matter to the sub-committee for a report, and to consider the same at a special meeting.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to Shanghai Electric Construction Co.'s 32,000 shares of £10 each, fully paid, Nos. 1 to 32,000; and to appoint a special settling day in Mount Lyell Comstock Copper Co.'s 325.332 shares of 4s. each, 2s. 6d. paid, Nos. 1 to 486,318 and 505,987 to 545,000; Platinum Corporation's 59,255 ordinary shares of £1 each, 10s. paid, Nos. 1 to 59,255, and 36,244 deferred shares of 1s. each, fully paid. Nos. 1 to 35,244; and Sungei Salak Rubber Co.'s 41,000 shares of £1 each, 10s. paid, Nos. 14,001 to 55,000.

Luton.—The Highways and Lighting Committee of the Corporation have made their annual inspection of the town as to the conditions of streets and generally as to the question of street-lighting, and have resolved that the borough engineer be instructed to prepare a report with a plan showing the number of lamps which should, in the opinion of the committee, be erected in the various streets of the town. It was also decided that the town clerk be instructed to write to the Limbury Parish Council informing them that it was the Council's intention to erect one lamp on the railway bridge under which the Leagrave-road passes, and a further one at the junction of such road and Selbourne-road.

Lambton.—On Saturday last a sad fatality occurred at the Lumley Sixth Pit, one of the Lambton Collieries, to a man named Benjamin Bowwater, aged 37. Deceased was employed as driver of one of the coal-cutting machines in the Five Quarter Seam, and which is driven by electricity. When Bowwater was just about terminating his shift he noticed there was something wrong with the machine, and immediately he touched a part of it he was pitched right on to the hauling rope. J. Perry at once ran to shut the power off, and along with others then ran to the aid of Bowwater. Artificial respiration was tried for a couple of hours, but it was of no avail. Deceased leaves a widow and two children.

Brynamman.—A largely attended meeting of Brynamman ratepayers assembled at Ebenezer Chapel Vestry (Councillor John James presiding) to consider the question of the public lighting of the outskirts of Brynamman. Mr. W. J. Williams moved a proposition in favour of lighting the outskirts. Mr. Rees Morgan seconded, and it was carried. The resolution ran: "That Mr. Daniel Richards be secretary, and that he prepare a petition to be in favour of obtaining light for the outskirts of Brynamman, and to submit same to the District Council." The motion was supported and discussed by the chairman and Messrs. J. Lewis and J. Benjamin Evans, and Messrs. Thos. Jones, Dd. Thomas, Dl. Richards, John B. Evans, Beadow, Dd. Howells, and W. G. Evans will take round the petition.

Manchester Cathedral.—Bishop Welldon (Dean of Manchester), before beginning his sermon at Manchester Cathedral on the 22nd, said: "The installation of the electric light is far advanced. It will, I am told, be completed by the end of next month, so that the light will illuminate the cathedral on the Sunday that the new lord mayor comes to worship here. But it has been a costly work; costlier than was contemplated at first, apparently because of its magnitude. There will be nearly 20 miles of wiring in the cathedral, because it has been thought right in so ancient and sacred an edifice to do the work in the best possible manner, and to avoid all interference or connection with the woodwork. But I believe the congregation will feel that the improvement not of the light only but of the atmosphere of the cathedral will greatly tend to comfort, reverence, and divine worship."

Saffron Walden.—It was reported at the Council meeting that the town clerk of Leamington had written with reference to the increase in the schedule of rates for the National Telephone service, and suggesting that local authorities should make a combined request urging the company to resume its former charges. Councillor Atkinson remarked that the charges had been increased in order to make better terms with the Government, when the latter took over the service at valuation in 1911. Councillor Gilling pointed out that the rate of increase was very considerable. The former charge was £8 a year for an unlimited number of calls. Now they were only to have 500 calls for £6, and were to be charged on a sliding scale for those exceeding that number, so that if they had 20 a day it would cost £23 a year. On the proposition of Councillor Atkinson, seconded by Councillor Brown, it was decided to join the borough of Leamington in its request.

Worksop.—Major C. E. Newton, R.E., on the 19th inst. held an inquiry at Worksop into the Urban Council's application to borrow £1,700 for electric light purposes. Mr. G. H. Featherstone, clerk, reported that the estimated population was 18,500, as compared with 16,112 at the last census. The annual rateable value was £67,769, and balance on outstanding loans £50,385. The amount originally borrowed for electric light purposes was £27,070, of which amount £4,951. 9s. 9d. had been repaid, leaving a balance of £22,118. 10s. 3d. The inspector commented upon the rapid increase in the assessable value, and it was pointed out that this was due to the development of Manton Colliery, the erection of a large mill, and the number of new houses which had been built. Evidence was given by Mr. J. P. Crowther, electrical engineer, who said £1,400 would be required for the cable, £100 for casual labour, and £200 for joint boxes. There was no opposition.

Newcastle.—A combination of tradesmen in Grey-street, Newcastle, has been making arrangements for the improved lighting of the street, and in a little while illuminating power to the extent of 80,000 candles will be installed. Grey-street has been subject to competition as a business centre, and the diminution of receipts has induced tradesmen to consider the position of the thoroughfare in relation to others. It was decided that a better system of lighting would be the best way of attracting customers, and, as a result, arrangements have been entered into with the Newcastle Electric Supply Co., whereby an annual payment has been fixed for supplying, erecting, and lighting 40 flame arc lamps, each 2,000 c.p., during the dark hours of the winter business days. The flame arc lamp has been selected as being the most striking form of intense lighting, and it is believed that the glow of illumination will attract large numbers of sightseers and shoppers. A remarkable feature of the new movement is that it is the outcome of co-operation among private traders.

Liverpool.—At the autumnal meeting of the Association of Chambers of Commerce in the Liverpool Town Hall (Lord Brassey, president, in the chair), resolutions were set down by the Bradford, Cardiff, Southampton, and Kendal chambers on the telephone rates, but by agreement the following motion was drafted, submitted, and adopted: "That, in the opinion of this association, the imposition of a new tariff by the National Telephone Co. and his Majesty's Postmaster-General, which entails an increased cost for the telephone on the large majority of users, is unnecessary and uncalled for, and this association requests the National Telephone Co. and the Postmaster-General to withdraw the new rates and to continue the facilities hitherto enforced." On the motion of Mr. W. Behrens (British Chamber of Commerce, Paris), a resolution was agreed to in favour of the establishment of an Anglo-French postal union, and the consequent reduction of letter postage between the two countries, and the diminution of the Anglo-French telegraphic and telephonic rates.

The New Cunarders and Wireless Telegraphy.—There are difficulties concerning the use of wireless telegraphy even from the greatest of liners. It is stated that the area of communication in ordinary steamers is about 250 miles. The "Lusitania's" area, owing to height and superior installation, extends to about 500. This means that when further out to sea the messages must be transmitted from ship to ship until the nearest land station is reached. On the first voyage of the "Lusitania," during two days after leaving Queenstown, little trouble was experienced in despatching Marconigrams, but on the third day all urgent messages had, for the sake of assurance, to be duplicated by touch with Cunarders and other liners on the eastern seaboard and with Cape Race on the western. On the fourth and fifth days the stations on the American coast proved exceedingly useful, the messages for Europe being sent on by cable from Marconi stations. The "Lusitania" could receive messages from Poldhu, Cornwall, at a distance of 2,000 miles, and hence it was that the Cunard bulletins published day by day contained, even when in mid-Atlantic, news of the previous day relating to the whole world sent from the Cornwall station during the night by Reuter's Agency.

Croydon.—To the Council at their last meeting the borough electrical engineer presented a report, through the Electricity Committee, upon the present mode of charging for electricity for power purposes—viz., the time switch system, which was inaugurated in October, 1904. At that time there were but few motors connected with the electric mains. From the experience now gained with this system of charging, and with a view to obtaining further consumers, the committee recommend, upon the suggestion of the engineer, that the charge for current for motor power purposes, on the time switch system, should be now varied and be as follows: 1½d. per unit for all times except between dusk and 11 p.m.; 3d. per unit for all current consumed between dusk and 11 p.m. The latter charge at present is 5d. per unit. The committee have considered the question of lighting factories by electricity. Under present arrangements it is necessary for such premises to be wired in duplicate with duplicate meters for lighting and power purposes, this resulting often in loss of consumers. With a view to removing objections raised by owners of factories and workshops, the committee recommend that electricity used for lighting purposes be charged through the same meters as the motors where the time switch system is in vogue, provided that the quantity used for lighting does not exceed 20 per cent. of the total amount of energy taken. By this arrangement one set of wiring only would be needed, and the undertaking will be saved a considerable amount of capital outlay in the purchase of meters. The report was adopted.

Tighnabruaich.—At a meeting of Cowal District Committee a requisition to form Tignabruaich into a special lighting district was considered. The chairman pointed out that they could not get authority for electric lighting without a provisional order, which would cost approximately £230, and if opposed from £250 to £400. Mr. Nicolson stated that the estimated cost of removing the present plant was £140. They had already got £135, with a guarantee for as much more as was needed. If they started without any expense he thought 3½d. or 4d. on rates would be sufficient. The local feeling was that if a provisional order was to cost more than £50 they would not go on with the scheme. The following motion was agreed to: "The committee, looking to the large cost and difficulty involved in

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forming districts to be lighted by electricity, resolve to recommend the County Council to petition Parliament to amend the Acts dealing with the matter, so that local authorities may be empowered to undertake electric lighting under similar provisions as apply to lighting by gas and other luminants, without necessity of a provisional order."

West Ham.—The Local Government Board have sanctioned the expenditure of £450 and £2,607 by the Town Council, sums the Board previously refused to grant in connections with loans for the electricity undertaking. The annual report of Mr. A. Hugh Seabrook, manager of the West Ham Corporation electricity department, records an adverse balance of £1,829 on the year's working. This, Mr. Seabrook says, would be a serious matter under ordinary normal working conditions, but during the year reductions in prices amounting to £9,500 have been made, and the increased sales of the one year have not been sufficient to cover the cost of the reductions. Private lighting consumers had received reductions amounting in the aggregate to £4,626, power consumers of £1,625, and the Corporation tramways with a reduction of ·21d. per unit had benefitted to the extent of £3,327. The sales were 8,000,000 units, the output increasing by 33⅓ per cent. at an increased cost of only 12 per cent. Mr. Seabrook records excellent results from advertising. He says: "Spasmodic and periodical advertising is money wasted. It must be persistent and systematic to do any good."

Guisborough.—The lighting of Guisborough formed the subject of considerable discussion at the meeting of the Urban District Council, at which it was intimated that offers had been received from Mr. Cecil Lugard, electrical engineer, and the local gas company. Mr. Charlton explained that he had worked out the figures for electricity, and had arrived at the conclusion that if this form of light were to be adopted it would pay the Council to go in for it themselves. The last offer of the gas company was a very fair one, and was much better than that made on the previous occasion. He proposed that they accept the offer for the coming year, and before the expiration of the Council's notice to terminate the contract at the close of the ensuing lighting season the members could consider the two offers. Mr. Scott said it would be hardly fair for the gas company to go to the expense of providing 30 or 40 new incandescent lights unless the notice was withdrawn, and the chairman, Mr. Orton, and Mr. Porteous thought that if these new lights were provided the contract ought not to end for at least two years. Mr. Batterbee said that if there had been no offer from the electrical company the Council would not have received such favourable terms from the gas company. He attributed these to the fact that they realised the danger of losing the lighting of the town. He thought the gas company's terms should only be accepted for a year, and that Mr. Lugard ought to be asked to put up a trial lamp. Finally it was agreed to adjourn the matter for another month, and to carry out Mr. Batterbee's suggestion regarding the trial lamp.

Erith.—At the last meeting of the Council Electric Lighting and Tramways Committee a letter was read from the Board of Trade consenting to the erection and use by the Council of an overhead wire for the supply of energy at a pressure of 3,000 volts, from a sub-station on Belvedere Marshes to the London County Council outfall works, Crossness, subject to the work being carried out in accordance with the details submitted to the department, and to any special regulations which may hereafter be made by the Board. The tenders received for the supply and construction of the overhead main were opened by the committee and referred to the electrical engineer for examination and report. Letters were read from the General Electric Co. and the British Insulated Wire Co. stating that they were unable to submit tenders and asking for the return of their deposits for the specification. The Committee resolved that the deposits be returned. A letter was read from the Local Government Board with reference to the application of the Council for sanction to borrow £3,000 for the purposes of their electricity undertaking, stating that the Board had decided to sanction the borrowing of £2,664, and enclosing formal sanction. In accordance with their usual practice, the Board had excluded sums amounting to £191 in respect of the debt outstanding on works which had been superseded, and also a sum of £145, representing the difference between the actual cost of the extension of the buildings and the amount of the estimate. The sanction was read and authorised the borrowing of £2,664, to be repaid within a period of 18 years. A further letter was read from the Local Government Board stating that the sum of £191 excluded from the amount of the loan sanctioned, was made up of two sums of £117 and £74, the former representing the outstanding debt on the grease extractor and piping which had been superseded, and the latter representing the outstanding debt upon the office buildings which had been removed to make room for the storage tank.

PROVISIONAL PATENTS, 1907.

SEPT. 16.

20539. Automatic device for lowering an electric trolley pole when it leaves the wire. John Randes-Willey, 7, Hester-street, Northampton.

20551. Improvements in ships' compasses. Charles Edwin Wrightson Akers, 44, Shakespeare-crescent, Manor Park, London.

20572. Improvements in electrically-operated firearms. Kennedy Beresford, 77, Colmore-row, Birmingham.

20592. Improved electric secondary cell. Parnell-Rabbidge, 111, Hatton-garden, London. (Complete specification.)

20600. Improvements in bridging blocks for dynamo-electric machines. Edward Heitmann and Frederick William Young, 28, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Oct. 18, 1906, being date of application in United States.) (Complete specification.)

20603. Improvements in electrostatic potential meters. Allgemeine Elektricitäts Ges., 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Sept. 15, 1906, being date of application in Germany.) (Complete specification.)

20609. Improvements in electrical transmitting apparatus for controlling the sighting of guns. Arthur Trevor Dawson and George Thomas Buckham, 7, Southampton-buildings, London.

20612. Improved electromagnetically-controlled cut-out or circuit breaker. Harry Rose, 112, Hillaries-road, Erdington, Warwickshire.

SEPT. 17.

20619. Improved electric lamp holder, with improved shade carrier holder, for bayonet cap electric lamps. Charles Maurice Escaré and Charles Damey, 9, Osborne-road, Thornton Heath, Surrey.

20639. Improvements in filling joint boxes to protect the joints of electric cables. Ernest Alexander Claremont, 4, Bloomsbury-square, London.

20650. Electric furnaces. Herman Lewis Hartenstein, 52, Chancery-lane, London. (Complete specification.)

20651. Carbon holders. Herman Lewis Hartenstein, 52, Chancery-lane, London. (Complete specification.)

20670. Improvements relating to mercury interrupters for electric currents. Léopold Jean Baptiste Drault, 11, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Sept. 21, 1906, being date of application in France.) (Complete specification.)

20676. Improvements in electrically-operated switching and other devices. Frank Conrad, Westinghouse Building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Sept. 20, 1907, being date of application in United States.) (Complete specification.)

20682. Improvements in or connected with the reproduction of pictures, writing, and the like by electricity. Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London.

20689. Improvements relating to the control of electrically-driven vehicles. Edward Augustus Jeffreys and William Brooks Sayers, 46, Lincolns-inn-fields, London.

SEPT. 18.

20748. Improvements in electrical fuses. John Jeffreys, 18, Southampton-buildings, London.

20774. Improvements in and relating to electric switches. The British Thomson-Houston Company, Limited, and Edmund Basil Wedmore, 83, Cannon-street, London.

20787. Improvements in the manufacture of copper wire. Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London.

20788. Improvements in electric batteries for medical purposes. Herbert John Haddan, 31, Bedford-street, Strand, London. (William Thompson and Jens C. Martin, .) (Complete specification.)

SEPT. 19.

20814. Improved electric cable or conductor connecting devices or means. British Insulated and Helsby Cables, Limited, and Harry Allen, 15, Water-street, Liverpool. (Complete specification.)

20824. Improvements in electric oscillographs. John Thomas Irwin, 23, City-road, Finsbury-square, London.

20867. Improvements in and relating to alternating-current machines of the commutator type. Allgemeine Elektricitäts-Gesellschaft, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Sept. 20, 1906, being date of application in Germany.) (Complete specification.)

SEPT. 20.

20878. Improvements in and relating to motor-driven clocks, electrically controlled. Isaac Hardy Parsons and Alfred Ernest Joseph Ball, 38, St. Saviour's-road East, Leicester.

20901. Improvements in central battery telephone exchange systems. John Alexander Romer, 1, Waveney-villas, Lausanne-road, Peckham, London.

20908. Improvements in automatic electrical signals for colliery inclines and the like. Robert Reed, 15, St. James'-row, Sheffield.

20919. Improvements in or relating to magneto machines chiefly for the ignition of internal-combustion engines. John Dalrymple Bell, 18, Hertford-street, Coventry.

20920. Improvements in magnetic ore separator. Lawrence Stevens Burt, 129, Salisbury House, London-wall, London. (William MacGregor Currie, Federated Malay States.)

20932. New method of manufacturing moulds used in the electrolytic manufacture of so-called honeycomb radiators and apparatus connected therewith. Ernest Friedheim, 18, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Nov. 27, 1906, being date of application in France.) (Complete specification.)

SEPT. 21.

20947. Method of inserting former-wound coils of flat copper into the slotted iron cores of electrical machines. Siemens Bros. Dynamo Works, Limited, Queen Anne's-chambers, Broadway, Westminster. (Siemens-Schuckertwerke, G. m. b. H., Germany.) (Complete specification.)

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20948. Method for reducing disturbances in telephone and telegraph lines. Siemens Bros. Dynamo Works, Limited, Queen Anne's-chambers, Broadway, Westminster. (Siemens-Schuckertwerke, G. m. b. H., Germany.) (Complete specification.)

20949. Improvements in the control of electrically-propelled vehicles and other apparatus. Siemens Bros. Dynamo Works, Limited, Queen Anne's-chambers, Broadway, Westminster. (Siemens-Schuckertwerke, G. m. b. H., Germany.) (Complete specification.)

20986. Improvements in or relating to magneto machines chiefly for the ignition of internal-combustion engines. John Dalrymple Bell, 18, Hertford-street, Coventry.

21030. Improvement in magnets for lifting. Märkische Maschinenbauanstalt Ludwig Stuckenholtz A.-G., Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Patents Act, 1901, March 21, 1907, being date of application in Germany.) (Complete specification.)

21035. Improved method of electric motor control and apparatus therefor. William Chauncey Yates and Walter Oscar Lum, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Sept. 22, 1906, being date of application in United States.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Oct. 10.)

1906.

13965. Electric furnaces. De Ferranti.

15835. Motor-operated electric switches. British Thomson-Houston Company. (General Electric Company.)

20327. Method of operation with lead-peroxide-zinc storage batteries. Ziegenberg.

21004. Systems of operating electric motors for braking purposes. British Thomson-Houston Company. (General Electric Company.)

21081. Apparatus for the manufacture of iron tubes by electrodeposition. Cowper-Coles.

21091. Electrical switch and like gear. Roberts. (Roberts.)

21129. Means of ventilating dynamo-electric machines, particularly petrol electric automobiles. Stevens.

21252. Accumulator boxes and other receptacles. J. Stone and Co. and Preston.

21543. Electrical speed and distance indicators for wheeled vehicles. Everett and Edgcumbe.

21667. Treatment of refractory materials by means of the electric arc and apparatus therefor. British Thomson-Houston Company. (General Electric Company.)

22981. Dynamo-electric machines. Jones, Pohl, and Phœnix Dynamo Manufacturing Company.

23002. Portable telephone and telegraph apparatus. Hjorth, Ljungman, and Berglund.

23010. Electric arc lamps. British Thomson-Houston Company. (General Electric Company.)

23040. Overhead electric traction gear. Sayers.

23306. Electric switches. Haywood.

24446. Protective devices for electric apparatus. British Thomson-Houston Company. (General Electric Company.)

25413. Means for regulating electric arc lamps. Clarke, Chapman, and Co., and Money.

25753. Electric motor control systems. British Thomson-Houston Company. (General Electric Company.)

28395. Holders for electric incandescent lamps. Müller.

1907.

502. Electrical transmission of time. De Peyrecave and De Peyrecave.

814 Incandescent electric lamps. British Thomson-Houston Company. (Allgemeine Elektricitäts-Ges.)

975. Means for compounding and regulating direct-current dynamo-electrical machines. Felten and Guilleaume Lahmeyerwerke Akt.-Ges. (Date applied for under International Convention, Jan. 13, 1906.)

2677. Alternating-current commutator electric motors for increasing the starting torque thereof. Felten and Guilleaume-Lahmeyerwerke Akt.-Ges. (Date applied for under International Convention, Feb. 3, 1906.)

3809. Regulating arrangements for electrically-driven hoisting, or winding, engine installations. Felten and Guilleaume-Lahmeyerwerke Akt.-Ges. (Date applied for under International Convention, Feb. 15, 1906.)

3948. Electric motor controlling devices. Allgemeine Elektricitäts Ges. (Date applied for under International Convention, April 18, 1906.)

10040. Arc lamps. Gallois. (Date applied for under International Convention, May 2, 1906.)

11178. Method of fastening metallic filaments in electric glow lamps. Haddan. (Bergmann Elektricitäts-werke Akt.-Ges.)

12090. Alternating-current commutating electric machines. Allgemeine Elektricitäts Ges. (Date applied for under International Convention, May 25, 1906.)

15338. Electrodes for searchlights. Geb. Siemens and Co. (Date applied for under International Convention, Dec. 17, 1906.)

COMPANIES' STOCK AND SHARE LIST.

Name	Amount paid.		Last price.
Commercial and Industrial.	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	—	⅛-⅜
—— Ord., 1 125,000	1	..	⅛-¼
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	5/32-9 32
British Aluminium Co., Ordinary, 2,001-40,000	5	..	4½-5¼
—— 7 per cent. Cum. Pref., 1-40,000	5	..	5-5½
—— "A" 6 per cent. Cum. Pref., 1-20 000	5	..	4¾-5¼
—— 4 per cent. Funding Certificates, 1-20,000	5	..	3½ 4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	100-103
—— 5½ per cent. Loch Leven Deb (Reg.), Red., 1-3,000	100	..	96-99
British Insulated and Helsby Cables, Ord., 1-100,000	5	—	6½ 7 xd
—— 6 per cent. Cum. Pref., 1-100,000	5	—	5⅞-6¼
—— 4½ per cent. Mortgage Debentures	100	—	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	—	85 89
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	3	—	1-1½
—— 4 per cent. Mortgage Debenture Stock	100	—	62 67
Brush Electrical Engineering, Ordinary, Nos. 1-106,751	2	—	⅛-¼
—— Non. Cum., 6 per cent. Pref.	2	—	⅞-1¼
—— 4½ per cent. 1st Debenture Stock	100	—	83-86
—— 4½ per cent. 2nd Debenture Stock	100	—	68-71
Callender's Cable, Debentures	100	—	105½-107½
—— Ordinary	5	—	9½-10¾
—— 5 per cent. Pref.	5	—	5¼-5¾
Consolidated Electrical Co., Ordinary, 1-110,000	1	..	7/16 9/10
Crompton and Co.	5	..	1⅞-2
—— 5 per cent. Debentures	100	—	96-99
Dick, Kerr, and Co., Ordinary, 1 250,000	1	..	1⅞-1⅞
—— 6 per cent. Cum. Pref., 1-305,000	1	..	1-1⅛
—— 4½ per cent. Debenture Stock, Red.	100	..	101-104
Edison and Swan United, "A" Shares, 1-99,251	5	—	1 1/16-1 5/16
—— "A" Shares, 01-017,139	5	—	2¼-2⅜
—— 5 per cent. Debentures	100	—	89-92
—— 4 per cent. Deb. Stock, Red.	100	—	83 85
Electric Construction, Nos. 1 to 112,100	2	—	⅛-¼
—— 7 per cent. Cumulative Pref.	2	—	2 1¼
—— 4 per cent. Perp. 1st Mort Deb.	100	—	77-81
Electrolytic Alkali Co., Ordinary, 1-202,218	1	..	3/16-5/16
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	—	—
General Electric Company (1900), 5 per cent. Cum. Pref.	10	—	8 8¼
—— 4 per cent. 1st Mort. Deb. Stock	100	—	92-96
W. T. Henley's Telegraph Works, Ordinary	5	—	11¼-12¼
—— 4½ per cent. Preference	5	—	5-5½
—— 4½ per cent. Debentures	100	—	105½ 107½
India Rubber, Gutta Percha, and Telegraph Works	10	—	14½-15½
—— 4 per cent. Debentures	100	—	97-99
National Electric Construction Co., 1-170,000	1	..	27/32-31/32
Parker, Thos., Limited, Ordinary	10	—	10-10¼
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5	..	5¼-4
Telegraph Construction and Maintenance	12	—	31-33
—— 5 per cent. Bonds	100	—	99½ 02½
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	..	9¼-9¾

Electric Lighting and Supply.—

Name.	Amount paid.		Last price.
	£		£
Adelaide Electric Supply Co., 6 p. c. Cum. Pref., 1-10 000	5	..	4¼-5
Bournemouth and Poole, Ordinary	10	—	9¾ 10¾
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	—	9¾ 10¼
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	—	9¾-10¼
—— 4½ per cent. Debenture Stock, Red.	100	—	99-11 2
Bromley (Kent) Electric Light and Power Co.	5	—	4¾-5¼
—— 4½ per cent. 1st Debenture Stock, Red.	100	—	98 100
Brompton and Kensington, Ordinary	5	—	7¼ 8¼
—— 7 per cent. Preference	5	—	7¼ 8¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	—	6¾ 7¾
—— Nos. 80,001-100,000	4	—	6¼ 7¼
Cambridge Electric Supply Company, £10 Ord.	8	—	12⅝-13⅝
Canadian General Electric Co., Common Shares	$100	..	114-116
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	—	99 102
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	—	3⅜ 4¼
—— 4½ per cent. Cum. Pref., 1-80,000	5	—	3⅜ 3¾
—— 4 per cent. Debenture Stock, Red.	100	—	96 99
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	—	3⅜ 3¾
—— ditto (1905) 40,001-80,000	5	—	3¼-4¼ xd
Chelsea Electricity Supply	5	—	3¼-4¼
—— 4½ per cent. Debentures	100	—	102-105
Chicago Edison Co., 1st Mt. 5 p. c. 30-yr. Gld. Bds., Red., 1-1,200	$1000	..	96-99 xd
City of London, Ordinary	10	—	9-10
—— 6 per cent. Cumulative Pref.	10	—	10¼-11¼
—— 5 per cent. Debenture Stock	100	—	122-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	—	97-100
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1,653	50	—	50-53
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100	..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5	..	4¼-5
—— 5 per cent. Preference, 1-50,000	5	..	4¼-5
County of London Electric Supply, Ordinary	10	—	6¾-7¾
—— 6 per cent. Cum. Pref.	10	—	10-11
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100	—	106-109
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	—	96-99
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5	—	½-1
—— 6 per cent. Cum. Pref.	5	—	1½-2
—— 4½ per cent First Mort. Deb	100	—	95-99
Electrical Development Co of Ontario, 5 per cent. 1st Mort. 37-year Gold Bonds, 0,751-15,75	—	—	75-77 p.c.
Electric Lt & Traction Co of Aust., 6 p c Cm Pf., 1 30,000	5	—	2¼-2⅝
5 per cent Debenture Stock Red	100	—	85½-89½
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red.	100	—	94-96
Folkestone Electric Supply, Ord. Nos. 1-10,000	5	—	4¼-5¼
—— 4½ per cent. First Deb. Stock, Red.	100	—	96-99
Hove Electric Lighting, Ord., 1-13,000	5	—	6¾-7¼
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100	—	101-104
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Deb. Stk. Red.	100	—	94-97
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	—	—
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5	—	8¼-9¼
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	—	94-97
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9¾-10¼
London Electric, Ordinary	3	—	1⅜-1⅝
—— 6 per cent. Pref.	5	—	4¼-4¾
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	88-92

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Name.	Amount paid.		Last price
	£		£
Madras Electric Supply Corporation, 5 per cent. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100	–	94-97
Metropolitan Ordinary, 100,001-300,000	5	–	4⅞ 5⅛
—— 4½ per cent. First Mortgage Debenture Stock	100	–	103-107
—— 4½ per cent. Cum. Pref.	5	–	4⅞ 5⅛
—— 4½ per cent. Mortgage Debenture, Red.	100	–	87-92
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds. 1926, C 1-1,000 ($500), D 1-3,000 ($500), M 1-4,400 ($1,000	—	..	72-74 p.c.
Mexican Light and Power Co., Capital Stock	$100	..	44-46
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14,000 ($1,000)	—	..	81½-83½
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	–	95-98
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,000	5	–	6¼ 6⅜
—— do., 57,001-75,000	5	–	6¼-6⅜
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid)	5	–	6¼ 6⅜
—— 5 per cent. Pref., 1-57,000	5	–	5 5⅛
—— do., 75,001-87,500 (issued at 10s. prem., 4s. paid)	5	..	5-5⅛
Notting Hill Electric Lighting	10	–	11 12
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	–	95 97
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	–	5¼ 6 xd
—— 4 per cent. Debenture Stock	100	–	95 97
River Plate Electricity Co., Ord., 1-119,687 & 120,501-120,507	1	..	⅞-⅞
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	..	⅞-1
—— 4 per cent. Debenture Stock, Red.	100	..	95-98
Rosario Electric Co., 6 per cent. Cum Pref., 1-20,000	5	..	5-5⅛
—— 6 per cent. Cum. 2nd Pref., 1-15,000	5	..	5-5⅛
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	–	96 98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	—	..	99 101 p.c.
Smithfield Markets Electric Supply, Ord. 1-12,000	5	–	⅛-1⅛
—— 4 per cent. Debenture Stock	100	–	71-75
South London, Ordinary	5	–	1⅛ 1⅜
South Metropolitan Electric Light and Power, Ord.	1	–	⅞-⅞
—— 7 per cent. Cum. Pref.	1	–	1-1⅛
—— 4½ per cent. 1st Mort. Deb.	100		100-103
St. James's and Pall Mall, Ordinary, 101-20,080	5	–	7⅛ 8⅛
—— 7 per cent. Pref.	5	–	6⅞ 7⅛
—— 3½ per cent. Deb.	100	–	86 91
Urban Electric Supply Co., Ordinary, 8-30-007	5	–	1⅛ 2⅛
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	–	2⅝ 3
Westminster, Ordinary	5	–	8⅛ 9⅛
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	–	5-5⅛

Electric Tramways.—

Name.	Amount paid.		Last price.
	£		£
Anglo-Argentine, 5½ per cent. Cum. Pref., 1-260,007	5	–	5 15/16 6 3/16
—— Ord.	5	–	8 3/8 8 7/16
—— Permanent 6 per cent. Debentures Stock, 1888	100	–	131-134
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	–	102-105
Barcelona Tramways, Ord., 1-20,000	10	–	—
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	–	—
—— 5 per cent. Deb., Red., 1-600	100	–	—
—— 4½ per cent. Red. Deb. Stock	100	–	—
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1	–	11/16 13/16
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	–	27/32-31/32
Birmingham and Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100	..	93 97
Blackpool and Fleetwood Tramroad	10	..	13⅜-13⅝
Bombay Elec. Supply & Trams. Co., 6 per cent. Cum. Pref.	8	..	7⅛-8
—— 4½ per cent. Deb. Stock, Red.	100	..	94-96
Brisbane Tramway Invest., Ord., 1-75,000	5	–	3¼ 3⅜
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	–	4⅞-5⅛
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	–	96-100
British Columbia Electric Railway Co., Ord. Def.	100	–	127-132
—— Ord. Pref.	100	–	111-115
—— 5 per cent. Cum. Perpetual Pref. Stock	100	–	104-107
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	–	100-103
—— 4½ per cent. Vancouver Power Deb.	100	–	102-104
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	–	2⅛ 2⅜
—— 6 per cent. Cm. Pf., 30,001-60,000	10	–	6¼ 6⅜
—— 5 per cent. Perpetual Debenture Stock	100	–	100-103
—— 4½ per cent. 2nd Deb. Stock	100	–	78-81
Buenos Ayres and Belgrano Trams	5	–	4 7/16 4 11/16
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	–	4⅝-5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	–	4⅝-5⅛
—— 5 per cent. Deb. Stock, Red.	100	–	105-110
—— Prov. Cert., all paid	100	–	100-103
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100	–	92-97
Buenos Ayres Gl. Nat. Trams. Co., 5½ per cent. Pref. Deb. Bonds, Red., 1-1,500	100	..	98-103
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	..	100-105
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	91-94
Calcutta Tramways, 1-105,000	5	–	7-7⅛
—— 105,001-137,610	5	–	5-5⅛
—— 4½ per cent. 1st Deb. Stock, Red.	100	–	102-105
Cape Electric Tramways, Nos. 1-480,000	1	–	5/16 7/16
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	–	4⅛ 4⅜
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100	–	98 101
City of Buenos Ayres Trams. Co. (1904). 1-248,000	5	..	5⅛-5⅜
—— 4 per cent. Deb. Stock, Red. 1985	100	..	98 102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	00	–	94-98
Cork Electric Tramway and Lighting Co., Ordinary	10	–	13-14
—— 6 per cent. Cum. Pref.	10	–	12⅜ 12⅝
—— 4 per cent. Debentures	100	–	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	–	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	–	12⅜-13⅜
—— 3½ per cent. Mort. Debs., 1-3,000 Red.	100	–	93-97
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100	..	98-101
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6,957	$1,000	–	82-87
Imperial Tramways, Ordinary	all	–	18-19
—— 6 per cent. Cum. Pref.	all	–	14-14½
—— 4½ per cent. Deb. Stock	100	–	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5	–	⅛ 1⅜
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	–	66 71
Kalgoorlie Electric Tramways, 1-250,000	1	..	5/32-5/32
—— 5 per cent. "A" Deb. Stock	100	..	89-93
—— 6 per cent. "B" Deb. Stock	100	..	77-81
Kidderminster and District Lighting and Traction, Pref.	5	–	9⅜ 10⅛
Lancashire United Tramways Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	–	94-97
—— £296,500 2nd Mort. Deb Stock	—	–	—
—— £83,330 Deferred Deb. Stock (all fully paid)	—	–	—
Lisbon Electric Tramways Limited, Ord. Nos. 1-594,188	1	..	1-1⅛
—— 6 per cent. Cum. Pref., Nos. 1-425,553	1	–	1-1⅛
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100	..	85-98
London United Trys. (1901), 5 per cent. Cum. Pref.	10	–	7⅜-8⅜
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	–	82 86
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Rd.	100	–	96-9

Name.	Amount paid.		Last price
	£		£
Manila Elec. R.R. and Lghtg. Corp., 5 p.c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,00	..	90-92
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 23,436-25,000	..	..	4⅞-5⅛
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	97-100
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	–	3/32 5/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	–	27/32-29/32
—— 4½ per cent. Deb. Stock, Red.	100	–	94-97
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	—	..	79-81 p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,00	–	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 1921-2,000 1922	100	–	101-103
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	–	⅜-⅞
Oldham, Ashton, and Hyde Tramway, Ordinary	10	–	12
—— 5 per cent. Cum. Pref.	10	–	8⅜-8⅞
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100	–	101-105
Potteries Electric Traction, Ordinary, 1-245,000	1	–	¼-⅜
—— 5 per cent. Cum. Pref., 300,001-545,000	1	–	⅜-⅝
—— 4½ per cent. Debenture Stock	100	–	95 98
Provincial Tramways Co., Ordinary, 1-28,912	10	..	4⅜-5⅛
—— 6 per cent. Cum. Pref., 1-10,000	10	..	10¼-11¼
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-30,000	5	..	5¼-5⅜
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	97-99
Sao Paulo Tramway, Light, and Power Co.	$100	..	115-120
—— 5 per cent. 1st Mort. Deb., Red. 1929. 1-11,000	$500	..	93-95 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1	..	⅞-1
—— 4 per cent. Deb. Stock, Red. 1940	100	..	80-84
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs, Red., 1-1,600	100	..	84-88
Yorkshire (West Riding) Elec. Tram Co., Ord., 70,001-110,000	5	..	1-1⅛
—— 6 per cent. Cum. Pref., 1-46,261	5	..	3⅛-3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	87-90

Electric Railways.—

Name	Amount paid.		Last price
	£		£
Central London, Ordinary	100	–	63-68
—— 4 per cent. Pref.	100	–	88-90
—— " " deferred	100	–	47-50
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	–	102-105
City and South London, Consolidated Ordinary	100	...	45-47
—— 4 per cent. Debenture Stock	100	..	102-105
—— 5 per cent. Pref. Stock '91	100	..	115-118
—— " " " '96	100	–	113-116
—— " " " '01	100	–	113-116
—— " " " '03	100	..	108-111
Liverpool Overhead, 5 per cent. Pref.	10	–	10-10¼
—— Ordinary, 1-50,000	10	–	3⅞-4⅛
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	–	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	...	55-58

Telegraphs and Telephones.—

Name.	Amount paid.		Last price.
	£		£
Amazon Telegraph Co., 1-25,000	10	..	3-3⅛
—— 5 per cent. Debs., Red., within 1-1,069	100	–	85-88
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000	$1,000	..	90-92
Anglo-American Telegraph Co., Ordinary	100	..	59-62
—— 6 per cent. Preferred Ordinary	100	...	103-104
—— Deferred Ordinary	100	...	16¼-16⅝
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100	...	99-102
Chili Telephone Co., 1-44,000	5	...	6⅞-7⅛
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100	...	91½-92⅛
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	...	6¼-7⅛
—— 10 per cent. Preference, 1-6,000	10	...	15⅞-16⅜
Direct Spanish Telegraph Co., Ordinary	5	...	3⅜-2⅞
—— 10 per cent. Cum. Preference	5	...	2-2⅛
—— 4½ per cent. Debs., 1-600	50	...	98-101
Direct United States Cable Co.	20	...	14⅜-14⅝
Direct West India Cable Co., 4½ per cent. Debs., Reg. within 1-1,200, Red.	100	...	100-102
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100	...	97½-100½
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8,000, 1913	25	...	100-102
Eastern Extension, Australasia and China, 1-300,000	10	...	12⅜-13⅛
—— 4 per cent. Mort. Deb. Stock, Perp.	100	...	102½-104½
Eastern Telegraph Co., Ordinary Stock	100	...	123-125
—— 3½ per cent. Preference Stock	100	...	86-88
—— 4 per cent. Mortgage Debenture Stock	100	...	103-105
Great Northern Telegraph Co. (of Copenhagen)	10	...	34-36
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1,200, Red.	100	...	100-102
Indo-European Telegraph Co.	25	...	55-57
Marconi's Wireless Telegraph Co., 1-256,127	1	...	⅛-¼
—— 256,128-384,190	1	...	⅛-⅜
Monte Video Telephone Co., Ordinary, 1-72,680	1	..	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492		...	¾-1
National Telephone, Preferred	100	...	106-108
—— Deferred Stock	100	–	106-108
—— 6 per cent. Cum. First Pref.	10	–	10¾-12⅛
—— 6 per cent. Cum. Second Pref.	10	–	10-12
—— 5 per cent. Non. Cum. Third Pref.	5	..	5¼-5⅜
—— 3½ per cent. Deb. Stock, Red.	100	–	86-88
—— 4 per cent Deb. Stock, Red.	100	–	101-103
Oriental Telephone and Electric Company	1	..	1¼-1⅜
—— 6 per cent. Cum. Pref.	1	..	1 3/16 1 5/16
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100	...	97-100
United River Plate Tele. Co., Ordinary, 1-100,000	5	...	7-8
—— 5 per cent. Cum. Pref., 1-40,000	5	...	5-5⅛
—— 5 per cent. Debenture Stock, Red.	100	...	—
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	...	98-101
West African Telegraph Co.	10	...	10-10¼
West Coast of America, 1-30,000 and 53,001-53,008	2½	...	1¼-1⅜
—— 4 p.c. Debs., 1-1,500, Gua. by Western Telegraph	100	...	97-100
West India and Panama Telegraph Co., Ordinary	10	...	7/16 9/16
—— 6 per cent. Cum. 1st Preference	10	...	7⅛-7⅜
—— 6 per cent. Cum. 2nd Preference	10	...	6⅛-7⅛
—— 5 per cent. Debs., Red., 1-800	100	...	99-102
Western Telegraph Co., 1-207,930	10	...	13-13½
—— 4 per cent. Debenture Stock, Red.	100	...	100-103

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open		Accounts for past year.							Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1907.	1906.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Mile of track. Passenger	Receipts per Mile of track. Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Sept 18	1,561	1,491	+ 100	— h	23½	25	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	,, 14	324	329	− 5	—	8	8	,, 15	14,528	3,316,380	353,945	1	9·71	1,830	5·16
Baker Street and Waterloo Ry.	,, 21	2,205	1,570	+ 635	10,835	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 22	1,083	1,055	+ 18	− 406	53 53	53 53	March 31	55,025	11,145,531	1,309,903	1·18	10·08	2,338b	6·03
Birmingham Corporation	,, 2	5,285	—	—	—	56½	—	,, 31	17,133	4,709,798	266,526	86	14·5	8,866	—
Blackburn Corporation	,, 18	1,181	932	+ 199	+ 1,613	24	24	,, 25	48,875	8,661,720	986,953	1·35	11·89	2,036	7·44
Blackpool Corporation	,, 19	1,956	1,901	+ 55	− 1,912	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	,, 21	1,198	1,341	− 143	− 1,198	16½	16½	Dec. 31	31,846	2,325,677	573,264	3·28	13 19	—	7·27
Bolton Corporation	,, 22	2,303	2,071	+ 232	+ 3,370	42	40	March 31	95,766	20,205,196	2,161,130	1·13	10 63	2,394	6·14
Bournemouth Corporation	,, 18	2,150	1,954	+ 196	+ 853	17·41	16·82	,, 31	55,276	10,058,288	1,121,623	1·32	11 83	3,226	7·19
Bradford Corporation	,, 21	4,676	4,485	+ 39	+ 1,071	95	95	,, 31	230,085	47,168,000	5,053,392	1 172	10 927	2,396	—
Brighton Corporation	,, 22	1,095	1,052	+ 43	− 2,681	9½	9½	,, 31	50,339	11,321,160	1,152,828	1·06	10·48	2,914·8	8 0 4
Bristol Tramway Company	,, 20	5,553	5,166	+ 387	—	51½	51½	Dec. 31	259,799	45,312,373	6 127,135	—	—	—	—
Burnley Corporation	,, 21	1,214	1,242	− 28	—	40	40	March 31	57,992	11,092,704	1,197,772	1·31	11 61	5,388	8·17
Burton Corporation	,, 22	279	286	− 7	− 378	8½	8½	,, 31	17 950	3,878,269	454,082	1·07	9·21	2,008	6 76
Cardiff Corporation	—	—	—	—	—	32 62	†32·26	,, 31	112,209	24,134,363	2,770,049	1·12	9·72	3,782	9·44
Carlisle Tramways Company	,, 7	193	229	− 36	− 603	8·5	8·5	Dec. 31	10 713	2,935 002	359,756	—	7·14	—	5 18
Central London Railway	,, 21	4,739	6,011	− 1,272	− 8,308	6	6	,, 31	347,588	4,875,547	1,261,214	1 86	65·10	57,931	35·80
Charing X, Euston, & Hamp. Ry	,, 21	2,485	—	—	—	8	—	—	—	—	—	—	—		—
City and South London Railway	,, 22	2,765	2 593	+ 173	+ 6,607	6¼	6¼	,, 31	—	—	—	—	—		—
Colchester Corporation	,, 13	245	240	+ 5	—	8	8	March 31	10,588	2 457,653	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	,, 19	545	517	+ 28	− 742	15½	15½	Dec 31	24,895	5 814,376	882,256	1·01	6·64	—	4·69
Croydon Corporation	,, 20	1,553	—	—	—	12c	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 20	248	246	+ 2	− 16	7 23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	,, 21	259	270	− 11	− 92	4½	4½	,, 31	11,250	2 853,200	284,343	·94	9·49	2,500	—
Dublin and Lucan Electric Ry.	,, 20	1,592	1,746	+ 146	— h	6¾	6¾	Dec 31	6,358	402,511	110,738	3·79	13·78	942	7 33
Dublin U.T.	,, 20	7,225	5,117	+2 107	+20 138	48½	48½	,, 31	267,489	50,050,949	7,077,372	1·18	9·07	691	5·55
Dundee City Tramways	,, 18	1,195	1 117	+ 78	+ 489	22	22	May 15	50 154	13 086 396	1,005 911	·906	1·96	2,180	7·42
East Ham Corporation	,, 21	974	877	+ 97	− 345	14	14	March 31	56,652	3,689,658	863,816	64	10 18	2,994	6 79
Glasgow Corporation	,, 21	18,814	17,8 4	+ 920	+ 5 019h	79½	79½	May 31	756,480	195,767,519	17,945,595	—	0·12	—	—
Gloucester Corporation	July 10	278	304	− 26	—	15	15	March 31	15,46	3,902,077	563,595	·60	6·58	999	5·32
G.N., Piccadilly, and Brompton	Sept 21	3,870	—	—	—	9	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	37	37	,, 31	74,019	17,849,642	1,540,707	—	1·53	2,085	8·56
Huddersfield Corporation	,, 21	1,615	1,513	+ 102	+ 2,0 7	35	35	,, 31	67,938	12 838,150	1 665,262	1·24	9·71	1,923	—
Hull Corporation	,, 21	2,350	2,243	+ 106	+ 3,061	26	26	,, 31	112,651	27,104,921	2,910,698	1	9 29	—	—
Ilford Corporation	—	—	—	—	—	10½	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 18	164	145	+ 19	+ 381	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	11,586	3,626,656	419,800	·737	6 62	1,480	5·22
Lancashire United Tramways	,, 18	1,451	1,032	+ 419	+2,265	38½	28	—	—	—	—	—	—	—	—
Leeds Corporation	,, 14	7,011	6,495	+ 516	+ 6,212	89½	89½	March 25	298,233	64,223 666	7,121,038	1 10	10·02	351	—
Leicester Corporation	,, 21	2,212	2 117	+ 95	—	42	42	Dec. 31	26,011	12 039,252	1,229,507	1	9·79	—	4 82
Liverpool Corporation	,, 14	11,565	11,137	+ 129	+ 6 972	104	104	,, 31	547 625	116,642 663	12 166 419	—	—	—	—
Liverpool Overhead Railway	,, 22	1,471	1,473	− 2	+ 1,181h	6·65	6 65	June 30	81,302	11,171,865	1,024 275	—	—	—	—
London County Council	,, 14	32,713	26,063	+6,650	+120,058	93	98	—	—	—	—	—	—	—	—
Lowestoft Corporation	—	—	—	—	—	6	6	Sept. 30	14,511	3,128,867	359,435	1 08	9 68	2,630	6 48
Maidstone Corporation	—	—	—	—	—	2	2	March 31	4,740	850 121	112,227	1 33	10 13	2,370	—
Manchester Corporation	,, 21	15,457	14 059	+1,398	+ 28 081	149	149	,, 31	631,956	126,900,875	14,123,124	1 19	10 73	4,299	6·99
Metropolitan District Railway	,, 22	14,789	14,592	+ 201	+ 4,842	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 22	7,347	7,829	− 482	− 416	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 21	140	148	− 7	+ 60	23	23	,, 31	6 159	1,992,647	206,358	82	7 14	2,239	—
Newcastle-on-Tyne Corporation	,, 21	3,984	4,052	− 68	+ 351	50	50	,, 31	197,849	43,061,934	4,326,152	1 07	10 98	3,967	7·0
Newport (Mon.) Corporation	June 29	639	628	+ 11	+ 1,797	15½	15½	,, 31	30,356	7,252,535	783,435	—	9 29	—	6·4
Oldham Corporation	—	—	—	—	—	34	34	,, 25	65,553	13,466,245	1,504,740	1 16	10 45	1,886	—
Portsmouth Corporation	May 25	2,330	1 578	+ 752	+ 632	23½	23½	,, 31	95,702	19 625,329	197,499	1·17	11 63	—	—
Reading Corporation	Sept. 19	635	629	+ 6	− 697	33½	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	11·23	21·29	,, 31	14,881	2,837,110	386,547	1·24	9·24	1,102	7 92
Rotherham Corporation	—	—	—	—	—	9½	9½	,, 31	23 569	5 251,472	593,054	1 07	9 53	2,612	7·49
Salford Corporation	,, 23	5 097	4 816	+ 281	+ 3 110	70½	70½	,, 31	214,111	39,213 560	4,894,580	1·28	10 29	—	—
Scarborough Tramways Co.	—	—	—	—	—	4½	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 22	5,692	5,288	+ 404	+ 6 368	35½	35½	,, 25	210,545	63 952,283	6,049 899	903	9 543	3,653	6 4/7
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,365	9 294,771	1,108,389	1·27	11·02	—	7·83
Southend-on-Sea Corporation	,, 11	613	596	+ 17	− 3 8	9	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	,, 31	39,550	6,766,031	1,027 730	—	9 23	—	4 75
Sunderland Corporation	,, 22	1,416	1,379	+ 37	− 424	20	20	,, 31	64,858	15 364 463	1 495,785	1·004	10·36	—	6·37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	4,937	1,315,757	102,751	0·87	11 53	1,371	—
Torquay Tramways	Sept 19	276	—	—	+ 5,190	5 16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 21	22,357	21,843	+ 514	—	13 68	12·43	,, 31	43,607	7,995,451	862,12	9·27	12·14	3,132	7·50
Warrington Corporation	—	—	—	—	—	9	9	,, 31	17,017	4,418 225	403 363	—	9 85	—	6·33
West Ham Corporation	,, 19	2,345	2,177	+ 168	+ 1 341	14·7	14 7	,, 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	,, 18	844	815	+ 29	+ 281	20	20	,, 31	41,905	8 847,066	950,338	—	10 583	2,062	6·1a

† And 98 miles of interlacing track. a Train mile. b Per mile of single track. c Miles of route. h Half-year's figures. k Double track.

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NOTES

Institution of Mechanical Engineers.—The first monthly general meeting of the coming session will be held in the institution house, Storey's-gate, St. James's Park, on Friday evening, Oct. 18, at 8 o'clock p.m., when the paper to be read and discussed will be "On the Indicated Power and Mechanical Efficiency of the Gas-Engine," by Prof. Bernard Hopkinson. Mr. F. W. Ellis has resigned from the office of hon. treasurer of the institution, and the council recommend the appointment of Mr. Arthur Hason in his stead.

Trade Marks in China.—We have received from the British and Foreign Patent and Trade Mark Office a translation of a proclamation published by the Taotai of Shanghai, stating that his attention has been called by Sir P. L. Warren, H.M. Consul-General, to the fact that complaints have been repeatedly received at the British Consulate-General of the fraudulent imitation of British goods by Chinese. He, therefore, after consultation with the Chinese Chamber of Commerce, and having been supplied by Sir P. L. Warren with a list of the goods most frequently imitated, proclaims, and has given instructions that the proclamation be everywhere posted, that such imitation must henceforth cease, and that anyone found to be violating the law will be punished without leniency.

Electro-Harmonic Society.—The twenty-second season will be opened this (Friday) evening with a concert at the King's Hall, Holborn Restaurant, commencing at eight o'clock The programme arranged for the opening concert attains the same high level as the arrangements made for previous seasons, so that an enjoyable evening is assured. In order to accommodate the increasing number of members, the committee have been obliged to consider the advisability of securing a larger hall, and as an experiment the last two concerts of the season will be held in the new St. James's Hall, Langham-place. Doubtless this experiment is intended as a preliminary to making the St. James's Hall the future home of the society's gatherings. If this is so, the expense will be much higher, and we hope that all connected with the electrical industry will come to the support of the society, and enable it to continue its pleasant and sociable gatherings.

Engineering and Temperament.—The *Daily Telegraph*, in an article dealing with the recent bridge disaster near Quebec, tells an amusing tale which illustrates the great contrast between the American and British temperaments—noticeable even in the industrial world. An English engineer was in an American city in which there had been a breakdown of the cables supplying electric current for the tramway service. Bare copper conductors, properly insulated from earth, but absolutely exposed to the street pedestrian traffic, were slung along a wooden fence, about 4ft. from the ground. Our Englishman, says the *Telegraph*, full of the rules and regulations of our own Board of Trade, inquired if the copper conductor were "live." "Certainly," replied his American host. "But if anyone accidentally touched that it would kill him," said the amazed Englishman. "Yes," said the American, and slyly added, "If anyone is fool enough to touch that cable, he's no use to us here." This sounds smart, but it would not suit us in this country, as witness the elaborate precautions of the Board of Trade on our railways, our bridges, our steamships, and our factories.

London County Council and their Tramway Employes.—The Highways Committee of the London County Council are meeting those of the employés who threaten to oppose the carrying into effect of the new tramways order respecting medical examination in a most conciliatory spirit. A letter was read at a final protest meeting held by the men last Saturday night from the clerk to the Council (Mr. Gomme), which stated: "It appears to the committee that some misapprehension exists as to the intentions of the Council in arranging for an examination to be made. The only consideration which has guided the Council in the matter has been the safety of the public, and the Council has no desire whatever to make use of the medical examination to the men's disadvantage." The Highways Committee have also consented to receive a deputation consisting of representatives of the men and of the Amalgamated Association of Tramway and Vehicle Workers on Thursday next, so that if the men's representatives leave the political aspect of the question alone a satisfactory adjustment of the relations between the Council and their tramway employés will be effected.

Proposed Union of Electrical Interests.—A movement has been set on foot which has for its object the remedying of the present state of things in the electrical industries. The editors of the various electrical journals have been approached to take the initiative and to act as an organising committee until sufficient support has been obtained to enable a representative council to be constituted. The intentions of the proposed union are set forth in the following extract from a communication which has been received: "It is intended to extend the invitation to join the union to everyone who is interested in electricity, whether as shareholder, consulting engineer, manufacturer, contractor, or trader—whether employer or employé. The union is to start without any political bias, and with neutrality as regards municipal trading and other like matters. The proposed procedure is, when sufficient subscribers have been enlisted, to classify the subscribers according to the branches of the industry in which they are specially interested, and to ask each branch to elect one or two members of a provisional council." The proposed annual subscription is 2s. 6d. per member.

"Light on Dark Doings."—Our volatile friends of the gas Press, who have of late been busy in proclaiming the great convenience of gas lighting, are recommended to ponder over the following paragraph that appeared in the *Globe* on Monday: "When it became dark this morning at Marlborough-street Police Court," writes our contemporary, "Constable Gwyther, 'the man at the gate,' performed his usual and now famous feat of pole balancing and gas lighting extraordinary, ably assisted by another constable and the usher. The latter vanished from sight for a few moments (it may have been to turn on the gas tap, which is in an inconvenient position in a passage), and as suddenly reappeared amid a faint smell of coal gas. Meanwhile Police-constable Gwyther jointed the official fishing rod, on the end of which was affixed a taper, and the other officer referred to having lighted the taper, skilfully directed the vibrating apparatus towards the gas cluster in the roof of the court. Amid intense silence a blaze appeared and assisted the magistrate to throw light upon the cases being heard. One of the court interpreters blew out the taper." It is curious to relate that while a ventilating fan in the court has for some years past been worked electrically, electric lighting has not yet been adopted.

Capital for Electricity Undertakings.—Appeals for new capital indicate in no small measure the activity displayed, or likely to be displayed, in the various industries among which the total capital subscribed is shared. It is for this reason that returns showing the capital applications for the nine months of the year and for the September

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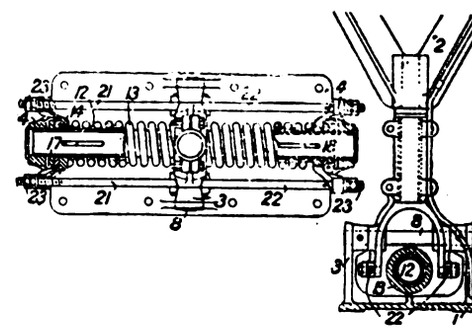
quarter which the *Economist* publishes merit attention. Our interest in the tabulated statements prepared by our contemporary centres chiefly upon the figures relating to electricity and tramways undertakings, which, we think, will be read with not a little interest. For electric lighting, power, and telegraph schemes £9,147,000 was called during the half-year ended June. No capital was issued during the September quarter, so that the total for the nine months of the year remained at £9,147,000, against £4,503,900 for the first nine months of 1906. The figure bears a fair proportion to the aggregate offerings during the first nine months, which have been £105,365,000, as compared with £96,160,000 in 1906 and £127,071,000 in 1905. The issue of capital for gas was much less than for electricity, the amounts for gas and water being £363,000 during the June half-year and £44,800 during the September quarter, or £407,800 for the nine months of the year as compared with £1,161,600 for the nine months ended September, 1906. Tramway and omnibus enterprise has claimed £621,500 this year as against £2,261,500 for the corresponding period of last year.

Victoria Falls Power.—Mr. Ralph D. Mershon, of New York, who landed at Southampton on Saturday last after a visit to South Africa in the interests of the Victoria Falls Power Company, was interviewed on his arrival. With regard to the project to transmit power from the Victoria Falls to the Rand, he stated that there was no doubt in his mind that such a transmission could be profitably effected. It was in 1897 that he carried out a series of experiments on high voltages, and three years ago undertook a series of further investigations along the same lines that enabled him to make the report he did to the Victoria Falls Power Company, Limited, as to the practicability of the project. On his present visit to South Africa he had personally inspected the Victoria Falls both above and below the gorge, and he was satisfied that an excellent electrical development could be made up to, if need be, 300,000 h.p.; and if means were taken, which could probably be done very economically, to conserve the water some little distance back from the falls, there would be a further large addition to the power that would be available. Mr. Mershon added that the immediate work which the company had to concern itself with was the early provision of a further steam-driven electrical generating station on the Rand. At the moment the company with its two existing stations was quite unable to cope with the demand for power, and they had been compelled in advance of the erection of the new station to arrange for an extension of the existing station at Brakpan. With regard to the erection of the new 24,000 h.p station, they were taking every possible means to expedite its completion, and that was the work which was engaging his attention at the moment.

Incorporated Municipal Electrical Association. The reports of the papers and discussions at the twelfth annual convention held in June at Sheffield have now made their appearance in volume form. The proceedings were fully dealt with in the columns of this journal at the time, and must be fresh in the minds of many readers, so that extended reference thereto is at present unnecessary. But it may perhaps be desirable to enumerate the subjects dealt with at the conference and embodied in the volume now issued, the value of which is considerably enhanced by the inclusion of much useful matter which the executive council have seen fit to add. Mr. S. E. Fedden's presidential address opens the volume, and his treatment of the various matters which affect the interests of municipal electrical engineers will be read with much zest by his colleagues. Then follow the papers presented at the meetings with reports of the discussion that took place upon them, including: Mr. A. L. Acland's "Extension of Electricity Supply to Outlying Districts"; "Cheap Power Supply to Municipalities," by Mr. C. E. C. Shawfield; "The Costs of Electricity Supply and their Relation to Scales of Charges," by Mr. H. R. Burnett; "Depreciation and Reserve," by Mr. C. H. Yeaman; "The Value of Photometry in Central-Station Practice," by Mr. R. M'Court; "Some Notes on Alternating-Current Distribution," by Mr. A J Cridge. Mr. Haydn Harrison has prepared some useful data on public lighting, from which it will be concluded that the total candle-power of electric lighting is considerably in excess of gas lighting, while the average cost per candle-power is more than 50 per cent. less in the case of electric light as against gas. Particulars are also given as to the studentship scheme of the association, enabling the winner to undertake a tour of one year for the purpose of visiting electricity and engineering works. Mr. R. McCourt (Harrogate) was successful in the competition for 1907.

Bow Collectors.—A patent has recently been granted to Messrs. Brecknell, Munro, and Rogers, of Thrissell-street, Bristol, for a type of bow collector designed for use with electric tramways and railways. Fig. 1 shows a plan, part being in section, and Fig. 2 a sectional end view of a bow collector which is constrained to assume a vertical position under the action of tensioning means, having only



one spring. The harp, 2, is formed with two downward extensions, each of which is pivoted on the rod, 8, mounted in projections, 3, formed on the casting, 1. The lower ends of the extensions are pivotally connected to rods, 21, 22, which extend longitudinally of the vehicle and loosely pass at their outer ends through projections formed on collars, 14, mounted on a cylinder, 12, secured in the uprights, 4. Nuts, 23, are screwed on to the ends of the rods. The cylinder is surrounded by the spring, 13, the ends of which bear against the collars. The initial compression of the spring is adjusted by means of the nuts, 17, 18, screwed on the cylinder. Upon any movement of the bow from its vertical position one of the collars, 14, is caused to move along the cylinder and compress the spring.

Proposed Home Office Regulations.—There is already in existence a strong feeling against the draft regulations proposed to be made by the Secretary of State for the Home Department in pursuance of Section 79 of the Factory and Workshop Act, 1901, for the generation, transformation, distribution, and use of electrical energy on all premises under the Factory Act and all pressures above 130 volts contiuuous and 65 volts alternating, which threatens to have some effect upon the form which the regulations will ultimately take. The electrical section of the London Chamber of Commerce have considered the question, and the result of their deliberations appears in a circular which they have addressed to the manufacturers' section of the chamber. They point out that the regulations, if sanctioned in their present form, will tend to

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restrict the use of electricity in factories. As the majority of power users in this country are using electricity under Board of Trade regulations, they deem it quite unnecessary for the Home Office, which has little experience in this particular industry, to impose more stringent regulations. The time for sending in objections has been extended to the end of October, and the electrical section are asking manufacturers using electrical power in their factories to write to the Home Office independently, stating that they will probably have objections to urge against the proposed regulations which cannot be formulated within the prescribed time, and asking if an extension of time may be allowed for this purpose. The main points of objection suggested by the electrical section are: (1) that any regulations issued by the Home Office should be on the lines of the existing Board of Trade regulations, so that manufacturers may not be working under two different sets of regulations; (2) that the regulations should be restricted in number as far as possible; (3) that there should be a right of appeal on the administration of the regulations from the local inspector; (4) that an extended period should be given to allow existing work, and work in progress, to be brought within the requirements. We understand that this has received a satisfactory response from leading manufacturers in the London district, while all the chambers of commerce in Great Britain which have been communicated with are taking a great deal of interest in the matter.

Energy in Wireless Telegraphy. — Numerous patents have from time to time been issued covering various types of antennæ or aerial systems which have been designed for the purpose of radiating and receiving electromagnetic waves. These investigations have been carried out largely along commercial lines, as a result of which very little quantitative research has been carried out under conditions permitting of delicate and highly accurate measurement. Some additional data obtained from a study of the action of these various types might throw much light upon one or more of the undetermined theoretical problems at present existing in this field. In the September number of the American *Physical Review* there is an account of an investigation, described by Mr. C. A. Culver, into the relative efficiency of several different types of receiving systems when used under various conditions. Experiments were carried out with several types of antennæ now in commercial use, as well as with one or two original systems, and the data collected indicate interesting results. These may be briefly summarised as follows. The resistance of the earth between the two stations is an important factor in the propagation of energy. The square of the energy received by a horizontal antenna was found to be approximately proportional to its length, while relatively small capacity areas showed equal efficiency in all planes of orientation about a vertical axis. Even in the case of capacity areas whose length was great compared with the width, only a slight decrease in efficiency was noticeable when the area was normal to the wave front. Open-circuited helixes were equally efficient in all planes of orientation, the energy received by such helix having a given length of wire being a function of its dimensions. An aerial almost slightly screened was but slightly less efficient than a similar unscreened system. In dealing with multiple-wired antennæ it was found to be practically immaterial as to whether the component parts were connected at the lower, upper, or both ends. In considering different types of receiving systems, the actual capacity was of less importance than the manner in which this capacity was distributed. Of the types tested, the system consisting of one or more wires normal to the earth's capacity was by far the most efficient, while it was also found that energy is propagated through the surface of the earth and not by means of a free ether wave.

Field Telephony.—The provision of a sufficiently light and portable telephone and telegraph apparatus is a problem to which the military authorities in England and abroad are giving a great deal of attention. Evidence in support of this is furnished by the extended series of interesting experiments carried out on the Continent with the "Telefunken" system of wireless telegraphy, which system was recently described in the columns of this journal. The prominent place which telegraphy and telephony occupies in the curriculæ of the military training colleges is largely due to the important developments which are taking place in these departments of applied science; while, as if to show what an important rôle will be played by the various applications of electricity in the development of military science, mention should be made of the prominence which the study of the subject of the X-rays occupies in the curriculum of the Royal Army Medical College. There are special classes in the use and management of X-ray apparatus for the officers and men under instruction there, and several practical hand-books dealing with the subject have recently appeared. The *United Service Gazette* calls attention to some interesting experiments which have been made during the past few days by the adjutant of the "Lincolnshire Imperial Yeomanry," Lord Kesteven, on his estate at Stamford with an improved portable field telephone and telegraph, the invention of Lieutenant Midhurst, of the Australian Corps of Signallers, Tasmania. This instrument, complete, with large-sized batteries, weighs under 3½lb., is about the same size as an ordinary pair of field-glasses, so that it can be encased in leather, and, with the aid of a strap, is carried in precisely the same manner as glasses. It can be used for considerable distances over wire fences or over permanent telegraph or telephone lines without interfering with the ordinary work on those lines. The invention has been designed for the use of mounted troops where telegraph wires are available. It was tried over grass land, the instrument being simply attached to ordinary plantation fences, and the wire used being in some instances the common wire used on farms. Lord Kesteven has expressed himself satisfied with the instrument, and states that it possesses advantages for signalling which cannot be obtained by the aid of the heliograph, as the latter was of no use on a cloudy day or in a thickly-wooded country.

Publications Received. — "Searchlights," by F. Nerz. (London: Archibald Constable and Co., Limited, 10, Orange-street, Leicester-square, W.C. 7s. 6d. net.) Mr. Charles Rogers is responsible for the English translation of this work, which explains the theory, construction, and applications of searchlights. Dr. Nerz has had experience with this class of apparatus extending over many years, and the presentation of the results which have been gained from his experience shows him to be well qualified for such a task. Bearing in mind the fact that searchlights are being employed for an increasingly large number of purposes, and that the circle of those interested in their use is rapidly widening, it is somewhat surprising that no comprehensive work was in existence which might serve as an introduction to the subject. In the present work the first few chapters treat of the history and general theory of searchlights, special attention being given to parabolic mirrors. Then follows a description of some typical searchlights, with their accessories, a chapter on details of construction, and finally, an account of various systems of transportable power supply.—The September *Bulletin* of the Société Belge l'Electriciens is notable for a communication from P. Harckman dealing with "Two Theories of

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Electrical Phenomenon." M. Orban, in describing in the same issue some of the industrial applications of electricity, deals especially with the electric driving of papermaking machinery. The "Brennan" gyroscope railway is dealt with by J. G. Carlier, who also gives an account of an instrument for determining the rate of acceleration in vehicles.—The *Transactions* of the Institution of Civil Engineers of Ireland, vol. 33, contains a communication from Mr. J. H. Hargrave on "Railway Signalling and Interlocking."—The American *Physical Review* for September contains the following communications: "Heat of Evaporation of Water," Arthur W. Smith; "Specific Heat of Solutions — V.," William F. Magie; "Inductance of Straight Conductor," K. Ogura and C. P. Steinmetz; "A Study of the Propagation and Interception of Energy in Wireless Telegraphy—Part I.," Charles A. Culver.—The August issue of the *Proceedings* of the American Institute of Electrical Engineers contains the papers read in Section 2 of the Niagara convention. The following are included: "Regeneration of Power with Single-Phase Electric Railway Motors," William Cooper; "Fractional Pitch Windings for Induction Motors," C. A. Adams, W. K. Cabot, and G. Æ. Irving, jun.; "Commutating-Pole Direct-Current Railway Motors," E. H. Anderson; "Track-Circuit Signalling on Electrified Roads," L. Frederick Howard. There is also included a report of the discussion at New York on "Electric Trunk-Line Operation" and "Lightning Arresters," as well as a paper read before the Chicago branch on "High-Voltage Direct-Current and Alternating-Current Systems for Interurban Railways," by W. J. Davis, jun.

Electrification of Main Lines. — The Southern Pacific Railway Company, through Mr. Kruttschnitt, director of maintenance and operation of the Harriman lines, has, the *Electrical World* learns, requested Mr. Frank J. Sprague to associate himself with Mr. A. H. Babcock, the electrical engineer of the company, in a study of all the data bearing upon the question of the feasibility of electrifying a part of the Sacramento division of the Southern Pacific system—*i.e.*, the section from Rocklin to Sparks; to prepare a general plan of electric traction, and to submit this to a board which is to deal with the subject broadly. Mr. Sprague has also been invited to serve on this board, and it seems that in the event of the adoption of electricity he is to remain with the company as its consulting engineer, without hindrance, however, to any other professional work in which he may be engaged. It will be admitted, our contemporary states, that this is news of extraordinary importance, and that electric traction in one of its most distinguished representatives has now presented to it a problem which in various respects is more difficult than any of those preceding. The Sacramento division of the Southern Pacific, running over the Sierra Nevada Mountains, is really a vital link in interocean travel. The enormous growth in trans-continental traffic over the Union Pacific and Southern Pacific, east and west, is far from being realised, although the immense earnings of the system serve as an indication. The road passes over the Sierras at an elevation of 7,000ft. at Summit, on the section between Rocklin on the west slope and Sparks on the eastward one, and all east-bound freight has to be lifted nearly 7,000ft. in a stretch of 83 miles of road. The line is single track, and very tortuous, with frequent grades of 1½ per cent., and a maximum of nearly 2½ per cent. The distance from Rocklin to Sparks across the range is 136 miles, and it is on this section that the enormous grades occur. But these are not the only adverse physical conditions. There are over 31 miles of snowshed and rock tunnel to encounter; and all the ordinary difficulties of summer are aggravated in winter by overwhelming falls of snow. The present service of traffic, both passenger and freight, is maintained by means of very powerful oil-burning locomotives of the best type extant, with which good results are obtained; but, although the road is kept up to a high degree of efficiency, it is only with difficulty that the traffic is maintained, and at times there is absolute blockade. Moreover, at some periods the traffic is so great that it has already reached the limits of the present capacity of the system. The problem that has been before the management for years is how to increase the capacity—to double track, to build an additional line, or to try a change of motive power. Rebuilding or new building of lines would involve tremendous outlay and delay, and meantime the traffic is growing swiftly, and must be taken care of *ad interim*. Mr. Harriman, in a memorable interview in the New York *Times* some months ago, expressed openly his conviction that the problem of increased capacity on trunk lines in general would be solved ultimately and satisfactorily by the adoption of electricity.

Electricity in Mines.—Two Home Office reports on the working of coal mines were issued at the end of last week, and these deserve to be studied by those who doubt the adaptability of electricity for certain classes of mining work. One of these reports is from Mr. Robert McLaren, H.M. Inspector of Mines for the East Scotland District (No. 1), and the other from Mr. J. M. Ronaldson, H.M. Inspector of Mines for the West Scotland District (No. 2). Two of the features of these reports which impress themselves upon the reader are the increasing use of electricity in mines, and the remarkable freedom from accidents from this cause in mines situate in the districts covered by the reports. Mr. McLaren says with regard to electricity that "this power is still increasing in the district, and is much in request for driving coal-cutting machines." The popularity of electricity for driving coal-cutters is well illustrated in the following figures which we extract from the reports. In the East Scotland district 176 coal-cutting machines were in use during 1906, electricity being the motive power employed for 112 and compressed air for 64. It is noteworthy that increased employment of coal-cutting machinery is largely due to the increasing favour of electricity as motive power, the increase for the year of electrical machines at work being 58, as compared with 16 of compressed air. And the report from the West Scotland district tells a similar tale. There, 129 coal-cutting machines were in operation last year, 59 being driven electrically and 70 by means of compressed air; and Mr. Ronaldson, commenting on the increasing number of coal-cutting machines in use, states that "while the use of compressed air as the motive power for disc and chain machines is not extending, electricity as a motive power for these types of machines is being more used." There were but two fatal accidents in both districts from the use of electricity. One man was killed by shock while in the act of renewing the picks on a disc. To enable this to be done the current was switched on sufficient to cause the disc to revolve the distance between the picks; while this work was in progress a slight shock was felt just as the current (450 volts continuous) was put on, and the leakage ran up the haulage rope which deceased was getting in order. In the other case, too, the fatality was caused by a leakage of a charge of 450 volts continuous current along a haulage rope with which the deceased was in contact. The machine was supposed to be "dead" at the time, but a later examination showed that the cable going through the machine casing to the field-magnet coil was bare inside and had come in contact with the metal of the casing, causing the machine to become alive, and all the

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parts connected as well. The cable was insulated in the usual way and was inside rubber tubing, right to the inside of the casing of the machine; it passed through the casing by a brass bush and small rubber ring screwed tightly up—apparently the cable had received rough usage to cause it to be bared in the inside of the casing. Both these accidents raise the question of proper earthing, and Mr. McLaren suggests that owners should adopt some form of earthing for these motors, which will have the effect of reducing shock to a minimum. A third wire, properly earthed, would take up any leakage and save shock to a considerable extent. Another great desideratum is the employment, in mines where electricity is used, of competent persons having a technical knowledge of electricity to see that the requirements of the electrical special rules are carried out.

London Street Traffic Problems.—If we are to wait until the recommendations of the London Traffic Commission are given effect to, we fear that any practical solution to the London traffic problem will be deferred for some years to come. The establishment of a central Traffic Board, a recommendation strongly made by the commissioners in their report—for whose attention all controversial matter should be left—meets with unanimous approval; but as the Government seem loth to move in the direction recommended, it becomes necessary to consider proposals which may be expediently adopted by local authorities and others for temporarily relieving the situation. Mr. W. Noble Twelvetrees, in his presidential address at the opening of the autumn session of the Civil and Mechanical Engineers' Society last night (Thursday), threw out some practical suggestions for the regulation of London street traffic by the improvement of street junctions. What he proposed was really the system of gyratory traffic regulation which was first mooted by Mr. Holroyd Smith some 10 years ago, and which has since been advocated by noted engineers in this country and elsewhere Mr. Twelvetrees believes that it can be adopted at some of the existing street junctions without expenditure of any kind worth considering, and at others without serious cost. He

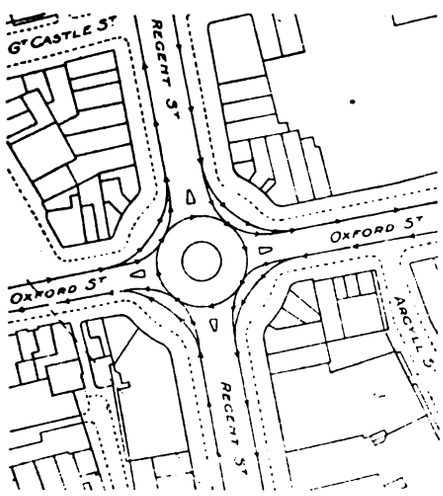

FIG. 1.

mentions a number of centres where the adoption of gyratory regulation would be feasible, one of which—Oxford-circus—may be chosen as typical of the difficulties that exist at busy junctions. According to the arrangement of Oxford-circus the single files of traffic give 16 points of direct conflict within a very small area in the middle of the circus, while outside the area there are no points of intersection. From the gyratory regulation of vehicular traffic which is proposed by Mr. Twelvetrees, conflicting points would be abolished and (as will be seen from Fig. 1) converging and diverging lines reduced. The four additional curves shown in the diagram are intended to illustrate the manner in which vehicles can pass directly from every street to the next street on the left hand without the necessity for entering the main stream of traffic moving round the circus. Reference was also made by Mr. Twelvetrees to the obstruction to ordinary caused by tramway junctions and termini in open spaces, the result of which is a series of tangled tracks, whereon cars get in each others way. A good idea of the manner in which an open space is allowed to be overrun by tramway lines, laid

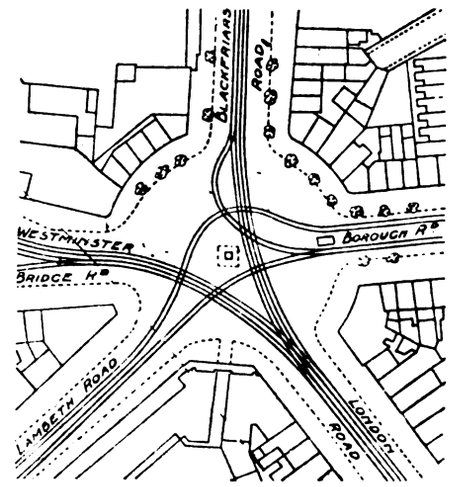

FIG. 2.

without the least attempt at systematic arrangement, is obtained from St. George's-circus, in South London (as shown in Fig. 2). This plan shows that at present there are no fewer than 12 direct crossings, and that the lines wander about the circus in the most inconvenient manner possible. A revised plan of the same circus with the lines set out on the gyratory system is shown in Fig. 3. The provision of suitable tramway termini both in the central and suburban districts of London is a matter which demands attention, as all will admit who have witnessed the intolerable nuisance caused at busy junctions, but whether

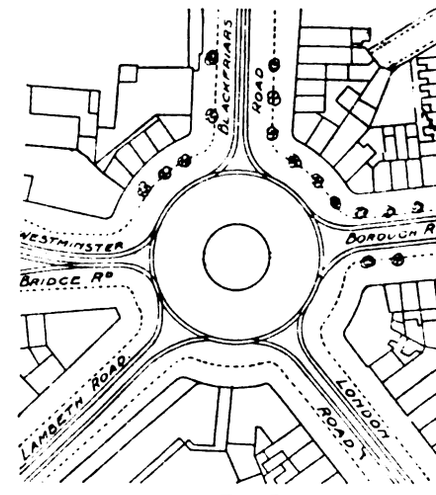

FIG. 3.

the gyratory system will obviate the trouble is open to question, for there will still be a considerable amount of intersection from the establishment of concentric circles of gyratory movement. Still, the system seems to have advantages which might be given a trial at centres where its adoption would be inexpensive, so as to allow its effects to be carefully noted before extending its adoption. But very little faith will be placed on all schemes for the relief of the London traffic problem which are only tentative, unless they are dealt with as parts of a larger scheme undertaken by a central authority.

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BLACKPOOL ELECTRICITY WORKS EXTENSION.

On Tuesday last the Mayor of Blackpool (S. Hill, Esq., J.P.) officially inaugurated the sixth extension of the electricity works at this highly appreciated Lancashire seaside resort. The chairman of the Electricity and Tramway Committee (Alderman J. Brodie, J.P.) opened the proceedings with a few appropriate remarks as to the progress of the undertaking, and was supported by Mr. Alderman Grime, vice-chairman, and also by Mr. ex-Councillor Pearson, who was the *first* chairman of the Electricity Committee in 1891. The improvements carried out since the commencement of supply have been of such a character as to draw from the first chairman very complimentary remarks. The station has so altered as to be almost beyond recognition, as many small 50-kw. rope driven sets were then in service, and these have since been put on the scrap heap to make room for more modern and up-to-date turbo machinery. The turbine set was then started up by the mayor after Mr. Mayhew, on behalf of the contractors, had presented to him a gold key for the unlocking of the lock and chain which held the stop valve in the "off" position. This little ceremony over, the mayor closed the field switches of both the alternator and generator, and in a very few minutes this new turbo set was taking the whole lighting and traction load of Blackpool. In order that our readers may follow the growth of the undertaking we give below the following particulars as to the different extensions, for the details of which we are indebted to Mr. Chas. Furness, the borough electrical and tramway engineer.

The first of these extensions was carried out in 1894-5, under the superintendence of the then consulting engineer, Mr. Robert Hammond, and the second in 1896-7, in accordance with the recommendations of the first borough electrical engineer, Mr. John Hesketh. Modifications and extensions of the last two schemes were carried out by Mr. Robert C. Quin, the late borough electrical engineer, on two occasions between 1897 and 1901. On the appointment of the present borough electrical and tramway engineer, Mr. Charles Furness (late borough electrical engineer to the Devonport Corporation), in March, 1902, a scheme was submitted and specification prepared for operating the whole of the steam turbine and reciprocating plant condensing. The existing condensers, which were then out of service, were overhauled, and modifications made, a cooling tower being erected on the works roof capable of dealing with 250,000 gallons of water per hour. The scheme was completed in 1904, and since this date the economies effected are largely the result of running condensing. From 1903 to 1906 many modifications and improvements were carried out in the boiler-house and engine-room with the object of bringing the works up to date, and placing them in a position to produce electricity efficiently and cheaply. These improvements were carried out by the existing works staff, and the cost has been met out of the revenue and reserve funds of the undertaking, though many items, such as mechanical stokers, superheaters, and coal elevator, could legitimately have been charged to the capital account. The fifth extension of plant was made in 1904, when the demand for traction current necessitated additional power, and this was met by the installation of a 450-kw. Browett-Lindley triple-expansion engine, coupled direct to a Westinghouse multipolar tramway generator.

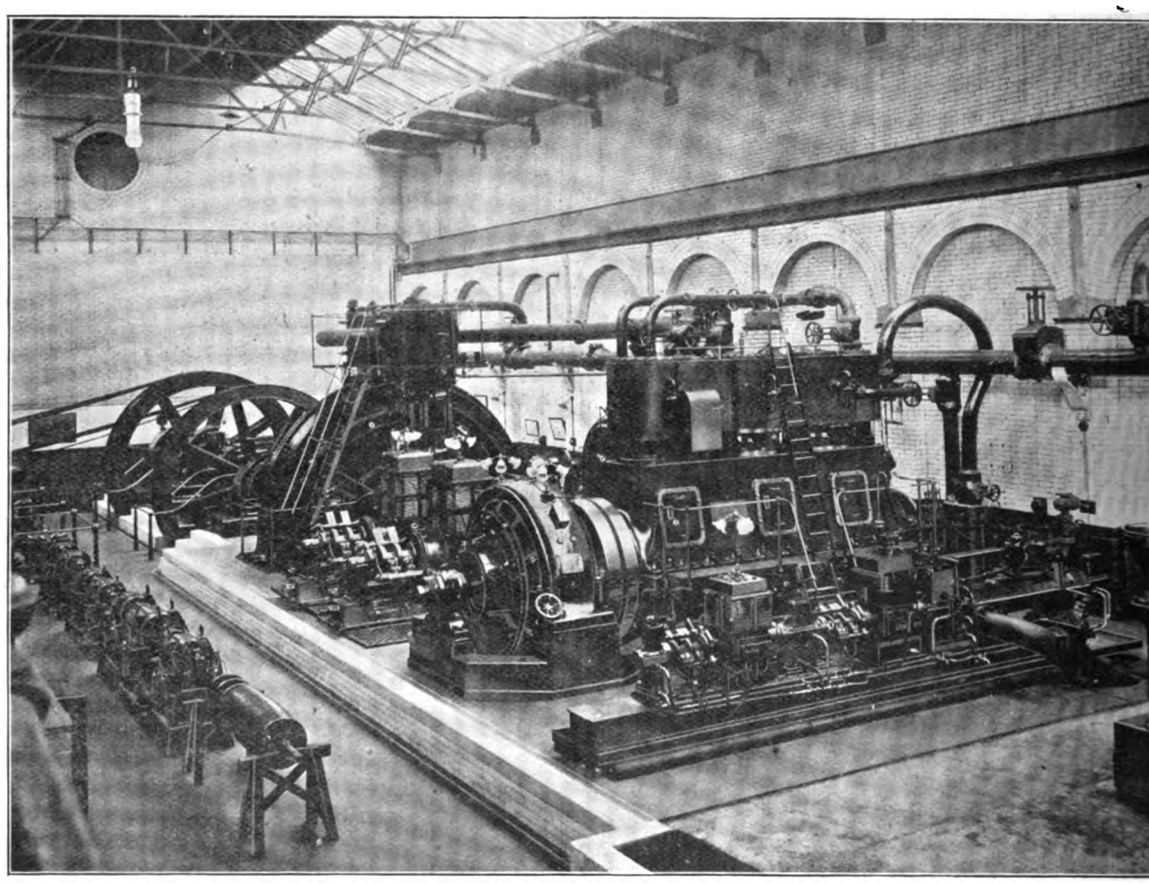

FIG. 1.—View of the Blackpool Electricity Works Engine Room, showing the old rope-driven sets at the back.

The sixth extension inaugurated on Tuesday is consequent on the increasing demand for electricity for lighting from private consumers, which it is satisfactory to note is yearly extending. On the recommendation of the borough electrical engineer, the Electricity Committee decided to install the best possible turbine plant that could be obtained, and after a deputation making a tour of inspection of the latest and largest turbos running in this country, it was decided to install a Willans and Robinson turbo as prime mover, direct coupled to a Dick-Kerr alternator for lighting and a Brown-Boveri generator for traction. The turbine is capable of meeting loads up to 1,200 kw. without the aid of steam by-pass valve, and of 1,500 kw. for short periods. The alternator has an output of 800 kw. to 1,000 kw, equivalent to a demand for 33,000 incandescent lamps of 8 c.p., and the Brown-Boveri generator's normal rating is 600 kw., with overloads up to 800 kw. for short periods. It will thus be seen that with one prime mover operating lighting and traction machines that public

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services in Blackpool—viz., electric lighting and tramways—will for many hours during the day, and many months during the year, be efficiently and economically dealt with from this new turbo plant. The addition of this machinery has increased the works capacity to 4,150 kw.

Fig. 1 shows some of the older plant in the Blackpool station, while Fig. 2 is a view of the new Willans turbine coupled to the 1,000-kw. Dick-Kerr alternator and 600-kw. Brown-Boveri direct-current generator. We have to congratulate Mr. Furness on having this new plant completed now, so that it may be well proved before the winter load comes on. Some interesting records of the Blackpool station were given in our issue of April 26, which showed that for the last five years the electricity sold has regularly increased and yet the coal burned has decreased quite as regularly. From the curves then produced this looks as though Mr. Furness would live to see the time when the output of the station would be so large that no coal at all would be needed. Unfortunately, an engineer, however keen he may be on economical running, cannot continue to improve on his own records.

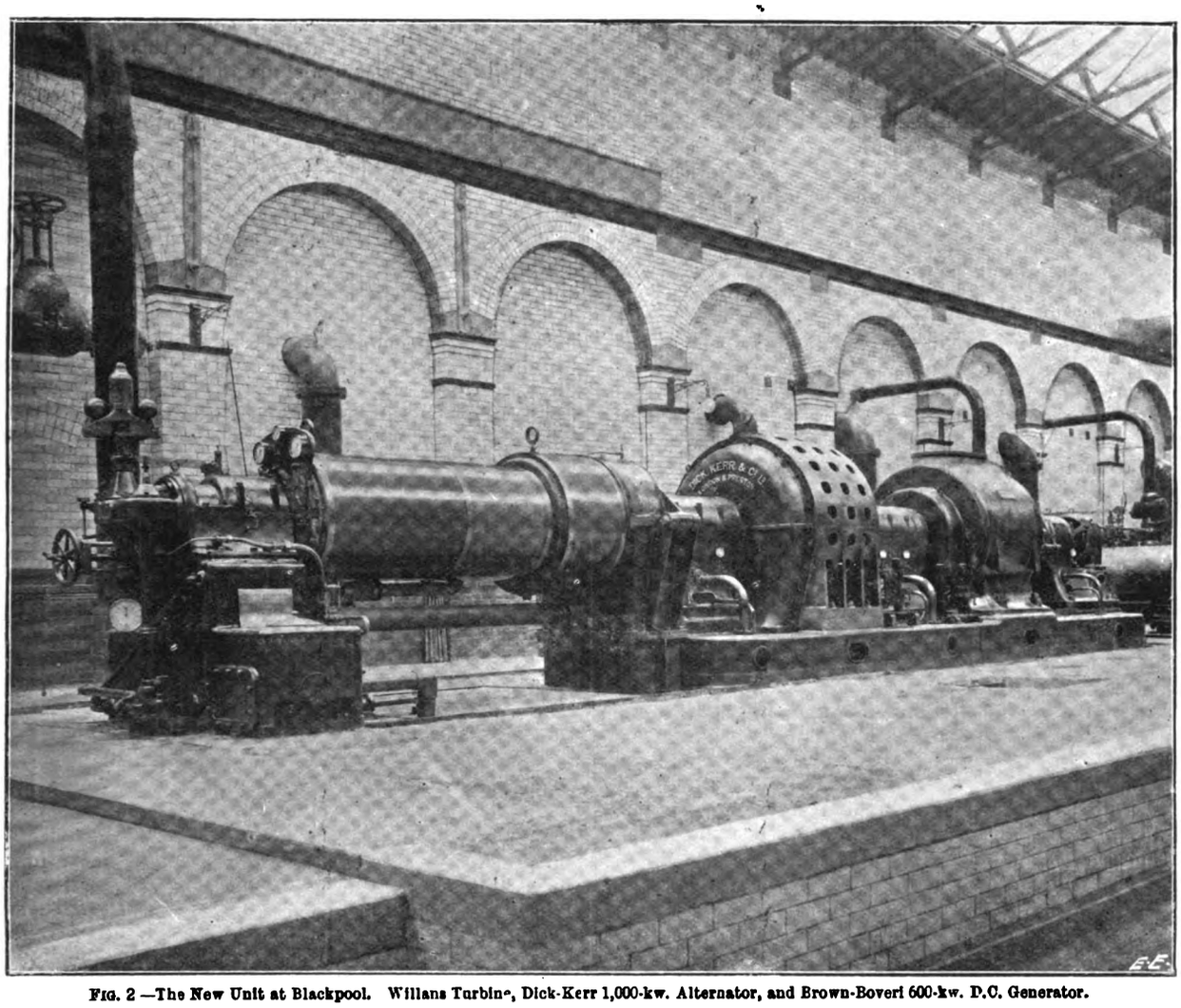

FIG. 2.—The New Unit at Blackpool. Willans Turbine, Dick-Kerr 1,000-kw. Alternator, and Brown-Boveri 600-kw. D.C. Generator.

MUNICIPAL TRAMWAYS ASSOCIATION.

ANNUAL CONFERENCE AT MANCHESTER.

(Concluded from page 444.)

Hours of Labour and Rates of Pay.

BY ALFRED BAKER, GENERAL MANAGER, BIRMINGHAM CORPORATION TRAMWAYS.

I must ask the indulgence of the members in that I am only able to place before them to-day the "Schedule of Hours of Labour and Rates of Pay, etc.,"* compiled during the last few weeks from information collected from various municipal tramway undertakings in the United Kingdom. I may remind you that it was at one of the meetings of the managers' section, held in Blackpool in June last, that I was asked to undertake this task, in conjunction with a small sub-committee consisting of Messrs. Hamilton, Spencer, and the secretary. Owing to a variety of circumstances it was found somewhat difficult to arrange a meeting to suit all parties, with the result that we had to confer by correspondence. This took up a considerable time, and to make matters more difficult the holiday season intervened. The conference will see, therefore, that there have been some difficulties to encounter, and that the time at my disposal has been all too short to devote to an important work of this character. However, every care has been taken to obtain accurate figures from each undertaking, and to set them out in the schedules as concisely and clearly as possible.

The subject before us hardly lends itself to the reading of a second "paper" (it will be remembered that I read a paper on this subject in Glasgow in 1903), and I propose, therefore, merely to call your attention to some of the figures and to the variation in the form of the schedules from those previously issued. Before doing so I may, perhaps, be permitted to refer to the paper I read at our second annual conference in 1903. I then quoted some figures showing the growth in the number of tramway undertakings during the previous six years—*i.e.*, from 1897. These figures showed that in 1897 there were 159 tramway undertakings in the United Kingdom, of which 42 only belonged to local authorities, the remaining 117 being in the hands of private enterprise. In June, 1903, no less than 74 new undertakings had come into existence, making a total of 233, of which no less than 118 belonged to local authorities. At the Glasgow conference I excluded municipally-owned horse tramways, and was only able to deal with figures relating to 34 municipal electric tramways.

* We are not publishing the schedule, and doubt the wisdom of the Municipal Tramways Association in so doing.—ED., *E. E.*

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To-day you have figures before you relating to no less than 84 electric undertakings owned and worked by municipal bodies—a wonderful development in four years.

Referring again to my Glasgow paper for a moment, I pointed out that during the previous five years under municipal control the wages of tramway men had been increased by no less than 42 per cent. and their hours decreased by 48 per cent. This, of course, was compared with horse traction, and was only possible by the introduction of electric traction with its largely increased earning capacity The figures before you to-day reveal the fact that wages have still further increased since 1903, although, of course, not at the same ratio as during the period alluded to. Comparing the wages of the 34 towns dealt with in 1903 with the wages paid to-day, I find that there has been an increase of about 5 per cent. If you will compare the schedules now in your hands with those I presented to you in 1903, you will find that one or two new features have been introduced. I particularly refer to "Time allowances," "Actual time men are on cars," "Actual time men are paid for," "Annual value of holidays," "Annual value of uniforms," and "Average rate of pay taking value of holidays and uniforms into consideration."

With regard to "time allowances," some few years ago a man's pay was always reckoned from the time he was actually on his car, nothing being allowed for the time occupied in "looking round" his car in order to see that it was equipped with everything necessary to meet all contingencies while it was on the road, or in seeing it safely stored away on its return to the shed. But this, to a large extent, has been altered, and "time allowances" are now made and paid for. Thus, when we say that a man works 60 hours a week, it does not always follow that he has been actually on his car 60 hours. In some cases you will observe that he is paid for as many as six hours in which he has been occupied in the way I have mentioned. It has been felt that this fact should not be lost sight of when our various committees are discussing this important question of rates of pay and hours of labour. A striking feature to be noted is the change which has taken place with regard to Sunday work. In 1903 there were only two towns which paid anything in excess of ordinary pay for Sunday work. To-day 21 towns, or 25 per cent. of those included in the schedules, give their men extra remuneration for Sunday labour, the rate adopted being generally time and a quarter.

The question of Sunday pay is one which has disturbed the minds of a good many tramway committees for a long time, and there is a considerable division of opinion as to whether tramway employés who only work six days out of the seven are entitled to extra pay for Sunday labour, it being held in some quarters that Sunday work is incidental to tramway business, and that having regard to the fact that the men get one rest day in seven, and to the generally excellent conditions under which they are employed, no extra remuneration is necessary. In several cases the concession has been made voluntarily, while in others the matter is now under consideration, and, therefore, I do not think it advisable to express any opinion on the matter. I may say, however, that when the matter was under consideration in my own town, we were confronted with the fact that the company operating the lines previous to the Corporation taking possession were actually paying time and a quarter for Sunday labour.

I think I may next call attention to the system which has recently come into practice of giving bonuses beyond their ordinary pay to motormen who have been free from blamable accidents during certain periods. Nearly half of the towns have adopted this practice with, I believe, good results. It will be seen that in Leeds ½d. per hour is paid to all motormen who during any calendar month have been free from blame in the matter of accidents, and no less than 97½ per cent. of the men have qualified for the bonuses, indicating the value of the arrangement. The amount paid in compensation during one financial year only equalled ½ per cent. of the receipts. I am not able to speak from personal experience of the value of the system, which has also recently been adopted in Birmingham, but I am strongly in favour of it. Of course, no extra remuneration should be necessary to make a motorman diligent, cautious, and alert at all times, but while human nature is as it is, I am afraid that with the majority of the men engaged in tramway work an extra inducement beyond the ordinary satisfaction a man gets out of doing his duty "for duty's sake" is necessary. There is one good feature about the business, and that is, the adoption of the system advertises the fact that the management is anxious to avoid accidents, desirous that the cars shall be driven with due regard to the lives and property of the public, and willing to adopt special means towards securing this end. Owing to the fact that bonuses in the majority of cases are contingent on the men being free from blamable accidents during certain periods, I have omitted to include bonuses in the columns relating to "Average rate of pay taking value of holidays and uniforms into consideration."

With regard to "Uniform and holiday allowances," I have given the annual value of these, and have for the purpose of estimating the real value of a tramway man's job worked out the weekly value and added it on to his wages. It seems to me only fair that these things should be taken into consideration, and when this is done I think we shall be pretty unanimous in the conclusion that in municipal service a tramway man's lot is not a particularly unhappy one, but, that on the contrary, it compares favourably with that of any unskilled labourer in the kingdom. When I say "unskilled," I do not overlook the fact that a good motorman is not made in a day; indeed, most of us know that it takes many months to make a thoroughly efficient motorman—one who may be relied upon in sudden emergencies. Still, our motormen and conductors cannot be classed with skilled artisans, who generally have had to serve an apprenticeship to their jobs. Yet the conditions of a motorman's employment in some of our cities compare favourably with the conditions of the skilled artisan. No doubt the members will be able to make comparisons with those employed in the staple trades of their own towns. Personally I am very glad that tramway labour is so well looked after, and I should be the last in the world to deal ungenerously with the men. Still, as I pointed out in 1903, it behoves us as far as lies in our power to prevent the pendulum from swinging too far. As I then said, "I think that, having regard to the peculiar nature of the work, tramway men should be generously treated, but there are limits, and as soon as these limits are passed so soon will the work in which we are all engaged be seriously prejudiced" I thing that if those words applied in 1903 they apply with, perhaps, more force to-day, when the "burden of the rates" is the universal cry.

It is not for me to say what the limit shall be. Every town must settle the matter for itself, but I do seriously suggest that in the matter of hours of labour and rates of pay tramway managers and committees should be careful, in perhaps the first flush of their success, not to fix rates out of proportion to the value of the work performed. This only leads to demands being made for similar treatment in other cities, which are difficult to resist when the men can point to some other place where specially favourable conditions exist. It is with the object of showing what is being done in various towns that the schedules have been prepared, and I hope the members of our association will find them of value in that direction.

The following is the discussion on the paper on "Staff Organisation" read by Mr. James Dalrymple, and reproduced in our last issue.*

Dr. T. W. A. NAPIER, of Wallasey, said that the tramway manager must be the sole manager—there must be no dual or triple control. Under the tramway manager the surveyor and the electrical engineer might be made partially responsible for departmental work.

Alderman T. HEY, of Halifax, agreed with the previous speaker. In the case of a tramway taking a supply from a combined central station the tramway manager should have access to the generating station. At Halifax they had been dissatisfied with the account for electricity, and had insisted on a further check. Three meters had been installed instead of one, with the result that a £3,000 overcharge had been saved.

Mr. A. NANCE, of Belfast, said that the scheme of organisation drawn up by Mr. Dalrymple was very good for an undertaking as large as that at Glasgow. He did not agree, however,

* *Electrical Engineer*, vol. xl., p. 443.

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with the author on the maintenance of the permanent way. At Belfast this had been constructed by the surveyor, and, therefore, he was the proper person to maintain the same. The surveyor was now responsible for the upkeep of the whole of the roadway and paving. The scheme worked satisfactorily, as all accounts had to pass through his (the speaker's) hands to be certified before they were passed on to the borough accountant. Again, with the supply of electricity he was in favour of leaving this in the hands of the electrical engineer. At Belfast the tramway current cost 0·59d. at the works, and the capital charges brought this up to 0·69d. In consequence he, as tramway manager, had no electrical staff to pay. At Belfast there was no friction whatever in the above arrangements, and any point in connection with the maintenance of the track was freely discussed with the surveyor. This gentleman was also responsible for the maintenance of the buildings.

Mr. H. M. SAYERS, speaking of the author's organisation chart, questioned the advantage of having both an electrical and mechanical engineer independently responsible for the working of the power-house plant. This should be under one head. He also advocated more intercommunication between the traffic department and the engineers, so that no interdepartmental friction should hamper the restoration of service in case of breakdown.

Mr. J. B. HAMILTON, of Leeds, said that while the self-contained power-house was ideal, it was not always possible. Where it could not be obtained there should be little difficulty in ascertaining the cost of the current supplied to the tramways. The difficulty with respect to the city surveyor doing the work of maintaining the track and street surface was that he was not concerned in the cost. They had got to a period when 10 per cent. of the whole revenue of the tramways might be required in track renewals, and hence it was the right thing that the tramway manager should do the work and be directly responsible. During the rush of construction it was only to be expected that the city surveyor would have charge of laying down the permanent way. He thought these gentlemen should now gracefully retire, as they were not conversant with the improved methods of track construction. In the organisation of the staff he had found that any system had to be varied in different towns to meet the individualities of the men employed.

Alderman TRUMBLE, of Croydon, considered that with a smaller system there was a great deal to be said in favour of keeping the permanent way under the surveyor. He would have to take instructions from the Tramway Committee, but he did not think it was good to have two departments working on the street surface.

Mr. J. LANCASTER, of Blackpool, said that the Tramway Committee consisted of only one-fourth of the members of the Council, and he did not think they would get the full powers asked for by Mr. Dalrymple. In Blackpool the surveyor was responsible for all the street surfaces. Frequently, when laying down tramways, the whole of the street had to be repaved, and he did not think it economical to have two departments doing this. He always reserved the right to say what should and should not be done to the tramway track, and admitted that sometimes repairs were not so expeditiously carried out as he would like.

Alderman H. LINSLEY, of Salford, said they had their own staff for repair work, and found it more economical.

Mr. A. ELLIS, of Cardiff, said he was quite content to leave the Cardiff track in the hands of the man who laid it, as he should not like to take over the responsibility of it now. He considered they should keep their own accounts, as the tramway manager was responsible for all the details already. Having done so much in the way of examining and passing accounts, it was better for the tramway manager to keep the books, and to hand them over to the city treasurer to certify.

Councillor S. FLINT, of Leicester, advocated the surveyor being in charge of the roads, and agreed with Mr. Ellis that the tramway department should keep its own accounts.

Sir J. B. ELLIS, of Newcastle, explained that in his city they had at first left all the trackwork in the hands of the city engineer. This gentleman retired 12 months after the tramways opened, and they then divided the responsibility, placing the track maintenance in the hands of the tramway manager. He purchased a complete equipment, with a stud of horses to move the tar kettles, etc. This course was found to be very unsatisfactory, and the repairs cost from £16,000 to £17,000 a year. They had, therefore, again put the matter under the hands of the city engineer, who worked to instructions of the Tramway Committee. To keep the charges distinct from other street work the city engineer kept a separate staff, who worked on the tramways only, with a full equipment of tar kettles, etc. The cost was now less than £5,000 per annum.

Alderman SMITH, of Liverpool, spoke of the absurdity of having two staffs to do practically the same work. It seemed as if at Newcastle one set of tar kettles was required for the paving work between the rails and 18in. on each side. If the paving were disturbed more than this, the other staff had to come out with its tar kettles. When they were all working for the good of the city there was no need for such sub-division, and there should be no difficulty in dividing the costs. The same applied to the supply of electrical energy. He could not see why two stations should be required in the same town. If the electrical engineer was unable to tell the Tramway Committee the cost of the supply to the tramways, he certainly was not fit for his job.

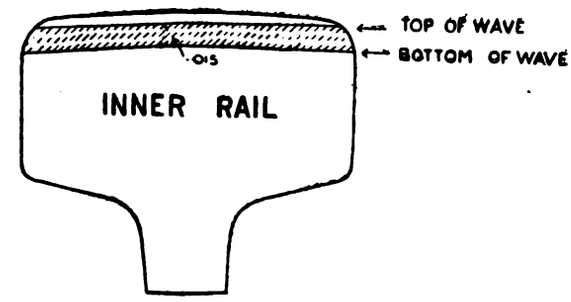
Bailie J. M'FARLANE, of Glasgow, said the master of works in Glasgow was responsible for the street surface generally, and there was no competition between him and the tramway department. It frequently happened that the whole of a street was repaved by the tramway department and the cost divided.

Mr. J. DALRYMPLE, in reply, maintained his opinion that the Tramway Committee should be responsible for the whole of the work. They should, above all things, keep their own accounts, so that the tramway manager may know day by day and week by week how his department was working financially.

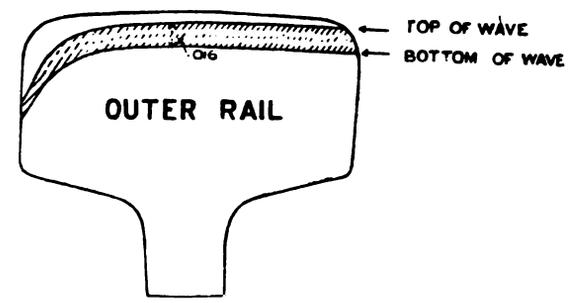
Rail Corrugation.

BY A. L. C. FELL, M.I.E.E., M.I.MECH.E., CHIEF OFFICER, LONDON COUNTY COUNCIL TRAMWAYS.

In May, 1905, the author visited America, and on his return presented a report to the London County Council, in which he made a few remarks on the subject of rail corrugation. The following is an extract from this report: "The question of rail corrugation is one that requires very



SKETCH SHOWING DEPTH OF WAVE OR CORRUGATION ON THE INNER RAIL OF ROLLINS STREET CURVE, SOUTH BOUND. RADIUS 1 000 FT., SUPER-ELEVATION 4 INS., GAGE 4 FT. 8½ INS. SPEED OF TRAINS ABOUT 25 MILES PER HOUR. AVERAGE LENGTH OF WAVE 2 FT 5⅞ INS. LENGTH OF SERVICE 365 DAYS.



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serious consideration, both in this country and in America, and unless the trouble is promptly dealt with serious damage will be done to the equipments and trucks, and the rails will have to be renewed before they are worn out. In this country corrugation has appeared on the rails of nearly every electric tramway system, the corrugations varying in length from 2½in. to 5in., the worst corrugations appearing at curves, where a short wave is formed on the outer rail and a long wave on the inner rail. The corrugation at first appears on the outer rail. I would here point out that corrugation gave great trouble shortly after the cable tramways started running on the Brixton section, but in this case it was found that the corrugation at the curves started on the inner rail, and was transmitted to the outer rail, and the long corrugation was on the outer rail, and not on the inner rail. No corrugation has been noticed on the rails used for horse traction, but it has appeared on steam-driven tramways, but never on steam railways. In every city I visited in America, except Buffalo, corrugation is to be found in a more or less marked degree. Apparently the higher the speed the greater the length

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of the corrugation wave. On several of the interurban lines the cars are run at speeds of from 20 to 30 miles per hour, and the corrugation in some instances was as much as 8in. long. On the Boston elevated railway, where the cars are run at upwards of 40 miles per hour, the corrugation was no less than 31in. long. The trouble on this line is so serious that the rails have to be renewed every few months. Before going to America I had for a considerable time been engaged in investigating this matter, and formed the theory that the trouble was originally caused by unevenness on the rail surface setting up a slight jumping or bounding action in the car wheels. I consider that the unevenness might be due to three causes: (1) chattering or vibration of the rollers when commencing to roll the ingot into a rail, causing a rough rail surface; (2) uneven or wide joints between rail ends, rigidly supported on a concrete bed; (3) jumping action set up in car wheels by variations of the wheel or track gauge To ascertain if my first theory was correct, I made some tests in the New Cross car-shed before the rails had been used in any way by the cars A long emery block, fitted under a truck, was lightly run over several lengths of track, and a distinct corrugation was noticeable on the rail surface, although in some instances it was not very regular in form. About nine months ago I had a water-tank car fitted up with a grinding apparatus, consisting of a carborundum block, 10in. long by 2½in. wide, which could be pressed down on to the running rails. By this means some of the worst corrugations were ground out, and have not yet reappeared. The corrugation of the rails is becoming somewhat serious on all the sections, but additional grinding apparatus is being fitted on the new water-tank cars, which will shortly be delivered, and I hope to be able to grind out the waves. I find that no attempt has been made hitherto in America to get rid of the trouble in the manner now suggested. With new rails arrangements should be made, if possible, for passing them through a grinding machine after rolling; the corrugations are so slight, that very little would have to be done to prevent the trouble developing in a serious manner at a later date." Since the above report was written, many causes and remedies have been suggested, and apparently it is only by a process of elimination that we can hope to get rid of corrugations entirely.

Possible Causes of Corrugation.—After further study and investigation on various tramway systems, the author has come to the conclusion that corrugations are not due entirely to one cause. The following are, in his opinion, some of the chief producers of the trouble: (1) Original roughness of rail after rolling. (2) Cold rolling of rails by the car wheels. (3) Soft rails and heavy cars. (4) Sand and grit on head of rail. It is quite possible that the use of sand on street tramways may cause corrugation. As a rule, sand is applied to the rail intermittently and lies in small heaps at short intervals. The natural tendency would be for the wheels, when revolving rapidly, to grind the head of the rail when passing on to each fresh heap of sharp sand; this would account for corrugations appearing at irregular intervals. It may be argued that under this theory there would be corrugation at all stopping places, but this is not a fact, and is probably due to the reduction in the speed of the cars before they arrive at the stopping places where sand would be applied. It has been found that at most of the stopping places the rails present a bright regular surface. (5) Defective and open joints. (6) Tight or wide gauge of track or wheels. (7) Loose or springy rails and points. (8) Defective trucks being out of square and buckling. (9) Slip of wheels at curves. (10) Wheels not being same diameter. (11) Flats on wheels. (12) Rapid acceleration and retardation, causing wheels to slip. With reference to the question of corrugation being caused by rapid acceleration, the author has made experiments, and found that if a car is too rapidly accelerated distinct signs of corrugation appear. The markings are not very deep, but would most probably develop. Similar experiments have also been made with a traverser in one of the London car-sheds. This traverser, which is 14ft. 8in. long and 23ft. 10in. wide, is driven by one Westinghouse No. 200 motor, run from the 500-volt tramway circuit, connected through countershafts to gear wheels keyed to the independent axles carrying two of the four wheels on which the traverser is mounted. The approximate weight of the traverser is 15 tons unloaded. In the first experiments the rails in the traverser pit were clean and wet. When the traverser was standing still the controller was rapidly worked round on to the fifth notch, and the wheels slipped badly before the traverser gained much speed; corrugations appeared with each experiment at about 2in. centres, the patch of corrugation being about 9in. long. In the next experiments the rails were painted with grease, but the corrugations were not visible. This may be an optical illusion, but in the author's opinion it tends to show that corrugations are more liable to occur under the heading of rapid acceleration with the wheel in good metallic contact with the rail, and not when the latter is covered with a film of grease or soft ungritty matter. (13) Defective brake mechanism, or by a too rapid application of the brakes causing chattering and a series of short skids. These and many matters may be responsible for the trouble, but the author still considers that the "original sin" is produced when the rails are rolled, and will quickly develop into corrugation unless the surface of the rails is ground immediately after they are laid. On the Vauxhall to Victoria route the rails were rubbed with carborundum blocks before electric cars began to run. Distinct signs of corrugation then appeared, and were ground out. A heavy service of cars has been in operation over these lines during the past 14 months, and there are only very slight signs of corrugation, except on the Vauxhall Bridge, crossing the Thames, where the corrugation is more serious. This is, no doubt, due to the spring of the rails on the bridge. In another case, where fully-developed corrugations along the Clapham-road were rubbed out in a similar manner at the same time, the rails are now badly marked again, the service of cars and the speed in each case being practically the same. Generally speaking, the outer rails of the curves are most deeply marked, and the pitch of the corrugations is fairly regular, the average being 2in. The inner rails of curves are usually marked in irregular patches. On straight tracks, however, the corrugations are not so irregular. On inclines the corrugations are deeper and more regular on the up than on the down grade. As a rule, corrugations do not appear on down grades where track brakes are regularly used as service brakes. In places where the rails are not anchored the corrugation is much worse than on lines where the rails are anchored or laid on extended yokes. In a paper read by Mr. Joseph A. Panton before the Institution of Electrical Engineers on March 21, 1907, he states that "enough evidence has now accumulated to contradict any rail theory that may be promulgated. It, therefore, behoves us to look elsewhere for a solution of this problem." He then gives various reasons why the rail theory fails to account for the presence of corrugation. Amongst others he states: "Because rails manufactured by every firm in the world have corrugated since the advent of electric traction." This is not quite correct, as there are several tramways where no corrugation has yet appeared. The author proposes to give a list of these tramways in another part of this paper. "That the rails did not corrugate in the days of horse and steam cars." Very few cases are known of corrugated rails on horse and steam tramways, but the author saw an interesting case a few weeks ago in one of the London docks where the rails carrying a large steam-driven jib crane were badly corrugated, the corrugations being about 2in. long, and extending nearly the whole length of the rail. "That check rails are corrugated to an equal degree and parallel to that on the crown of the rail." With very few exceptions the check rails are not corrugated on the London tramways. "That it takes on the average three years to develop corrugations on a new system, and only three weeks on relaying with new rails thereafter." Corrugations have appeared on some of the rails in London after they have been in use for a few days, but on most of the rails they have appeared in about six months. Mr. Panton's view is that the cause of the trouble lies in the faulty construction of the trucks, and not in that of the tracks. The author does not agree that corrugations generally are caused by defective trucks, although this may, under certain conditions, be responsible for corrugations. The reason for

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this statement is based on the following fact: When ordering additional rolling-stock about two years ago, the author came to the conclusion that the ordinary stock trucks on the market were unsuitable for heavy service. He, therefore, in conjunction with eminent truck manufacturers set to work to design a truck that would meet the requirements, and be a thoroughly sound mechanical job. This was done, and the results have been very satisfactory. Some of these trucks were put into service on the Aldwych subway line, and similar trucks were put into service on the Popar line. On the subway line, where the rails are laid on longitudinal sleepers, corrugations were noticed a few days after the line was opened. These were ground out, but appeared again after a few months' working, and it was anticipated that the trouble would become serious, but for the past three months there has been practically no change—if anything, the corrugations are somewhat less marked. On this line the steel cars are fitted with magnetic track brakes and sand boxes of the intermittent flow type. On the Poplar route, which has been running with a heavy service of cars for upwards of 10 months, no corrugations have yet appeared. In this case the rails are mounted on extended yokes, and are anchored. The author thinks the chief cause of corrugation on the subway lines is the fact that the rails are on

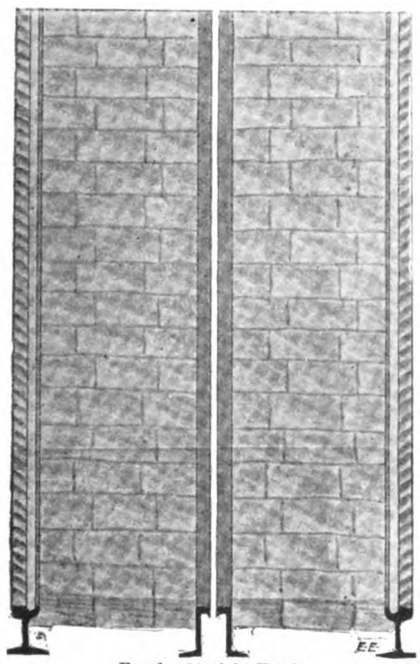

FIG. 1.—Straight Track.

a springy bed, and the cars run at speeds up to 20 miles per hour. On the Poplar route the cars cannot be run at a very high speed owing to the heavy vehicular traffic. The cars on this route are fitted with magnetic track brakes and sand boxes of the continuous-flow type.

Wave Form of Corrugations.—The wave form of corrugations is generally the same, and the marking is usually not at right angles to the head of the rail. In most cases the corrugation appears as shown in Fig. 1, which gives a typical example of corrugations on a straight track Occasionally the corrugation is at right angles to the rail, and sometimes the reverse direction to that shown in Fig. 1. Fig. 2 shows corrugations on the rails of a slightly curved track. Fig. 3 shows corrugations on the rails of a curve with a 40ft. radius. The author has noticed that the corrugations on the inner rail become longer as the curve becomes sharper. This is, no doubt, accounted for by the additional slip on the inner wheels. Some years ago, when inspecting the Hamburg tramways, it was noticed that the groove of the outer rail of each curve was partly filled up, so that the outer wheels would run on their flanges, thus increasing their running diameter and reducing the "marking time action" on the inner wheels to a minimum. The writer believes that this method of construction would reduce corrugations at curves. It has also been noticed that apparently with very high speeds the corrugation wave is longer, but in the author's opinion it is not altogether the high speed which causes the long corrugation. Most probably the heavier cars, used when running (as in America) at speeds up to 50 miles per hour, are responsible for the longer waves. On tram-

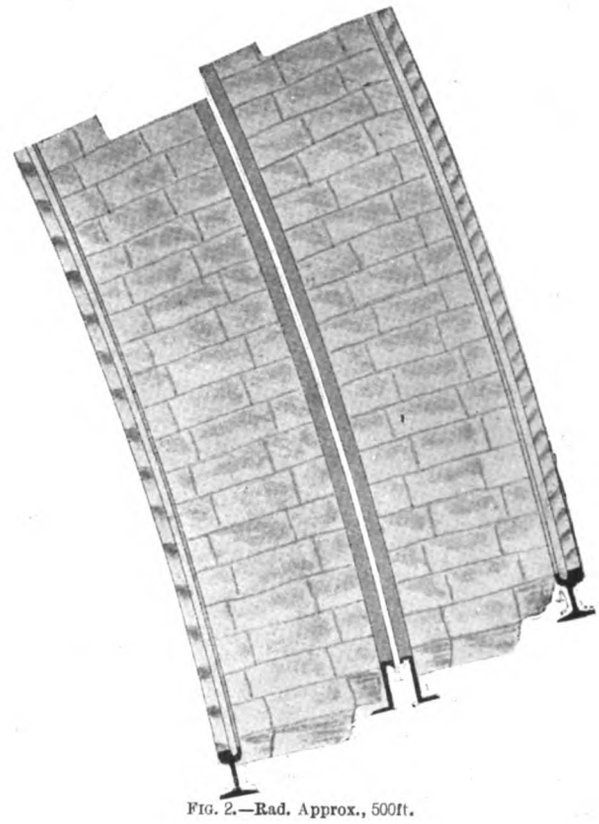

FIG. 2.—Rad. Approx., 500ft.

ways where magnetic track brakes are used constantly as service brakes, corrugation has not appeared to any appreciable extent. Several routes in London have been running for nearly 12 months under these conditions. If this state of affairs continues, it will support the theory

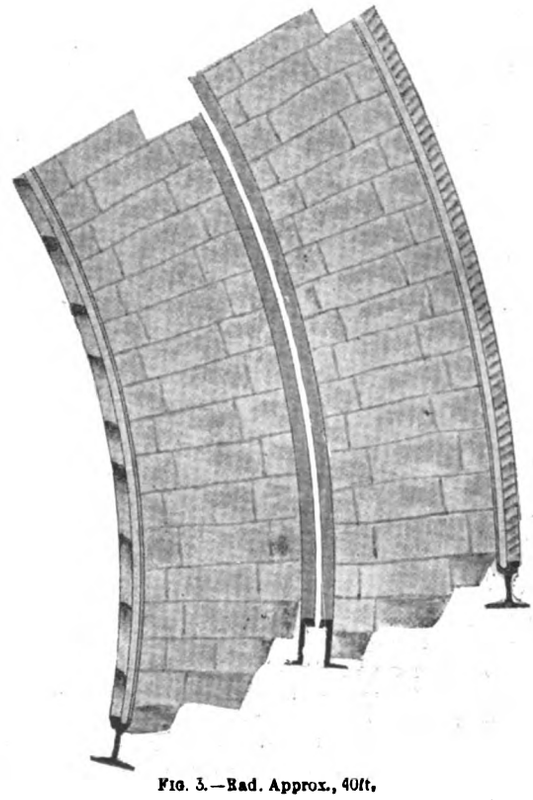

FIG. 3.—Rad. Approx., 40ft.

that corrugations may sometimes be caused by the application of the wheel brake, but experience generally shows that corrugations may appear at any time, and in the majority of cases the trouble does not become serious until after about two years' service. This, of course, depends on

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the service of cars run on each particular tramway. An important question which has to be answered before the root of the evil can be discovered is, Why are corrugation waves the same length with varying speeds within certain limits, say from four to sixteen miles per hour? One possible explanation is that corrugation may be in some instances caused by the cold rolling of the rail by the car wheels. With a light car, such as a horse car, the rolling is almost imperceptible. With a heavier electric car the weight is sufficient to cause cold rolling, and a wave starts at the softest part of the rail and travels forward until the weight of the car is not sufficient to carry the wave further. The wheels then ride over the top of the wave, and violent oscillation is set up, and the corrugation gradually extends. This theory will possibly partly account for the non-appearance of corrugations on heavy railways. In this case the weight of the train would be sufficient to roll the rail throughout its whole length, especially as the whole of the wheels under the carriages are simply acting as rollers Numerous instances can be given of corrugation appearing on manganese and cast-steel special work. In most of these instances the corrugation has appeared on the rail butting up to the special work or on a movable point tongue, the corrugation gradually extending to the fixed casting. A peculiar instance of corrugation was observed by the author in St. George's-road, London, where there are patches of corrugation 18in. long and 9in. apart extending throughout the length of one 45ft rail. The centres of the corrugations are 3in. apart. It has been suggested by many engineers that corrugations most frequently appear at stopping places. This has not been the experience in London.

Corrugation on Cable Tramways.—The fact that corrugation has appeared on cable tramways with light cars rather opposes the theory of cold rail rolling, but this is a subject which should be dealt with separately. One fact, however, might be mentioned—viz., that on the Birmingham tramways some years ago corrugation appeared on one of the two systems then in operation. On one system the cars were, I believe, run at a speed of eight miles per hour, and on the other at six miles per hour. On the higher-speed line the corrugation was serious, but on the slow-speed line no corrugations appeared. Corrugation also appeared on the Streatham-hill line in London, where the cars were run at a speed of eight miles per hour. This supports the theory that speed in some degree is responsible for corrugation. No doubt in this instance it was caused by the vibration transmitted by the cable at the particular speed of eight miles per hour.

Suggested Remedies.—The experience on tramways generally in this country, in America, and on the Continent is that, with few exceptions, corrugations appear sooner or later due to many causes on every electric tramway. It is, therefore, a question of what can be done to reduce the trouble to a minimum. The following suggestions will, in the author's opinion, be found beneficial: Track.—(1) The rail should be anchored down at intervals of not less than 7ft. 6in. (2) A hardwood packing block ¾in. thick should be placed between the anchor and the rail flange. (3) All joints should be close butted and carefully filed. Possibly it would be an additional safeguard if the rail joints were welded. (4) A water-car fitted with carborundum grinding blocks should be run over the line to remove all irregularities before the cars commence running. This will be found a simple, quick, and inexpensive process if carried out immediately after the track is constructed, and the development of corrugations will be deferred for a considerable time. (5) Immediately the slightest sign of corrugation appears to grind the rails, as suggested above. (6) By partly filling up groove of outer rail so that outer wheels run on flanges at sharp curves. Rolling-stock.—(1) Secure first-class trucks of good mechanical design, which will not buckle or get out of square; (2) see that the trucks are absolutely square; (3) the diameter of the wheels should be kept equal as nearly as possible; (5) by separately driving each wheel or by introducing differential gear, as in the case of a motorcar; (5) by using continuous-flow sand-boxes; (6) by using magnetic track brakes as service brakes.

In the latest return published in the early part of the present year in the *Tramway and Railway World* it is stated that no corrugations have appeared in the following towns up to that time:

TOWNS AND CITIES WHERE RAIL CORRUGATION HAS NOT BEEN OBSERVED.

Name of town or city.	Length of time electric cars in operation.
Ashton-under-Lyne	4½ years.
Barking Town	3 ,,
Bexley	3 ,,
Bolton	6 ,,
Bradford	8 ,,
Bury	3½ ,,
Chester	3½ ,,
Colchester	2½ ,,
Darlington	2 ,,
Doncaster	4½ ,,
Dundee	6½ ,,
Gloucester	2½ ,,
Great Yarmouth	4½ ,,
Ilford	4 ,,
Northampton	2½ ,,
Nottingham	6 ,,
Walsall	3 ,,
West Bromwich	4 ,,
West Ham	3 ,,

TOWNS AND CITIES WHERE RAIL CORRUGATION HAS APPEARED.

Name of town or city.	Length of time electric cars have been running before corrugation appeared.	Average service.
Aberdeen	—	5 minutes
Ayr	4 years	10 ,,
Birkenhead	3 ,,	5 ,,
Birmingham	—	—
Blackburn	3 months	7 ,,
Blackpool	18 ,,	—
Brighton	3½ years	4 ,,
Burnley	6 months to 2 years	5 ,,
Cardiff	2½ years	—
Croydon	3 ,,	3-5 ,,
Darwen	5½ ,,	—
Dover	6 ,,	6 ,,
East Ham	3 ,,	3-5 ,,
Erith	9 months	10 ,,
Glasgow	6 months to 3 years	1½-5 ,,
Huddersfield	6 years	5-10 ,,
Hull	3 months	2 ,,
Ipswich	1 year	3-5 ,,
Leeds	1 ,,	2½-10 ,,
Leicester	2 years	—
Liverpool	2-3 ,,	½-3 ,,
London County Council	6 months	2 ,,
Manchester	2 years	5 ,,
Newport	3 ,,	4 ,,
Portsmouth	2 ,,	3 ,,
Preston	1½ ,,	3 ,,
Reading	2½ ,,	5-7 ,,
Rochdale	2 ,,	10 ,,
Salford	3-4 ,,	—
Sheffield	—	4 ,,
Southend-on-Sea	—	10 ,,
Southport	3 ,,	3-6 ,,
Sunderland	2½-3 ,,	5 ,,
Wallasey	2 ,,	5-10 ,,
Warrington	3 ,,	10 ,,
Wigan	3 ,,	10 ,,
Wolverhampton	4 ,,	3 ,,

It will be interesting to hear from the representatives of the places where corrugation had not appeared at the time of the publication of the above return whether corrugation has since developed. The author has noticed in the replies sent in by these towns it is not stated whether there is a very heavy service or whether the cars are run at fairly high speeds. It will be advantageous to have this information, and also to know whether small cars are used. The author has in this short paper endeavoured to indicate the various causes, and what has been done and may be done to minimise corrugation on electric tramways. It is a very complicated subject, and he has realised that in dealing with the matter many debatable points have been introduced for discussion. He only hopes that the paper may be of some slight assistance to the members of the association.

DISCUSSION.

Alderman DUNSFORD, of Southampton, said that there they had had to reconstruct between five and six miles of track due to corrugation of the rails. The fault was in the rails and not in the roadway under them. On new lines recently laid corrugations had started immediately the cars were put to work. They

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had ground them out, and for the last four or five months there had been no signs of them reappearing.

Mr. BLACKBURN, of Lancashire, attributed the trouble to the motor drive being at one end of the axles. This tended to throw the axle out of its proper position. He suggested that with two gear wheels for driving, the fault would be avoided.

Mr. J. ALDWORTH, of Nottingham, did not agree with Mr. Blackburn, as the method of driving was used in all towns, and corrugations were not found in many places.

Mr. H. E. YERBURY, of Sheffield, attributed the fault to the rolling-mill. After the rails were in position, cold rolling and the oscillation of the cars contributed to aggravate the effect. He showed some trolley wire with corrugations caused, he thought, by oscillation and slip. He suggested that anchoring the rails and longitudinal sleepers would improve matters, and, no doubt, a differential gear on the car axles would also help. He asked Mr. Fell if any physical or other tests of the rails showed any difference of composition or molecular structure between the crests and hollows of the waves.

Mr. H. MOZLEY, of Burnley, said he had found corrugations on a down grade of 1 in 18 on which 15-ton cars were used. Slipper brakes were employed on the cars. He found it cost 1·8d. per yard to rub out the corrugations.

Mr. C. J. SPENCER, of Bradford, had only a slight case of corrugation in Bradford, which occurred on a track carried over made ground. He disagreed with Mr. Blackburn in attributing the corrugations to one-sided drive, as with rigid axles he did not think it made any difference where the driving force was applied. The proposal to use a gear at each end of the motor was not new. He had used it in the car designed for running between Bradford and Halifax, where the gauge had to be changed.

Mr. J. S. D. MOFFETT, of Rochdale, thought corrugations were caused by the slip of the wheels and cold rolling.

Mr. STEPHEN SELLON attributed the corrugation of rails to the composition of the steel. While chief engineer to the British Electric Traction Company, he had found that Belgian rails did not corrugate as English rails did. He considered that the remedy was a high-carbon, high-silicon steel, and that the rolling of the rails should be carefully inspected. Any chattering of the rolls might set up incipient corrugation, and hence inspection was necessary. When the Engineering Standards Committee were drawing up their specification they were dominated by the English rail rollers, and the correct composition for the steel recommended by Sir Alex. Kennedy and himself was not accepted.

Mr. ARTHUR ELLIS, of Cardiff, and Mr. GOODYER, of Croydon, spoke of corrugation observed on railways. The lines in question were respectively the Taff Vale Railway and the London and North-Western Railway between Carnarvon and Llanberis.

Mr. R. W. SAVILLE SMITH, of Darwen, had found that with steam tramways in that town no corrugations appeared on Belgian rails. With electric traction they developed in about five years, and the total life of the rails was about 14 years.

Mr. J. B. HAMILTON, of Leeds, agreed with Mr. Sellon that the Sandberg specification for the steel gave a good rail.

Mr. H. E. BLAIN, of West Ham, said that he had ground out the corrugation which appeared on one or two small portions of his track.

Mr. A. L. C. FELL, in reply, was pleased that so many agreed with him that the rail itself was the chief cause of corrugation. He thought that the rail rollers knew more about the controversy than we did. He had given a trial order for rails of the Sandberg specification.

Mr. F. SPENCER, of Halifax, then read a statement on the maintenance of the paving of the tramway track and its margins at the cost of the tramway undertaking. His committee suggested that combined action should be taken to get Section 28 of the Act of 1870 altered.

Mr. H. E. BLAIN, of West Ham, seconded the suggestion, and the conference resolved that the Executive Committee should consider what course to take to remedy the present state of affairs.

The conference then closed with votes of thanks to the mayor and Corporation of Manchester, the president, and the secretary.

ON THE GASES EXHAUSTED FROM A PETROL MOTOR.*

BY PROF. B. HOPKINSON AND L. G. E. MORSE.

There has recently been a considerable amount of discussion upon the nature of the gases exhausted from motorcar engines. Results of tests published in various technical journals show that in many cases a considerable percentage of carbon monoxide is present in these gases. The investigation here described deals with the conditions under which carbon monoxide is formed in a high-speed internal-combustion motor, and the relation between the composition of the exhaust gases, the strength of mixture, the power developed by the engine, and the thermal efficiency.

The experiments were made in the engineering laboratory of Cambridge University on a four-cylinder 16-h.p. to 20-h.p. Daimler engine, which was kindly lent by the manufacturers. The following are the particulars of the engine:

Total volume of one cylinder with piston on out-centre	0·04 cub. ft.
Volume of compression space	0·0104 ,,
Compression ratio	3·85
Diameter of cylinder	3·56in.
Length of stroke	5·11in.

The ordinary carburettor supplied with the engine was used in the experiments, but arrangements were fitted by which the quantity of petrol delivered from the carburettor could be readily controlled. In this carburettor, which is of the float-feed jet type, a certain amount of air passes at a reduced pressure over the jet where it takes up the charge of petrol to an amount depending on the pressure over the jet. The air, thus charged with petrol vapour, mixes with a further quantity of air before entering the inlet pipe of the engine. Separate controlling valves were provided on each of these air streams, and by varying the relative amount of throttling the petrol consumption could be adjusted over a wide range. In order to make the conditions as uniform as possible, the whole of the tests were conducted at a nearly constant speed of 700 r.p.m. to 750 r.p.m., and the main air inlet was kept open to the atmosphere with but little throttling, so that the pressure in the inlet pipe of the engine close to the inlet valves, which was measured by means of a mercury gauge, was always within ½lb. per square inch of the atmosphere. Under these circumstances the amount of air taken into the engine per stroke is very nearly constant under constant conditions of external temperature and pressure.

The petrol used was Pratt's motor spirit. The density varied slightly with different samples between limits of 0·715 and 0·720. The calorific value of all the samples was practically the same, and amounted to 18,900 B.Th.U. per pound (lower value). The indicator diagrams were taken with the indicator designed by one of the authors. The power given by the engine was measured by a Prony brake of the ordinary type, the load on which could be read correct to about 2 per cent. When running at a constant speed and with constant suction, as in these experiments, the mechanical and pumping losses in the engine are also constant, and amount at a speed of 725 r.p.m. to 2 h.p., equivalent to a load of 4lb. on the brake at a radius of 43in.

In making a test the air passages were first set to give approximately the desired petrol consumption, which could be done with considerable accuracy. The timing of the spark was then adjusted until the brake load was a maximum. When all the conditions had become steady, one observer watched the level of the petrol in the graduated tank from which it was drawn, while another read, on a counter attached to the half-time shaft, the number of revolutions corresponding to a given fall in the tank, the beginning and end of which were signalled by the first observer. Owing to the impossibility of keeping the speed quite constant, this method of taking petrol consumption is much superior in accuracy to that based on time and speed observations. The samples of exhaust gases were taken over mercury. The gases were analysed by the ordinary volumetric methods, the CO_2 being absorbed by potash, the oxygen by pyrogallol, the CO by an acid solution of cuprous chloride, and the hydrogen by palladianised asbestos.

The following table contains the results of a series of such tests made on two consecutive days, the conditions (other than petrol consumption) being as nearly as possible the same throughout. The first row of figures gives the measured consumption of petrol per 1,000 revolutions, the second the brake load, and the third the thermal

* Paper read before Section G of the British Association at Leicester.

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efficiency on the indicated power, based on the measured calorific value of 18,900 B.Th.U. per pound. The next four rows give the measured amounts of carbon dioxide, carbon monoxide, oxygen, and hydrogen, reckoned as percentages of the volume of dry exhaust gas. The residual gas after all these have been absorbed will be nitrogen, mixed possibly with some unburnt hydrocarbon vapours of negligible volume, and with sufficient water vapour to saturate it, which may be taken as about 2 per cent. The eighth row of figures shows the quantity of nitrogen found by difference in this way. Dividing the nitrogen by 3·76, the total amount of oxygen used is obtained, and this is given in the next row of figures. If from the total oxygen be deducted that which went to form the absorbed gases (its volume is equal to the sum of the CO_2, the O_2, and half the CO), the remainder is the oxygen which has combined with hydrogen to form steam. The volume of the resulting steam is shown in the last row of figures.

Petrol consumption	0·181	0·191	0·197	0·217	0·250	0·293
Brake load at 43in. radius—lb.	25	27·5	29·3	29·4	29·3	27
Thermal efficiency	0·244	0·252	0·261	0·238	0·204	0·162
CO_2—measured	10·9	12·8	13·5	10·6	9·6	6
O_2—measured	3·6	1·5	0·2	—	—	—
CO—measured	—	—	0·7	5	6·25	11 6
H_2—measured	—	—	—	2·1	2·65	8·7
N_2, by difference	84	84	84	81	80	73
Total O_2, calculated from N_2	22·4	22·4	22·4	21·5	21·3	19·4
H_2O calculated	15·8	16·2	16·8	16·8	17·2	15·2

The composition of the petrol, determined by combustion and weighing the CO_2 and water produced, was as follows:

	Per cent.
Hydrogen	14·86
Carbon	84·66
	99·52

from which it appears that the volume of steam formed should be 1·05 times the combined volume of CO_2 and CO in any case in which the petrol is all burned. The ratio of these two volumes, as found above, is always considerably greater than this, the smallest value (corresponding to 0·197lb. of petrol) being 1·18. Various causes contribute to this result. Some soot is always formed, and probably also some acetylene, both of which tend to reduce the burnt carbon as compared with the burnt hydrogen. Moreover, a small error of defect in the estimation of the CO_2 causes a large error in the ratio; if, for example, the CO_2 in the third analysis (0·197) had been 14 instead of 13·5, the calculated H_2O would have been 15·6 and the ratio 1·06.

The analyses show that when the petrol consumption is about 0·2lb. per 1,000 revolutions, the available oxygen is completely burned to CO_2 and steam. The petrol is, however, not completely burned, since there is always some soot and probably also some hydrocarbons in the exhaust. The quantity of available oxygen is probably about sufficient to burn 0·19lb. of petrol under normal atmospheric conditions. If the supply of petrol exceeds 0·2lb., oxygen disappears from the exhaust, but CO and hydrogen are present in increasing quantities; if it be less than 0·2 there is excess of oxygen and no CO.

On Fig. 1, Curve A shows the relation between brake load and petrol consumption, the quantity of carbon monoxide and oxygen found in the exhaust gases being marked at various points on the curve. It will be seen that the curve has a very flat maximum extending from 0·196lb. to 0·25lb. per 1,000 revolutions. Within errors of observation the power is constant over this range, and over the greater part of it carbon monoxide is present in considerable quantities.

It is at once apparent from this that if the carburettor be set in the usual manner so that the engine gives its maximum power, no attention being paid to petrol consumption, the exhaust is almost certain to contain large quantities of carbon monoxide. If, however, the consumption of petrol be observed, and be kept down to the lowest figure consistent with the engine giving its maximum power, or something near it, the formation of carbon monoxide may be completely prevented. In order to secure this result a slight sacrifice of power—perhaps 1 or 2 per cent.—may be necessary, but it is obvious from an inspection of the curve that in this particular engine the power is, within errors of observation, the maximum the engine can give at the point at which maximum efficiency is attained and at which carbon monoxide disappears.

In interpreting the relations between power and petrol consumption shown by this curve, it is necessary to remember that under the conditions of the experiments the amount of oxygen taken by the engine is practically constant, and that the power developed will depend upon the amount of heat produced by the combustion of that oxygen. The oxygen may be burnt either to carbon monoxide, to carbon dioxide, or to steam, and the development of heat depends upon the relative proportions in which these three gases are produced. A given quantity of oxygen combining with carbon to form carbon dioxide or carbon monoxide, or with hydrogen to form steam, gives amounts of heat which are in the proportion of the following numbers respectively:

CO_2	97,000
CO	58,000
H_2O	120,000 (lower value)

from which it is obvious that the engine would give the greatest amount of power if the combustion could be so

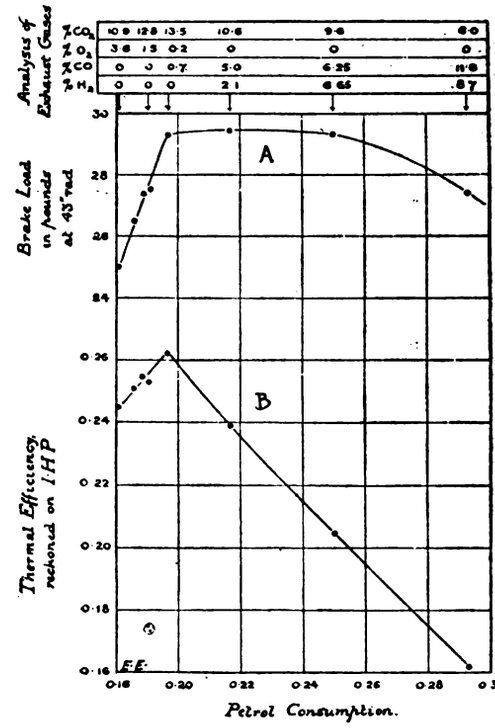

FIG. 1.

arranged that only the hydrogen in the petrol were burnt, the carbon being wholly discharged as soot. It is therefore quite possible that a greater amount of power might be developed owing to the more efficient utilisation of the oxygen, with a mixture in which the petrol was in excess of that which the air could completely burn. The analysis given in the table above shows the manner in which the oxygen is utilised in each case. In the following table the proportion in which the oxygen is shared between carbon dioxide, carbon monoxide, steam, and unburnt, is shown for some of the analyses given above, and the corresponding quantity of heat developed is also given, being calculated from the percentages:

Petrol consumption	0·181	0·197	0·250	0·293
Per cent. of oxygen to CO_2	48·6	60·3	45	30·9
Per cent. of oxygen to CO	—	1·5	14·6	29·9
Per cent. of oxygen to H_2O	35·2	37·5	40·4	39·2
Per cent. of oxygen unburnt	16·2	1·2	—	—
Total heat	89,500	104,400	100,570	94,300
M.E.P., from load (lb. per sq. in.)	61	70	70	65·2
Thermal efficiency (on indicated power)	25·1	24·6	25·6	25·4

It will be apparent from this table that the mean pressure is nearly proportional to the calculated amount of heat, and that the thermal efficiency, reckoned on the heat actually produced by the combustion, is constant.

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The curve B (Fig. 1) shows the thermal efficiency based on the actual petrol consumption and the indicated power. It will be seen that the curve reaches a very sharp maximum near the point 0·2lb. per 1,000 revolutions, at which the petrol is just sufficient to be burnt by the available oxygen. The falling off of the efficiency according to an approximately straight line law when the consumption is in excess of this is, of course, to be expected, because the amount of heat developed, being dependent upon the constant quantity of available oxygen, remains nearly constant. The almost equally rapid decline in efficiency when the petrol consumption is reduced is also due to incomplete combustion of the fuel. As there is plenty of oxygen to burn it, this incompleteness of combustion is, at first sight, not easy to explain. It appears to be caused by the dilution of the mixture by the exhaust gases of the previous explosion, in consequence of which the mixture in the cylinder of the engine, as distinct from that in the inlet pipe, is already fairly dilute, even when there is as much petrol vapour present as can be completely burnt by the available oxygen. If the mixture be further diluted by adding excess of air, the explosion becomes so slow that the flame has not time to spread completely through the cylinder, and consequently a good deal of petrol vapour is discharged unburnt in the exhaust along with the oxygen which ought to have burnt it.

The analyses show that the quantity of oxygen taken into the engine per 1,000 revolutions is nearly equal to that required to burn 0·19lb. of petrol—that is, about 7·3 cubic feet; the corresponding quantity of air is 35 cubic feet, reckoned at 0deg. C, and 14·7lb per square inch. The amount of mixed air and petrol vapour drawn into one cylinder of the engine in the course of a suction stroke will, therefore, be 0·0177 cubic foot under the same conditions of temperature and pressure. Now, the mean temperature of the gases at the end of the suction stroke may be taken as 130deg. C. without serious error, and the pressure as approximately 14lb. to the square inch. The total quantity of gas present reduced to standard conditions will, therefore, be about 0·0256 cubic foot, and of this, as we have seen, only about 0·0177 cubic foot, or 70 per cent., is explosive mixture, and the remainder, or 30 per cent., is exhaust gas. The mixture when it enters the engine cylinder is, therefore, diluted with nearly half its volume of inert gases.

The indicator diagrams in Fig. 2 show clearly the character of the mixtures with different consumptions of petrol. It will be seen that the Diagram A, which corresponds to a consumption of 0·165lb. per 1,000 revolutions, shows all the characteristics of a weak mixture, the ignition being very slow. This may be compared with Diagram B, corresponding to 0·2lb. per 1,000 revolutions: the best mixture, as regards power and thermal efficiency, for this engine. The setting of the spark is the same in A and B. In Diagram C the consumption of petrol is about the same as in A, but the spark has been very much advanced, so that the diagram approaches more nearly in shape to that given by the stronger mixture; but the firing under these circumstances is irregular, and the power is no greater than before. Diagram D is that given by 0·29lb. of petrol per 1,000 revolutions, and E by a similar mixture, but with the spark more advanced.

In a gas-engine using high compression, the volume of the exhaust gas present in the charge is much smaller, and the power can be varied over a wide range by altering the strength of mixture without seriously altering the efficiency or causing incomplete combustion. The compression space in the Daimler engine is approximately one-quarter of the total cylinder volume, and in addition to the gases retained in that space after exhaust, a good deal of exhaust gas gets from the exhaust pipe into the inlet pipe during the overlap of the exhaust and inlet valves.

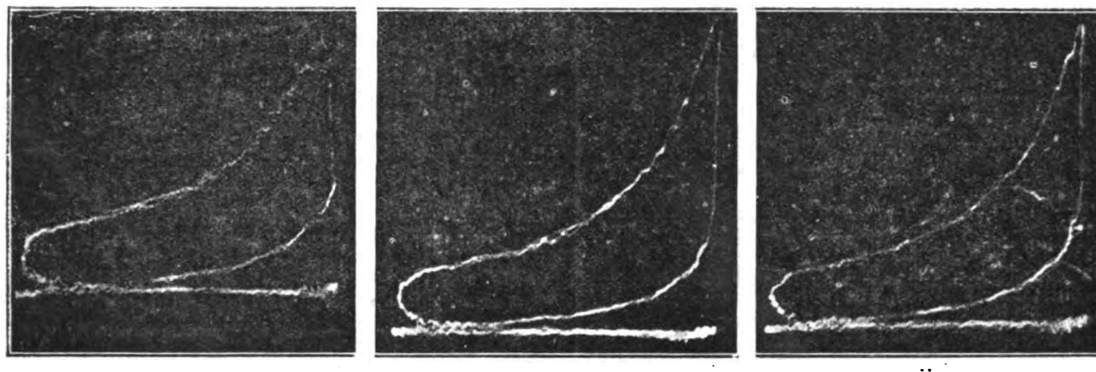

Diagram A. Scale, 1 in. = 135 lb. per square inch. Petrol, 0.165 lb. per 1000 revolutions.

Diagram B. Scale, 1 in. = 135 lb. per square inch. Petrol, 0.197 lb. per 1000 revolutions.

Diagram C. Scale, 1 in. = 135 lb. per square inch. Petrol, 0.172 lb. per 1000 revolutions.

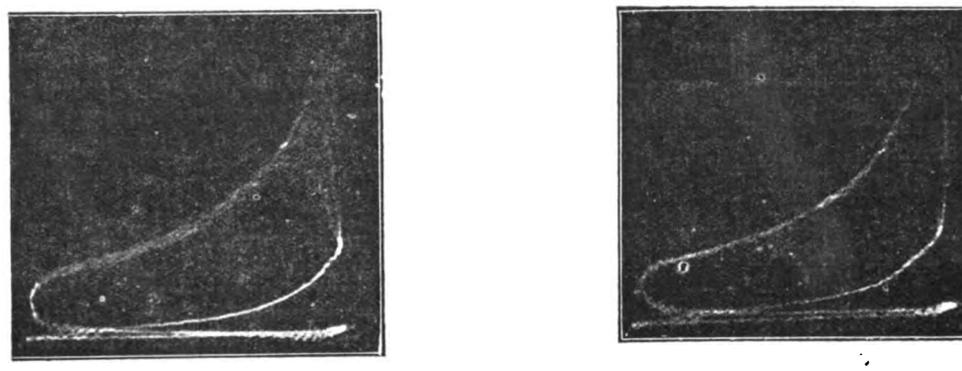

Diagram D. Scale, 1 in. = 135 lb. per square inch. Petrol, 0.297 lb. per 1000 revolutions.

Diagram E. Scale, 1 in. = 135 lb. per square inch. Petrol, 0.293 lb. per 1000 revolutions.

FIG. 2.

The thanks of the authors are due to Dr. Fenton and Mr. Tasker for kindly making an analysis of the petrol, and to Mr. de Morpurgo for assisting in some of the tests.

PRACTICAL SMOKE ABATEMENT.*

BY WM. NICHOLSON.

(*Concluded from page 456.*)

The sub-section ought to be amended thus: The words "not being the chimney of a private dwelling-house," ought to be deleted for reasons already pointed out. The two words "and other" should be between the words black—smoke, then proceedings could be taken against black and

* Abridgement of paper read before the Llandudno conference of the Sanitary Inspectors' Association by the Chief Smoke Inspector of Sheffield.

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other smoke if sent forth in such quantity as to be a nuisance. The quantity of smoke which is a nuisance (within the meaning of the Act) is the smoke which is not necessary for trade purposes, and can be practically prevented, so that all fireplaces and furnaces must be constructed to consume as far as practicable the combustible used therein, and must be carefully worked. After the words "that where," ought to be followed by "the Government, the corporation, or" a person, then proceedings could be taken not only against a person, but a corporation or even the Government, who are often bigger sinners than other people. Section 92 enacts that it is the duty of local authorities to detect and abate smoke nuisances. This needs carrying out or a heavy penalty imposed for dereliction of duty. Section 94 empowers local authorities to serve notices requiring the abatement of nuisances. Section 95 gives power to take out a summons for non-compliance with the notice. Section 96 says the Court, if satisfied there is a nuisance, can impose a penalty not exceeding £5 and make an order to abate. Abatement orders are frequently made, but rarely is the full penalty imposed, which is not a sufficient smoke nuisance deterrent. Section 98 enacts that the penalty for contravention of the order of the court is 10s. per day during default, but if the order is knowingly and wilfully disobeyed, the penalty is £1 per day, which ought to be £10 per day and imposed; then it would work wonders. Section 105 gives power to an aggrieved person to take proceedings, and it has proved a very salutary section, because its enforcement has in some instances driven defaulting authorities to do their duty. Section 106 gives power to the Local Government Board to authorise proceedings to be taken for the abatement of nuisances when local authorities refuse, the costs of the said proceedings to be charged to the defaulting authority. An excellent section, but hitherto, *re* smoke, it has been a dead letter. Section 107 says a local authority can take proceedings in a superior court if the summary proceedings are an inadequate remedy. Section 108 says the local authority can proceed where cause of nuisance arises without their district. One more section, at least, is badly needed—viz., power to local authorities to determine the height of chimneys according to the demands of the district, because some courts say "that the power to regulate the height of chimneys cannot be squeezed into Section 91." The above smoke law, with the few suggested amendments, is practicable, reasonable, perfectly just, and sufficient to deal satisfactorily with every aspect of the smoke question, and it ought to be universally administered. In the United States there are ordinances prohibiting smoke from Government and corporation chimneys, as well as chimneys belonging to other people, and even in Dresden legislation is very drastic demanding the abatement of smoke, and they have an official Government inspector to render help to smoke-makers, and who also insists on the law being administered.

Administration of Smoke Law.—Smoke law, like any other law, if perfect, and capable of working wonders, is not automatic, and is absolutely useless if it is not administered.

Acting Local Authorities.—It is very gratifying to the few who have been fighting the smoke fiend for years, to notice that some of the local authorities are beginning to realise the damage that is being done by the smoke nuisance, and they are commencing to move in the matter.

Sheffield's System.—We proceed under the Public Health Act, 1875. Seventeen years ago the boiler smoke crusade was commenced because chimneys daily emitted from 15 to 50 minutes, and some more, in the hour. Boilers were tested to find out how much smoke ought to be allowed for their efficient working. Very liberal limits were fixed—viz.: one boiler, two minutes in the hour; two boilers, three minutes; three boilers, four minutes; four and more boilers, six minutes. Also, one boiler with one and more furnaces, six minutes in the hour. Only black smoke is recorded, as smoke of any other colour is outside the Act. To do justice to the smokemaker, not less than one hour's observation should be made, and frequently two or more consecutive hours. When a chimney exceeds the limit allowed, the works are visited and all particulars obtained *re* boilers, appliances, fuel, cause of nuisance, to find out what ought to be done to prevent it. A statutory notice to abate the nuisance is served, requiring the owners to do certain things, and take such other measures as are necessary to abate the said nuisance. Subsequent observations are made, and if the nuisance is not abated, an intimation is served without prejudice to proceedings. Then corroborative observations are made by two inspectors, and if the nuisance is still unabated, the works are visited again to see if anything has been done. The case is reported to the committee (by number), and instructions given to take proceedings. The evidence must satisfy the court of the non-necessity of the smoke complained of. Then an order will be made to abate the nuisance, and sometimes a fourth of the full penalty is imposed. If the order is disobeyed further proceedings are taken, and a penalty of 2s. 6d., or as much as £1 per day during default is occasionally imposed, or £5 per day can be imposed under a local Act. This practical administrative system has resulted in reducing the smoke nuisance 90 per cent.

London and the Provinces.—In 1905 the Royal Sanitary Institute and the London Coal Smoke Abatement Society asked the corporations and councils in the United Kingdom to state what was being done in the direction of smoke abatement. Two hundred and five authorities complied with the request — 30 said they did nothing, and others said they were glad to see black smoke as it indicated good trade (it would have been more correct if they had said *great waste*), 25 said the nuisance was increasing, in 40 it remained stationary, and 80 think it is decreasing. In 21 towns policemen act as smoke inspectors, which is an absurdity, for it is unreasonable to expect a policeman to have the necessary technical knowledge; 22 authorities have special smoke inspectors, some one and others more. Forty-one towns make hourly observations, and allow from two to fifteen minutes in the hour; two, four, and even eight minutes continuously. Eight towns make half-hourly observations, and allow from 2½ to four minutes in the hour, and even this is too liberal an allowance. In the Metropolis only 897 statutory and 394 intimation notices were served for 4,355 nuisances, and the prosecutions totalled only 61 in the two years 1903 and 1904. During the said two years 109 provincial authorities had reported to them 9,553 nuisances, 4,059 intimations and statutory notices were served, 2,345 prosecutions, and seven of the 109 authorities were responsible for 2,181 of then. The remaining 102 authorities had reported to them in the two years 6,182, 2,087 cautions and notices were served, and there were only 164 prosecutions. The average penalty per prosecution was about £2.

Apathetic Authorities.—A few authorities are actively engaged in abating smoke, a few are doing a little both in London and the provinces, but there are hundreds of authorities who are not only indifferent, but most resolutely indisposed to move in the matter. Why? Some members of municipalities are smokemakers, and some of them believe it is not possible to stop smoke without injury to trade; hence naturally they are not disposed to interfere with the matter, and they designate those who are so disposed as cranks, faddists, and other complimentary names. Invariably when it is proved to such persons that smoke is a waste of their fuel they are disposed to action. A typical town clerk said he would never take a smoke case in court unless he was sure of getting a conviction, and to do that it was necessary to prove that the smoke emitted was not necessary, and to prevent it would not interfere with the trade or process carried on. To do this expert knowledge of a very varied and technical character was required, which an ordinary sanitary inspector could not be expected to possess, unless he went through a special course of technical training.

Smoke Inspector's Certificate.—Sheffield in 1892 appointed as an experiment an inspector who held the Sanitary Institute certificate at 30 per cent. more salary than the then inspectors were receiving. He proved to be a very smart inspector, and so satisfied were the committee with his services that they decided to give the other inspectors the 30 per cent. advance when they procured the said certificate. The special training necessary to obtain the certificate is now acknowledged to be essential to qualify

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a person for an inspector. There are hundreds of authorities who need special smoke inspectors, but there are not many who have had the necessary training to fill these responsible administrative positions. Lectures, classes, and special courses of instruction (dealing with every aspect of the smoke question) ought to be provided, qualifying examinations held, and smoke inspectors' certificates awarded.

Sanitary Inspectors' Association.—The smoke nuisance is not the creation of a few cranks—whom some consider the bigger nuisance—but it is a reigning ravaging reality, and a nuisance which is national in its operations. It is no respecter of person or property, for it metes out dirt and destruction most liberally to all. All experts are agreed on the non-necessity for the continuation of the nuisance, because abatement is practicable and profitable. There is almost sufficient smoke law—sound, sensible, reasonable, and practicable—to deal most effectively with the various aspects of the question if it is enforced. But upon whom does it devolve to put in motion the smoke abatement administrative machinery? Undoubtedly and indisputably it is the duty of the Sanitary Inspectors' Association, who are experts in the abatement of all kind of nuisances, and the smoke nuisance—one of the greatest—ought not to be ignored. We are the professional public health purveyors, a work of the utmost national importance not realised by many, and having this day put our hand to the smoke-abatement plough, it is our duty, realising the damage smoke is doing, to continue the crusade: (1) by obtaining (some of us) a more extensive, efficient, and practical education on the many and various aspects of this great smoke question, which time will not permit us to consider to-day; (2) to impress upon our educational authorities the importance of teaching in our schools the science of coal combustion, the common causes of excessive smoke, and its practical economic prevention; and (3) to educate the general public on the question, plainly pointing out the result of the nuisance—viz, dirt, damage, disease, and death—also that the poor who are the least able to protect themselves are the greatest sufferers. Such practical plain teaching would arouse England to a sense of its duty on this question, and the country would then demand a discontinuance of the nuisance, if not by making a raid on the House of Commons like the suffragettes, by ponderous persistent petition to Parliament to take the necessary steps to stop this wholesale slaughter by smoke. Then the Government, knowing it was the will and for the well-being of the country, would take action, for the Prime Minister at Glasgow a short time ago said "That his Majesty's Government were most willing to do all in its power to stop this terrible smoke evil which was undermining the health of the country." This demand ought to be made without delay, the Government would respond, and there would follow remarkable results. The atmosphere would be fit for a civilised people to breathe, and more sunshine and many other benefits would contribute in no small degree to the public health and the public happiness which is *The National Wealth*.

BUSINESS GETTING BY ELECTRICAL CONTRACTORS.

Quite a considerable amount has been lately written concerning the advisability of everyone in the electrical industry, including manufacturers, wiring contractors, and anyone else who has an interest in electrical development, combining in one great publicity movement with the object of securing the maximum attention to electrical processes. This stage has not yet been reached in England, although in America such combined publicity is in active operation. The north-eastern area of England, however, is, and has been for a considerable time, a noteworthy area of engineering activity, and this latest phase of commercial engineering, that of business getting by means of publicity, has not been neglected either by manufacturing concerns in this area, or by the electric supply companies, whose object it is to push electrical manufactures in order to sell the current required to operate them.

Up till lately, however, the advertising activity of the electrical contractors seems to have remained dormant, their attitude apparently being that of waiting until the energies of the manufacturer and the supply company had evolved enough business upon which they could subsist. Latterly, however, a distinct move forward has been made by an enterprising firm of electrical engineers and contractors, Messrs. Robson and Coleman, of Newcastle-upon-Tyne. They have adopted the method of mounting a large bill, coloured in red and yellow, upon a cut-out card of the shape of a mammoth electric lamp, measuring 36in. by 20in., and lettered according to our illustration. This is displayed in the shop front of any business installation which they are wiring, or in the top-room windows of any private-house installation which comes through their hands. The City of Newcastle and its environs is, therefore, dotted with this sign display, intimating that Messrs. Robson and Coleman are wiring the house for electric light. More particularly in the newer districts, this sign incidentally indicates that a certain street has had an electric main laid past the houses, and is, therefore, an indirect advertisement for the electric supply companies operating in the area covered by the work of Messrs. Robson and Coleman.

To show the extent to which this firm's energies in publicity extend, it may be mentioned that a little while ago the Newcastle Horticultural Society held an exhibition in one of the Corporation public parks of Newcastle. It was considered advisable to illuminate the bandstand by means of a temporary installation. Messrs. Robson and Coleman were put in charge of this work, and their lamp sign was placed in a prominent position on the roof of the bandstand, becoming a splendid advertisement for the firm in the eyes of thousands of people who attended the exhibition from all parts of the counties of Northumberland and Durham. This novel and striking advertising device, which was perfectly cheap and simple to construct, should, we think, prove an incentive to electrical contractors in other parts of the country to evolve a similar system of advertising; the actual design shown has been registered by this wide-awake firm of electrical contractors, but it should surely not be difficult to evolve a similarly striking electrical device. Such a display not only gives prominence to the firm's own name, but induces a careful consideration of electricity as an illuminant by the man in the street, owing to the fact that he gets the idea into his head, by the constant vision of these signs in all parts of the city, that electric light is going ahead.

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Lecturers.—Applications are invited for Assistant Lecturer and Demonstrator in the Physics and Electrical Engineering Department, and Assistant Lecturer and Demonstrator in the Mechanical and Civil Engineering Department, Portsmouth Municipal Technical Institute. Salary, £125 to £150 per annum. See advertisement.

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MUNICIPAL TRAMWAYS ASSOCIATION.

The sixth annual conference of the above association, held at Manchester last week, was eminently satisfactory both from the numbers attending and for the interest of the communications read and discussed. Last, but by no means least, was the hospitality shown by the Corporations of Manchester and Salford, and by the directors of the White City at Trafford Park. The managing director of the company who have erected this place of entertainment expatiated to the tramway managers, after a good dinner, on the advantage of having a White City on the outskirts of every tramway system. This inducement to travel would, he said, only add 5 per cent. to the capital account of the tramways, and would increase the receipts of the tramway system by one-third. While trying the attractiveness of the side shows, several tramway managers found that the oscillation of the cars used on the same interfered with the digestion of their dinner. Reverting to the Municipal Tramways Conference, there was one paper read at this meeting on "Hours of Labour and Rates of Pay" which, we think, could have been held over to the spring meeting, which is private and confined to managers only. Mr. Alfred Baker accompanied his paper with a schedule which gives full details of the wages paid on all the municipal tramway systems within the United Kingdom. The publication of this schedule is sure to cause labour troubles, especially in those districts where the Socialist votes rule the elections. We believe in ample remuneration being paid to municipal tramcar drivers and conductors, but there is a limit to the steady increase in the wages of municipal servants, otherwise the indictment that municipal trading tends to create "an aristocracy of labour and to demoralise the voter" becomes more than an accusation. This paper was evidently felt by the committee to be a doubtful one, as they excluded the representatives of the Press from the second day's discussion on it. We understand that the meeting was then used by some of the councillors present to rehearse the speeches they are preparing for the November elections. The paper will be most useful on this occasion to those who wish to secure the labour vote. Of the other papers read, that by Mr. Fell on "The Corrugation of Tramway Rails" was the most valuable. On this subject theories abound, and the author had prepared a list of thirteen possible causes of corrugation. He had only twelve suggested remedies, so that the evil has evidently yet to be cured. Still, he gave some valuable information as to the advantage of grinding the rails *in situ* before the cars commence to run over the same. This seems to have had a good effect on certain of the London lines. As soon as the discussion opened theories began to be added to the "possible causes" of Mr. Fell, and one was surprised to find that there are nineteen towns and cities in England where rail corrugation has not yet been observed. With so many causes for the effect it is obvious that some must be of the negative order, since the net result is so poor. The communication by Mr. Dalrymple, of Glasgow, on "Staff Organisation,' was interesting, although his scheme proposed is suitable only for extremely large cities like Glasgow. The discussion showed that tramway managers are, as a rule, keen on taking responsibilities and on being in direct control of everything pertaining to their systems. In some quarters this can be carried much too far, as, for instance, in the erection of a separate power station for the supply of the tramways. One has only to take the author's own case for this, and on examination it will be found that the Glasgow Corporation have not gained by dividing up their electrical stations. The capital charges borne by the tramways department in respect to their power station are

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absurdly high, and much waste of money would have been avoided had the power production been left to the electrical engineer rather than to the tramway manager. We endorse the opinion expressed by one speaker in the discussion to the effect that there is no difficulty in ascertaining the cost of the supply to a tramway from a combined lighting and tramway station. The electrical engineer who cannot equitably proportion his costs and convince both the tramways and the lighting committees of the fairness of his figures should look elsewhere for his proper sphere. That there are cases in which the tramways are overcharged we are well aware, but that frequently is due to the policy of the committees interested. Even then there is no reason why the tramway engineer should assume authority over the engineer responsible for the production of the electrical energy. The city engineers, quite as much as the electrical engineers, are asked to resign some of their responsibilities to the tramway manager. It is curious that, while these managers complain that the maintenance of the road surface between the rails and on eighteen inches each side, which have to be maintained by the tramway department under the Act of 1870, is still charged against them now that horses have given place to electric tramcars, which involve no wear on these surfaces, Mr. Dalrymple asks that this portion of the roadway shall be the private ground of the tramway manager, who may maintain the rails in good order and neglect the street surface. We are sure that in most towns the proposed course will not find favour, and that the borough engineers will still have charge of the maintenance of the street surface, even if this involves some work on the permanent way of the tramway department. In conclusion, we hope that the tramway managers who now control the above association will remember that their title is the "Municipal Tramways Association," and that while this title stands it would be only right to admit to their meetings those municipal servants who have been responsible for the construction of their tramways, and are still responsible for the maintenance of the permanent way.

PRACTICAL NOTES ON PLUMBED JOINTS.

BY W. PLEASANCE.

The use of lead-covered cables is now almost universal and the introduction of this type of main has brought about several points which are foreign to the older class of mains engineering. One of the principal problems is that of keeping intact the lead sheath, and it is with that branch of the subject dealing with the use of plumbed joints that this article is intended to deal. There appears to be amongst many engineers a distrust of plumbed joints, which shows itself in the use of most expensive jointing devices and service boxes. This attitude is, perhaps, due to the difficulty, not so much marked nowadays as in former times, of obtaining reliable plumber jointers to do the work, and also to a lack of practical acquaintance with plumbing amongst mains engineers, owing to the fact that working in lead does not come within the ordinary workshop course. The first difficulty is easily overcome if each jointer who makes application for work is required to make a plumbed tee joint under the inspection of a main's superintendent or foreman, who has a knowledge of plumbing. Only thoroughly capable men would be accepted and good supervision should be subsequently exercised over their work, each jointer being made aware that every joint executed would be entered in the company's records with the name of the jointer placed against it.

The second difficulty should not occur if it is remembered that the only difference between sweating copper and plumbing lead is the use of a solder of slightly different composition which is more plastic and retains heat longer on account of the bulk in which it is used. The advantage of plumbed-sleeve joints as against box joints is apparent when the items required for a tee-service joint in each case are enumerated. With a plumbed sleeve, all that is required is the insulating material, a little solder, plumbing metal, and about 10in. by 14in. of lead sheeting, and the necessary oil or compound. In the case where a service box is used, the cost of the box is from 10s. to 15s., or 30s., about four times as much compound or oil is necessary as in the case of a plumbed sleeve, and where brass glands are used one needs as much plumbing metal as for the sleeve. The advantage, therefore, appears to lie very much in favour of the plumbed sleeve as regards cost.

With plumbed joints the strands of copper are mechanically jointed, the inner conductor of the main in concentric cables remaining unbroken, the area of the joint being greater than the rest of the cable, and the only danger to the sleeve being that of faulty plumbing. With good supervision this should seldom occur. With a box, unless it is a split one, the main cable has to be cut and the sweating of the fitting to the cable is very often, owing to the difficulty of getting to the work, a most awkward job. In some cases the fittings are left unsweated, but where this is done there is always the chance of the insulating compound working its way between the surfaces and setting up contact resistance. Moreover, any subsidence of the ground and consequent strain upon the cable has a tendency to cause the core to draw out of the fitting, or draw the fitting out of place, probably causing it to short circuit or earth on to the box.

Where compound glands are used, there is a possibility of the compound not taking on to the lead, or even if it does so in the first case, the subsequent strain may break the joint and allow the water to creep along. If in order to prevent this, the compound is made more elastic, there is a liability for it to run, bitumen, of which many compounds largely consist, being a live material, having at all times a tendency to find its level; it will, therefore, often work itself out of the boxes. This may be a matter of years, but on systems which have been laid for some time trouble has been found due to this cause. In a box with metal glands there are as many plumbs to be made as on a lead sleeve, each gland being fitted with a red-lead joint, and there being another joint for the cover.

The certainty of continuity of the lead sheath is another advantage of plumbed joints. Electrolysis, due to earth return currents, has been a vexed question of late years, particularly since the advent of tramway systems, and many remedies have been proposed to meet this dangers, and although no settled standard practice appears to have been arrived at in order to abolish such corrosion, it is pretty generally agreed that sufficient bonding of the sections of return circuit prevents a considerable part of the danger, and this applies most strongly to the outer coverings of current-carrying conductors. For this reason alone the plumbed joints on a lead-covered cable should have a considerable amount of careful attention.

The tools to be added to a jointer's kit for plumbing are not many—a metal pot, a large and small ladle, a shave hook, a hook for the metal pot, a large and small dresser, a plumber's cloth, and a small mirror are all that is necessary. The plumber's cloth should be made of thick moleskin, folded in upon itself so as to make six thicknesses, and should be sewn at the sides and across. A cloth 4½in. to 5in. square will be found large enough for plumbed joints up to about 1in. diameter. The cloth should be well soaked on the side used with melted tallow, or as the plumbers call it, "touch," and should be kept in good condition by having a little tallow rubbed in occasionally. Should the cloth be too rough a little chalk will make it work smoothly. Plumbers' metal is a mixture of lead and tin, in the rough proportion of two to one, resin being added during the mixing. The metal supplied by a well-known maker will usually be found to stand more working than home-made material, which is a matter for consideration when dealing with cable. When the metal is too fine, that is to say, having a tendency to hang to the cloth, a little lead should be added, and if too coarse and tending to set too quickly, a little more tin is required. Plumbers' black or soil is usually bought ready made, but can be prepared by mixing lamp black with glue or size. Blistering when heat is applied is a sign that too much size is present.

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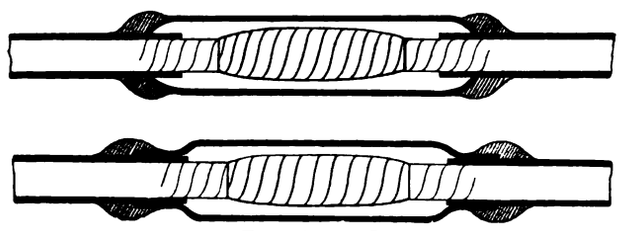
Lead soil pipe is much used for sleeves and for the larger joints it has many advantages, especially where there is room to pass the sleeve up the cable, as the use of pipes saves a seam in the lead. For average work, however, the jointer has only to carry a roll of lead sheeting in his truck to be ready for any emergency. The butted joint on a straight sleeve has advantages over a split-soil pipe.

The thickness of lead which may be used depends upon the size of cable which it is intended to encase, but where the joints are in no danger of rough usage, eight-pound lead will be found very serviceable. This is just over one-eighth thick, seven and a half-pound lead being exactly one-eighth in thickness. The cable joint having been made and insulated, the portions of the sheath with which the plumbed joint will come in contact must be carefully scraped with the shave hook, each stroke of the shaving tool just covering the edge of the last. This having been done, the portion of the lead over which the molten metal is not intended to run should be tarnished or covered with black. The sleeve, after having been prepared in a similar way, should be put into place and the ends shaped down until they fit closely on the lead of the cable; with a final cleaning up the joint is now ready for the metal. The jointer must now see that his metal is at the right heat. This can be done by putting a piece of newspaper into the metal; if this is too hot the newspaper will be set alight, while it will only be scorched to a light brown if the metal is right. The jointer then warms the joint slightly, and rubs a little tallow on the shaved parts, then holding his cloth, which should be warm, under the joint he slowly ladles the metal over the bright parts working the cloth backwards and forwards until he has got enough metal in the hollow of the cloth. When this is done he slowly works the metal round the joint keeping the soft metal in front. The object of this being to keep the metal on the move and obtain the joint without further heat or metal. In this operation it should be remembered that as the inner metal takes on to the comparatively cold cable sheath and sleeve and hardens immediately, no more pressure should be exerted than is sufficient to keep the outer metal on the move, as the cooling metal must not be pressed out of place. As soon as the joint is shaped the cloth should be quickly and lightly passed round in order to give a smooth appearance to the joint, the hand being hollowed so as to give to the shape. The side of the joint where the metal touches the tarnish receives a little extra pressure in order to make a neat finish, and nothing but the cloth should be used to obtain this. The joints must now be examined both on the top, and also underneath with the aid of the mirror, and finished off by rubbing it with tallow.



FIGS. 1 AND 2.

Owing to the large amount of metal sometimes dealt with in plumbed joints, particularly where brass glands to service boxes are used, it is sometimes difficult to finish a joint without the use of a blow pipe in order to keep the metal soft on account of the high conductivity to the surrounding metal, but where possible the use of a blow lamp should always be avoided. After the sleeve is thus fixed, it should be filled with insulating compound, which is done by means of making a straight, short cut in the top of the sleeve, pressing down one side and raising the other so as to make a lip, through which pour the oil or compound. When the chamber is full the depressed side of the lip should then be pulled up to meet the other, both being then hammered down and scraped clean, and sweated. Figs. 1 and 2 show the way in which plumbed joints may be made on a straight sleeve, both for large and small size cables. It is hoped that the instructions contained in these notes may give some help to those unacquainted with the practical side of plumbing.

ENGINEERING AND MACHINERY EXHIBITION.—II.

The outstanding feature of Olympia Exhibition is, as we mentioned in our first notice last week, the extensive and varied display of lathe and gear cutting machines and small hand and machine tools. And in this respect, one cannot fail to notice the contrast between the displays of British and foreign manufacturers, for while the former, with two or three notable exceptions, have contented themselves with displays of somewhat modest pretensions, the German manufacturers occupying stands have thought it worth their while to display their goods on a large scale.

One of the first stands to attract attention on entering Olympia is that of Messrs. C. W. Burton, Griffiths, and Co., Ludgate-hill, London, E.C., who are showing a number of turret lathes, gear-cutting and grinding machines. There is to be seen in motion a "Burton" new automatic gear-milling machine, for cutting the teeth of spur and worm wheels by the hobbing process. This machine shows the latest design for this class of gear cutter, and is capable of cutting gears up to 28in. diameter by 10in. face when not coarser than 3·628 diametral pitch. When seen in operation the machine was cutting teeth in steel gear blanks for automobile change-speed gears. A Bardons and Oliver turret lathe, with automatic chuck and wire feed, was seen in operation producing pins and studs from the bar, as was also seen various "Pittler" machines and turret lathes, including a full automatic screw machine, capable of taking bars up to 1⅜in. and turning in length 4-15-16in. Another

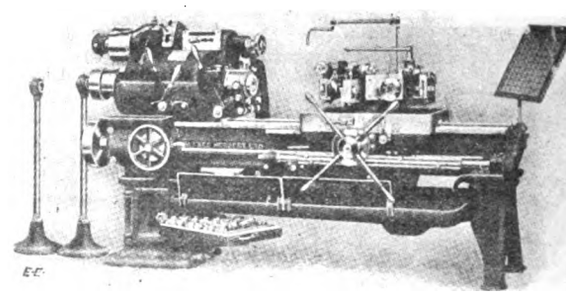


FIG. 1.—Patent Hexagon Turret Lathe 2in. by 30. Alfred Herbert, Limited.

machine of interest is the two-spindle "Rice" high-speed sensitive driller, a feature of which is the employment of ball bearings to all the running parts, and the method of driving the spindle by means of roller feathers. All the machines at this stand are driven electrically through belting supplied by Dawson's Balata Belting Company, Mark-lane, London, E.C The portable electrically-driven drilling machines on show at this stand are of an interesting variety, while at an adjacent stand Messrs. Burton, Griffiths, and Co. are showing selections of small tools. Messrs. Alfred Herbert, Limited, Coventry, are showing a fine selection of modern machine tools, each machine being an interesting example of the most approved practice. Moreover, the arrangement of the stand has been specially designed with a view to having in operation the whole of the machines, thus constituting a model workshop. Chiefly interesting is a 2in. by 30in. hexagon turret lathe, shown in Fig. 1. This machine is fitted with a single pulley head, which renders the cone pulley obsolete and the countershaft superfluous. Sixteen spindle speeds are obtained forward or reverse, arranged in geometrical progression. To obtain any feed the dial is rotated until the number corresponding to the required feed comes opposite the pointer. The hexagon turret permits bars to pass clear through. This form of turret gives a much larger area for the attachment of tools in the most advantageous position, the tools being entirely free from spring. The tool holders are attached to the faces of the turret; a check on the back of each tool ensures its correct location. The feed rack which actuates the turret is inverted, so that chips cannot get into it. Twelve automatic stops are provided, which act in either direction. A new and interesting tool is in use upon this machine, this being a new patent roller steady tool, which is easily set, and in

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which the cutter does not require to be forged. Its adjustment to and from the centre of the work is in a straight line, and its height is the same for all diameters. The "Coventry" patent self-opening diehead is also shown with this machine, which is in operation producing bolts from mild-steel bar. A selection of milling and grinding machines is also shown; also

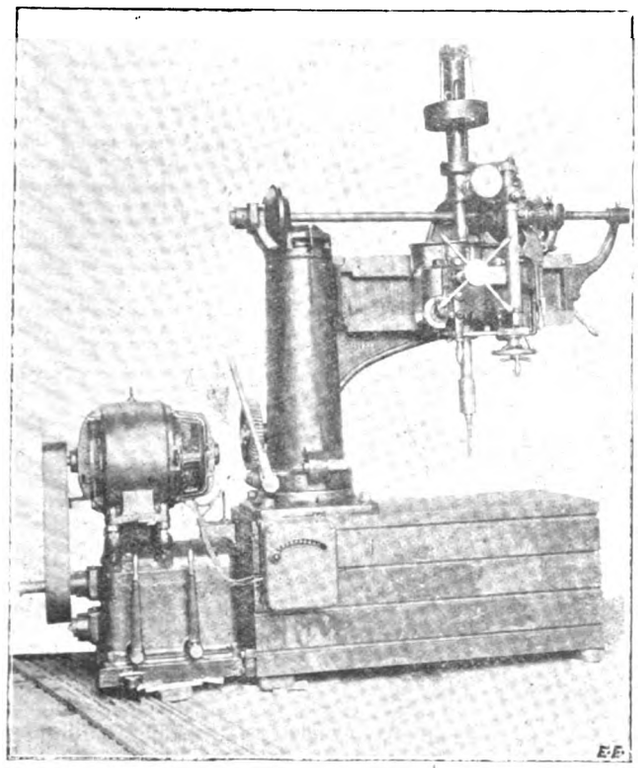

FIG. 2.—30in. Turning and Boring Mill. John Stirk and Sons.

a new spur and spiral gear hobbing machine for gear cutting. Messrs. Henry Pels and Co., of 265, Strand, London, W.C., are showing one of John's joist shears, driven by an 11-h.p. Westinghouse motor, which will be found useful for the rapid and clean cutting of rolled steel sections, and a John's double-ended notching machine, driven by an 8-h.p. Westinghouse motor, among their selection. This stand is of interest as showing in operation a number of Westinghouse motors and the Westinghouse silent chain drive. The stand of Messrs. Chas. Churchill and Co., 9-15, Leonard-street, Finsbury, London, E.C, cannot be passed over. Two examples of the turning lathe are shown, one being a typical sample of modern practice and the other an antique specimen of a comparatively early stage. This latter machine suggests to us the mechanical limitations by which our predecessors were handicapped. The modern tool is a well-designed high-speed lathe by Ernault. A more important modification of the lathe brings us to the turret machine, in which a bar passing through the hollow live spindle is operated on by a series of tools till the required part is completed and cut off, whereupon the bar is brought forward the necessary distance, and the cycle of operations is repeated. The Warner and Swasey hexagon turret lathe and the N. and W. combination turret machine form good examples of semi-automatic repetition tools of this class. Still more specialised and complex developments of the same general idea bring us to the fully automatic machines, in which ingeniously combined cams assume the functions of the operator, and enable the machines to perform their allotted tasks without constant and individual attention and manipulation on the part of the attendant. In the "Simplex" machines (of which two are shown at work) four bars are operated on simultaneously, with a very largely increased output as the result. A two-spindle machine of the same make, which is specially adapted for the manufacture of nuts and similar pieces, is also exhibited. So much for work from the bar. Another tool, the Potter and Johnston automatic chucking and turning machine, applies similar methods to the handling of castings and forgings, and has an ingenious arrangement by which both ends of the piece can be machined at the same time. In this way a second chucking is in many cases avoided, and greater accuracy, as well as increased speed, secured. Plain and universal grinding machines are also shown, while the No. 0 Biernatzki gear generator, which cuts the gears by means of a hob, instead of employing a formed cutter in the ordinary way, will not fail to attract attention. Among the minor matters of interest on this stand may be mentioned the following: A semi-automatic screw-slotting machine, an admirable little machine for quickly forming the heads on rivets up to ⅜in. diameter by a noiseless spinning action. A useful wet emery tool grinder, with a gravity water supply of particularly good type, and a highly efficient trueing device. The Norton "Alundum" grinding wheels, which are now so well known and deservedly popular; and a selection of small tools and cutters of both carbon and high-speed steels.

Messrs. John Stirk and Sons, Limited, Ovenden-road, Halifax, have an exhibit which will be of interest to electrical engineers. We illustrate (Fig. 2) their 30in. boring and turning mill with patent motor drive. The motor is 2½ h.p., and is made an integral part of the machine, thus securing the utmost rigidity. The speed of the motor is 800-1,600, which, in conjunction with mechanical changes, enables the table to be run at any speed between 4 r.p.m. and 200 r.p.m. Another interesting exhibit (which is shown on the stand of Messrs. Anderson Bros. and Newbould, Limited, Attercliffe Forge and Rolling Mills, Sheffield) is a 10in. centre special high-speed and heavy-duty lathe, driven by 35-h.p., direct-coupled, variable-speed electric motor by the Lancashire Dynamo and Motor

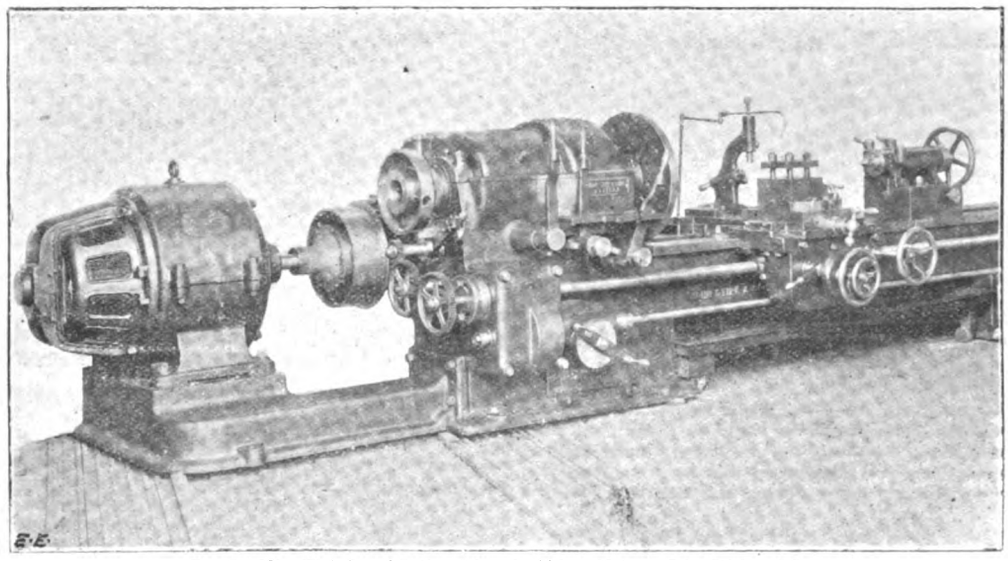

FIG. 3.—12in. High-Speed Lathe, driven by 35-h.p. Motor. John Stirk and Sons.

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Company, Limited, Manchester (Fig. 3). The lathe has all-gear head, and has a very wide range of speeds, which can be operated with the lathe running. With 1¼in. or 1½in. by 1in. SaBeN tool, this lathe will remove 10cwt. of turnings per hour from mild steel bar. Messrs. Schuchardt and Schutte, 34, Victoria-street, Westminster, S.W., are showing on their large stand, in the centre of the main hall, a collection of machine tools in operation, all direct motor driven (motors by the Lancashire Dynamo and Motor Company), whereas the machines exhibited on Stand No. 186 are not in motion, but show other examples of their manufacture and of the various tools they handle.

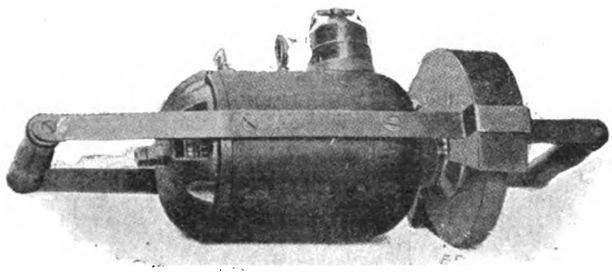

FIG. 4.—Portable Grinding and Polishing Machine, Type P.B P.L. S. Wolf and Co.

Messrs. Drummond Bros., Limited, Ryde's-hill, Guildford, Surrey, are showing a complete line of their small lathes, specially designed for motor repairing. These lathes are fitted with a quite novel form of slide rest, in the design of which is incorporated a large boring carriage. The loosening of one nut allows the upper slide to be entirely removed, leaving a truly surfaced table fitted with ⊥ slots, converting the tool from a lathe to a regular boring machine for such work to motors as cylinder re-boring, re bushing gear cases, etc. In addition, they are showing a small hand lever bench shaping machine, and also a very heavy 9in. centre, 9ft. gap bed lathe—an extremely powerful tool designed for the use of high-speed steels in general manufacturing work. Messrs. John Lang and Sons, Johnstone, near Glasgow, have among their exhibits a 30in. swing

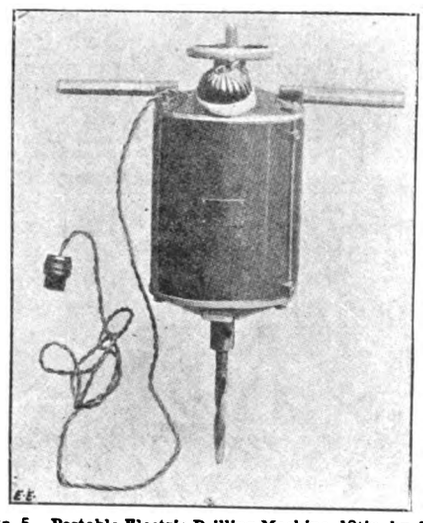

FIG. 5.—Portable Electric Drilling Machine, 12½in. by 6in. Light Electric Motor Co.

surfacing and boring lathe, having Lang's patent variable-speed drive and Lang's patent automatic speed-changing mechanism. The bed of the lathe is Lang's patent type, having plate covering upper surface, so as to prevent the cuttings from falling on the working surfaces. The saddle has hexagon turret and a sample set of tool holders. Special attention is directed to surfacing feed. As the tool travels towards the centre the lathe automatically increases in speed, and thereby keeps the cutting speed of tool practically constant.

The stands occupied by Messrs. S. Wolf and Co., 138, Southwark-street, London, S.E., are notable for a fine selection of electrically-driven grinding and polishing machines. Fig. 4 illustrates a portable hand grinding and polishing machine for such work as vice, finishing castings, motor chassis work, also for polishing and grinding work *in situ*. These machines are entirely enclosed and fitted with ball bearings running in solidified oil. There is also displayed at this stand a selection of magnetos and plugs for high and low tension ignition, cables, distributors, pressure gauges, etc. A full and complete assortment of electric drills with magnetic drill posts are shown in operation by the Consolidated Pneumatic Tool Company, Limited, Palace Chambers, 9, Bridge-street, Westminster, S.W. Messrs. Selig, Sonnenthal, and Co., 85, Queen Victoria-street, London, E.C., have an imposing stand on which is displayed a varied selection of horizontal and vertical milling machines, boring and surfacing lathes, drilling and grinding machines, and numerous machine tools of latest design. One exhibit that is rather unique is the stand occupied by the Light Electric Motor Company, Limited, Seven Kings Electric Works, Ilford, Essex, for, in addition to a comprehensive display of portable electric bench tools, there is an electric motor hairbrush suitable for hairdressers' saloons. The motor and brush are mounted on the same spindle, and the combination is an efficient substitute for the belt-driven hair-brushes now so common in barbers' shops. The drilling machines shown by this company can be connected to any existing lighting circuit (incandescent) in consequence of the small consumption of current. The windings of the machines have the advantage of giving a speed regulation according to the size of drill used. Fig. 5 illustrates a high-speed portable drilling machine having a capacity up to ⅝in., in mild steel. The whole apparatus weighs about 21lb., and has a current consumption of 2·5 amperes on 220 volts. This machine can be supplied for any voltage up to 250, either continuous or alternating current. The stand of Messrs. Ludw. Lowe and Co., Limited, Farringdon-road, Clerkenwell, London, E.C., is in the mining hall, leading from the main hall, and there will be seen a fine selection of machine tools and workshop appliances—many being in operation.

There are yet a number of exhibitors who are displaying appliances in which the electrical engineer will take a great deal of interest, and we hope to revert to these exhibits in our next issue, and to extend our notice to other important features of the exhibition.

THE ECONOMIC DISTRIBUTION OF ELECTRIC POWER FROM BLAST FURNACES.*

BY B. H. THWAITE, A.M.I.C.E. (LONDON).

Although in numerous papers and articles contributed since 1894, and in his evidence given before the Royal Commission on Coal Supplies, the author has reiterated the statement that blast furnaces should be made as far as possible the source of power for manufacturing industries situated within a certain area of such furnaces, it has always been realised that where such blast furnaces were associated with steelworks and rolling-mills, there was until last year an unfinished link that prevented the full chain of possible benefits from being completed, in the fact that the heavy rolling-mills had not been electrically harnessed. Fortunately, this unfinished link has at last been forged, for which thanks are due to the enterprise of Continental electrical firms. To those who strive with more or less strenuousness for the prevention of waste of fuel and of power, and the reduction of the incubus of dead charges on working costs, the successful solution of the problem of harnessing electric energy for driving heavy rolling mills is a fact of great economic significance. The heat and power efficiency of existing rolling-mills is deplorably low. The associated steam-boiler plant necessary to satisfy the maximum requirements of a rolling-mill operation, and the effect of condensation in steam-pipes, means a heavy thermal loss. Before the date of the actual proof that blast-furnace waste gas could be directly converted into power with an expenditure of 7,000 B.Th.U. to 8,000 B.Th.U. per indicated horse-power hour (equivalent to a reduction of as 10 is to 30 compared with a good steam-power plant), the waste of energy involved in ordinary rolling-mill plants was a matter of indifference, because the waste of heat about balanced the supply—indeed,

* Paper read at the Vienna meeting of the Iron and Steel Institute.

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the power available from the blast-furnace gases had often to be supplemented by coal; but now that it is realised how valuable as a power agent this gas has become, the waste of fuel is morally and financially inexcusable. Unlike the blast furnace (which may work steadily on, year in and year out, without week end or other stoppages), the rolling-mill may or may not remain steadily employed: a paucity of orders may mean the closing down of the mill for weeks, because, although pig iron may be stocked with little or no risk, it is not usual to stock mill products which may never be wanted. During this non-operating period the blast-furnace gas used for firing the steam-boilers is set free or blown into the air. This waste of fuel may be cut down considerably, if not entirely, by the application of the pooling system to be described, which involves the displacement of steam by gas power. Modern gas-power electrification methods will set free a great volume of gas which, thermo-dynamically converted in a gas-engine, will increase the power equivalent of such gas by 300 to 400 per cent.

The objection that is advanced against the gas-power electrification of the rolling-mills relates to the heavy expenditure involved in such a technical reform. The objection is a real one, and unless removed or reduced, will tend to confine the advantages of applications to firms of immense financial resources. Few British joint-stock administrators would be permitted by their shareholders

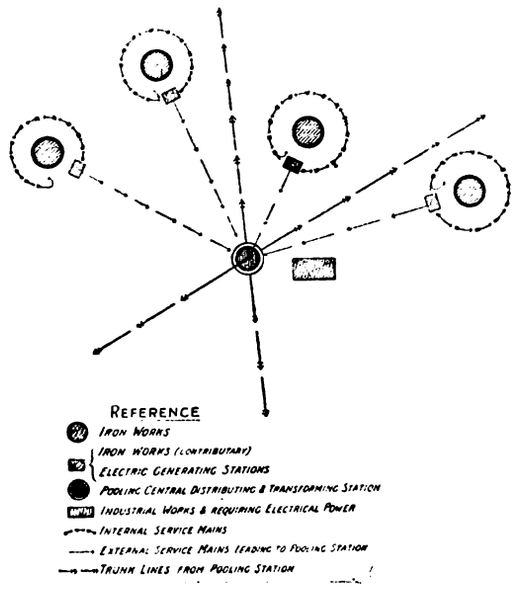
REFERENCE
IRON WORKS
IRON WORKS (CONTRIBUTARY)
ELECTRIC GENERATING STATIONS
POOLING CENTRAL DISTRIBUTING & TRANSFORMING STATION
INDUSTRIAL WORKS & REQUIRING ELECTRICAL POWER
INTERNAL SERVICE MAINS
EXTERNAL SERVICE MAINS LEADING TO POOLING STATION
TRUNK LINES FROM POOLING STATION

FIG. 1.

to risk the investment. But if it can be shown that for some iron-making concerns it will be possible to reduce the capital investment to the amount necessary to provide the equipment of the new rolls with electric motors, as distinct from the electric generators, and that such an investment will be financially well justified, the objection standing in the way of such electrification will be considered, even by the most cautious and conservative of managements, as of no deterrent consequence. The author's proposal, first suggested in 1894 and 1898, repeated at different times since, and again to be described here, would, as an incident, secure a substantial reduction of the expenditure of a complete electric equipment of an iron and steel works, so as to cover all power demands. The basis of this programme is to pool the waste furnace gases from all the furnaces of an iron-making district independently of the ownership of such furnaces. The energy (electrically transformed) of the different furnaces would be transmitted to a central distributing and transforming station in which the current would be transformed to the voltage to satisfy different customers. Of course, there may be cases where the furnaces are so concentrated as to justify the delivery of the *furnace gases* to a pooling or central station for conversion into electrical energy, but usually it would be found to be more practical to transform the gas into electrical energy on the site of the ironworks for transmission to a distributing central station (see Fig. 1).

The first call on this power would, of course, be the satisfaction of the internal demands of the iron and steel works, the balance of power remaining being available for external distribution over a wide area, the extent of which, owing to the familiarity with and knowledge of the resources and safety of high-pressure transmission systems, is being yearly increased. When the author put forward the first long-distance electrical transmission project of over 100 miles in 1892, the line pressure then suggested was considered dangerous in the extreme: to-day, power is being easily and profitably transmitted over varying distances at very much higher pressures than those suggested in 1892. In 1892 the pressure specified was 20,000 volts; to-day, transmissions of 250 miles with 88,000 volts pressure are in daily service. The pooling programme proposed would be provided by a separate and distinctive joint-stock electric power organisation on the lines of the county electric power companies, which sprang from the author's 1892 proposition, with the exception that a proportion of the output is preferentially allocated to the satisfaction of the power demands of the iron and steel works from which the gases are drawn. The balance could be transmitted to any group of customers whose power demands justified the cost of distributing mains and associated transforming stations, but a more appropriate field of demand for an all-the-year supply would be the satisfaction of the electric energy requirements of the many profitable electro-chemical and electro-fusion processes described in the author's paper read before this institute at Glasgow in 1901.

Included amongst these processes in which the demand for power would correlate with its production at the blast furnace, or from Jan. 1 to Dec. 31, there are the production of high-class steel from selected scrap, special alloys, such as ferro-silicon and ferro-titanium, ferro-chromium, besides the production of carbides (silicon and calcium). Some of these processes could take the current just as supplied, in large or small proportions, and at any moment, so that the levelling up of the load or the demand could be readily effected — obviously an important factor in the economic production and sale of electricity. In the selection of the customers it would be advisable to secure the class of demand for operations such as mine pumping, electrolytic and like processes, on which the supply could be turned on or off whenever available, so that the distribution of the current could be arranged to fill up any gaps in the demand. As an example of the kind of power demands that would be found in an average field of industrial operation surrounding ironworks, exclusive of the municipal and rural demands for current for lighting and tramway power purposes, the following is given to represent a German district for which the pooling system was first outlined by the author:

	Electric horse-power.
For the coal mines in the district.....	1,300
Chemical (metallurgical) requirements	2,500
Electro-chemical requirements	1,500
Works and town electric lighting	500

In large districts the power driving requirements of the factories would provide a demand running into thousands of horse-power, although the direct driving of important machinery will secure a great saving of (and consequent reduced demand for) power compared with belt driving and its associated power losses. The satisfaction of electric transport power requirements is becoming an increasing factor both for water and rail transport services. By this pooling system the tall stacks of the furnaces would become centres from which would radiate the benefits of the cheap power, and the advantages would be reciprocal. Besides removing the many smoke-stack polluters of the atmosphere, the additional profit would increase the stability of the iron industry of this country. The flexible demand for power which it would be the aim of the power organisation to secure would be appropriate for the intermittent periods of mill idleness, whether temporary or prolonged—for instance, the sudden release of power for external services at the week-end periods of mill idleness (or during longer periods of compulsory idleness due to the falling off or cessation of orders) would be available for one or other of these flexible power demands.

(To be continued.)

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SOME NOTES ON STARTING SWITCHES.

The draft regulations recently issued by the Home Office contained, among other clauses, the condition that "every electrical motor shall be controlled by an efficient switch or switches for starting and stopping, so placed as to be easily worked by the person in charge of the motor," and that "every electrical motor rated at more than one-third of a horse-power shall be further protected by a release that will automatically break the circuit if the current is interrupted, unless the motor is capable of re-starting automatically on the current being restored." Although there is some doubt that the regulations will go through in quite the same form as drafted, there is imparted to the study of gear which will comply with this specification a distinctly novel interest. The exceedingly low limit of power to which a suitable releasing device must be applied ($\frac{1}{3}$ h.p.) renders cheapness of design a most important part, and the question arises as to the necessaries, as opposed to the conveniences, which are to be included in motor starter design. There is no doubt that a no-voltage release is imperatively necessary in such switches. The Home Office regulations are at least sane on that point. Power supply systems do occasionally break down, in spite of the reassuring assertions of electricity supply canvassers, and it would be obviously unsafe to trust to the thoughtfulness of an unskilled workman to place the switch in the "off" position when supply failed. A point to be remembered in connection with such a release is that the line voltage should actuate the trip coil, inasmuch as the no-voltage release should be equally efficacious when the field of the motor, be it shunt, series or compound, is at any state of excitation The question as to how far expense may be sustained in the case of motors of small size involves a consideration of the cost of overload devices, and in this connection the use of insulating varnishes and enamels, and the careful winding of spools so as to impose the least possible potential difference between adjacent turns and layers, and to frame, so as to cut down the insulation required to a minimum, need investigation. The study of insulating materials is nowadays, however, receiving great attention, so that cheapening of costs of windings can be confidently expected. The overload release as an adjunct to a starter is not an inevitable necessity. Some engineers still prefer to rely on a double-pole fuse placed in the motor circuit, and there is much to be said on the score of cheapness in favour of fuses, notwithstanding the alarming outcry about their unreliability of action. The chief dangers are, of course, those of gradual deterioration of the fuse, and of inexperienced or lazy workmen putting in heavy strands of metal which is hard to fuse in order to get over frequent blowings of the fuses that may be caused by incorrect use of the motor, or some inherent defect in its design. Both these can to a large extent be overcome by a system of periodical inspection by the electrician in charge of the plant. In some cases a magnetic overload tripping device has its inconveniences. A fuse has a certain time lag, while a magnetic fuse acts very often on an instantaneous rise of current. This difficulty is so marked that some overload releases are fitted with special time-limit devices giving, say, a delay of 15 seconds on a 50 per cent. overload, and cutting down the lag to about five seconds when the load is double the normal. These, however, are usually pretty costly. A device for a motor under 1 h.p. will probably cost about 15s., which is a considerable item. For larger motors, of course, the extra expenditure may be admissible, as the cost does not climb in proportion to the horse-power. Where it is decided to break the circuit by means of a magnetic overload device, the circuit breaker should be so arranged that it cannot be closed by the operator unless the starting switch is in "off" position. It is also advisable, where an inductive circuit such as that of a motor armature and field is broken so near the hand of the operator, to quench the arc formed on breaking by means of a magnetic blow-out. For the sake of cheapness, starter resistances are sometimes made of ordinary iron spirals slung from point to point in a frame in the open air. This, though affording quick cooling and saving in wire, is bad, and at some time or other there is a flare up. The resistance material should be constructed from one of the numerous alloys now on the market, which must be certainly free from rust or chemical change, and preferably one which has a low temperature coefficient. It should be properly supported and mechanically held in place, either by enamel or (as in the case of one very good starter) by clean, dry, silver sand, so that there is no danger of short-circuiting internally. The conductors, although only intended for use during short periods at a time, should be able to stand full load current continuously without overheating; it is an advantage if they can stand 50 per cent. overload for, say, one minute. The contacts of the starting arm should be renewable, and, if possible, the break should be made on carbon in preference to copper. The best makes of starters have a leading arm attached by a spring to the contact arm, so arranged that on opening circuit this arm drags behind the main contacts, leaving the last contact with a snap and thus giving a quick break action. For large starters, say about 10 h.p. capacity, a magnetic blow-out for quenching the arc formed on opening the circuit is desirable. The contacts on the face of the starter should also be renewable and capable of being easily faced true again. It will thus be seen that even when reduced to the lowest possible limits of safety and good workmanship the starting switch is an expensive device.

FINSBURY TECHNICAL COLLEGE.

On Wednesday last the Lord Mayor of London, accompanied by the sheriffs, attended in State at the City and Guilds Institute Technical College in Leonard-street, City-road, to open the new wing, which has been equipped partly for the art department and partly as an engineering laboratory. Among the gentlemen present to receive the Lord Mayor were Sir John Wolfe Barry, Sir William White, Sir Edward Clarke, Sir Alexander Kennedy, Sir Henry Kimber, M.P., Sir Philip Magnus, M.P., Alderman Sir T. B. Crosby, Prof. W. C. Unwin, Prof. W. E. Dalby, Prof. Silvanus Thompson, Mr. A. F. Yarrow, Sir John Watney, Mr. George Baker, Mr. S. S. Gladstone, and several masters of city companies.

The LORD MAYOR said it afforded him much gratification to see before him so many young men who were at the outset of their career in life. He was not a scientific man, but he was convinced that it was a good thing for a young man to approach his work in a scientific manner. In almost every walk of life, in fact, science was necessary. There was a rule in life which he hoped all the young men there present would follow, and that was to be not only scientific, but honest and truthful. Any young man who had health and strength, and who was honest and truthful and had a little science, was bound to get on in the world.

A description of the engineering laboratory, equipped under the supervision of Prof. E. G. Coker, appeared in our issue for Aug. 30.

FORTHCOMING EVENTS.

FRIDAY, OCT. 4.

Electro-Harmonic Society.—At 8 p.m., at King's Hall, Holborn Restaurant, smoking concert.

MONDAY, OCT. 7.

Society of Engineers.—At 7 p.m., at Royal United Service Institute, Whitehall, "Liquid Fuels for Internal-Combustion Engines," by Mr. R. W. A. Brewer.

Dick-Kerr Engineering Society.—At Preston, "Refrigerating Machinery," Mr. K. Lightfoot.

TUESDAY, OCT. 8.

Manchester Geological and Mining Society.—At 4 p.m., at 5, John Dalton-street, Manchester, "Air Percussion and Time in Colliery Explosions," Mr. James Ashworth.

THURSDAY, OCT. 10.

Birmingham and District Electric Club.—At 7.30 p.m., at the Colonnade Hotel, "The Possibilities of Electrical Development," Mr. R. Borlase Matthews.

Rugby Engineering Society.—Thursday, Oct. 17, "Steam Turbines, with special reference to the Willans-Parsons Type," Mr. E. R. Briggs.

Institution of Mechanical Engineers.—"The Indicated Power and Mechanical Efficiency of the Gas-Engine," Prof. Bernard Hopkinson.

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COMPANIES' MEETINGS AND REPORTS.

YORKSHIRE ELECTRIC POWER.

The ninth half-yearly meeting of the Yorkshire Electric Power Co. was held at Leeds on Monday, Mr. Arnold G. Lupton, M.P., presiding.

In moving the adoption of the report, the CHAIRMAN stated that the generation, distribution, management, and general expenses exceeded the total receipts by £403, which debit was increased to £1,211 by interest on mortgages during the half-year. The increase of consumption was 850 kw., as against 445 kw. for the corresponding half-year. During the last two weeks the income had fully covered the whole costs. An important agreement had been made with the Electrical Distribution of Yorkshire, which was formed for the purpose of acquiring electric lighting provisional orders, and mains were being laid in Horsforth. The Company had arranged with the Corporation of Brighouse to give them a supply for lighting, power, and tramway purposes. The Company had completed an agreement with the British Carbide Factories, which had leased a part of the site at Thornhill, and were now proceeding to erect buildings, to be ready by the end of the year, in which, for the first time in England, they would manufacture calcium carbide on a large scale. The carbide company had contracted to take a yearly supply equal to three times the present rate of sale. It was being realised that electro-chemical and electro-thermal processes, such as the manufacture of aluminium, etc., could be carried out as cheaply in England as abroad, and there would be a continued development of such industries in the Company's area.

The report was unanimously adopted.

SWANSEA IMPROVEMENTS AND TRAMWAYS.

The ordinary general meeting of the Swansea Improvements and Tramways Co. was held on Monday at the offices, Donington House, under the presidency of Mr. C. G. Tegetmeier.

The CHAIRMAN, in moving the adoption of the report (*Electrical Engineer*, Sept. 27), said that he could congratulate the shareholders upon the fact that for the half-year to June 30 the traffic receipts of the tramway undertaking showed a satisfactory increase of £614 as compared with the corresponding period of the previous year, the total amount having been £22,317. The profit on the working for the half-year was £3,742, which, added to the balance of £2,000 brought forward, gave £5,742 at the credit of the profit and loss account, and it was proposed to deal with this sum by placing the same amount to the reserve and depreciation account, as they did a year ago—viz., £1,000, to pay the preference dividends at the rate of 6 per cent. per annum on 984 shares, and at the rate of 5 per cent. per annum on 4,016 shares, and to carry forward the balance of £3,443. It was not their custom to propose the payment of a dividend on the ordinary shares at the close of the June half-year, but to wait until the full accounts for the whole 12 months were available. With respect to the improvement undertaking, the accounts disclosed a net loss for the half-year of £256, after allowing £302 for accrued interest on mortgages.

Mr. W. G. BOND seconded the motion, which was unanimously carried.

WILLANS AND ROBINSON.

The report of Willans and Robinson for the half-year to June 30 last, to be submitted at the meeting on the 9th inst., states that after the necessary adjustments involved in the recent reduction of capital, and after writing off the sum of £6,466 as depreciation (at Rugby), a profit of £18,275 is shown for Rugby, reducible by a loss of £2,233 at Queen's Ferry. The net profit is therefore £16,041, out of which the directors propose that dividends be paid at the rate of 6 per cent. per annum upon the preference shares, absorbing £9,999, and 10 per cent. per annum on the ordinary shares (equal to 2 per cent. upon the original value), absorbing £3,333, and that the balance of £2,708 be carried forward. The premises and plant at Queen's Ferry having been recently written down so heavily, further depreciation is for the present unnecessary. The remaining loss, £2,233 for the half-year, is less than Queen's Ferry contribution to the two items of debenture interest and directors' remuneration, and there can, therefore, be no question that it is more profitable to keep the works open and employed, even upon the present inadequate scale, than to close them.

BRITISH THOMSON-HOUSTON.

The report of the British Thomson-Houston Co. for the year ended March 31 last, to be submitted to the meeting on the 10th inst., states that during the period under review the Company has contracted to supply to the Metropolitan Railway Co. 10 electric locomotives and the electrical equipment for several trains, most of which have since been delivered. The electrical equipments for heavy traction work heretofore supplied to various railway companies continue to give complete satisfaction, including the equipments used on the system of tube railways operated by the Underground Electric Railways Co., all trains of which are equipped with the Company's apparatus. The Company has sold a number of turbo-generators during the year, the largest single contract being with the Liverpool Corporation for three of 2,000 kw. each. During the period under review the Company has disposed of a large amount of securities, and reduced proportionately its liabilities. The net amount realised by the sale of securities (after taking into consideration some additional shares acquired during the year) was £136,727, and the entire proceeds were used to reduce the Company's indebtedness. This leaves the debentures and shares owned at March 31, 1907, at £105,801, and also £54,600 in shares in a patent-owning company—or a net reduction during the year in all securities of a little over £111,000. The trading profit for the year, after deducting general and technical expenses, discounts, debenture and other interest, amounts to £14,994. The amount carried forward from March 31, 1906, was £4,124—making a total available profit of £19,119. The whole of this profit, with the exception of £1,071 carried forward, has been applied to various depreciations. On the balance-sheet of last year the balance of the excess cost of manufacturing incident to the establishment of the manufacturing business of the Company amounted to £31,707 (£36,000 having been previously written off). Nothing was added to this account during the year, and the directors have decided to write off a further sum of £15,000, leaving a balance of £16,707, from which further sums will be written off from time to time until finally disposed of. The directors have resolved to depreciate apparatus, meters, supplies and special tools, etc., necessary for their production, by a much larger sum than heretofore, appropriating for the purpose this year £29,642. To take care of these heavy depreciations, it has been decided to make use of the premium reserve account of £40,000.

CENTRAL CHILI COPPER.

The report of the Central Chili Copper Co. for 1906, to be presented to the meeting on the 8th inst., states that during the period under review, while high prices have ruled for copper, the Company has been obliged to contend against rising prices in coal and coke, and for practically all the other commodities employed in its business. Exceptional difficulties have confronted the management owing to the continual scarcity and high price of labour. The Chilian Government is fully alive to the necessity of encouraging immigration, and there is reason to believe that the Company's requirements in the near future will at least be partially met by miners recruited and brought to Chili at the expense of the Government. The profit for mining and smelting has, notwithstanding these adverse conditions, amounted during the year to £32,467. Of this sum, after making provision for depreciation, interest on debentures, London expenses, etc., £24,202 has been carried forward to the accounts of the current year, and on May 31, 1907, there was paid a dividend, on account, of 5 per cent., or 1s. per share, amounting to £15,623. The directors propose to carry the available balance of £8,578 forward. During 1906 just over 43,000 tons of ore were smelted for a return of regulus containing 1,857 tons of fine copper. The gold and silver recovered during the year were valued at £7,118. As in past years, a large proportion of the copper produced was derived from ores purchased from the neighbouring mines at prices varying in proportion to the London prices for standard copper. The Company's properties yielded 19,000 tons of ore of 3·86 per cent. copper, while there were purchased 24,000 tons of ore containing 7·42 per cent. copper. The quantity and grade of ore from the Company's own mines, and of the ores purchased, having amounted to about the same as in 1905, the increased profit for 1906 has resulted partly from the higher price of copper which has ruled during the year, and partly from a more efficient management at Panulcillo. The compressor and machine drilling equipment has just been finished and put into operation. This is the first employment of machine drills on the Company's properties, and it is expected the rapid development of the Panulcillo mine will be thereby greatly facilitated. The extensions to the smelting plant are well in hand, the whole of the machinery for this purpose having arrived on the mine, and the general manager advises that the new water-jacket blast furnace will be in operation in October.

NEW COMPANIES REGISTERED.

North Hummock (Selangor) Rubber Co.—Registered Sept. 28. Capital, £100,000 in £1 shares. Objects: to acquire, cultivate, and exploit certain lands, to be called the North Hummock Estate, belonging to the Bukit Rajah Rubber Co., in the district of Klang, Selangor. Registered office: 20, Eastcheap, E.C.

Karak Rubber Co., Limited.—Registered Sept. 19 by Holt Beevean and Crowdy, 10, Lincoln's-inn-fields, W.C. Capital, £50,000 in £1 shares. Objects: to acquire lands or other immovable property in the Malay Peninsula, India, Ceylon, the East Indies, or adjacent parts of Asia, to grow, treat, cure, manufacture, prepare for market, and deal in indiarubber, guttapercha, balata, and other gums and natural products of any kind, etc. Registered office: 138, Leadenhall-street, E.C.

Synthetic Rubber Co.—Registered Sept. 25. Capital, £100,000 in £100 shares. Objects: to adopt an agreement with F. W. Kinyon and L. Gottschalk, and to carry on the business of manufacturers of and dealers in natural and artificial rubber, guttapercha, balata, and similar substances, dealers in synthetic rubber, manufacturers of and dealers in articles made wholly or partly of rubber, guttapercha, balata, and the like, including waterproof fabrics, insulating compounds, and cables, tubing, hose piping, motor and other vehicle tyres, synthetic, analytic, manufacturing, and experimental chemists, etc.

Liens Registered, etc.

A. B. P. Accumulator Co., Limited, Stockton-on-Tees.—Discharge registered Sept. 19 to the extent of £1,545 of debentures dated March 20, 1903, for £7,500.

Maxim Electrical Co., Limited, Westminster, S.W.—Lien registered Sept. 17 for £2,000 5 per cent. debentures, part of £15,000. Amount previously issued, £12,200. No trustees. Secured on the business, assets, and effects.

Yenisei Copper Co., Limited, London, E.C.—Discharge in full registered Sept. 19 of a debenture dated Oct. 26, 1904, for £3,364. 16s.,

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and discharge in full registered Sept. 19 of two debentures dated July 25, 1906, for a total sum of £3,421. 5s. 6d.

South American Railway Construction Co., Limited, London, E.C.—Mortgage registered Sept. 18 for £20,000, and, by way of collateral security, a debenture of even date for securing the same sum. Charged on the undertaking and all the property and assets, including the uncalled portion of the nominal capital of £101,000, both present and future.

OPENINGS FOR CONTRACTORS.

ABBEYDALE—Wesleyan church (£6,000).

ACTON—School in Acton-vale by Council.

AMBLE—Erection of Council school (£2,261).

ANTWERP—Municipal buildings. M. le Bourgmestre de la Ville.

ARDWICK—New infants' school for Manchester Education Committee.

ARLESFORD—New infirmary and alterations at workhouse. Architects, Messrs. Causlor and Hill, 12, Jury-street, Winchester.

ASPULL—Erection of elementary school by Education Committee.

BARNOLDSWICK—Alterations and additions to Station Hotel. Messrs. E. and J. Crabtree.

BARNSLEY—House in Harvey-street; Mr. R. Smith. Extensions to chapel, Parker-street; six houses, Day-street; Mr. T. Lindley. Five houses, Middlesex-street; Mr. S. Walker. Seven houses, Queen's-avenue; Mr. M. Rhodes. Fourteen houses, Caxton-street; Mr. T. Potter.

BEDWELLTY—House in Albion-terrace; Mr. R. Treasure. Mission-room, New-road; Mr. R. W. Roberts. Two shops, High-street; Mr. J. Davies.

BEN RHYDDING—Erection of house. Architect, Mr. W. H. Marten, Ilkley.

BERKHAMPSTEAD—Alteration and additions to Berkhampstead Golf Club House and additions to the club house, Northchurch.

BEVERLEY—High school in Norwood. Architect, Mr. B. S. Jacobs, Lincoln's-inn-buildings, Hull.

BLAENAVON—Houses in Oxford-terrace. Mr. T. Ruther.

BLAIRGOWRIE—Villa for Mr. E. Carmont in Perth-road.

BODMIN—New machinery at the workhouse.

BONNYRIGG—Proposed public library.

BRIDPORT—Erection of school for Corporation. Town clerk, Mr. C. G. Nanter.

BRIGG—50 houses for Rural District Council.

BRIGHOUSE—Erection of secondary school for Town Council (£10,000)

BRITHDIR—New Council schools for Gelligaer Council.

CAMBRIDGE—Erection of smithy for Corporation; three houses, Collier-road; Messrs. Colsons and Lofts. House and shop, Burleigh-street; Mr. A. Spence. Shop and warehouse, Market-hill; Messrs. Hallack and Bond.

CANTERBURY—Alterations to police station by Corporation.

CASTLE HEDINGHAM—Alteration and enlargement of Council school (£700).

CHELMSFORD—Extra accommodation at workhouse (£2,000).

CHESTER—Offices for weights and measures department for Town Council (£480)

CHICHESTER—Erection of school in Tower-street by Council.

CHINLEY—Church room (£560). Architects, Messrs. Currie and Thompson, Derby.

CHOPWELL—Ninety cottages for the Consett Iron Co. Architect, Mr. C. E. Oliver.

CLEADON—New Council school. Architect, Mr. J. H. Morton, 50, King-street, South Shields.

COLNE—Building of Inghamite Chapel (£4,000).

CONSETT—Villa at Blackfyne. Architect, Mr. T. H. Murray.

COSHAM—Erection of nursing sisters' quarters at Alexandra Hospital. War Department.

CROPWELL BUTLER—New school for the Notts Education Committee.

CWMAMMAN—Rebuilding of Calvinistic Methodist Church (£2,600). Architect, Mr. T. Roderick.

DORKING—Provision of mortuary by Urban District Council.

DUBLIN—New college in Upper Merrion-street for the Commissioners of Public Works.

DUNDALK—Electric lighting scheme being considered by Corporation.

DUNDEE—Erection of school at North End (£15,500).

DUNGANNON—Erection of labourers' cottages by the Rural District Council (£11,713).

DURHAM—Training college at Neville's Cross for County Education Committee; dwelling-house at Ushaw Moor for Mr. R. Pearson; dwelling-house at Pity-Me for Mr. R. Hird; dwelling-house at Clarence Ville, Coxhoe, for Mrs. T. Weightman; dwelling-house at Clarence Ville, Coxhoe, for Mrs. J. Pallister; dwelling-house and shop at Bowburn for Mr. J. Richardson; alterations to premises at Whitesmocks for Mr. W. Pearson; new streets and building sites at Bowburn for Mr. J. Oxley; alterations to out-offices at Bearpark Village for the Bearpark Coal and Coke Co.

EARLSWOOD—Erection of elementary school (£8,000).

EAST HAM—Building of temporary school by Education Committee (£5,500).

ELAN VALLEY—Erection of school, schoolmasters' houses, offices, workshops, and cottages for the Birmingham Corporation.

ELLAND—Four dwelling-houses in Victoria-road.

ERITH—Extensions to the electricity undertaking by Council (£2,264).

FLIMBY—Dwelling-house at the Green for Mr. F. Ferguson.

GLASGOW—Liberal club, Buchanan-street.

GOLCAR—Store and shop for Slaithwaite Equitable Industrial Society.

GRAVESEND—Improvements at stations of S.E. and C. Rly.

HAGLEY—New church for St. Saviour's Parish (£3,900).

HARBY—Elementary school for the Notts Education Committee (£300).

HASLINGTON—Alteration and enlargement of school by County Education Authority.

HASTINGS—New wing at Buchanan Hospital (£3,000).

HEANOR—Erection of Prior Memoria Church (£3,500) Architects, Messrs. Naylor and Sale, Derby.

HERTFORD—Erection of new Council offices (£3,500).

HILLSBOROUGH—New Congregational church.

HORNSEY—Erection of cottage hospital, Park-road.

HOUGHTON-LE SPRING—Alterations at isolation hospital by Guardians. (£195).

HYDE—Erection of secondary school by Manchester Education Committee.

ISLE OF WIGHT—Isolation hospital for Rural District Council (£715).

KIRKCALDY—New church for St. John's Parish.

LANCASTER—Erection of public convenience in Nelson-road by Council.

LEEDS—Pair of houses in Street-lane. Architect, Mr. W. H. Beavers, 26, Bond-street.

LEVENSHULME—Erection of technical school by Council (£5,000).

LEXDEN—Infirmary for Guardians (£1,600).

LEYTON—Additions to branch library (£500).

LLANISHEN—Erection of lodge, stable buildings, and motor-house. Architect, Mr. G. E. Halliday, 19, Castle-street, Cardiff.

LONDON, E.—Eight dwelling-houses, East Ferry-road, Poplar. Messrs. Briggs and Son.

LONDON, E.—Additions to Brunswick Hall, Whitechapel-road. Messrs. G. Baines and Sons.

LONDON, N.—Dwelling-houses in Queen's-road, Dalston. Mr. D. P. Hayworth.

LONDON, N.E.—Rewiring of Hoxton baths by Shoreditch Council (£103).

LONDON, N.W.—New Baptist church, Cricklewood (£6,000). Architect, Mr. A. Keen.

LONDON, S.E.—Block of houses, Girton-road, Lewisham. Messrs. Eastman Bros.

LONDON, S.E.—Erection of parochial hall, Surrey-square, Walworth. Messrs. Outts.

LONDON, S.E.—Tower and spire to St. George's Cathedral, Southwark (£14,000).

LONDON, S.E.—Erection of buildings at Charlton for Messrs. Moore, Nettlefold, and Co.

LONDON, S.W.—Seven buildings, Garratt-lane, Wandsworth. Mr. H. Vignold.

LONDON, S.W.—Block of houses in Acre-lane, Brixton. Messrs. Eedle and Myers.

LONDON, S.W.—Extension of electric lighting by Fulham Council (£2,330).

LONDON, W.—Erection of motor-shed, Hammersmith. Messrs. Fullers, Limited.

LONDON, W.—Additions to Langham Hotel, Langham-place, Marylebone. Mr. J. M. Anderson.

LONDON, W.C.—Enlargement of Bloomsbury County Court. Commissioners of H.M. Works.

MAESTEG—Establishment of secondary school.

MARLPOOL—Erection of church (£3,300).

MATLOCK—Residence for H. Challand at Matlock Bank.

MEXBOROUGH—Erection of schools for Council. Architect, Mr. J. E. Knight, 33, College-street, Rotherham.

MILFORD HAVEN—Erection of new post office.

MOUNTAIN ASH—Establishment of cookery centre by Council (£781).

NEWBURY—Two houses, Falkland-road; Messrs. J. and A. Davis. Houses in Post Office-road and Falkland-road for Mr. W. Bridgeman.

NEWCASTLE—Six houses in Ferndale-road; two houses and shops in Nunn's Moor-road.

NORTHWICH—A new library is to be erected.

NORWICH—Public conveniences (£2,260).

OULTON BROAD—Erection of adult school (£300).

POLLOKSHAWS—Fire station, dwellings for brigade, and baths (£5,000).

POOLE—New school for Chester Education Committee.

PORTLAND—Erection of caretaker's cottage for the Urban District Council. Waterworks engineer, Mr. R. S. Henshaw.

PORTSMOUTH—Rebuilding of out-patients' department, Royal Portsmouth Hospital (£4,000).

PRESTON—Elementary school, Deepdale-road (£12,500).

PRESTWICH—Erection of church (£5,000). Architect, Mr. P. M. Chalmers, Glasgow.

RADCLIFFE—16 houses for Co-operative Society.

ROCHDALE—Erection of public baths.

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Ross—Two houses. Architect, Mr. A. H. Pearson.
Rowley—Public library by Urban District Council.
Salford—New board offices for Guardians.
Scunthorpe—Erection of Primitive Methodist church and schools. Architect, Mr. H. Harper, 54, Long-row, Nottingham.
Selly Oak—Extensions to Wesleyan Church (£3,000).
Sevenoaks—Additional machinery at the workhouse for the Guardians.
Southend—Extension of electric light works b. Corporation (£21,000).
Stapleford—Erection of fire station and caretaker's house (£700).
Stradey Marsh—Galvanising works for the Stradey Steel Co.
Swinton—Wiring of buildings for Urban District Council.
Tanfield Lea—Elementary school for Stanley Education Committee.
Teignmouth—Erection of public lavatories for Town Council.
Thirsk—Improvements to houses in market place for Major Bell.
Thrapston—Erection of elementary school under consideration by Council.
Timoleague—Erection of new parish church. Mr. M. A. Hennesey, Cork.
Tonmawr—50 houses for the Whitworth Collieries. Architect, Mr. J. C. Rees.
Torpenhow—Restoration of vicarage (£800).
Tunstall—Fourteen houses, Coley-terrace, Fulwell; electric mains in Ford, Hylton, Ryhope, and Tunstall; six houses, Oxford-street; two houses and shops, Royle-street, Grangetown.
Wakefield—Alterations and additions to the workhouse for the Guardians.
Walsall—Erection of pump-house for Corporation. Town clerk, Mr. J. R. Cooper.
Walsall—Wesleyan chapel, Dale-street (£1,100).
Warrington—Improvements to Council school. Architects, Messrs. Wright, Garnet, and Wright, 45, Sankey-street.
Waltham Abbey—Enlargement of cloakrooms of Council school (£397).
Waterloo—Additions to the nave of St. Mary's Church.
Wentbridge—New school for Council. Architects, Messrs. Tennant and Collin, Pontefract.
West Ham—Extensions of Corporation electricity undertaking (£3,057).
Windermere—Residence on the Rayrigg estate. Architect, Mr. J. Stalker, 54, Highgate, Kendal.
Woodbridge—Erection of Council schools for East Suffolk Education Committee.
Wolstanton—Enlargement of Ellison-street School by Education Committee.
Worcester—Extensions of electricity mains for Council (£305).
Wrexham—Provision of a 60-kw. set in connection with the electricity undertaking (£500).
York—Proposed new secondary school (£15,000).
Ystrad Mynach—New Council schools for Gelligaer Council.

PERSONAL.

Mr. S. G. Marston, senior charge engineer, Hanley electricity works, has been promoted to mains superintendent.

Mr. J. H. Hodgson, senior shift engineer at the electricity works, High Wycombe, has been promoted to the post of chief assistant.

Mr. J. E. Bridgman, charge engineer, Stalybridge, has been appointed charge engineer at the Hanley Corporation electricity works.

Mr. Charles D. Burnet, electrical engineer, and Mr. G. G. Scurfield, assistant electrical engineer, to the Carlisle Corporation, have resigned their positions.

The Rotherham Borough Council have increased the salary of the electrical engineer and tramways manager (Mr. E. Cross) from £350 to £400 per annum.

Mr. E. Ford, accounts and correspondence clerk in the Hanley electricity department, has been appointed to a similar position in the West Ham Corporation electricity offices.

We regret to record the death of Mr. John Yule, manager of the gas and electric light works of the city of Ontario, Canada. Mr. Yule had been in the city's employ for 26 years.

The Walsall Corporation have appointed Mr. A. S. Barnard, recently electrical adviser to the Government of Ceylon and the Colombo Corporation, as borough electrical engineer in place of Mr. A. Wyllie.

Mr. J. R. Wilson, of Heston and Isleworth electricity works, Hounslow, has been appointed second engineer-in-charge at these works, at a commencing salary of £120, rising to £150 per annum.

Mr. C. E. Vormeister, A.M.I.E.E., is leaving the Eccles Corporation electricity works, having been appointed on the staff of the Royal Technical Instute, Salford, as instrument maker and lecturer in electric wiring and fitting.

Mr. W. B. Turner, who, as previously stated, has resigned his position at the electricity works, High Wycombe, was last week presented by the staff and employés of the company with a mahogany case containing a solid brass rolling parallel, together with an illuminated address signed by the subscribers.

The United Electrical Co., of Budapest (who are members of the European Incandescent Lamp Manufacturers' Syndicate), have placed the sole agency for the sale of their incandescent lamps, including also the "Wolfram" metal-filament lamps, in the hands of Messrs. Straus and Co., 211, Upper Thames-street, London, E.C.

Thermit, Limited, have been appointed sole agents in the United Kingdom for the sale of McKnight's tramway point silencers and heel adjusters, etc. Samples can be inspected at 27, Martin's-lane, Cannon-street, E.C., where all inquiries should be addressed.

Colonel J. J. Mellor, one of the directors and formerly chairman of the Metropolitan Railway Co., has resigned owing to ill-health. The vacancy has been filled by Mr. Thomas Parker, F.R.S., who is at present consulting engineer to the company, and under whose direction the recent electrification of the railway was carried out.

Mr. John H. Smeeton has resigned his position as London manager to Messrs. Richardsons, Westgarth, and Co., and has accepted the position of London managing director to the Fusion-Welded Metals, Limited, a company recently formed to exploit the new invention for welding copper and various alloys on to steel, and for welding together any two classes of steel by means of copper or any alloy. The Fusion-Welded Metals, Limited, have opened offices at 56, Victoria-street, London, S.W.

Mr. John Shaw, who heretofore has combined the duties of textile expert to the British Thomson-Houston Co. with those of manager of their Manchester office, has been appointed mill engineer of the power and mining department of the British Thomson-Houston Co. owing to the rapid and extensive development of their textile business, which has necessitated the organisation of a special staff for dealing with the same. Mr. Shaw's headquarters will continue to be at the Manchester office of the company, although his duties will extend to the whole of the United Kingdom. Mr. W. J. Cusack, of the head office staff, has been appointed manager of the Manchester office vice Mr. Shaw. Both appointments date from Oct. 1.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Antwerp.—The Municipality invite tenders for one 30-ton electric crane. Deposit £280. Tenders by Nov. 12.

Antwerp.—Tenders are invited by the Municipality for lighting by electricity of the Place de Meir Hall. Tenders by Oct. 18.

Spain.—Concession of Seville telephones. Particulars from the Post and Telegraph Department, 10, Cerretas, Madrid. Tenders by Oct. 15.

Madrid.—The Post and Telegraph Department invite tenders for the establishment of the Alicante telephone system. Tenders by Oct. 17.

Brussels.—Tenders are invited for cables and accessories. Particulars from the Telegraph Department, 11, Rue de Louvaine. Tenders by Oct. 9.

Paris.—Tenders are invited for tubing to protect cables. Particulars from the Posts and Telegraph Department, 103, Rue de Grenelle. Tenders by Oct. 15.

Pontevedra (Spain).—The Municipality invite tenders for the installation and supply of electric lighting and power for 20 years. Tenders by Oct 29.

Toro (Spain).—Electric lighting and power supply installation for 10 years for the Municipality. Particulars from the Ayuntamiento Constitucional. Tenders by Oct. 30.

Grimsby.—Tenders are invited by the Corporation Electricity Department for additional switchboard panels. Particulars from the Borough Electrical Engineer. Tenders by Oct. 21.

Madrid.—Tenders are invited by the Post and Telegraph Department for the privilege of exploiting Valledolix telephone system for 10 years. Deposit, 10,000 pesetas. Tenders by Oct. 18.

Melbourne.—The Postmaster-General's Department invite tenders for 11 sets and a common-battery switchboard, and 3,000 subscribers telephones, etc., for the Windsor exchange. Tenders by Jan. 7.

Napier (New Zealand).—The Town Council invite tenders for lighting and power plant and an electric tramway equipment. Particulars from Mr. F. Bowen, town clerk. Tenders by Dec. 31.

London.—The London County Council invite tenders for three electrically-driven boiler feed pumps, each of 9,000 gallons per hour capacity, for the Greenwich tramway station. Tenders by Oct. 8.

Birmingham.—Tenders are invited for the supply of 49,000 tons of coal to the generating stations of the Corporation Electric Supply Department. Tenders to the City Electrical Engineer by Oct. 12.

Portrush (Ireland).—The Urban District Council invite tenders for a complete lighting installation by electricity or gas. Copies of specification can be seen at the Town Hall, Portrush. Tenders by Nov. 2.

Sydney.—The Postmaster-General invites tenders for the supply of wire insulators, fittings, etc. Particulars from the Commonwealth Offices, 72, Victoria-street, Westminster, London, S.W. Tenders by Nov. 6.

Paris.—Pumping plant and electric dynamos and motors for the Municipal Waterworks Department. Estimate, £36,000. Particulars from the Canals and Waterways Department, Hotel de Ville, Paris. Tenders by Oct. 24.

St. Marylebone.—Tenders are invited for the supply of flame arc lamp carbons. Specifications, etc., from the resident electrical engineer, Mr F. A. Wilkinson, 19 and 20, York-place, W. Tenders to the Town Clerk by Oct. 16.

Adense (Denmark).—Tenders are invited for four dynamos for the Municipal Electricity Works. Particulars from the Commercial Intelligence Branch of the Board of Trade, Basinghall-street, London, E.C. Tenders by Oct. 7.

Tunbridge Wells.—Tenders are invited by the Corporation for the supply, delivery, and erection of the work in connection with the

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installation of a 500-kw. turbo-alternator, condenser, and pipework in sections. Tenders by Nov. 1. See advertisement in last issue.

Adelaide.—The Deputy Postmaster-General for Queensland invites tenders for a common battery switchboard and 3,000 subscribers' telephones. Specification No. 166. Particulars may be obtained from the Commonwealth Offices, 72, Victoria-street, London, S.W. Tenders by Jan. 8, 1908.

Rangoon.—For pumping plant for Rangoon Municipality. Particulars, etc., of Messrs. Ogilvy, Gillanders, and Co., London agents to the Rangoon Municipality, Suncourt, 67, Cornhill, London, E.C., accompanied by a remittance of 10s., which will not be returned. Tenders to the Agents by Oct. 31.

Gloucester.—The Electricity Supply Committee invite tenders for the supply of rough slack steam coal from Nov. 1, 1907, to March 31, 1908, to be delivered to the electricity works, Commercial-road, Gloucester, as required. Particulars from the City Electrical Engineer. Tenders to the Town Clerk by Oct. 8.

Victoria.—The Deputy Postmaster-General at Melbourne invites tenders for the supply and delivery at Melbourne of 11 sections of a common-battery switchboard and 3,000 subscribers' telephones and other apparatus for telephone exchange, Windsor, in accordance with Victorian specification No. 148. Tenders by Jan. 7.

Manchester.—Tenders are invited for the supply of special (permanent way) track work, for the Tramways Committee. Specifications, etc., from Mr. J. M. M'Elroy, general manager, Tramways Department, 55, Piccadilly, Manchester, on deposit of £2. 2s., which will be returned on receipt of a bona fide tender. Tenders to the Chairman of the Tramways Committee, 55, Piccadilly, Manchester, by Oct. 8.

Alexandria.—Tenders are invited for the following electrical equipment for the port of Alexandria: five large and seven small transshipping engines, six cranes of four tons, 36 cranes of two tons, 25 windlasses, various small plant and necessary accessories, and the construction and installation of a central power station. Particulars from M. le Directeur des Ports et Phares, Alexandria. Tenders by Nov. 1.

Londonderry.—Tenders will be received by Mr. J. A. Williams, secretary, Technical Instruction Committee, Savings Bank, Londonderry, up to 3 p.m. on Oct. 11 for wiring and fitting the new Municipal Technical School, Londonderry, for electric light, etc., according to plans, specification, and schedules, copies of which may be obtained from the architect, Mr. E. J. Toye, 20, Great James-street, Londonderry, on deposit of £2. 2s. returnable on receipt of bona fide tender.

Manchester.—The Electricity Committee invite tenders for the supply and erection at their Stuart-street generating station of the following: (Specification No. 16) high-pressure steam-pipes and valves, etc.; (No. 17) low-pressure pipes, including exhaust steam, air-pump discharge, and circulating water-pipes and valves. Specifications, etc., from Mr. F. E. Hughes, secretary, Electricity Department, Town Hall, Manchester. Tenders to the Chairman of the Electricity Committee by Oct. 9.

RESULTS OF TENDERS.

Gloucester.—The City Council have accepted the tender of the Sloan Electrical Co., at £132. 16s., for the supply of carbons for the ensuing 12 months.

Oldham.—Thermit Limited have obtained an order from the Oldham Corporation Tramways for one of their portable rail-grinding equipments (Mattinson's patent.

London, W.—The Paddington Borough Council have accepted the tender of the Bell Telephone and Electric Co., at £115, for the installation of electric fire-alarms.

Tyrone.—The Committee of Management of the Tyrone County Hospital have accepted the tender of A. Paterson and Son, Belfast, at £720, for the installation of electric plant in the institution.

Clonmel (Ireland).—Newtons Limited, Taunton, have received, through the Alliance Electrical Co., Dublin, the order for two generators required at the District Lunatic Asylum, Clonmel, co. Tipperary, Ireland.

Brighton.—The Corporation have accepted the tender of W. Cory and Son for the supply to the Corporation electric power station, Southwick, during six months commencing Oct. 1, of not less than 13,000 or more than 15,000 tons of washed nuts, or alternatively for supply during 12 months commencing same date of not less than 22,000 or more than 24,000 tons of washed nuts.

Bermondsey.—The Electricity Committee have accepted the tender of Messrs. Johnson and Phillips for the supply of 220 yards $^{7}/_{18}$ twin lead-covered, rubber cable for £21. 8s. 5d.; 110 yards $^{7}/_{22}$ twin lead-covered, rubber cable (armoured) for £8 16s. 11d.; and 220 yards $^{7}/_{16}$ three-core, lead-covered, paper cable for £24. 7s.; and also their tender for the supply of 500ft. of flexible galvanised steel wire rope for £1. 7s. 6d.

BUSINESS NOTES.

TRACTION.

Darlington.—The Electricity and Light Railways Committee are recommending the Corporation to revert to the charging of ½d. fares on the tramways.

Mexico Tramways.—The directors have declared a dividend at the rate of 4 per cent. per annum for the quarter ended Sept. 30. Cheques for the same will be posted from Toronto, Canada, on Nov. 1.

Crosland Moor.—The extension of the tramways to Dryclough-road, Crosland Moor, was passed on the 26th ult. by an inspector of the Board of Trade, and cars commenced running on that section on Friday morning last.

Italy.—Mont Cenis Tunnel is to be equipped for electric traction. This is to meet the competition of the route *via* the Simplon Tunnel. The line between Bussoleno and Mondane is to be electrified.

Croydon.—The Local Government Board have sanctioned the borrowing of £3,820 by the Council for the reconstruction and widening of the railway bridge in connection with the trams at Penge-road, South Norwood.

Heysham.—The electrification of the line between Lancaster and Heysham is being steadily proceeded with. The line will be operated on the single-phase system and power will be generated at the power-house situated at Heysham Harbour.

Bradford.—It is expected that the extension of the Bradford city tramways to Wibsey, *via* Brownroyd-hill, will be completed by the end of the week. Plans are being sent to the Board of Trade, and the official inspection will be made shortly.

Sheffield.—Whilst a Sheffield Corporation tramcar was proceeding towards Heeley in London-road, shortly after five o'clock on Saturday afternoon last, a man who was crossing the metals was knocked down and killed instantaneously, his head being terribly injured.

Madras Electric Tramways.—The receipts for the fortnight ending Sept. 30, 1907, totalled Rs.16,583, against a total of Rs.13,063 for the corresponding weeks of 1906. The gross receipts from Jan. 1, 1907, amounted to Rs.309,404, against Rs.256,023 for a like period of 1906.

Derby.—The Council have passed the following resolution: "That the Tramways Committee be instructed to strictly enforce the penalty clauses of the contract with Messrs. Blackwell and Co. for the construction of the Ashbourne-road tramway route unless otherwise instructed by the Council."

North-Eastern Railway and Electrification.—The general manager of the North-Eastern Railway Co. states that there is no foundation whatever for the report that the company were embarking upon a scheme for the electrification of their Newcastle, Gateshead, and South Shields branch lines.

Leeds.—The Leeds City Council have authorised the Finance Committee to obtain sanction to borrow £42,313 for the construction of a tramway from Headingley to Lawnswood, another from Kirkgate to Cross Green-lane, *via* East-street, and a third from the Easy-road terminus to Hunslet-road, *via* South Accommodation-road.

Amalgamation of Motor Clubs.—Arrangements between the members of the Motor Club and the British Motor Boat Club were recently completed at the Motor Club House, Coventry-street, W., and the amalgamation of the two clubs is now an accomplished fact. An inaugural dinner to celebrate the event is being arranged.

Sunderland.—A tramway employé named William Sutton, 54, was walking between two cars in Fawcett-street, Sunderland, on Saturday last, when he was accidentally caught between the protecting front of one car and the rear end of the other. Sutton sustained a compound fracture of the leg, and was removed to the infirmary.

Leith.—A report has been presented to Leith Town Council regarding the proposed extension of the electric tramway system to the suburban districts. A conference is to be invited with the Edinburgh Corporation with the view of having certain portions of the work undertaken jointly by Edinburgh and Leith. The cost of the whole scheme is estimated at £76,000.

Rio de Janeiro.—Regarding the concessions recently granted to the Rio de Janeiro Tramway, Light, and Power Co., the British Empire Trust Co. intimate that the extensions of the tramway franchises are until 1970, and that other privileges secured include the use of larger cars, fixed stopping places, and the right to run cars from one section of the city to the other.

Greenwich.—The Highways Committee have reported to the Council that the majority of the frontage occupiers and owners having objected to the proposal to double the portion of the tramway track lying between Blackheath-road and John Penn-street, Lewisham-road, the idea had been abandoned by the London County Council, and a single track would remain when the line was reconstructed.

West Bromwich.—The Town Council have forwarded a letter to the South Staffordshire Tramways (Lessee) Co. protesting against their action in abolishing children's ½d. fares in the borough. It was stated that the Highways Committee thought this was a great injustice to the children, and especially those of the working classes who were in the habit of taking their fathers' meals by tram.

Levenshulme.—At the last meeting of the Urban District Council a letter was read from the Manchester Corporation with reference to the tramway lease, in which they contended that they were not liable for watering and scavenging the tramway in this district. The committee decided that the decision already come to by the Parliamentary Committee should be adhered to, and that the point be settled by arbitration.

Rotherham.—At the next meeting of the County Borough Council the Tramways Committee will recommend that the authorised tramway from Effingham-square, along Frederick-street, Bridge-street, College-road, Midland-road, and Wortley-road, to Bradgate, be constructed, and that the borough and electrical engineers be instructed to prepare the necessary details, specifications, etc., for the carrying out of the work.

Gloucester.—In connection with the renovation of the tramcars, it appearing from the general manager's report that the repainting of the cars might be done more cheaply if carried out at the depôt gradually during the year than by contract, the Light Railways Committee of the Corporation have instructed the general manager to arrange for the necessary repainting to be carried out at the depôt, as required, by workmen employed by the Corporation.

California.—An electric interurban railway is under construction in California, in which an interesting feature of the design is the

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proposal to operate the cars by an under-running third rail carrying direct current at 1,200 volts. The entire length of the road will be about 70·5 miles. The third rail will be of special section, having the form of the letter T inverted. The weight of this rail is to be 22·4lb. per yard, and it will be of special low-carbon steel.

Dundee and Broughty Ferry Tramways.—The annual report of the directors of the Dundee, Broughty Ferry, and District Tramways Co. sets forth that the profit on the year's working amounts to £3,461, from which a dividend on the 6 per cent. preference shares had been paid, leaving £461 to be carried forward. The long-continued unfavourable weather had had a material effect in preventing greater expansion of the company's business. The earnings for the year reach the sum of £12,351.

Huddersfield.—The tramcar service during the Honley Feast holidays was marred by a couple of mishaps to the trolley wires. About six o'clock on the 22nd ult. one broke in the Bradford-road, but falling clear of the car, which was a covered one, occasioned nothing more serious than a slight delay in the service; whilst at 6.15 p.m. on the next evening another one happily failed to drop upon an open car near the railway bridge, Woodhead-road, Salford, although the progress of other cars was impeded for half an hour.

Electric Cars in Collision.—A dense fog hung over Middlesbrough on the 23rd ult., and traffic in the town and on the river was much interfered with. At Linthorpe two electric cars collided, and the driver of one, named Stongroon, received such injury to his leg that he had to be removed to the North Riding Infirmary for treatment. The cars met on a small stretch of single line, and the accident was no doubt largely due to the running of a number of extra trams to cope with the crowd attending the football match.

Wrekenton.—At a meeting of the Wrekenton and District Tramway Extension Committee information was received from the Gateshead Town Improvement Committee that the Birtley Iron Co. had refused to entertain the suggestion to construct a tunnel at the Wrekenton railway crossing so as to allow of the safe transit of the Gatehead and District trams over the railway. The local committee were informed that the Town Improvement Committee intended to take steps to compel the railway company to make the crossing safe.

Edgbaston.—A meeting of the Edgbaston Financial Sub-Committee was held on the 30th ult., at which the accounts showing the expense entailed by the recent parliamentary opposition were passed, and out of the balance in hand a sum of £75 was voted to the Harborne Committee towards the costs of their opposition. The Edgbaston Committee continues in office for the purpose of watching, and, if necessary, taking action in opposing any future Bill or provisional order having for its object the authorisation of tramways along the Hagley, Harborne, or any adjacent roads.

Electric Train in Collision.—An electric express train from Newcastle to Tynemouth was in collision on the 26th ult. near Wallsend, dashing into a horse and cart as it crossed the line. The cart was laden with cement and was knocked on to the up line, while the horse was killed and the cement scattered. The train was pulled up to the accompaniment of blue flame, and after the debris had been cleared the passengers were transferred to another train. The driver of the cart was uninjured, but the driver of the train sustained cuts, owing to the glass front of the motor-box being broken.

Hanwell.—The General Purposes Committee reported to the Council that they had considered a letter of the secretary to the Hanwell Ratepayers' Association referred to them by the Council, but were unable to recommend that any action be taken on the lines suggested in the letter. The Council was asked to get the tramways company to make all fares terminate at Hanwell-broadway, instead of at Eccleston-road as at present. Mr. Williams said he had written to Sir J. Clifton Robinson on the matter, and had received a reply in which Sir Clifton said he regretted the company could not make the changes requested.

Indian Monorail.—Mr. Louis Brennan, the inventor of the monorail gyroscopic carriage, has been granted £6,000 by the Indian Government towards the cost of his experiments in connection with the design of the full-sized monorail vehicle which he is building for that Government. The War Office, which is greatly interested in the invention from the military point of view, is also assisting Mr. Brennan in connection with the experiments by giving him the use of the Brennan torpedo factory. The question as to whether the motive power of the first full-sized carriage shall be steam or electricity generated by petrol engines, has yet to be decided by the authorities.

Liverpool.—A special meeting of the City Council has been summoned for Wednesday, Oct. 23, at half-past two, to consider the desirability of applying to the Board of Trade for a provisional order for the construction of a new tramway route at the north end of the city, which would require lines to be laid along Hale-road, Selwyn-street, part of Westminster-road, and Melrose-road. The length of these new lines would be approximately 1,180 yards of double lines an 1 540 yards of single line, or equivalent to about 1 mile 1,140 yards of single track. To make the resolution effective, two-thirds (92) of the members of the Council must be present and vote at the meeting, and a majority of those present and voting must concur in the resolution.

East Ham.—The total revenue of the Corporation's tramways undertaking last year amounted to £47,140, an increase of £3,000 over the previous year, whilst the operating costs came out at £31,623. This left a gross profit of £15,517, and after deducting interest of loans, sinking fund, etc, contributions amounting to £10 933, there is still left £4,584, which is the net surplus on the year's working. The number of passengers carried was 15,049,240, or, in other words, the population of the borough was carried 120 times over. The electric lighting accounts do not show such a good result, although there was a gross profit on the year's working of £8,371. After deducting interest and sinking fund contributions, etc., amounting to £8,447. there is left a deficit of £76.

Killed by an Electric Train.—A distressing fatality occurred at Birkdale on the Lancashire and Yorkshire Electric Railway between Liverpool and Southport. An extra porter named James M'Intyre, who resided at 111, Kew-road, Birkdale, was engaged in carrying signal lamps between Ainsdale and Birkdale stations. In doing so M'Intyre was walking along the edge of the sleepers between the two stations when a stopping train came along. The driver sounded his horn repeatedly, but M'Intyre apparently did not hear the approach of the train, and was knocked down and killed instantly. M'Intyre, who was 30 years of age, was a single man. M'Intyre served in the South African war, and had two medals and several clasps for this campaign. He was shortly leaving the service of the company.

Wakefield.—At a meeting of the Wakefield Chamber of Commerce on the 30th ult., Mr. A. T. White in the chair, discussion took place on the proposed abandonment by the Wakefield and District Light Railway Co. of certain sections of the line which they had obtained powers to construct. Mr. C. H. Clayton (hon. secretary of the Wakefield Tradesmen's Association) attended, and asked the chamber to support his association in a deputation to the Board of Trade next week. Major Bolton said it was not fair that the company should have constructed their lines over the best portions of the district, and now seek to drop those which would not, perhaps, produce very large returns at the outset. It was pointed out that there was very inadequate communication between Ardsley, Morley, and Wakefield, whilst better means of getting to and from Altofts were also urgently needed. The chamber passed a resolution emphatically objecting to the proposals of the company.

Lancaster.—On the 6th ult. the chairman reported to the Tramways Committee that, in view of the construction of the portico at the new town hall, it had become necessary to move certain poles in front of that building, and that the New Town Hall Committee had authorised the committee to make attachments to the corner of the new building if required. The engineer submitted a plan showing how he suggested the overhead line might be erected without interfering with the new town hall at an estimated cost of £24, and reported that it was necessary to erect two temporary poles near the Oval while the alterations were being carried out. Resolved that, subject to the sanction of the Streets Committee, the temporary poles referred to be erected in the position shown on the plan. The committee considered the question as to the alteration of the traffic during the winter months. Resolved that the summer traffic be continued until the end of October, except that the cars on the Park route do not proceed further than Bay View-terrace.

Leyton.—At the last Council meeting a report as to the working of the trams during the half-year was submitted. The number of people carried up to date was 6,202,000; number of units used, 804,000; car miles run, 659,000. The working expenses per car mile were 6·18d.; the total expenses per car mile were 9·9d. The total receipts for the half-year were £30,343. and the working expenses £16,562, leaving a gross profit of £13,781. Of that gross profit they paid £10,199 for repayment of principal, interest, and loan charges, and £380 for street widenings, making £11,549. This left a net balance of £2 232. This the committee considered very satisfactory after the unusual summer they had had. If they had had a normal summer there would have been a considerable increase. The amount of capital charges was more this year, because they had to pay the extra cost for temporary loans, which would not occur again. When they considered the facilities offered to the people by the tramway service it was apparent they had so far justified the extension of the undertaking. The report was adopted.

Birmingham.—A serious tram accident occurred on the 1st inst., as the result of which 19 men, belonging to the artizan class, were injured. The car left the city terminus in Edmund-street for Lodge-road shortly after six o'clock, and contained 20 workmen *en route* for their respective places of work. The accident occurred while descending the steep gradient at the junction of Warstone-lane and Icknield-street. The driver, William Mountford, had previously observed that his magnetic brakes were not working properly, and called the attention of an inspector to the fact The latter boarded the car for the purpose of testing the brakes, but it seems to have got out of control going down the declivity, and at the curve leading into Icknield-street it suddenly left the line and overturned. The driver, apprehending the danger, shouted to the passengers to jump, but only one succeeded in getting off. The others were thrown into the road with great violence. The car, which smashed against the iron palisades of a grass plot at the bottom of Warstone-lane, was wrecked completely. It is a remarkable coincidence that it is the same car to which an accident happened some months ago a short distance from the scene of Tuesday's occurrence, several passengers being then injured.

Maidstone.—The first tram passed over the rails on the new route to Loose last Monday, the appearance of a car in this part of the town arousing considerable interest. The car used was one of seven new ones bought for the traffic on the extension. The trip was made to test the line prior to the Board of Trade inspection of the route before it is opened to the public for traffic. A start was made from Mill-street at 2.15, the passengers on the car being the Mayor (Councillor Ed. Vaughan), Councillor E. Wakefield, Mr. E. A. Evans (resident engineer for the consulting engineer to the Corporation), Mr. T. E. Tarling (resident engineer for Messrs. Dick, Kerr, and Co., the contractors), Mr. Saunders (tramways manager for the Borough Corporation), Mr. G. L. Lawson (assistant engineer for Messrs. Dick, Kerr, and Co.), Mr. Henry Arkell (engineer for Messrs. Henley, the cable contractors), Mr. C. Semark (foreman for Messrs. Dick, Kerr. and Co.), etc. A good start was made, and all went well until Upper Stone-street was reached. When a little way above the Brenchley Arms it was found that the window sill of a house, which has been purchased by the Corporation, and will be pulled down before the line

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is open, impeded the progress of the car, which was brought to a standstill. Once by this, however, no further trouble was encountered, except by branches of the trees on the Loose-road, as far as the cemetery, which it was found swept the top of the car, and will have to be lopped considerably. When the pioneer party arrived at Loose the toast of "Success to the Trams" was heartily drunk, and the return journey afterwards made with a good run home. Upper Stone-street's population turned out in full force to witness the advent of the trams, and appeared greatly interested. There are sharp turns at both ends of Knightrider-street, which will require carefully negotiating by the drivers, particularly at the Stone-street end, as the cars come down the hill. The junction at the top of Mill-street will become a very busy spot, and with the trams running in addition to the heavy traffic which already passes the corner, it will probably be found necessary to have a constable on point duty. It is expected the line will be open in time for the October fair. The extension will give employment to about 20 additional men.

East and West Ardsley.—At a meeting of the East and West Ardsley District Council a letter was read from the Board of Trade (Railway Department), dated Sept. 16, which was as follows: "Dear Sir,—I am directed by the Board of Trade to advert to your letter of the 22nd ultimo, objecting to the application of the Wakefield and District Light Railway Co. for a direction that their powers cease as regards a portion of the lines authorised by the Wakefield and District Light Railway Order, 1902, and to transmit herewith a copy of a communication which has been received with reference thereto from the company.—I am, sir, yours truly, J. W. Wills." "A copy of a letter dated Sept. 6, from the assistant secretary (Railway Department) Board of Trade, from Messrs. Ashurst, Norris, Crisp, and Co., of London, *re* the Wakefield and District Light Railway Order, 1901-2, with respect to the letter from the Council and the Wakefield City Tradesmen's Association, intimating that there was no agreement that the Ardsley line should be constructed, nor, so far as the promoters' legal advisers were aware, had there been any other scheme embodying a proposal to construct that line. There was, they submitted; no real substance with the argument that the line would lead to through communication with Bradford, for even if the line were constructed, the through communication would not exist, as there was no line authorised between Ardsley and Tingley. Without such a line their clients considered that it would not pay to construct the Ardsley line. Generally, they added, that their clients had no funds at their disposal for the construction of the lines which they desired to abandon, and that it was not expedient, nor consistent with public policy, to endeavour to force them into raising money for constructing lines which they were convinced would not pay interest on the cost of construction. In similar circumstances Parliament had by the West Riding Tramways Act, 1907, granted to their clients an extension of time for some, and allowed them to drop other unconstructed tramways authorised by the West Riding Tramways Act, 1904." The clerk had received a letter from the Wakefield Corporation asking for a deputation to be sent to a conference to be held at Wakefield to oppose the scheme of dropping the Ardsley line, and it was decided that the chairman and clerk attend.

York.—The Corporation Tramways Committee have passed the following resolutions: "That the Council be recommended to apply to the Board of Trade, in November next, for a light railway order, or a provisional order authorising the making, laying down, constructing, and working of the tramways, or to lease the undertaking to a company, and that powers be obtained in respect of the following routes—viz: (Route No. 1) railway station to city boundary, Fulford, *via* Station-road, Rougier-street, Railway-street, Micklegate, Ouse Bridge, Low Ousegate, Nessgate, Clifford-street, Tower-street, Fishergate, and Fulford-road; (Route No. 2) railway station to city boundary, Tadcaster-road, *via* Queen-street, Blossom-street, the Mount, and Tadcaster-road; (Route No. 3) Blossom-street to city boundary, Acomb-road, *via* Holgate-road and Acomb-road; (Route No. 4) Lendal Bridge to railway bridge, Haxby-road, *via* Lendal Bridge, Museum-street, St. Leonard's-place, Gillygate, Clarence-street, and Haxby-road. That before exercising the powers contained in the foregoing resolution, a poll of the citizens be taken to determine whether the Corporation should construct and work the tramways themselves, or lease the undertaking to a company." As regards the cost for carrying out the scheme so recommended the committee reprint the paragraph in their July report on this point, which is as follows: "The acting city surveyor and the city electrical engineer have gone carefully into the question of the estimate of the cost of laying down the track and equipment, and the necessary work in connection therewith, for a system of tramways on the assumption that the above routes are adopted. They estimate: (1) the cost of laying down a system of tramways by the overhead system of traction, including the extension and adaptation of the existing car-sheds, the provision of 20 tramcars, and of the necessary street improvements, including the strengthening of Lendal Bridge, at a total cost of £110,917; and (2) for laying down the tramways by a surface-contact system, including similar works and cars, at the sum of £119,959, and in such estimates provision has been made for rails weighing 100lb. per lineal yard, which seems to be the generally approved standard of weight of rails. Owing to the narrowness of several of the thoroughfares through which the tramways will have to be taken, it is suggested that the gauge of the tramways to be laid down should be 3ft. 6in., the usual narrow-gauge width.

LIGHTING AND GENERAL

Westbury.—The telephone service has been extended to the village of Bratton.

Houghton-le-Spring.—The Board of Guardians have resolved to light by electricity the union offices.

Honley.—The Urban District Council have decided to relinquish gas in favour of electricity at the district known as Berry Croft.

Willesden.—The District Council have issued a return showing that a profit of £783 had been made on electric lighting since the last report.

Woodbridge.—A report is to be prepared and presented to the Urban District Council at their next meeting as to the cost, etc., of lighting the district by electricity.

Fulham.—The Electricity Committee are recommending the Council to provide seven Nernst lamps in Ranelagh-avenue and Hannington-street in lieu of the existing gas lamps.

Gann's Electric Lamp.—A subscriber has asked us to inform him who is the agent for or makers of the above. We would thank a reader who may know to send us on the information.

Notice of Dividend.—The *London Gazette* announces that a first and final dividend of 6s. 8d. in the £ has been declared in the estate of D. Roberts, electrical and motor engineer, 30, Macklin-street, Derby.

Release of Trustee.—According to the *London Gazette*, J. Bowling, 22, Park-row, Leeds, has been released from trusteeship in the estate of A. Dickinson, electrical engineer, the Electrical Works, Dixon-lane-road, Wortley.

South Metropolitan Electric Light and Power Co.—We are asked to state that the warrants for the payment of interest for the six months to Oct. 1, 1907, on 4½ per cent. first mortgage debenture stock, have been posted.

Calcutta Electric Supply Corporation.—The directors have declared an interim dividend on the paid-up share capital of the company for the half-year ended June 30 last at the rate of 6½ per cent. per annum. The dividend is payable on Nov. 15.

Eastern Extension, Australasia, and China Telegraph Co.—The directors of the Eastern Extension, Australasia, and China Telegraph Co. have declared an interim dividend for the quarter ended June 30 last of 2s. 6d. per share, free of income tax.

Hove Electric Lighting Co.—The directors of the Hove Electric Lighting Co. have declared an interim dividend on the share capital of the company at the rate of 8 per cent. per annum for the half-year ended June 30 last, such dividend to be payable on Oct. 15.

Ware.—At the last meeting of the Urban District Council the clerk reported that the time limit in connection with the electric lighting order which the Council had sold expired last month, and nothing had been done. The clerk was instructed to call the attention of the company to the fact.

Killed by an Electric Saw.—At the Old Park Works of the Patent Shaft and Axle Tree Co. at Wednesbury on the 25th ult., John Brennon, a blacksmith, received a fatal electric shock whilst cutting a piece of iron with an electric saw, and two other men were injured, one being in a serious condition.

Bridgend.—It having been reported to the Council that several lamps had been maliciously damaged, the electrician recommended that notices be printed offering a reward to anyone who would give information that would lead to the conviction of persons damaging them. The recommendation was adopted.

Leek.—At the last meeting of the Council the Electricity Committee recommended that a spare cylinder end be obtained for the No. 2 engine at a cost of £20; that the North Staffordshire Railway Co. be informed there is no present probability of extending the mains to Rudyard. This was agreed to.

Felling.—The Urban District Council have decided to send a memorial to the Postmaster-General pointing out that the postal, telephonic, and telegraphic facilities in the district were entirely inadequate for the needs of the residents, and asking that steps be at once taken to afford the residents of Felling suitable facilities for the transaction of their business.

Aston.—The Electricity Committee report that the works in connection with the supply of lighting current to Erdington are proceeding satisfactorily, and that the high-tension plant at the station is practically completed, whilst the mains and sub-stations are in so forward a state that it is anticipated that the first sub-station (Wheelwright-road) will be in operation shortly.

Todmorden.—On the recommendation of the Electricity Committee, a new scale of charges for electricity has been adopted by the Council as follows: for lighting, a flat rate of 4½d. per unit (increased from 3d.), with the option of a sliding scale varying from 6d. per unit to 2d. per unit; for power, 100 units or less per quarter 2d. per unit, 100 to 150 1½d., 150 units and over 1½d.

Swatow (China).—At the beginning of 1906 a native company, with a capital of 100,000dol. in 10,000 shares of 10dol., to be held only by Chinese, was formed to supply electric light to the city of Swatow. A contract for the necessary plant was signed in May, all machinery, etc., to be delivered within six months, but owing to disputes with the contractors the company has not yet commenced working.

Doncaster.—The Wesleyan church in Nether Hall-road has been completed by the addition of an organ which has been built by Messrs. Norman and Beard, of London and Norwich. The organ contains swell organ, great and pedal organs, and couplers. The console is detached with tubular pneumatic action throughout, and the organ is blown by an aeromotor driven by electricity. The cost of the instrument was £620.

Motor-Starting Apparatus.—The Adams Manufacturing Co., of London and Bedford, advise us that, owing to the enormously increased demand for their "Igranic" motor starting and controlling apparatus in the Yorkshire district, they have just appointed as their agent in that district Mr. Charles H. Holgate, of School Close Works,

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Leeds. Mr. Holgate intends to carry a large stock of the standard "Igranic" apparatus.

Mountain Ash.—The Local Government Board have asked for particulars of the Council's electric lighting scheme, plans of the proposed works, distributing mains, etc. The clerk has been instructed to give the necessary particulars, and state that the matter was in abeyance to see what the generating company would do in Parliament, and that in the meantime the Council would, if necessary, apply for an extension of their present order.

Cambridge.—The Council have received a request from the Postmaster-General for their sanction to the laying of underground telegraph wires through certain streets, and have agreed subject to the following conditions: that the surface of the ground shall be restored by the borough surveyor at the cost of the Postmaster-General; and that it be understood that no liability shall attach to the Corporation in respect of any damage which may occur through any subsidence of the trenches.

Greenock Electricity Works Valuation.—An adjourned meeting of the Greenock Valuation Appeal Court has been held to consider the valuation of the burgh electricity works. Mr. Hamilton (assessor) stated that the figure on the roll last year was £5,440, and that it had been proposed to increase it to £5,770. This had been appealed against, and as a result of negotiations it had been decided, subject to the approval of the Court, to fix the amount at £5,250, a reduction of about £200.

Colchester.—The Electricity and Tramways Committee reported to the Council that, after consideration of the proposal for placing the two undertakings under the management of one committee, it had been proposed: "That, after most careful consideration, and bearing in mind the fact that the electricity supply station and tramways depôt are so far distant from each other, this joint committee is not in favour of the amalgamation of the two departments in question." The proposition was carried.

National Telephone Co.—The National Telephone Co. on Saturday afternoon moved into their new building, adjoining the Gerrard-street exchange, with only a few minutes' suspension of the service. Altogether 12,000 wires, including those which connect the Gerrard-street exchange with all the other exchanges in the metropolitan area, were transferred in nine minutes, and the staff, numbering about 300, moved into their new quarters, which give them triple the capacity of the former building.

Halifax.—The Halifax Corporation Telephone Wayleaves Committee have appointed a sub-committee to interview representatives of the county boroughs of Leeds, Sheffield, Bradford, Huddersfield, and Rotherham with a view to calling a conference of representatives of local authorities in the United Kingdom on the question of payments of acknowledgments for privileges granted to the National Telephone Co. and as to the manner in which the monopoly of the company is being exercised.

Dick-Kerr Engineering Society.—The third annual smoking concert in connection with the above society was held in the George Hotel, Preston, on Friday evening, Sept. 27, and was well attended by a large number of members and friends. After the usual formalities an excellent programme was given by several members of the society. The 1907 08 session commences this month, and the first meeting will be on Oct. 7, at which a paper will be read by Mr. K. Lightfoot, the subject being "Refrigerating Machinery."

Hanley.—Mr. C. H. Yeaman, the borough electrical engineer, commenced a new course of popular lectures upon electrical engineering on Monday night at the Hanley Municipal Secondary School. These lectures were inaugurated last autumn, when Mr. Yeaman delivered a series of addresses dealing more particularly with the practical side of his subject. Each evening he held the attention of considerable audiences, and it is hoped that all those who attended last year, and a good many more as well, will take the new course. Mr. Yeaman's object is to popularise a knowledge of the everyday uses of electricity.

Edinburgh.—The Electric Lighting Committee of Edinburgh Town Council had before them on the 2nd inst. a report as to a proposed special rate to consumers of electricity for lighting purposes who do not use the light during the hours of heaviest loads. It was agreed to recommend that for one year a charge of 2d. per unit be made to these consumers, who would not use their light between the hours of 4 p.m. and 7 p.m. during November, December, January, and February. If the recommendation is approved, the supply of current during these hours in the premises of the consumers concerned will be disconnected by means of a time switch.

Bedwellty.—At the last meeting of the District Council a deputation representing Argoed district attended with a request for assistance in continuing telegraphic arrangements in that district. It was pointed out that for the last few years there had been a deficiency, and the public had to be appealed to for subscriptions to meet it. If the Council could do something to assist them by relieving them of the financial responsibility, it would be a great advantage. The Clerk said he did not think anything could be voted to assist Argoed; the contract would expire next year, and that would be the time to apply. It was eventually decided that the Council render the assistance asked for provided it could legally be done.

Stoke.—At the last meeting of the Electricity and Destructor Committee, the engineer (Mr. Tiddeman) reported that the consumption during July and August showed an increase of 90 per cent. on the corresponding period of last year. The town clerk informed the committee that the Act confirming the provisional order authorising the Council to supply electrical energy in Fenton had received the Royal assent. The draft of an agreement between the Corporation and Messrs. Kerr, Stuart, and Co., relating to the supply of electricity to the California Engineering Works, was submitted to the committee. The approval or otherwise of this agreement was left to the chairman, vice-chairman, electrical engineer, and town clerk.

Hampstead.—The Lighting Committee of the Borough Council have presented a statement showing the position of the electric lighting undertaking, from which a grant in aid of the general rates has been made four times. Over 400 new consumers have had their premises connected during the past year, bringing the total number up to 5,966, and the number of 8-c.p. lamps now connected is 294,019. Recently substantial reductions have been made for meter rents and for public lighting, but notwithstanding these reductions the total income for last quarter was £7,293, as compared with £6,848 received in the corresponding quarter last year.

Worcester.—For the October meeting of the Council the Electricity Committee report that Messrs. McKenzie and Holland have agreed to install two motors of 15 h.p. and 12 h.p. in their Bridge-yard department as a trial, previously to installing motors in other departments, and they resolved that the electrical engineer be authorised to at once proceed with the laying of the new main to the works at an estimated cost of £215. The committee also decided that, provided the Great Western Railway Co. will agree to take a supply of current for their hoist motors at Shrub-hill, the electrical engineer be authorised to extend the direct-current mains from Cromwell-street to Shrub-hill Station, a distance of 307 yards, at a cost of £90.

Lancaster.—On the motion for the adoption of the Sanitary Committee's minutes at the last Council meeting, reference was made to a report by the borough accountant and surveyor on a visit to the Preston refuse destructor, as a result of which the committee had decided upon expert investigation of the working of the Lancaster destructor. While the plant was about the same size as that at Preston, and they destroyed about half as much refuse, they received from the Electricity Committee only £250 a year for steam supplied, whereas the Preston Committee received £1,000 for steam. Whilst at Preston the fuel bill at the electricity works as the result of using the destructor steam was only £100 a year, the fuel bill at Lancaster is £1,500 a year.

Newcastle.—At the monthly meeting of the directors of the Newcastle-upon-Tyne Incorporated Trade Protection Society the following resolution was adopted, and copies ordered to be sent to the local members of Parliament, as well as the Newcastle Town Council: "That the new scale of charges are excessive, the increased cost varying from 13 per cent. to 100 per cent.; that this increased cost will largely fall upon traders who are the principal supporters of the telephones; that the result will be to discourage the growth of telephony, and to add to the financial burdens of traders. The Postmaster-General should, therefore, be pressed to reconsider the matter, as it is of the utmost importance that there should be an efficient telephone system at moderate charges."

Liverpool and District Electrical Association.—The first social in connection with the above association was held at the Queen's Café, Victoria-street, Liverpool, on Saturday, Sept. 28, the chair being taken by Mr. Myer. The musical programme terminated with a vote of thanks to the artistes, proposed by the chairman, and seconded by Mr. J. J. Richardson. Mr. Samuel Frith, the hon. secretary and treasurer, then addressed the meeting as to the objects of the association, and extended a cordial invitation to the visitors, both ladies and gentlemen, to join the association, as all persons interested in electricity are eligible as members. A further invitation was extended to accompany the association on its visit to the Widnes and Runcorn transporter bridge and power station on Saturday, Oct. 5, per 3.35 p.m. train from Lime-street.

Salvage Steamer for Submarines.—A submarine salvage vessel, which has been constructed to the order of the German Admiralty at the Howaldt Yard at Kiel, was launched there on Saturday. The new vessel, which is 70m. long, is made up of two single vessels joined together and fitted with appliances, so that it can be used for raising and docking a submarine which has come to grief. Above the middle of the two parts of the ship strong cranes with a lifting capacity of 500 tons will be placed which will hoist the submarine out of the water and place her on movable supports, when the repairs can be effected. The salvage vessel will be fitted with steam-engines and electric motors, and will have a speed of 11 or 12 knots. The cost is being defrayed out of three million marks set aside in the naval estimates for the construction of new submarines and the continuation of experiments.

Southborough.—A letter has been received from the superintendent engineer of the Post Office Telegraph Department to the Urban District Council stating that, in reference to his previous application for consent to erect certain telegraph poles, he pointed out that it was proposed to erect ornamental patent poles, and these would be so arranged that they would in no way be dangerous to motor and other traffic, and he would be glad if the clerk would cause this to be explained at the Council's meeting. If necessary, he would be pleased to arrange for the Department's engineer to go over the route with the Council's representative in order to arrange suitable sites for the poles. The line was being erected in order to establish telegraph communication at Southborough New Town, and he trusted that no objection would be raised to granting the necessary consent. The Council have decided to consent to underground cables only.

Wrexham.—The Electricity Supply Committee have recommended the Council to adopt the following scale of charges for electrical energy used for motor purposes: up to 200 units per quarter 2½d. per unit; for each unit in excess of 200 units and not exceeding 300 per quarter, 1¾d. per unit; for each unit in excess of 300 units per quarter, 1½d. per unit; with a discount for prompt payment of ¼d. per unit in all cases. The electrical engineer's monthly report includes the following statement: Electricity used for tramways, August, 1907, 13,991 units, July, 1907, 13,237 units; used for lighting, etc., August, 1907, 26,348 units, July, 1907, 22,881 units—total units generated, August,

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1907, 40,339; July, 1907, 36,118. New consumers connected, four. The Council have agreed to make application to the Local Government Board for sanction to the borrowing of the sum of £500 for providing a 60-kw. set in connection with the electricity supply undertaking.

Westminster.—The City Council Electricity Committee have received a letter from the Westminster Electric Supply Corporation enclosing certificate *re* test of the electric light installation at Caxton Hall. The test was made on July 25, 1907, and the insulation was found to be well above that required by the rules of the Institution of Electrical Engineers. The switches and distribution boards were all examined and overhauled, and are in a satisfactory condition. The corporation state that their men have adjusted the tension on the spring contacts, and left the fuses in a safe condition, but owing to the spring contacts being made of soft copper, these will not keep tight, and ought to be constantly examined and adjusted. They state that the whole installation is a first-class job with this one exception. The committee have directed the town clerk to make inquiries of the corporation as to whether the defect mentioned should be remedied, and at what cost.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to Alby United Carbide Factories' 2,500 vendors' ordinary shares of £1 each, fully paid, Nos. 22,501 to 25,000; a further issue of 70,000 ordinary shares of £1 each, 16s. paid, Nos. 101,001 to 170,000; and 65,000 5½ per cent. cumulative preference shares of £1 each, 16s. paid, Nos. 1 to 65,000 (special application). The committee has also been asked to appoint a special settling day in Matale Ceylon Rubber Co.'s 15,000 shares of £1 each, fully paid, Nos. 15,001 to 30,000; United Serdang (Sumatra) Rubber Plantation's 69,000 shares of £1 each, 15s. paid, Nos. 1 to 69,000; and Willans and Robinson's funding certificates for £34,999. 13s; and to allow the Alby United Carbide Factories' 97,500 ordinary shares of £1 each, fully paid, Nos. 1 to 22,500 and 25,001 to 100,000 (special application), to be quoted in the official list.

York.—The Council Electricity Committee report that the cable for the supply of electricity to the Friends' Retreat, on the Heslington-road, has been laid down by a connection with the cable on the Cemetery-road, and the wiring and installation of the electric light at the Scarcroft and Park-grove Council Schools have been completed. A new feeder pillar is being erected in Parliament-street, which will do away with several of the old type of disconnecting boxes at the corner of Parliament-street and Pavement. The committee have accepted the tender of Messrs. Rymer Bros. for the supply of coal required for the electricity department for the ensuing 12 months. They have also accepted the tender of Messrs. Catling and Co., of Layerthorpe, for painting the electric lamp-posts, brackets, piping, boxes, etc. A letter had been received by the chairman of the committee, Alderman Scott, from Mr. John Fenwick expressing satisfaction with electric work done by the department for his firm.

Bristol.—The adjourned Local Government Board inquiry respecting an application of the Bristol Corporation to borrow £34,600 to extend their electric undertaking at Avonmouth was held at the Council House on the 1st inst. by Mr. H. R. Hooper. The town clerk having given details of the indebtedness of the city, setting forth that of every committee and the unexercised borrowing powers, said that when the inquiry was opened it was gathered that he (the inspector) wished to have before him the capital cost of the four schemes which had been considered by the Electrical Committee, and also the annual cost of working each scheme. Mr. Faraday Proctor had worked out the capital cost and the annual cost in respect to each of these schemes, which he would lay before him. He had been in consultation with Major Cardew, who agreed with those figures. When the evidence had been given he (the town clerk) believed that he (the inspector) would be satisfied that scheme No. 1 was in all respects the best which could be devised for the purpose. After hearing the evidence the inspector closed the inquiry.

Colne.—At the last meeting of the Town Council the electrical engineer submitted his monthly report upon the work of the department since the previous meeting, which was accepted and ordered to be filed. The engineer again introduced the question of the proposed extension of the electric cable to Cotton Tree district, and submitted particulars as to the number of persons who had expressed a desire to be supplied with electricity for lighting and power purposes in that district, and, after consideration, it was resolved that the engineer be instructed to obtain further information upon the matter, and submit the same to a meeting of the sub-committee, who shall be empowered to authorise the carrying out of the work if they deem the probable consumption sufficient to justify the necessary capital outlay. The engineer reported upon the preparatory work which was necessary in connection with the installation of the new dynamo and boiler on order for the electricity works, and it was resolved that the construction of the engine bed and the boiler seating be carried out by workmen to be employed by the engineer.

Belfast.—At a meeting of the Electrical and Tramways Committee the clerk read the following letter: "Local Government Board, Dublin, Sept. 20, 1907. Sir,—The Local Government Board for Ireland have had before them the plans, etc., forwarded by you on the 13th inst., in respect of the application of the Corporation of Belfast for sanction to a loan of £75,000 for the purpose of providing additional plant and meters, and making extensions in connection with the electric lighting system of the city; and in reference thereto, and to previous correspondence on the subject, the Board desire to express their sanction to the borrowing of the sum applied for in pursuance of the Electric Lighting Acts, and Section 237 of the Public Health (Ireland) Act, 1878, repayment to be made within a period of 25 years—that being the longest which can be allowed having regard to the character of the works to be carried out under the loan, as disclosed in the specifications. The plans, etc., have been retained in this department.—I am, sir, your obedient servant, H. Courtenay, assistant secretary.—Town Clerk, Town Hall, Belfast."

Portable Wireless Apparatus.—The United States army is being equipped with a light, portable, and compact wireless telegraphic outfit which can easily be transported on pack animals. One 2-kw. dynamo is provided for each army division which can be driven by a spirit motor. This dynamo weighs 135 kilos, and will be carried in one of the horsed wagons belonging to the ordinary baggage train of the division. The transmitter and receiver are distributed amongst the various companies. Each group of apparatus weighs no more than 140 kilos, and is so arranged as to be carried by a pack horse. They comprise the two elements of the accumulators, which are charged for 10 hours' working; 10 sections of a mast which, when put together, make an antenna 18m. high; and the receiver and transmitter. The latter are constructed for a workable radius of from 25 km. to 40 km. Fessenden's electrolytic detector is used in the receiving instrument. It is stated that each installation can be placed together and put into working order within about 20 minutes.

Southampton.—At the last meeting of the Town Council the Electricity and Tramways Committee, having considered a report on the subject of free wiring from the electrical engineer, recommended the Council to obtain parliamentary powers to carry on the work of free and assisted wiring, to install wires, fittings, etc., and to hire out arc lamps, heating apparatus, and motors, either at a rental or on the deferred payment system. It was explained that the work had formerly been done by a company, but the latter had been given formal notice to terminate the agreement, as the Corporation thought it would be better to carry out the work themselves. It was felt that a large number of people would use the light if it were not for the initial cost. The clause was agreed to. The same committee stated that they had had under consideration the resolution of the Council as to placing the electric light and tramway undertakings under separate committees and management, and it was recommended that the resolution of the Council passed at their meeting on the 11th ult. do take effect, as far as the appointment of separate committees was concerned, on Nov. 9 next. Agreed to.

Devonport Exhibition.—Further to our brief note respecting this exhibition, which is meeting with considerable success, and attracting a great amount of interest throughout the neighbourhood, we are informed that Messrs. W. C. Heath and Co., electrical contractors, of Plymouth, exhibited a number of the latest types and patterns of electrical supplies there. In addition to an interesting range of Ediswan instruments and desk fans, etc., they are taking time by the forelock, and preparing their customers for the coming winter by illustrating practically the uses of electric radiators, those on exhibition being of Ediswan manufacture. Since it is evident that no exhibition would be complete without the "Ediswan-Carbone" flame arc, two of the yellow flame pattern were shown burning, with the remarkable efficiency of 5 c.p. per watt, or one-fifth watt per candle, a figure which quite casts into the shade any of the recent American or Continental importations. With a view of also showing the possibilities of the smaller patterns, two of the new four-ampere "Ediswan Radiant" enclosed arc lamps were also shown, and in view of the great efficiency of both the "Ediswan-Carbone" and "Ediswan Radiant," it is interesting to note that both the types are British made throughout at the Ediswan Works, Ponder's End, Middlesex.

Brighouse.—At the last meeting of the Town Council a report was presented, signed by the mayor, dealing with the terms proposed by the Yorkshire Electric Power Co. to supply in bulk the electricity required in the borough. The report stated that the company were prepared to give a supply of direct current for tramways and lighting at a charge of £6 per annum per kilowatt of maximum demand, plus ¼d. for all units consumed, the charge for the whole supply not to exceed 1·25d. per unit. The period fixed was 14 years, with a revision of price at the end of seven years. The company required a guarantee of minimum annual payment of 30,000 units per annum for lighting, and when the tramways take their load a minimum quantity should also be stated. Unless the tramways came along before September, 1908, the company were not compelled to give a supply of current before that period. In that case the company were prepared to give the supply of energy to the trams, the minimum not to exceed for lighting and power £1,000 per annum. The Corporation is to provide the land, build the transforming sub-station, and provide the switchboard and balancer; the company to put down all transforming plant and apparatus, supply all labour in the sub-station, and bear all loss of transforming except the loss in the balancer. The report was adopted by the Council.

Torquay.—To the Council at their meeting Mr. John A. Purves, Exeter, wrote that he and his brother were owners of the electric light and power provisional order for Paignton, and that it was their intention to at once proceed with the erection of a station and the laying of mains. They had been approached by the Dolter Electric Tramway Co. and the National Electric Traction Co. regarding the supply of power for the proposed extension of the tramways into Paignton. If they did this they would have to put down a power station of considerable magnitude, and it occurred to them that, instead of supplying power, they might arrange to sell electricity in bulk to the Torquay Corporation, who could then resell to the tramway company, or use it for their own consumption as they thought fit. Should it be thought there was anything in his suggestion, he would be glad if they would make an appointment for him to meet the committee, when the matter could further be discussed. Alderman Mortimer, chairman of the Electric Lighting Committee, to whom the letter was addressed, said he did not think they were justified in entering upon negotiations on the lines suggested, and he did not regard the matter as of sufficient importance to bring before the Council. The Mayor said they had their own electricity works, and should not sacrifice them to take power in bulk. The matter was referred to the Electric Lighting Committee.

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PROVISIONAL PATENTS, 1907.

SEPT. 23.

21039. Improved ring or nut for securing shades to incandescent electric lampholders. Jabez Barnes, 128, Colmore-row, Birmingham.

21072. Improved trolley head. David Amos and Herbert John Carroll, 56, Ludgate-hill, London.

21073. Improvements in and relating to windings of dynamo-electric machines. Siemens Bros. Dynamo Works, Limited, and Max Kloss, Queen Anne's-chambers, Broadway, Westminster. (Complete specification.)

21077. Improvements in electromotors. Charles Arthur Allison, 52, Chancery-lane, London. (Hugh Behan, United States.) (Complete specification.)

21086. Improvements in electric signs and the like. John Herbert Graham and Abram Emanuel Abrahams, 8, Quality-court, Chancery-lane, London.

21087. Improvements in diaphragms or tympans for phonographic and telephonic apparatus. Joseph George Coombs, 55, Chancery-lane, London. (Complete specification.)

21104. Magazine fuse for electric light and power circuit. Percy Basil Fletcher, 165, Queen Victoria-street, London. (Complete specification.)

21106. Improved system of single and multiplex telegraphy. Simon Eisenstein, 7, Southampton-buildings, London.

21119. Improvements in electric indicators. Carl von Pecz, 31, Bedford-street, Strand, London. (Complete specification.)

21127. Improved anti-vibration device for the electric lamps of automobiles, carriages, and the like. John Oldfield and Robert Alexander Oldfield, 5, Corporation-street, Birmingham.

SEPT. 24.

21145. Improvements in and relating to electrical fittings. Eustace Graham Sheppard, Brook Green Works, Hammersmith, London.

21167. Improvements in switches for electric circuits. Erich Pirdschun, 91, Lindenallee, Essen-on the-Rhur, Germany.

21173. Improvements in or relating to automatic switches for use in electric circuits. Siemens Bros. Dynamo Works, Limited, 139, Queen Victoria-street, London. (Siemens-Schuckertwerke, G. m. b. H., Germany.) (Complete specification.)

21174. Improvements in or relating to switches, relays, measuring instruments, and the like, for use in electric circuits. Siemens Bros. Dynamo Works, Limited, 139, Queen Victoria-street, London. (Siemens-Schuckertwerke, G. m. b. H., Germany.) (Complete specification.)

21176. Electric signal system. Alfred Louis Sohm, 111, Hatton-garden, London. (Complete specification.)

21197. Improvements in or relating to mountings or fittings for tubular incandescent electric lamps. David Assersohn, 7, Southampton-buildings, London.

21224. Improvements in and in the manufacture of boron and in the production of electric incandescing bodies therefrom. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

21225. Improved methods of varying the speed and power factor of asynchronous motors. Ateliers Thomson-Houston (Anciens Etablissements Postal-Vinay), 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Sept. 25, 1906, being date of application in France.) (Complete specification.)

SEPT. 25.

21228. Improvements connected with trolleys for electric traction. Frederick George Holmes, 194, Brighton-road, Croydon, Surrey.

21243. New or improved cleat for wiring electric and telephone wires. Robert Urquhart Cruikshank, 154, St. Vincent-street, Glasgow.

21252. System for wireless telegraphy and telephony. Louis Maiche, 2, Boulevard Beaumarchais, Paris, France. (Complete specification.)

21255. Improvements in or relating to electrical fuses or cut-outs. Edward James Coller, 111, Hatton-garden, London.

21272. Improvements in apparatus for measuring electrical resistance. Evershed and Vignoles, Limited, and Sidney Evershed, 1, Queen Victoria-street, London.

21273. Improvements in and relating to magneto-electric machines for ignition purposes. Charles Anthony Vandervell and Frederick Isidore Hoffman, 1, Queen Victoria-street, London.

21299. System of directed wireless telegraphy. Ettore Bellini and Alessandro Tosi, 31, Bedford-street, Strand, London. (Complete specification.)

21308. Improvements in and relating to switch mechanism. Allgemeine Elektricitäts-Gesellschaft, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Sept. 26, 1906, being date of application in Germany.) (Complete specification.)

21307. Improvements in filament supports for electric incandescent lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

SEPT. 26.

21332. Improvements in or relating to electrically-heated apparatus. Walter Henry Welch and Harvey Frost and Co., Limited, 111, Hatton-garden, London.

21336. Improvements in and relating to electric plugs and sockets. John Charles Chalmers and William Alexander Robertson, 44, West George-street, Glasgow.

21341. Improved globe or shade holder for inverted incandescent and other gas lights and for electric lights. The Birmingham Lamp and Gasfittings Company, Limited, and Arthur Edward Davies, 128, Colmore-road, Birmingham.

21363. Improvements in or in connection with the control of electric motors. John Smith Raworth and Arthur Basil Raworth, Queen Anne's-chambers, Westminster. (Complete specification.)

21403. Improvements in combined electric and percussion primers for ordnance. Severiano Antonio de Castilho, 24, Southampton-buildings, London.

21407. Improved brush-holder for dynamo-electric machines. Athelstan John Garratt, 322, High Holborn, London.

21408. Improved detector for wireless telegraphy. William Phillips Thompson, 6, Lord-street, Liverpool. (Ges. für drahtlose Telegraphie m. b. H., Germany.) (Complete specification.)

21414. Improvements in electrical transmitting apparatus for controlling the sighting of guns. Arthur Trevor Dawson and George Thomas Buckham, 7, Southampton-buildings, London.

SEPT. 27.

21438. Suspenders for electrical conductors. William Ernest Gray, India Rubber, Gutta Percha, and Telegraph Works Company, Limited, Silvertown, Essex.

21460. Improvements in armature windings. Siemens Bros. Dynamo Works, Limited, Charles Altmann, and Wilhelm Lau, Queen Anne's-chambers, Broadway, Westminster. (Complete specification.)

21467. Improvements in or relating to electricity meters. Elektrizitäts Akt.-Ges., vorm. Schuckert und Co., 139, Victoria-street, London. (Date applied for under Patents Act, 1901, Oct. 3, 1906, being date of application in Germany.) (Complete specification.)

21475. Improved electric battery, also applicable for the manufacture of sulphuric acid. Lucien Paul Basset, Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Oct. 2, 1906, being date of application in France.) (Complete specification.)

21476. Improved manufacture of incandescent electric lamps having metal filaments. Arthur George Bloxam, Birkbeck Bank-chambers, Southampton-buildings, London. (Siemens und Halske Akt.-Ges., Germany.) (Complete specification.)

21478. Holder for carbons of arc lamps. Horace Ashton, 33, Cannon-street, London.

SEPT. 28.

21507. New or improved electrical stop motion for engines. James Edward Sweet and Anthoney Hargreaves Waite, 4, St. Ann's square, Manchester.

21510. Improvements in or connected with electric switches. Ivan Vlasto, Thomas Clark, and William Watson, 15, Water-street, Liverpool.

21516. Automatic switch for electrical transformers. Percy Good, 11, Southwark-street, London.

21531. Improved electrical telegraphic and mechanical transmitter. William Hamilton, 94, Heald-place, Rusholme, Manchester.

21535. Improvements in and relating to electric transformers. Louis Maiche, 2, Boulevard Beaumarchais, Paris, France. (Date applied for under Patents Act, 1901, Dec. 6, 1906, being date of application in France.) (Complete specification.)

21537. New or improved pole for operating the trolley arms of electric tramcars and like vehicles. Mark Webster, 3, Brown-street, Market-street, Manchester.

21551. Improvements in control systems for electrically-propelled vehicles. William Cooper, Westinghouse Building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Oct. 3, 1906, being date of application in United States.) (Complete specification.)

21569. Improvements in or connected with telephone receivers. Eugene Durand, 88, Chancery-lane, London.

21574. Improvements in induction coils for generating high-tension current. William Phillips Thompson, 6, Lord-street, Liverpool. (Polyphos Elektrizitäts, G. m. b. H., Germany.)

21584. Improvements in dynamo-electric machines. James Burke, 55, Chancery-lane, London. (Date applied for under Patents Act, 1901, Feb. 4, 1907, being date of application in United States.) (Complete specification.)

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21588. Improvements in or relating to electric controllers for railway service and the like. Thorsten von Zweigbergk, 111, Hatton-garden, London. (Complete specification.)

21579. Improvements in and relating to wireless transmission of electric emanations. Harry Grindell Matthews, 22, Southampton-buildings, London.

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Oct. 17.)

1906.

16746. Apparatus for use in electric telegraph systems. Johnson and Johnson Secret Wireless Telegraph and Telephone Testing Syndicate.

18687. Splicing ear for electric trolley wires and the like. Croft.

18965. Telephonic apparatus. Graham.

20308. Compensated dynamo-electric machines having commutating poles. Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, Sept. 20, 1905.)

21513. Process and apparatus for the treatment of metallic tungsten and for the manufacture of electric lamp filaments therefrom. British Thomson-Houston Company. (General Electric Company.)

21669. Manufacture of electric incandescent lamps having metal filaments. British Thomson-Houston Company. (General Electric Company.)

23012. Arc lamps. Angold and Maxim Electrical Company.

24669. Inductor electric generator. Rabbidge.

27210. Dynamo-electric generators. Leitner.

28509. Lightning arresters and like protective devices for electrical installations. Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, Jan. 2, 1906.)

1907.

1196. Supports for the filaments of incandescent electric lamps. British Thomson-Houston Company. (Allgemeine Elektricitäts-Ges.)

1585. Machines for use in the manufacture of incandescent electric lamps. British Thomson-Houston Company. (General Electric Company.)

2053. Electrical apparatus for automatically indicating the positions of trains on railways. Trautmann, née Sprie.

2202. Brushes for use in dynamo-electric machines. Akt.-Ges. Brown, Boveri, et Cie. (Date applied for under International Convention, Feb. 2, 1906.)

2460. Manufacture of compositions of matters of a refractory character and adapted for electrical insulation and other uses. Brooks. (Asbestos Wood Company.)

2604. Electric time switches. Cauderay. (Date applied for under International Convention, Feb. 6, 1906.)

2687. Electrical transmission of power. Siemens Bros. Dynamo Works, Limited. (Siemens-Schuckertwerke Ges.)

3631. Iron electrodes for accumulators with alkaline electrolyte and method for manufacturing same. Jungner. (Date applied for under International Convention, Feb. 14, 1906.)

3711. Method of producing electro-active cement-like substances of iron and nickel hydrates for forming electrodes, and accumulators constructed with such electrodes. Jungner. (Date applied for under International Convention, Feb. 15, 1906.)

3831. Method for the production of electrodes of magnetic metals by means of electrolytic oxidation, electrodes produced in this manner, and accumulators provided with such electrodes. Jungner. (Date applied for under International Convention, Feb. 16, 1906.)

4714. Signalling by electromagnetic waves. Fessenden.

5958. System of push-button apparatus for operating or controlling electric lifts. Mair.

6341. Apparatus for controlling electric currents. Bremaecker.

6973. Electric brakes for electromotors. Kallmann.

7529. Thermo-mercurial electric contact makers. Ogle.

7984. Electromagnetic devices for the obtaining of a sequence of effect as applied to automatic controlling devices and the like. Smith and Linzell.

9554. Dynamo-electric machines provided with commutating poles. Mudge. (Date applied for under International Convention, Aug. 24, 1906.)

9743. Means for locking electric switch boxes. Day. (Meyer Akt.-Ges.)

11475. Operating devices for electrical switches for use in connection with train-controlling systems. Siemens-Schuckertwerke Ges. (Date applied for under International Convention, June 16, 1906.)

11917. Electrodes for resistance furnaces. Rochling, Schoenawa, and Rodenhauser.

12223. Electric arc lamps. Girdlestone and Thorkelin.

13062. Photometer for testing the luminous power of electric lamps. Bartels.

17067. Electric hand lamps. Loebl and British Ever-Ready Electrical Company.

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.

Name.	Amount paid.		Last price.
	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	–	½-⅝
—— Ord., 1 125,000	1	..	¼-½
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1	–	5/32 9/32
British Aluminium Co., Ordinary, 2,001-40,000	5	..	4-5
—— 7 per cent. Cum. Pref., 1-40,000	5	..	4½-5⅝
—— "A" 6 per cent. Cum. Pref., 1-20,000	5	..	4½-5
—— 4 per cent. Funding Certificates, 1-20,000	5	..	3⅝ 4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	100-103
—— 5½ per cent. Loch Leven Deb. (Reg.), Red., 1-3,000	100	..	96-99
British Insulated and Helsby Cables, Ord., 1-100,000	5	–	6¼ 7 xd
—— 6 per cent. Cum. Pref., 1-100,000	5	–	5⅝-6¼
—— 4½ per cent. Mortgage Debentures	100	–	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	–	85 8
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	3	–	1-1½
—— 4 per cent. Mortgage Debenture Stock	100	–	62 67
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	–	½-¾
—— Non. Cum., 6 per cent. Pref.	2	–	¾-1½
—— 4½ per cent. 1st Debenture Stock	100	–	85-86
—— 4½ per cent. 2nd Debenture Stock	100	–	68-71
Callender's Cable, Debentures	100	–	105½-107½
—— Ordinary	5	–	9⅜-10⅜
—— 5 per cent. Pref.	5	–	5¼-5⅝
Consolidated Electrical Co., Ordinary, 1-110,000	1	..	7/16 9/16
Crompton and Co.	5	..	1½-2 6
—— 5 per cent. Debentures	100	–	96-99
Dick, Kerr, and Co., Ordinary, 1 250,000	1	..	1½-1¾ xd
—— 6 per cent. Cum. Pref., 1-305,000	1	..	1-1½ xd
—— 4½ per cent. Debenture Stock, Red.	100	..	101-104
Edison and Swan United, "A" Shares, 1-99,261	5	..	1 1/16-1 5/16
—— "A" Shares, 01-017,139	5	–	2¼-2⅜
—— 5 per cent. Debentures	100	–	89-92
—— 4 per cent. Deb. Stock, Red.	100	–	83 85
Electric Construction, Nos. 1 to 112,100	2	–	¾-⅞
—— 7 per cent. Cumulative Pref.	2	–	⅞ 1
—— 4 per cent. Perp. 1st Mort Deb.	100	–	77-81
Electrolytic Alkali Co., Ordinary, 1-202,218	1	..	3/16-5/16
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	–	—
General Electric Company (1900), 5 per cent. Cum. Pref.	10	–	8 8¼
—— 4 per cent. 1st Mort. Deb. Stock	100	–	90 95 xd
W. T. Henley's Telegraph Works, Ordinary	5	–	11-12
—— 4½ per cent. Preference	5	–	5-5¼
—— 4½ per cent. Debentures	100	–	105½ 107½
India Rubber, Gutta Percha, and Telegraph Works	10	–	14½ 15½
—— 4 per cent. Debentures	100	–	95 97 x d
National Electric Construction Co., 1-170,000	1	..	13/16 15/16
Parker, Thos., Limited, Ordinary	10	–	10-10¼
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5	..	—
Telegraph Construction and Maintenance	12	–	20½ 21½
—— 5 per cent. Bonds	100	–	98½ 99½
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	..	8¼-8½

Electric Lighting and Supply.—

Name.	Amount paid.		Last price.
	£		£
Adelaide Electric Supply Co., 6 p. c. Cum. Pref., 1-10,000	5	..	4¼-5
Bournemouth and Poole, Ordinary	10	–	9⅜ 10⅜
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	–	9⅜ 10⅛
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	–	9¼-10¼
—— 4½ per cent. Debenture Stock, Red.	100	–	99 100
Bromley (Kent) Electric Light and Power Co.	5	–	4¾ 5⅛ x d
—— 4½ per cent. 1st Debenture Stock, Red.	100	–	98 100
Brompton and Kensington, Ordinary	5	–	7⅛ 8
—— 7 per cent. Preference	5	–	7⅛ 8¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	–	6¾ 7¾
—— Nos. 80,001-100,000	4	–	6¼ 7¼
Cambridge Electric Supply Company, £10 Ord.	8	–	14⅜-15⅜
Canadian General Electric Co., Common Shares	$100	..	101-108 xd
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	–	99 102
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	–	3⅛ 4⅛
—— 4½ per cent. Cum. Pref., 1-80,000	5	–	3⅜ 3⅝
—— 4 per cent. Debenture Stock, Red.	100	–	96 98
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	–	3⅜ 3⅝
—— ditto (1905) 40,001-80,000	5	–	3¼-4¼ xd
Chelsea Electricity Supply	5	–	5¼ 5¾
—— 4½ per cent. Debentures	100	–	104 5
Chicago Edison Co., 1st Mt. 5 p. c. 30-yr. Gld. Bds., Red., 1-1,200	$1000	..	96-99 xd
City of London, Ordinary	10	–	9- 0
—— 6 per cent. Cumulative Pref.	10	–	10½-11½
—— 5 per cent. Debenture Stock	100	–	122-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	–	97-100
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1,533	50	–	50-53
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100	–	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5	..	4¼-5
—— 5 per cent. Preference, 1-50,000	5	..	4¼-5
County of London Electric Supply, Ordinary	10	–	6¾-7¾
—— 6 per cent. Cum. Pref.	10	–	10-11
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	–	106-110
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	–	93-99
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5	–	¾-1
—— 6 per cent. Cum. Pref.	5	–	1½-2
—— 4½ per cent. First Mort. Deb	100	–	76 81
Electrical Development Co. of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, 10,751-15,750	—	..	75½-77½ p.c.
Electric Lt. & Traction Co of Aust., 6 p.c. Cm Pf., 1 30,000	5	–	2¼-2⅜
— 5 per cent Debenture Stock Red	100	–	95½ 99½
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red.	100	–	94-96
Folkestone Electric Supply, Ord. Nos. 1-10,000	5	–	4¾-5¼ xd
—— 4½ per cent. First Deb. Stock, Red.	100	–	98-99
Hove Electric Lighting, Ord., 1-13,000	5	–	6¾-7¼
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100	..	101-104
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Deb. Stk. Red.	100	–	94-97
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	–	—
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5	–	8¼-8½
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	–	93-102
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9⅜-10⅛
London Electric, Ordinary	5	–	1¼-1⅜
—— 6 per cent. Pref.	5	–	4¼-4⅜
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	–	88-92

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Name.	Amount paid. £		Last price £
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock., Red. (Prov. Certs.), all paid	100	..	94-97
Metropolitan Ordinary, 100,001-300,000	5	—	4⅞ 5⅛
—— 4½ per cent. First Mortgage Debenture Stock	100	—	103-107
—— 4½ per cent. Cum. Pref.	5	—	4⅞ 5⅛
—— 5½ per cent. Mortgage Debenture, Red.	100	—	87-92
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds. 1935, C 1-1,000 ($100), D 1-5,000 ($500), M 1-4,400 ($1,000	—	..	72-74 p.c.
Mexican Light and Power Co., Capital Stock	$100	..	46-48
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 $500), 4,001-14,000 ($1,000)	—	..	81½-83½
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	—	96-98
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,000	5	—	6¼ 6⅜
—— do., 57,001-75,000	5	—	6¼ 6⅜
—— do 75,001-87,500 (issued at £22 prem., 16s. paid)	5	—	6¼ 6⅜
—— 5 per cent. Pref., 1-57,000	5	—	5 5¼
—— do., 75,001-87,500 (issued at 10s. prem., 4s. paid)	5	..	5-5¼
Notting Hill Electric Lighting	10	—	11 12
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	—	95 97
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	—	5⅛ 6 xd
—— 4 per cent. Debenture Stock	100	—	95 97
River Plate Electricity Co., Ord., 1-119,687 & 120,501-120,507	1	..	⅞-1
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	..	⅞-1
—— 4 per cent. Debenture Stock, Red	100	..	95-98
Rosario Electric Co., 6 per cent. Cum. Pref., 1-20,000	5	..	4⅞-5⅛ xd
—— 6 per cent. Cum. 2nd Pref., 1-15,000	5	..	4⅞-5⅛ xd
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	—	96 98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	—	..	99 101 p.c.
Smithfield Markets Electric Supply, Ord. 1-12,000	5	—	½-1½
—— 4 per cent. Debenture Stock	100	—	71-75
South London, Ordinary	5	—	1⅞ 2⅛
South Metropolitan Electric Light and Power, Ord.	1	—	⅞-1
—— 7 per cent. Cum. Pref.		—	15/16 1 3/16
—— 4½ per cent. 1st Mort. Deb.	100	—	98-100 xd
St. James's and Pall Mall, Ordinary, 101-20,080	5	—	7⅛ 8⅛
—— 7 per cent. Pref.	5	—	6⅞-7⅛
—— 3½ per cent. Deb.	100	—	86-91
Urban Electric Supply Co., Ordinary, 8-30-007	5	—	1⅛ 2⅛ xd
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	—	1⅞-2⅛ xd
Westminster, Ordinary	5	—	8½ 9½
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	—	4⅞-5⅛

Electric Tramways.—

Name.	Amount paid. £		Last price. £
Anglo-Argentine, 5½ per cent. Cum. Pref., 1-260,007	5	—	5 15/16-6 3/16
—— Ord.	5	—	7 1⅞ 7 15/16 xd
—— Permanent 6 per cent. Debenture Stock, 1888	100	—	131-134
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	—	102-105
Barcelona Tramways, Ord., 1-20,000	10	—	—
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	—	—
—— 5 per cent. Deb., Red., 1-500	100	—	—
—— 4½ per cent. Red. Deb. Stock	100	—	—
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1	—	11/16 13/16
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	—	27/32-31/32
Birmingham and Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100	..	91-93 xd
Blackpool and Fleetwood Tramroad	10	—	13⅝-13⅞
Bombay Elec. Supply & Trams. Co., 6 per cent. Cum. Pref.	8	..	7⅛-8
—— 4½ per cent. Deb. Stock, Red.	100	..	94-96
Brisbane Tramway Invest., Ord., 1-75,000	5	—	3 5/16 3 9/16
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	—	4⅞-5⅛
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	—	96-100
British Columbia Electric Railway Co., Ord. Def.	100	—	130 135
—— Ord. Pref.	100	—	113-117
—— 5 per cent. Cum. Perpetual Pref. Stock	100	—	104-107
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	—	100-103
—— 4½ per cent. Vancouver Power Deb.	100	—	102-104
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	—	1⅞-2⅛
—— 6 per cent. Cm. Pf., 30,001-60,000	10	—	5⅛-6⅜
—— 5 per cent. Perpetual Debenture Stock	100	—	97-100 xd
—— 4½ per cent. 2nd Deb. Stock	100	—	78-81
Buenos Ayres and Belgrano Trams.	5	—	4 7/16 4 11/16
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	—	4⅜-5⅛ xd
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	4⅜-5⅛ xd
—— 5 per cent. Deb. Stock, Red.	100	—	105-115
—— Prov. Cert., all paid	100	—	102 105
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100	—	92-97
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb. Bonds, Red., 1-1,500	100	..	99-103
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	..	100-105
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	91-94
Calcutta Tramways, 1-105,000	5	—	7-7½
—— 105,001-157,610	5	—	5-5⅛
—— 4½ per cent. 1st Deb. Stock, Red.	100	—	102-106
Cape Electric Tramways, Nos. 1-480,000	1	—	5/16 7/16
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	—	4⅛ 4⅜
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100	—	98 101
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	..	5⅛-5⅜
—— 4 per cent. Deb. Stock, Red. 1985	100	..	98 102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	00	—	94-98
Cork Electric Tramway and Lighting Co., Ordinary	10	—	13-14
—— 6 per cent. Cum. Pref.	10	—	12⅞-13⅜
—— 4 per cent. Debentures	100	—	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	—	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	—	12⅞-13⅜
—— 3½ per cent. Mort. Debs., 1-3,000 Red.	100	—	93-97
Hastings and Dist Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100	..	97-100 xd
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6,857	$1,000	—	82-87
Imperial Tramways, Ordinary	all	—	18-19
—— 6 per cent. Cum. Pref.	all	—	14-14½
—— 4½ per cent. Deb. Stock	100	—	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5	—	⅞ 1⅛
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	—	66-71
Kalgoorlie Electric Tramways, 1-250,000	1	..	3/32-5/32
—— 5 per cent. "A" Deb. Stock	100	..	89-93
—— 6 per cent. "B" Deb. Stock	100	..	77-81
Kidderminster and District Lighting and Traction, Pref.	5	—	9⅜ 10⅛
Lancashire United Tramways Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	—	94-97
—— £296,500 2nd Mort. Deb Stock	—	—	—
—— £33,330 Deferred Deb Stock (all fully paid)	—	—	—
Lisbon Electric Tramways Limited, Ord., Nos 1-594,188	1	..	1-1⅛
—— 6 per cent. Cum. Pref., Nos. 1-425,653	1	—	1-1⅛
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100	..	92-97
London United Trys. (1901), 5 per cent. Cum. Pref.	10	—	7⅜-8⅜
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	—	82-86
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Rd.	100	—	96-9

Name.	Amount paid. £		Last price £
Manila Elec. R.R. and Lghtg. Corp., 5 p.c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1, 00	..	90-92
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,625 and 23,436-25,000		..	4⅛-5 xd
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	96 98 xd
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,000	1	—	1/16 3/16
—— 5 per cent. Cum. Pref., 600,001-1,000,000	1	—	27/32-29/32
—— 4½ per cent. Deb. Stock, Red.	100	—	94 97
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	—	..	79-81 p.c.
Milwaukee Electric Rail and Light, 5 per cent. 20-yr Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	—	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., £01-2,000 1922	100	—	101-103
New General Traction, 6 per cent. Cum. Pref., 1-10,000 54,001-74,000	5	—	⅜-½
Oldham, Ashton, and Hyde Tramway, Ordinary	10	—	8
—— 5 per cent. Cum. Pref.	10	—	8⅜-8
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mtt. Deb. Stk.	100	—	101 105
Potteries Electric Traction, Ordinary, 1-245,000	1	—	¼ ⅜
—— 5 per cent. Cum. Pref., 300,001-345,000	1	—	¼ ⅜
—— 4½ per cent. Debenture Stock	100	—	95-98
Provincial Tramways Co., Ordinary, 1-58,912	10	—	4⅜-5⅛
—— 6 per cent. Cum. Pref., 1-10,000	10	..	10⅛-13⅛
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-30,000	5	..	5⅛-5⅜
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	97-99
Sao Paulo Tramway, Light, and Power Co.	$100	..	108-113 xd
—— 5 per cent. 1st Mort. Deb., Red. 1929. 1-11,000	$500	..	93-95 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1	..	⅞-1
—— 4 per cent. Deb. Stock, Red. 1940	100	..	80-84
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs, Red., 1-1,600	100	..	84-88
Yorkshire (West Riding) Elec. Tram. Co., Ord., 70,001-110,000	5	..	1-1⅛
—— 6 per cent. Cum. Pref., 1-46,261	5	..	3⅛-3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	87-90

Electric Railways.—

Name	Amount paid. £		Last price £
Central London, Ordinary	100	—	63 68
—— 4 per cent. Pref.	100	—	88-90
—— ,, ,, deferred	100	—	45-48
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	—	102-105
City and South London, Consolidated Ordinary	100	...	45-47
—— 4 per cent. Debenture Stock	100	...	102-105
—— 5 per cent. Pref. Stock '91	100	...	116-119
—— ,, ,, ,, '96	100	—	113-116
—— ,, ,, ,, '01	100	—	113-116
—— ,, ,, ,, '03	100	...	108-111
Liverpool Overhead, 5 per cent. Pref.	10	—	10-10⅛
—— Ordinary, 1-50,000	10	—	3⅞-4⅛
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	—	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	...	55-58

Telegraphs and Telephones.—

Name.	Amount paid. £		Last price. £
Amazon Telegraph Co., 1-25,000	10	..	3-3½
—— 5 per cent. Debs., Red., within 1-1,069	100	..	85-88
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000	$1,000	..	90-92
Anglo-American Telegraph Co., Ordinary	100	..	95-98
—— 6 per cent Preferred Ordinary	100	...	97-100
—— Deferred Ordinary	100	...	15½ 16
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort Deb. Stock, Red.	100	...	99-102
Chili Telephone Co., 1-44,000	5	...	6⅜-7¼
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100	...	90-92 xd
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	...	6¼-7⅛
—— 10 per cent. Preference, 1-6,000	10	...	15⅜-16⅜
Direct Spanish Telegraph Co., Ordinary	5	...	3⅛-3⅜ xd
—— 10 per cent. Cum. Preference	5	...	9-9½
—— 4½ per cent. Debs., 1-600	50	...	98-101
Direct United States Cable Co.	20	...	12¼-12¾
Direct West India Cable Co., 4½ per cent. Debs., Reg. within 1-1,200, Red.	100	...	100-102
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1929	100	...	97½-100½
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8,000, 1913	25	...	100-102
Eastern Extension, Australasia and China, 1-300,000	10	...	11⅜-12⅛
—— 4 per cent. Mort. Deb. Stock, Perp.	100	...	102-104
Eastern Telegraph Co., Ordinary Stock	100	...	130-135
—— 3½ per cent. Preference Stock	100	...	86-88
—— 4 per cent. Mortgage Debenture Stock	100	...	103-105
Great Northern Telegraph Co. (of Copenhagen)	10	...	34-36
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1,200, Red.	100	...	100-102
Indo-European Telegraph Co.	25	...	56-57
Marconi's Wireless Telegraph Co., 1-256,127	1	...	13/16-1 1/16
—— 256,128-384,190	1	...	⅞-1
Monte Video Telephone Co., Ordinary, 1-72,680	1	..	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492		...	¾-1
National Telephone, Preferred	100	...	106-108
—— Deferred Stock	100	—	106-108
—— 6 per cent. Cum. First Pref.	10	—	10⅛-12⅛
—— 6 per cent. Cum. Second Pref.	10	—	10-12
—— 5 per cent. Non. Cum. Third Pref.	5	—	5⅛-5⅜
—— 3½ per cent. Deb. Stock, Red.	100	—	86-88
—— 4 per cent. Deb. Stock, Red.	100	—	101-103
Oriental Telephone and Electric Company	1	..	1⅛-1⅜
—— 6 per cent. Cum. Pref.	1	..	13/16 15/16
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100	...	97-100
United River Plate Tele. Co., Ordinary, 1-100,000	5	...	7-8
—— 5 per cent. Cum. Pref., 1-40,000	5	...	5-5⅛
—— 5 per cent. Debenture Stock, Red.	100	...	—
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	...	99-102
West African Telegraph Co.	10	...	10-10⅛
West Coast of America, 1-30,000 and 53,001-53,008	2½	...	1⅜-1⅝
—— 4 p.c. Debs., 1-1,500, Gua. by Western Telegraph	100	...	97-100
West India and Panama Telegraph Co., Ordinary	10	...	7/16 9/16
—— 6 per cent. Cum. 1st Preference	10	...	7⅛-7⅜
—— 6 per cent. Cum. 2nd Preference	10	...	6⅛-7⅛
—— 5 per cent. Debs., Red., 1-800	100	...	99-102
Western Telegraph Co., 1-207,930	10	...	12⅛-12¾
—— 4 per cent. Debenture Stock, Red.	100	...	100-103

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.							Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1907.	1906.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Sept 25	1,579	2 205	- 625	— h	25½	25	May 31	64,071	15,530,351	1,379,723	0 98	11·14	2,512	6·45
Ayr Corporation	,, 28	3 1	363	- 52	—	8	8	,, 15	14,528	3,316,380	353,945	1	9·71	1,830	5·16
Baker Street and Waterloo Ry.	,, 23	2 310	1,580	+ 730	+ 11,625	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 29	1,133	1,151	- 18	- 423	23·53	3·53	March 31	55,025	11,145,531	1,309,903	1·18	10·08	2,338b	6·03
Birmingham Corporation	,, 28	6 673	—	—	—	56½	—	,, 31	17,133	4,709,788	266,526	·86	14·5	8,866	—
Blackburn Corporation	,, 25	1,213	1,067	+ 146	+ 1,760	24	24	,, 25	48,875	8,661,720	986,953	1·35	11·29	2,036	7·44
Blackpool Corporation	,, 24	1 956	1,803	+ 153	- 1,809	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	,, 28	1,127	1,122	+ 5	- 1,193	16½	16½	Dec. 31	31,846	2,325,677	573,264	3·28	13·19	—	7·27
Bolton Corporation	,, 29	2 329	2,145	+ 183	+ 3,552	42	40	March 31	95 766	20,205 196	2,161,130	1·13	10·63	2,394	6·14
Bournemouth Corporation	,, 25	1,9.0	1,842	+ 78	+ 941	17·41	16·82	,, 31	55,276	10,058,288	1,121,623	1·32	11·83	3 226	7·19
Bradford Corporation	,, 28	4,862	4 645	+ 3 7	+ 1,788	95	95	,, 31	230,085	47,108,000	5,053,392	1·172	10·127	2,396	—
Brighton Corporation	,, 29	1,030	1,031	- 1	- 2,683	9½	9½	,, 31	50,339	11,321,160	1,152,828	1·06	10·48	2,914·8	8·0 4
Bristol Tramway Company	,, 27	5,283	5,132	+ 151	—	51½	51½	Dec. 31	259,799	45,312,373	6 127,135	—	—	—	—
Burnley Corporation	,, 28	1,253	1,214	+ 39	—	40	40	March 31	57,992	11,092,704	1,197,772	1·31	11·61	5,388	8·17
Burton Corporation	,, 29	282	—	+ 4	- 372	8½	8½	,, 31	17,950	3,878,269	454,082	1·07	9·21	2,068	6·76
Cardiff Corporation	—	—	—	—	—	32 62	†32·26	,, 31	112,209	24,134,363	2,770,049	1·12	9·72	3,782	9·44
Carlisle Tramways Company	,, 7	193	229	- 36	- 505	8·5	8·5	Dec. 31	10,713	2,935 002	359,756	—	7·14	—	5.18
Central London Railway	,, 28	4,930	6,265	-1,275	- 9,585	6	6	,, 31	347,588	4,875,547	1,261,214	1·86	65·10	57,931	5·60
Charing X, Euston, & Hamp. Ry.	,, 23	2.559	—	—	—	8		—	—	—	—	—	—		
City and South London Railway	,, 29	3,069	2 9:0	+ 109	+ 6,716	6½	6½	,, 31	—	—	—	—	—		—
Colchester Corporation	,, 19	245	240	+ 5	—	8	8	March 31	10,588	2,457,553	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	,, 26	519	555	— 6	- 748	15¼	15¼	Dec 31	24,895	5,814,376	882,256	1·01	6·64	—	4·69
Croydon Corporation	,, 27	1,525	—	—	—	12 c	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 27	263	251	+ 2	- 13	7 23	7·23	March 31	—	—	—	—	—		
Dover Corporation	,, 28	268	268	—	- 920	4½	4½	,, 31	11,250	2,853,200	284,343	·94	9·49	2,500	
Dublin and Lucan Electric Ry.	,, 27	2,046	1,880	- 166	— h	6¾	6¾	Dec 31	6,358	402,511	110,738	3·79	13·78	942	7·33
Dublin U.T.	,, 27	7,070	4,968	+2.102	+22 6 0	48½	48½	,, 31	267,489	50,050,949	7,077,372	1·28	9·07	691	5·65
Dundee City Tramways	,, 25	1,151	1,170	- 19	+ 471	23	22	May 15	50,154	13.086 396	1,005 911	·906	11·96	2,180	7·42
East Ham Corporation	,, 28	956	898	+ 63	- 277	14	14	March 31	56,652	3,689,658	863,816	·64	10 18	2,994	6 79
Glasgow Corporation	,, 28	18,308	18.722	- 414	— h	79½	79½	May 31	756,430	195,767,519	17,946,595	—	10·12		—
Gloucester Corporation	July 10	278	304	- 26	—	15	15	March 31	15,466	3,902,077	563,595	·80	6·68	999	5·32
G.N., Piccadilly, and Brompton.	Sept 28	4.080	—	—	—	9	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	37	37	,, 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 21	1,615	1,513	+ 102	+ 2,077	35	35	,, 31	69,938	12 838,150	1,665,262	1·24	9·71	1,923	—
Hull Corporation	,, 28	2,422	2,226	+ 195	+ 3,255	26	26	,, 31	112,651	27,102,921	2,910,698	1	9 29	—	—
Ilford Corporation	—	—	—	—	—	10½	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 25	149	131	+ 18	+ 201	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	11,586	3,626,656	419,800	·727	6 62	1,480	5·22
Lancashire United Tramways	,, 25	1,344	1,002	+ 342	+ 12,653	38½	28	—	—	—	—	—	—	—	—
Leeds Corporation	,, 21	6,635	6 203	+ 432	+ 6,623	89½	89½	March 25	298,233	64,223,666	7,121,038	1 10	10·02	351	—
Leicester Corporation	,, 28	2,221	2.123	+ 98	—	42	42	Dec. 31	26,011	12.039,252	1,229,507	1	9·79	—	4 82
Liverpool Corporation	,, 21	11,140	10,868	+ 272	+ 7,245	104	104	,, 31	547 625	116,642 663	12.166 419	—	—	—	—
Liverpool Overhead Railway	,, 29	1,538	1,417	+ 121	+ 1,302h	6·65	6 65	June 30	81,302	11,171,865	1,024,275	—	—	—	—
London County Council	,, 14	32,713	26,063	+6,650	+120,058	98	98	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 28	262	242	+ 20	—	6	6	Sept. 30	14,511	3,128,867	359,435	1 08	9 68	2,630	6·48
Maidstone Corporation	—	—	—	—	—	2	2	March 31	4,740	850.121	112,227	1 33	10 13	2,370	
Manchester Corporation	,, 28	16,230	14,526	+1,764	+29,777	149	149	,, 31	631,956	126,900,875	14,123,124	1·19	10 73	4,299	6 99
Metropolitan District Railway	,, 29	7,669	7,998	- 329	- 745	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 29	15,010	14,785	+ 225	+ 5,067	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 28	148	137	+ 11	+ 72	2½	2½	,, 31	6,159	1,992,647	206,358	·82	7 14	2.239	—
Newcastle-on-Tyne Corporation	,, 28	4,016	4,037	- 21	+ 338	50	50	,, 31	197,849	43,061,934	4,326,152	1 07	10·68	3,857	7·0
Newport (Mon.) Corporation	June 29	639	628	+ 11	+ 1,397	15¼	15¼	,, 31	30,356	7,252,535	783 435	—	9 29	—	6·4
Oldham Corporation	—	—	—	—	—	34	34	,, 25	65,553	15,466,245	1,504,740	1 16	10·45	1,886	—
Portsmouth Corporation	May 25	2,330	1 578	+ 752	+ 632	28½	28½	,, 31	95,702	19,625,329	197,499	1·17	11 63	—	—
Reading Corporation	Sept. 26	652	661	+ 11	- 696	33½	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	11·29	21·29	,, 31	14,881	2,837,110	386,547	1·24	9·24	1,102	7 12
Rotherham Corporation	—	—	—	—	—	9½	9½	,, 31	23,569	5,251,472	593,054	1 07	9 53	2,612	7·49
Salford Corporation	,, 30	4,868	4,613	+ 255	+ 3,365	70½	70½	,, 31	214,111	39,213,560	4,894,590	1·28	10 29	—	—
Scarborough Tramways Co.	—	—	—	—	—	4½	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 29	5,738	5,336	+ 401	+ 6,769	35½	35½	,, 25	210,545	63 952,283	,049,899	903	9 543	3,653	6 4,7
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,365	9 294,771	1,108,369	1·27	11·02	—	7 53
Southend-on-Sea Corporation	,, 25	504	424	+ 80	- 214	9	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	,, 31	39,550	6,766,031	1,027,730	—	9 23	—	4 75
Sunderland Corporation	,, 29	1,267	1,336	- 69	- 493	20	20	,, 31	64,858	15.364 463	1,495,685	1·004	10·36	—	6 37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	4,937	1,315,757	102,751	0·87	11 53	1,371	—
Torquay Tramways	Sept 26	239	—	—	+ 5,429	5 16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 28	881	839	+ 42	+ 557	12 68	12·43	,, 31	43,607	7,995,451	862,12	9·27	12·14	3,132	7 50
Warrington Corporation	—	—	—	—	—	9	9	,, 31	17,057	4,418 225	403 363	—	9 85	—	6 73
West Ham Corporation	,, 26	2,362	2,300	+ 62	+ 1,403	14·7	14·7	,, 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	,, 25	324	838	- 14	+ 256	20	20	,, 31	41,905	8,847,066	950,338	—	10 583	2,062	6·15

† And 98 miles of interlacing track. a Train mile. b Per mile of single track. c Miles of route. h Half-year's figure k Double track.

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NOTES

Aberdeen Electricity Undertaking.—The special committee of the Aberdeen County Council appointed in connection with the Bill promoted by the Aberdeen Town Council to obtain power to extend the electric lighting area and to acquire the Cults electricity undertaking have had under consideration a report by Sir Alexander W. B. Kennedy on the question of the County Council purchasing the Cults undertaking, which they have power to do up to January next. Sir Alexander has advised the committee not to purchase the undertaking, and the committee are acting upon his recommendations.

Bradford Scientific Association.—Dr. J. H. Rowe presided at the annual meeting of the Bradford Scientific Association last week, at which the annual report, which was presented, recorded a year of steady work. A good series of lectures which had been arranged had been most successful, but the excursions during the summer months had been seriously interfered with by the weather. The number of members had slightly increased during the year. The report and the financial statement of the treasurer (Mr. F. G. Skelton), which showed the association to be in a satisfactory condition, were adopted, and the election of officers resulted as follows: president, Mr. C. Haigh; vice-presidents, Mr. E. J. Sutcliffe, Dr. J. H. Rowe, and Mr. H. C. Hunt. A council of 12 was also elected. The general secretary is Mr. R. Butterfield. An excellent series of lectures for the coming winter was announced.

International Exhibition in Russia.—An international exhibition of modern appliances for lighting and heating is to be held in St Petersburg early in December under the auspices of the Imperial Russian Technical Society, in which foreign exhibitors are invited to participate. The objects of the exhibition are to spread information about the different existing varieties of modern lighting and heating apparatus, and to ascertain their comparative merits. Among the articles which are asked to be shown are arc lamps for constant and alternating currents; incandescent lamps (electric); carbons for arc lamps, etc.; means used for artificially intensifying and the diffusion of light; electric heating apparatus; apparatus for preventing fires and accidents in connection with the use of kerosene, gas, and electricity for lighting and heating; measuring apparatus for electricity; photometric and actinometric apparatus. Further particulars regarding this exhibition may be obtained from the Imperial Russian Agency, Cromwell-road, South Kensington, London, S.W.

London, Brighton, and South Coast Electrification.—The London, Brighton, and South Coast Railway Company are making such excellent progress with the electrification of their loop line from London Bridge to Victoria, that they expect to run an experimental service in March, 1908. A month later, it is hoped, the full service will be in operation. By the way of experiment, the electrification of the South London line between London Bridge and Battersea Park is to be commenced forthwith. The single-phase overhead system is to be adopted by the Brighton Company, and the electrification contract has been secured by the Allgemeine Elektricitäts-Gesellschaft, of Berlin. The permanent way is not interfered with by the adoption of this system, and the greater traction economy obtained by utilising the current as it comes from the generating station is another item in its favour. Sub-stations and transformers become unnecessary, and although the energy employed will represent 6,600 volts, no high-pressure wire can be reached by anyone except the employés of the electrical staff. The overhead conductors are to be supported by lattice girders, erected from 100ft. to 300ft. apart. These bridges will support the conductors over the roofs of the trains.

The Junior Institution of Engineers.—On the invitation of the organising managers, Messrs. Bridges and Smith, a large number of the members of the Junior Institution recently visited the Engineering and Machinery Exhibition at Olympia Divided into groups, they were shown round by Dr. Hele-Shaw, F.R.S., and Messrs. John Bilbie, W. H. Cook, Thos. How, and Captain H. Riall Sankey, members of the hon. advisory council, who, owing to the limited time at disposal, made a point of directing attention to the especially interesting of the many fine exhibits which are to be seen. The exhibitors themselves greatly assisted in this arrangement, the result being that the members were enabled to closely inspect and have explained to them all the prominent and novel features throughout the building. At the conclusion Sir Alex. B. W. Kennedy, as president of the exhibition, addressed the party in one of the rooms near the entrance, where afternoon tea was taken on the invitation of Mr. Geo. B. Woodruff, member of the institution. The thanks of the members for the arrangements which had been made for their reception were expressed by the chairman, Mr. Lewis H. Rugg, and by Mr. B. E. Dunbar Kilburn. In the evening the members met in the lecture hall (Colonel Sir Edward Raban, past president, being in the chair) to hear an extremely interesting and well-illustrated lecture by Dr. Leonard Hill on "Deep Diving and Caisson Work."

Fixation of Nitrogen.—An American patent recently issued to Dr. C. P. Steinmetz describes a method for the fixation of nitrogen from the atmosphere by submitting air to the action of an electric arc of minimum volume and the greatest practicable length. The former process in which short arcs have been used is criticised on the ground that it requires a great number of electric arcs and high-tension currents, is expensive and troublesome, and the apparatus employed is liable to get out of order, while, owing to the multiplicity of the arcs, readjustments and repairs are troublesome and time-consuming. Dr. Steinmetz claims to overcome these difficulties by the employment of a single electric arc maintained by direct current, which arc is magnetically deflected or drawn laterally to a distance within which it can be safely maintained, and also magnetically rotated within its sphere of action so as to sweep through the air which is to be converted into nitrous compounds. The arc is established between electrodes entering a cylindrically enclosed chamber, and an electric motor rotates about the cylinder two opposing electrical magnets, the legs of which project inwardly towards the air chamber, so that the magnetic flux passes substantially at right angles with the axis of the arc. In this manner the arc is both deflected and rotated, the latter motion serving the double purpose of extending the sphere of action of the arc and of limiting the time within which the arc acts upon any portion of the air which passes through the converting chamber.

Engineering Standards Committee. — Report No. 35, which has just been issued (price 2s. 6d.), deals with the work done by the committee in connection with copper-alloy bars for use in automatic machines. The specification is drawn up on very similar lines to that for steel bars for use in automatic machines issued by the committee in May, 1907, and is intended to standardise as far as possible the bars from which copper and brass nuts and bolts are manufactured, so as to enable manufacturers to stock a definite class of material. It is interesting to note that the committee have primarily divided this material into two classes. In the class of bar known as Class B they impose no mechanical tests, but, in contrast to the specification for steel bars in Class A, mechanical

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tests are imposed for the smaller sized bars below ⅜in. hexagon and ⅜in. round or square, and for these a special standard test piece has been provided. The specification is based upon evidence collected from users and manufacturers of copper-alloy bars, and, prepared with that thoroughness and accuracy so characteristic of the work done by the committee, should prove of great value. Among those who have served on the sectional committee on screw threads and limit gauges, and sub-committee on rolled and drawn sections, we notice the names of Colonel H. C. L. Holden (War Office), Dr. R. T. Glazebrook, Sir William Preece, Colonel R. E. B. Crompton, Mr. William Reavell (Messrs. W. Reavell and Co., Limited, Ipswich), H. J. Brackenbury (Sir W. G. Armstrong, Whitworth, and Co., Limited), and others.

Supply of Electricity Bill. — The Associated Municipal Electrical Engineers of Greater London, an association brought into existence last year, and which is showing itself fully alive to the requirements of the extensive district from which its members are drawn, are sparing no effort towards securing the reintroduction next session of the Supply of Electricity Bill, 1907, which was withdrawn last session owing to pressure of business after passing the House of Lords and coming before the Commons, and the borough councils whom they have approached on the matter are, acting on the advice of the association, making urgent representations to the Board of Trade with a view to securing the reintroduction of the measure. The history of this piece of legislation affecting suppliers of electricity is rather of an unfortunate character, but it is to be hoped the Government will see that the Bill becomes law next session. The Bill is one of great importance to all owners of electricity undertakings. It provides, amongst other matters, for the compulsory acquisition of land for generation stations by the incorporation of the provisions of the Lands Clauses Act which relate to the purchase and taking of lands otherwise than by agreement. It also provides that the Board of Trade may make an order for breaking up streets outside the area of supply for the purpose of allowing electricity to be brought from a generation station situated outside that area, such order, however, to be made only with the consent of the local authority in whose district the streets are situated. Further, that the Board of Trade may authorise any company or persons to supply electricity in bulk to any local authority, company, or person authorised to supply electricity in any area for the purpose of distribution in that area, and to authorise any local authority to supply electricity in bulk to any other local authority. Although the scope of the Bill is limited, the importance of its passing cannot be overestimated; and as it is not contentious, the delay in passing it seems unaccountable.

Publications Received.—There have just come to hand the September numbers of *Science Abstracts* (Section A, Physics; Section B, Electrical Engineering—price, 1s. 6d. each), which Messrs. E. F. and N. Spon, 57, Haymarket, London, S.W., have published under the auspices of the Institution of Electrical Engineers and kindred institutions.—"Guide to the Engineering Profession" is the title of a book which Mr. W. Galloway Duncan has published through Messrs. James Mathew and Co., 17, Cowgate, Dundee (price, 3s. net). No originality can be claimed for this work, which but repeats the opinions of others on the training of engineers which have been expressed in various technical publications at different times; and the author quite frankly acknowledges the sources of each of his articles. The book places before those interested the necessary qualifications and training for the four great branches of the profession—civil, mechanical, electrical, and mining—and, inasmuch as each of the authorities quoted is a recognised expert in the educational requirements of his particular branch, the collection may serve a useful purpose.—The *Calendar* of the University *College* (University of London) for the session 1907-08 has just been issued. It contains many new features. There is a sketch of the history of University College by Dr. Carey Foster, together with a full statement of the statutes and regulations under which the college is now governed in its new position as an integral portion of the University of London. It also contains a set of plans that show the uses to which the extension of buildings are being put. It appears that the space now available for university purposes is greater by one-third than it was last session. Among the most striking features of the new developments are the enlargement of each of the engineering departments and of the drawing office, the enlargement of the department of applied mathematics, and the provision of special rooms to be known as the Galton research laboratories in connection with the Eugenics Institute founded by Mr. Francis Galton.

The Proposed Home Office Regulations.—Further opposition to the draft regulations proposed by the Home Office for the use of electricity on premises which come under the Factory Act is announced this week—this time from a local authority. In our issue of last week we referred to the growing opposition among manufacturers against the Home Office proposals, and there is now to be recorded the first opposing voice among local authorities. The Stepney Borough Council at their meeting on Wednesday evening considered the matter on the report of their Electricity Committee, and the ground upon which Stepney base their objection to the regulations is, broadly speaking, that it would be unsatisfactory for generating stations for the supply of electricity to be called upon to comply with regulations of two separate Government departments—namely, the Board of Trade and the Home Office—which in many respects are inconsistent with each other, and the Electricity Committee have set out in detail the grounds of their objection to various regulations. Thus with regard providing switches, circuit breakers, etc., with handles or other means of working, insulated from the system, or in connection with the insulation and protection of electrical joints, etc., the committee say that such regulations should not apply to public generating stations working at "medium" or "low" pressure, it being perfectly safe to handle copper links on switchboards involving use of bare copper connections. Then, again, with regard to Section 12, which provides for the control of an electrical motor by an efficient switch, and the further protection of every motor rated at more than ⅓ h.p. by means of a release that will automatically break the circuit if the current is interrupted (unless, of course, the motor is incapable of restarting automatically on the current being restored), the committee urge that this should not apply to polyphase motors, while as regards the regulation relating to means for quickly stopping an electrical motor driving machinery, the committee say: "This should not be applicable to a public generating station where the provision required is other than a control switch."

Electrical Culture of Plants.—Dr. E. H. Cook, the chairman of Bristol Education Committee, has devoted attention to the subject of an increased power of germination in seeds, either with low or high tension currents. Apart from the increased rapidity with which growth started, Dr. Cook was unable to satisfy himself that the passage of low-tension current through the soil made any difference to the plant. By an overhead discharge of very high-tension current (up to 45,000 volts) he obtained a con-

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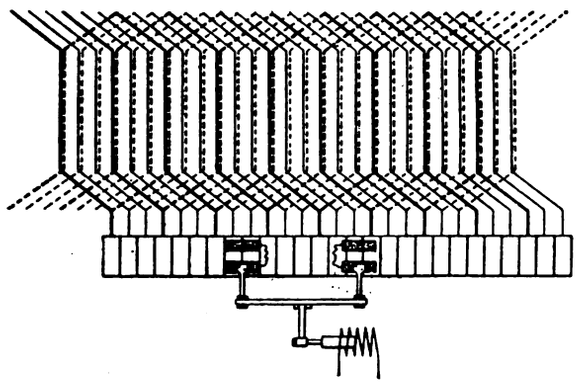
tinued increase in the rate of growth At Bitton, Mr. J. E. Newman during 1905 made a practical test at the Golden Valley Nurseries. The electricity was derived from a machine of the Wimshurst type; one conductor was earthed, the other was connected with a system of aerial wires running through greenhouses and over garden plots about 16in. above the top of the plants. To these aerial conductors at short intervals short pointed bits of wire were connected to facilitate discharge. The points were towards the ground. An oil-engine kept the electrical machine running for 108 days, about nine hours a day. Cultivation in other greenhouses and in other plots was carried on under normal circumstances for the purposes of comparison. The results of electrification were remarkable. They are recorded as follows: cucumbers, 17 per cent. increase; strawberries (five-year plants), 36 per cent. increase; strawberries (one-year plants), 80 per cent. increase and more runners produced; broad beans, 15 per cent. decrease, but ready for picking five days earlier; cabbages (spring), ready for picking 10 days earlier; celery, 2 per cent. increase; tomatoes, no difference. One point requires special mention in the case of the cucumbers grown in the houses. "On May 8," says the report, "a spot disease, of bacterial nature, appeared in all the houses, and unquestionably made far more headway in the unelectrified houses. It seems probable that the ravages of the disease were largely inhibited by the electric discharge, for during one week, when the influence machine broke down, the disease progressed far more rapidly under the wires, and was again checked upon restarting the machine. The action of the electric discharge may be due to one of two causes. Either the resisting properties of the host have been increased, or the attacking power of the parasite diminished."

Prevention of Sparking in Alternating-Current Commutator Motors.—A method that has frequently been proposed for preventing sparking in an alternating-current commutator motor consists in providing the armature with two or more distinct windings connected to successive commutator segments, and employing brushes of such width as not to bridge two segments connected to the same winding. The above method is effective at starting and at low speeds, but it is disadvantageous at high speeds when interruptions in the current in individual windings occur with great rapidity and produce serious sparking.



At high speeds a single armature winding is satisfactory because both the armature current and the field strength are small in value. A patent recently granted to Mr. Marius C. A. Latour, and described in the *Electrical World* of New York, relates to means for combining in one structure a machine that acts at starting as though there were a plurality of distinct armature windings and operates at full speed as though there were a single armature winding. The arrangement proposed is shown in the accompanying illustration. At each commutating point there are two brushes, each brush being of a width insufficient to bridge two segments connected to the same winding. At starting, the two brushes are in line, so that the machine starts like a motor with a plurality of windings and a single set of narrow brushes. When the motor is up to speed one brush is shifted so that the two which are in electrical connection have together sufficient width to bridge two segments connected to the same winding.

Dairy Farming by Electricity in California.—With the advent of high voltage electric power lines in California, a new impetus has been given to the dairy business in many localities, says the *Journal of Electricity, Power and Gas* of San Francisco. Where before there were no systems of irrigation and only wheat could be raised, the electric power has made irrigation possible by the installation of pumping plants which result in rich crops of succulent alfalfa. For illustration of electric irrigation, the town of Dixon, Solano County, California, may be cited. From the central power station there about 50 miles of suburban lines radiate through the rural districts, furnishing both illuminating current and power to the surrounding farms. The majority of the plants consist of rotory pumps, driven by 10-h.p. motors, and have a capacity of 900 gallons a minute, or a stream as large as a man's body. At a depth of 80ft. an inexhaustible supply of water is obtained. The wells are 10in and 12in. in diameter, in which the water rises to within 16ft. of the surface. The pumps are placed in pits to be as near the surface of the water as possible. The number of acres watered by a single pump is as high as 120, which keeps the machine running continually, but with the advantage over other power that it requires no attendant to care for it; for after turning on the switch the pump cares for itself. The current is generally purchased at a flat rate of 12s. to 16s. per month per horse-power. Among the many advantages of this system of irrigation are that the owner is independent and has absolute control of his water supply; he can use it whenever he wants it without fear of quarrels with his neighbours, who, under other conditions, might want to use it at the same time; he has no fear of drought, and the water is always clean and free from noxious weed seeds. And the benefits of electric power on the farm do not stop here, for by it nearly all of the drudgery can be ameliorated. The farmer no longer has to rise in the small hours to attend to the monotonous work of milking, for with the modern electric milker three hours' work is done in one. This milking device has passed the experimental stage, and is a practical success in daily use. Not the least of its merits is sanitation, for the milk not only is untouched by the hands, but it does not even come in contact with the air. All other mechanical work, as separating the cream, sawing wood, etc., done by the same power.

High-Tension Insulators.—When we remember that it is only some 15 years ago that we regarded with wonder the transmission of 30,000 volts over 100 miles, and that there are to day thousands of miles of long-distance transmission at voltages ranging from 11,000 to 65,000 volts, we may well believe that the future will see the transmission of much greater quantities of power over long distances But is the science of properly and safely insulating line voltages of high potentials keeping pace with the demands of transmission engineers? That is a question which has often been put, and which finds expression once again in a paper read before the Canadian Electrical Association by Mr. C. E. Delafield last month. Up to the present time, as Mr. Delafield points out, the commonly accepted form of insulator is what is known as the pin type, the pin being of wood or metal. Present practice has demonstrated that wood can be safely accepted for insulator pins up to 25,000 or 30,000 volts. Beyond that it seems to the author advisable, for mechanical

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reasons, to use malleable iron, but the pin type of insulator has reached such dimensions, in the endeavour to meet the requirements for higher voltages, that it seems to be the consensus of opinion of the leading high-tension engineers that this type of insulator has reached the limit of good line construction; for not only is it a difficult matter to find a pin that will take the necessary stress incident to a large-size insulator, but the problem of manufacture, from the standpoint of pottery, is one that is extremely difficult. Mr. Delafield shares the belief of many engineers that a suspended form of insulator will be the type which will be used, which he says can be so designed to be mechanically strong and a good dielectric as well. As is well known, the design of an insulator should allow for a factor of safety sufficiently large so that abnormal electrical strains will not lead to breakdowns. In Mr. Delafield's opinion, a factor of 3 is necessary. This factor, he says, has decided the limiting possibilities of the pin type of insulator, as upon a 60,000-volt line voltage it would be necessary to build an insulator of mammoth proportions and uncertain body, having a weight that is almost prohibitive to pin work. The ideal insulator is one having a minimum amount of electrostatic capacity with a maximum amount of mechanical strength, and this would point to the suitability of glass insulators, well petticoated, for high-pressure transmission lines.

Industrial Disputes.—While the past year has been free from disturbance in the electrical industries, the same cannot be said of industries in general, for the nineteenth annual report by the Board of Trade on strikes and lock-outs in the United Kingdom during 1906, which has just been issued, shows that during the past year the relations between employers and employés have been more troublesome than during other recent years. As usual, most of the time lost in 1906 was accounted for by disputes in the engineering and cognate trades as well as in the transport trades, and if the threatened differences in the railway world culminate in a strike, the record for the current year will be very bad indeed. Questions of remuneration were, again, the most frequent causes of disputes. The year was one of improving employment, and was accompanied, as is frequently the case, by an increase in the proportion of workpeople who struck work to obtain an increase in wages. The number of workpeople directly affected by disputes arising out of refusals to work with non-unionists and other questions of a similar nature was about one-third of the total directly involved in all the disputes of the year. The results of disputes on questions of wages were in favour of the employers, only 17 per cent. of the workpeople directly affected being able to attain their object, while 35 per cent. were unsuccessful and 46 per cent. arranged compromises. In disputes as to hours of labour most of the workpeople effected compromises. Most of the disputes were settled by the parties themselves or their representatives. During the year 46 disputes, directly involving 10,777 workpeople, were settled by arbitration or conciliation—a considerable increase on the figures of the previous year. The principal agencies for conciliation and arbitration are, however, mainly concerned with the prevention rather than the settlement of strikes and lock-outs. In 1906 the various voluntary boards of conciliation and arbitration are known to have settled 697 cases, in only 12 of which was a stoppage of work involved. The cases vary greatly in importance, some involving the adjustment of wages over large districts, while others affect only a few persons. The progress of arbitration in trade disputes is a phenomenon which should give rise to the greatest satisfaction. Indeed, this is quite a feature of the report, as our analysis thereof in a future issue of this journal will show. The past two years' working of the Conciliation Act of 1896 has been of great import, and encourages the hope that the promotion of arbitration will do much to prevent disastrous strikes and lock-outs, from which capital and labour have suffered so grievously.

Electrically-Driven Rolling Mills.—In many respects the meetings of the Iron and Steel Institute held this year in Vienna were unique, but, perhaps, in none more so than in the visits to the iron and steel making districts of Austria, where the members were enabled to see for themselves what unlimited scope the iron and steel industries afford for the application of electricity. But for the moment special interest attaches to the latest development of electricity in these industries—*i.e.*, its application to reversing rolling mills of high power—an example of which was furnished in the visit to the Hildegardehütte at Trzynietz, in Austrian Silesia. A detailed description of this most interesting installation, representing the first large electric reversing rolling mill in the world, was given by Mr. D. Selby Bigge in a paper before the Iron and Steel Institute in May last. After much consideration, steam was adopted as the primary motive power, and steam-turbine plant was decided upon. The plant driven at the works consists of the reversing rolling mill, 10,350 h.p. maximum; the non-reversing mill, 750 h.p. normal; and 300 motors, varying from 5 h p. to 70 h p. The whole power production is centralised in one generating station, which contains one Parsons type three phase turbo-generating plant, the turbine being constructed by the Erster-Brunner Company and the alternator by Messrs. Brown-Boveri, having an output as follows: 3,000 kilowatt-volt-amperes, 50 cycles, 3,000 volts, 3,600 h.p., running at 1,500 r.p.m., or giving with a power factor of 0·8 an output of 2,500 kw. There are also two turbo-alternators by the A.E.G. of Berlin, each having a capacity of 1,250 kilowatt-volt-amperes, or 1,000 kw. on a power factor of 0·8, 3,000 volts, 240 amperes each, 50 cycles, running at a speed of 3,000 r.p.m. Owing to the enormous fluctuations in the load, a method of keeping it from exceeding a predetermined maximum is essential, and the Ilgner system of flywheel converters has been adopted. The effect is that, although the rolls may take momentarily as much as 10,000 h.p., the energy taken from the mains is only one-tenth of that, upon which fact the economy of the system is based. The success of the plant in operation, as shown at Trzynietz and elsewhere, proves beyond doubt the possibility of the practical working of electrically-driven rolling mills, and the question resolves itself into an entirely economic one. It is claimed that in the case of blast furnaces the value of the electrical rolling mill is greatly augmented, for it is said that electricity can by that means be generated at a rate of from 0·15d. to 0·2d. per unit, inclusive of interest and depreciation on the capital outlay involved. The subject seems to have received far greater attention on the Continent than in Great Britain, and if steelmakers in this country are to maintain their position when prices are low, they cannot afford to let the matter pass unnoticed. Continental steelmakers are already availing themselves of this innovation. Two electric rolling mills of 10,000 h.p. have been started up at the Resicza Ironworks in Hungary, while another mill of 15,000 h.p. is being erected at the Rombacher Ironworks near Metz, and a third is to be installed at the Hustner Works.

Mercury-Vapour Rectifiers.—It has been found that when a mercury-vapour rectifier has been transported from one place to another there is likely to be a small quantity of mercury on or about the anodes of the tube. If this mercury is not removed before the device is put in opera-

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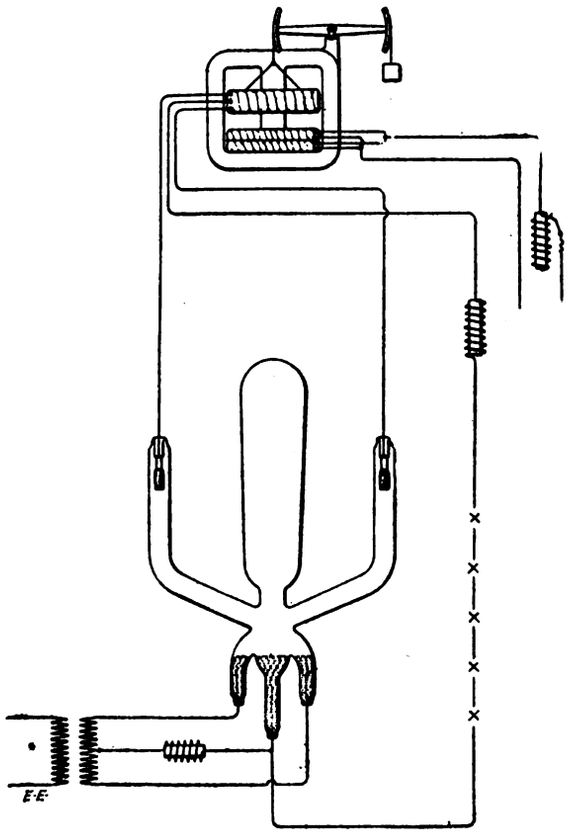
tion at high voltage it may cause deterioration, or even destruction, of the device. Mr. Samuel Ferguson recently took out a patent in the United States for a method of removing the mercury from the anodes of a constant-current vapour rectifier by running the device at about normal current on short-circuit for a time long enough to distil off any mercury which may have collected around or in the anodes during shipment. A view of a constant current rectifier to which the method is applicable is given in the accompanying illustration. The rectifier tube consists of a central chamber and side arms, and is provided with carbon anodes. These anodes are mounted near the ends of the arms, and are out of the direct path of the vapour blast emanating from the mercury cathode. The vapour device is provided with the usual auxiliary or maintaining anodes and supplied with energy from a separate transformer. The main source of current for the rectifier consists of a constant-current transformer of the usual form, receiving energy from constant potential mains. The load circuit of the rectifier is



one or more series of arc lamps. When the equipment is operated on short circuit, or on a low load, the current heats the anodes sufficiently to distil all mercury from them, or from the spaces immediately adjacent, and the low voltage used for this treatment is small enough to avoid any danger to the tube, even though mercury be present at the beginning of the operation.

The Training of Engineers.—Since this problem has come within the range of public attention we have been treated to a more or less fortuitous expression of public opinion as to the principles upon which the technical training of engineers should be based. In some respects it is desirable that the public should not be indifferent to the importance of a sound system of technical education and its relation to the industrial life of the country, for history contains evidences of no few educational and industrial reforms that have had their origin in popular movements. But what many of the present-day advocates of reforms in the system of technical education seem to overlook is the necessity for a closer communion between the training in preparatory and secondary schools and the training in offices, factories, workshops, or on works, and the ultimate preparation of young men for the universities and the higher technical institutions, so that they may be able to enter industrial life equipped with a combined theoretical and practical training, and with a knowledge of men and of the conditions under which they will have to labour. It is a great mistake to imagine that a code of education alone is likely to produce worthy followers of the standard-bearers of engineering science. The personality of the technical student is of equal, if not of greater, importance than any information he is likely to acquire from the classroom, and this fact should not be overlooked by those who deal with the question. We may not all share the dislike of Herbert Spencer—himself an engineer of no small repute—of the established systems of education; nor may the retort of John Ericsson to a friend who expressed regret at his (Ericsson's) not having passed through a technological institute—viz., that if he had taken a course at such an institution he would have acquired such a belief in authorities that he would never have been able to develop originality and make his own way in physics and mechanics — find ready acceptance; but the fact remains that many of the most brilliant pioneers in the realms of engineering have lacked—nay in some cases have even disdained—specialised education. Mr. Edison, probably the most remarkable inventor who ever lived, is himself a self-trained man. Sir Benjamin Baker, who recently passed away, is an instance of many famous engineers, none of whom passed through a curriculum appropriate to the profession they afterwards followed. And to turn from electrical engineering to other branches of that industry, there occurs to our mind the names of Brindley and George Stephenson, who were without any early instruction; and of Telford, a shepherd boy who had no culture beyond that which a Dumfries-shire parish school afforded, and yet who lived to carry out immense works of civil engineering, which form an endurable monument to his name and fame. Of course, it would be absurd to argue from these few examples against established systems of technical education, for these great masters of science, who, before they presented their great gifts to the world, had searchingly and patiently applied them to the touchstone of experiments, belonged to the intellectual aristocracy of their class (which is ever but a very small portion of the whole community), and could, therefore, transcend the narrower limits imposed by the established forms. But the examples we have cited show that what is required of technical education is that it should conduce to the development of a pupil's inventive powers. As we have already said, the temperament of a pupil has a great deal to do with this achievement, and the affinity of imagination to true consecutive science is also not clearly recognised by teachers and pupils. The story of Newton's apple, though apocryphal, serves to remind us that Newton was endowed with an imagination which could conceive the law of cosmic unity of stupendous import, and which had the power to urge him to direct the light of his vast intellect upon its elucidation. And when we search the records of the applications of electrical science, we see how prominently the faculty of imagination enters into the life work of Kelvin, Edison, and Rutherford, Marconi and Tesla; we are almost tempted to believe that it is this one faculty which has lifted them so high above their many great contemporary investigators. It is this faculty, so akin to the inventive faculty, which should be developed in a pupil, and, combined with practical and efficient instruction in the scientific problems underlying engineering, there should be turned out from our training colleges men who will give a wonderful stimulus to the engineering industries of this country.

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LARGE GAS-ENGINES IN GERMANY.

The Key Engineering Company's Tour.

[BY OUR SPECIAL CORRESPONDENT.]

SAARBRUCKEN, *Oct. 9.*

On Tuesday last a party of 20 engineers started for the iron manufacturing districts of Germany to inspect a number of large gas-engine plants working on blast-furnace and coke-oven gas. The Key Engineering Company have organised the trip, and great credit is due to Mr. Leonard Andrews for the amount of interesting visits he has crowded into four days. That this involves some labour on the part of the visitors we know, but every arrangement to lessen this has been made. Our party, leaving Charing Cross on Monday night, included Prof. W. C. Unwin, Mr. S. E. Fedden, Mr. C. S. Vesey Brown, Mr. Llewellyn Preece, Mr. E. T. Ruthven-Murray, Mr. H. Bell, Mr. W. Handcock, Sir Vezey Strong, Mr. A. Clough, Alderman Smith (the deputy-chairman Electric Light Committee, Liverpool Corporation), Mr. T. Roles, Mr. Edw. W. Cowan, Mr. Leonard Andrews, Mr. R. B. Slacke, and the representatives of the electrical papers.

The final programme of the visit reads as follows:

Monday, Oct. 7.—Leave Charing Cross at 9 p.m. for Metz, *via* Ostend and Brussels.

Tuesday, Oct. 8.—Arrive Metz at 12.49 mid-day. Visitors will be taken by motorcars to Homecourt, where three 1,650-h.p. gas-engines working on blast-furnace gas will be seen driving three-phase generators coupled in parallel, and a fourth plant of similar capacity will be seen in course of erection. It is also hoped to get permission for visitors to see the electrically-driven rolling mills in operation at Homecourt. Leave Metz at 5.8 p.m. and arrive at Saarbrucken at 7.10 p.m.

Wednesday, Oct. 9.—Visitors will be taken by motorcars to the Government mines at Heinitz, where a 650-h.p. engine and 1,300-h.p. engine will be seen working in parallel on coke-oven gas driving alternators in parallel (three additional 1,300-h.p. engines and two 3,000-h.p. engines are on order for this installation, two of the former being in course of erection). Motorcars will take the visitors on to the iron and steel works at Neunkirchen, where two 1,000-h.p. E. and S. engines and one Körting engine will be seen driving blast-furnace blowers. In the afternoon the works of Messrs. Ehrhardt and Sehmer will be visited, where large gas-engines, blowing engines, rolling-mill engines, high-lift pumps, etc, will be seen in course of construction. Visitors will leave at 5 52 p.m. for Frankfort, arriving there at 9.30 p.m.

Thursday, Oct. 10.—Visit Messrs. Lahmeyer's works in the morning. Leave Frankfort at 1.40 p.m. for Mayence, arriving Mayence at 2.15 p.m. Visitors will be taken down the Rhine in a petrol launch as far as Bingen if weather is favourable. Leave Bingen at 5.3 p m, arrive Cologne 7.55 p.m, or, alternatively, train straight through from Frankfort to Cologne leaving Frankfort at 1.40 p.m, arriving Cologne at 5.51 p.m.

Friday, Oct. 11.—Leave Cologne 6 a.m. for Dortmund. The Hoesche Iron and Steel Works at Dortmund will be visited and, if time permits, a coal mine where electrical winding plants are in operation. At this installation two 2,000-h.p. single-tandem engines, working on blast-furnace gas will be seen driving continuous-current generators. Leave Dortmund 3.47 p.m, arriving Cologne 5.46 p.m. This train is timed to catch the 6.1 p.m. from Cologne, arriving London at 5.38 the following morning.

So far we have proved the first day's proceedings to be full of interest and railway travel. The Homecourt plant was in full work yesterday, the three 1,600-h.p. gas-engines working in parallel. Two smaller units, also made by Messrs. Ehrhardt and Sehmer, were also in parallel with each other, supplying some special circuits. The comments on the plant I shall leave over to another article, as time has not permitted any figures to be worked out. The fact that a fourth engine of 1,600 h.p. is now being erected proves that the plant has worked satisfactorily.

The day of 24 hours ended at Saarbrücken, where Mr. Sehmer entertained us all to dinner. Good fare and short speeches completed the welcome to Germany.

THE POSSIBILITIES OF ELECTRICAL DEVELOPMENT.*

BY R. BORLASE MATTHEWS, WH.EX., A.M.I.C.E., A.M.I.E.E.

A chairman of a municipal electric lighting committee, during the course of a discussion on the income *per cap.* per annum of various electric lighting stations, remarked when a particularly good instance was brought to his attention, "Ah, but they have been established 15 years." An admission that a central station which had been in operation for a considerable time ought to be in a better position than a more recently established one. This is a fact which most people will accept. But why should it be so? The newer station will undoubtedly have the most up-to-date plant and distribution system, and apparently ought, therefore, to have everything in its favour. The solution must obviously be in the fact that the people of to-day need educating as regards the uses of electricity. Because the older station has had time in which it has gradually and slowly carried out this education of the people, it is, therefore, in a better position than the new one This leads at once to an inquiry as to why it should take so long a time to educate the public to use electricity. Now, time is but the sequence of ideas, and the public in any district would take two years instead of ten in learning to appreciate electricity, provided that the sequence of essential ideas about electricity were accelerated five times.

But how is it that there is this need for acceleration? Why are the essential ideas as a matter of fact so slowly acquired? On reflection, it is evident that the reason may be found in the fact that electrical information is not conveyed to the people in a simple and thoroughly digested form. Consider for a moment the college youth of to-day, who starts at a point in the path of knowledge which the foremost philosophers and scientists of the past only attained after much patient investigation and original thought. This is possible, because the student acquires only the essential and digested ideas of those who have gone before him, and who in process of acquiring these ideas had to lead up to them by a long series of subsidiary ideas that could afterwards be discarded. Likewise the accumulated experience of many people in the applications of electricity must be gathered together and the essence presented to prospective customers in such a way that, busy though they may be, they may rapidly be brought to the point at which they can intelligently consider whether or not electricity would meet their needs better than anything else, and appreciate that nowadays electricity is a luxurious necessity rather than necessarily a luxury—and a convenience that no one who can afford the ordinary comforts of civilisation need fear to add to his home. It is, then, hardly necessary to point out the great advantage that commercial development of electricity will be, both to those who are connected directly with the electrical industry as consultants or as manufacturers, and, also, to the world at large—the participants in the ameliorated conditions of life that will exist when electricity comes into its own, and is no longer regarded as a strange mysterious force, but accepted as an everyday assistant in the relieving of industrial and domestic labour, and, if it is possible, by the systematic presentation of such facts as are stated above, to bring about this desirable condition of affairs in two years instead of ten, it is surely of vital importance to exert every effort in the required direction. But who are the channels through whom these facts are to be conveyed to the general public? They are the central-station managers and the manufacturers of electrical apparatus. But few of the former seem to be as fully alive to their opportunities in this line as they might be, while the latter are doing very little compared with the

* Paper read before the Birmingham and District Electric Club, Oct. 10.

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possibilities which lie before them. Yet it is obvious that while the central stations are the first to benefit by any increase in the use of electricity, the manufacturers will also in a short time feel the benefit thereof, and that, therefore, the interests of both classes are intimately bound up in a campaign of this nature.

Turning now to a consideration of the nature of these opportunities and possibilities which lie to-day before the central stations and electrical manufacturers. As regards the central stations, nearly one-half of the population of the country is already to be found within their area of supply, and this area must logically increase as time goes on, since, in accordance with the laws of economics, the private plants that are brought within the area of supply must gradually give place to the central stations, which latter, in addition to the low generation costs, have the advantage of good diversity and load factors. Now, the central station is conceded by economists to be in its very nature monopolistic, and subject, therefore, to no competition for a like service. In consequence, laying aside any other adverse conditions, it lacks the keen and constant commercial stimulus which is such an aid to progress. It likewise lacks, by reason of its isolation, both the ready opportunity for, and also a very great incentive toward, that aggressive co-operation with manufacturers, contractors, and other central stations which would be beneficial to all parties concerned. For central stations not competing against one another are, therefore, in a position in which extensive co-operation could be the means of bringing about results not only far beyond any success of the past, but also surpassing even their most sanguine expectations. The manufacturers of electrical apparatus, too, need to be more thoroughly awakened to the advantages that will accrue to them from a more extensive use of electricity, for their efforts at the moment—owing possibly to a jealous fear of their competitors—are not being exercised in altogether the right direction. They do not look sufficiently far ahead. They are now occupying themselves chiefly in urging upon their customers the merits of that particular apparatus which they manufacture. If, in addition to this, they could be induced to put before the public the general advantages of electricity for those main purposes for which their apparatus is manufactured as an auxiliary, then the more general use of electricity would create a greater demand for what they wish to sell, and their business would be more prosperous than was previously the case. Having, then, arrived at the conclusion that the dissemination of digested essentials is the golden key which will open up the electrical Elysium, and having also pointed out by whom this key is to be applied, it is advisable to consider in more detail the general methods that should be employed to bring about further electrical development.

Co-operative Development.—In this matter of electrical development all connected in any way with the electrical industry must co-operate together if the maximum of result is to be obtained by the minimum of effort. Representatives of these different interests having met together, a definite scheme or plan of campaign must be prepared in order that every inch of ground may be covered, and that without overlapping. If a collective co-operative educational campaign is adopted, in which the advantages of the use of electrical devices are exploited on a general basis, disregarding all individual claims and the individual differences of different manufacturers, a great deal of unnecessary waste of competitive advertising in popularising the service will be avoided. The advantages of new business resulting from such a campaign will, of course, benefit all concerned. For all those interested in the electrical business are really one body, whether they recognise the fact or not, and a more general use of electricity must benefit, not merely one, but every branch of the industry. So all will be duly repaid for their share of the expenditure in such an educational campaign as is here suggested. At the same time, an artificial condition of affairs is not brought into play, since the existing competitive trade relations, so essential to true progress, are not in any way removed. For of the orders that the new business has rendered available, the proportion that will be obtained by each manufacturer will depend entirely upon his individual activity. Competition will certainly be lessened to a degree owing to the greater demand, and at times even an embarrassment of unfilled orders will occur, but that will not be to the disadvantage of any manufacturer. A commercial programme is opened up which is logical and consistent: every shilling spent upon it will carry its full force and effect toward the extension of the electrical business; and this not only without competitive opposition, but, on, the contrary, with a disposition on the part of all to see it do its full work. Further, it is quite reasonable to anticipate that the evolution and growth of the campaign will tend to general improvement and harmony in trade relations, which means again, within certain limits, increased selling and distributing efficiency.

These various sections of the electrical industry co-operating together in a combined educational movement along the lines that have been suggested may, for the purpose of reference in this paper, be designated the "Electrical Association." The scope of such an electrical association is a very wide one. In its initial stages it will have to progress comparatively slowly, so that those most interested in it may be satisfied as to the results it is bringing about, and as confidence is established it will be able to branch out and produce exceedingly satisfactory returns. In an educational or advertising campaign it is not easy to adduce direct evidence of results obtained. However, experience has shown that contemporaneously with the adoption of a good system receipts do advance remarkably, and that also any reduction of expenditure in this direction brings about a corresponding decrease in the income. The first step of the electrical association should be to impress upon the manufacturers and dealers in supplies the previously-mentioned underlying idea of the whole scheme—namely, that which benefits electricity as a whole is bound in the end to benefit also the individual branches of the industry. Therefore, all must work together for the common good. This preliminary movement is by no means so easily accomplished as might be supposed, on account of the long-standing and deep-rooted ideas about the necessity of constant rivalry in trade, and also on account of the prevalent distrust and suspicion with which manufacturers have been accustomed to regard each other. For this reason, the assistance is required of the professional institutions and trade associations—such as the Institution of Electrical Engineers, the Municipal Electrical Association, and the National Electrical Manufacturers' Association, etc.—together with that of a few of the more progressive manufacturers. When once the manufacturers and dealers in supplies have realised the necessity of a co-operative educational campaign, they must approach the central-station managers in order to bring them first to an appreciation of the possibilities of the development of the supply of electricity by personal appeal along well-directed lines to the inhabitants of the area within reach of the distribution system; and then, secondly, to bring them to a clear understanding of the necessity for concerted action with all connected with the electrical industry in any way, whether it be technically as engineers or commercially as traders—concerted action in a well-planned scheme for educating the public as a whole by general publicity in newspapers, magazines, etc. The general field coming within the scope of the central stations can best be opened up by making arrangements for passing on from one manager to another details of successful methods of getting new consumers, of retaining old ones, of newspaper and general advertising, of canvassing. With regard to the isolated factory owner, the area of supply of some central station or other will undoubtedly be eventually extended to comprise his works, when he will be included in the educational campaign of the particular central station concerned. Before this takes place, the various applications of electricity must be brought to the manufacturer's attention in a personal way through the electrical association by a similar plan to that which should be carried out by the central stations in their own territory. The electrical wiring contractors and dealers also need to have the subject of the extension of the business brought before them in a similar way, the matter, of course, being dealt with from their standpoint. For the purpose of supplementing the work of the central stations among archi-

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tects, builders, contractors, auctioneers, and estate agents, a special campaign should be initiated dealing with the subject in a general way, and pointing out briefly and forcibly the very great present and prospective utility of electric service for light, heat, and power. It is obvious that this line of work is of fundamental importance to all electrical interests, as a building correctly wired is an almost certain user of electric service. On the other hand, thousands of possible customers are lost on account of properties not having been wired in the past. This loss will all the more be keenly felt and appreciated as electrical appliances become more efficient, making them more and more available for people in moderate circumstances, which appears to be the present development in the lighting and heating field.

When the plans of the association for the development of the central-station field are well under way, further plans must be considered for the organisation of a general publicity scheme on a much more indirect yet exceedingly valuable basis—namely, through the Press. Now, there can be no question that electricity is one of the most interesting subjects in the world. Its application to the daily life of the people is constantly becoming more widespread. This is an electrical age. The attention which the world has recently given to wireless telegraphy and Röntgen rays shows with what eagerness the public watches in every development. Electricity will always have a large "news value." Even such well-known subjects as the telephone and telegraph are constantly featured in the day's news. The interest in electricity is perennial. It is only necessary to describe some novel application and it immediately becomes news. As such, if properly handled, a great deal of space in the newspapers throughout the country could be employed to further the objects of the association. These notes, in addition to telling of the novelties of the day, should also give information as to novel uses of old objects, showing in a practical way, though not too pointedly, how any reader could make use of the same things himself. This is publicity of a most valuable kind. The local central station could follow it up directly. If conducted properly, the results obtained should be extremely satisfactory to newspaper proprietors and readers alike, as well as to those who are engaged in an industry which represents the latest practical benefits of science and progress. A general scheme of newspaper and magazine advertising, in which the advantages of electrical devices are displayed and exploited on a general basis, regardless of any partisan spirit, would be a tremendous power, for through it people would become familiar with electricity, it would become a household word, talked of at the table, a familiar topic, instead of a mystical, far-away, dimly understood subject; and time-worn expressions to the effect that electricity is a somewhat dangerous thing, only as yet in its "infancy," would become relegated to the past. Newspaper advertising in an indirect way will undoubtedly lead to the modification of many of those careless and sensational paragraphs which come into an editor's hands from time to time, and do a great deal of damage to the central-station business by exaggerated accounts of mishaps.

This proposal for the formation of an electrical association is, admittedly, an attempt in a very small degree to get away from the competitive extension of a market, and to reap the advantages which must accrue when commercial effort is directed and massed, without competitive opposition from within, toward popularising the service and extending the business. The sales expenses of electrical manufacturers are keenly competitive. For every increase in selling expense or increased gain in business on the part of one manufacturer, a corresponding effort is necessitated on the part of others, analogous to the maintenance of the navies and standing armies of the nations. This necessary competitive strain is very largely for business which is either already existing or else resulting from the normal growth in business generally, whereas the object of the association would be to open up a market beyond this, a market snatched from the future, a market that cannot be developed now, except by co-operative means. It is not reasonable in this day and generation to set to work to make a change in a competitive system which is as old as the world, and will only change on the basis of different motives inspiring men's activities. However, the idea on which the association is based will not come into conflict with the present system, for it strikes a higher plane, leaving existing conditions as they were; in this way not being founded on an artificial method, it can justify itself. Even without precedent, as it so appears, it stands comparison with the apparent commercial tendencies of the present time, for the order of business development may be stated as follows: individualism, partnership, incorporation, amalgamation, general association. The ground upon which is based the contention that co-operation is both fair and feasible for all the manufacturing interests, is the almost absolute dependence of one interest upon the others. For instance, the maker of the power station plant and distribution system relies for his market very much upon the commercial activity of the manufacturer who produces the final utilities, such as lamps, heating devices, and motors, through which the public is electrically served. In like manner must be noted the dependence of the manufacturer, supplies dealer, and wiring contractor, in varying degrees, upon the commercial activity of the central station and others in exploiting electric service to the public; and ultimately must be pointed out the dependence of all connected with the electrical industry upon this great, preoccupied, incredulous, and indifferent public, with its tremendous purchasing power of many thousands of pounds. The popularising of electric service to this final market is certainly a common object, on the basis of which co-operation is correctly founded.

Such a scheme as has been outlined, if fully developed, will mean the expenditure of a considerable amount of money, and the question arises as to how the funds are to be raised, and how proportioned out among the contributors. Since an increase of sales resulting from a combined electrical development campaign does not depend in any way directly on the capital investment of the individual manufacturer or central station, but rather on the individual activity of each, the contribution must logically be based as a percentage upon the sales. The municipalities and the lighting companies should also be called upon to contribute to the association, since they are going to derive benefit from its operations. From the point of view of the interests of all connected with the electrical industry in any way, many of the municipalities will have to be stirred up to get after business in somewhat the same energetic way that West Ham and one or two other municipalities are doing to-day. It will be no use to put forward objections to the effect that the Local Government Board or other authorities stand in the way, for if the association were formed one of its early duties would be to so arrange matters as to facilitate any legitimate expenditures necessary for the proper development of municipal undertakings. Before turning from the question of expenditures, it must be pointed out that the electrical association should be formed on such lines that it does not make profit or declare a dividend. Neither should it engage directly in the business of selling electric current or manufacturing or selling electrical machinery, apparatus, or supplies of any kind, since it should be a co-operative body existing for the mutual benefit of its members If it were in any way a profit-earning concern it would not inspire confidence, and so would defeat its own ends.

Central-Station Publicity.—More especially during the past year central-station engineers in this country have begun to realise that it is as necessary to adopt modern commercial methods for selling electricity as it is to sell any other commodity. In addition to this, the fact is beginning to be appreciated that although electricity is in open competition with other less advantageous means of providing the lighting, heating, and power required by the public, yet the amount sold is not anything like proportionate. Now, though it may be broadly stated that modern methods of selling electricity are merely based on sound common-sense business principles, there are many practical details, the knowledge of which would make all the difference in the time required to attain the desired end. These details are not generally known, though the technical Press has rendered considerable aid, but such assistance, owing to its necessarily general character,

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is rather meagre for application in particular cases. It is unfortunate that in the early stages of the application of new methods to the commercial development of electrical undertakings the work is often carried out in a half-hearted way, for the results, as compared with the expenditure, are then far from satisfactory. However, even a half-hearted attempt is better than no movement at all, as it gives the far-sighted manager an opportunity of testing the new methods, and thereby realising something about the possibilities of which they are capable if carried out on a larger and more systematic scale. The smaller central stations are holding aloof from any definite scheme of development chiefly on account of the fear of expense. This need not be in any way out of proportion to their business, and almost without exception is essential to their financial success. The advertising matter they require must be obtained from concerns making a speciality of this class of work, for the cost of printing and designing in small quantities is prohibitive. They usually suffer from the delusion that everyone within reach of their distributing system knows they are there. That may be so, but it is not sufficient; they must be educated just as if they did not know of the station's existence. The commercial sales department of a central station, if aggressively conducted, will accomplish results in a year or two that otherwise would not be obtained for many years under the more ordinary methods. Therefore, it behoves the supply authorities to investigate these methods, and to make it their business to increase business—to increase their load factors by every honest logical means, taking advantage of every modern commercial method that will serve their purpose, so that they may provide the inhabitants of their territory with that service which will add so much to the brightness and healthiness of their surroundings, and to the relief of domestic and industrial labour. With the experience that has been gained by central stations generally, considerable advance in publicity methods is to be looked for in the near future, especially if assistance is rendered by the manufacturers, either individually or collectively, through an electrical association.

Trade Literature.—Recently a very noticeable change has taken place in the form of the trade literature issued by those manufacturers whose products—sold and distributed through dealers and contractors—appeal directly to the consumer, in that special publications are issued, designed to assist the dealers and contractors in their sales, the manufacturers even going so far as to print the distributors' name on the booklet or whatever it may be. This fact shows that manufacturers are beginning to realise the advantages to be gained by co-operating with the contractor. They are also prepared to supply the central stations with similar literature, but the latter find themselves in the somewhat difficult position of their having to push one particular maker's apparatus, whereas it is to their best interests to encourage trade generally. From the inception of the electrical industry, special care and attention have been given to the keeping of accurate engineering data and records of central-station operation in a more or less uniform manner. The costs of production are most carefully watched, and have become a matter of friendly rivalry between station and station. It is evident, therefore, that it would be wise to commence the keeping of records of the operation of the commercial sales side of the business, so that questions regarding important commercial problems could be asked and answered readily and with certainty. These records should be kept in such a way that the results obtained in one town may be compared with those obtained in another town. The most satisfactory general basis of comparison seems to be the income *per cap.* per annum. This method, while not a strictly accurate one, gives an excellent idea of the commercial activity of each town. Where the prices per unit are low, the income *per cap.* per annum is usually greater than where they are high, indicating that low prices induce more people to become consumers. Taking the average of English towns having populations varying from 70,000 to 175,000, it will be found that the average total income *per cap.* is 4s. 10½d. This amount, representing the income *per cap.* of central stations in this country, varies from 2s. 3d. to 4s. 10d. There are 47 undertakings only which have an income *per cap.* of 7s. 6d. or over. With a properly conducted campaign there is no reason why the total income should not reach 15s. *per cap.* per annum. In those American cities where an active campaign has been carried into effect, the income *per cap.* per annum ranges from 20s. to 24s. In other American cities which have not adopted an aggressive movement for new business the income *per cap.* is about 5s.

An American Association.—In the United States of America an association was initiated two years ago, under the title of the Co-operative Electrical Development Association, which has done excellent work in advancing the electrical industry. The basis of its operations are very much the same as those laid down in this paper, but adapted to American conditions. Its inception was due to the lamp manufacturers considering a scheme for increasing their business by educating the general public as to the advantages of electricity as a means of illumination. The committee appointed to consider this scheme came to the conclusion that not only would the lamp manufacturers benefit, but also the whole electrical industry, and that, therefore, the general manufacturers should be invited to join them, which invitation was accepted. This association has recently been incorporated in accordance with American laws. A report presented at that time contains some very interesting figures, indicative of the results obtained so far through the efforts of the association. The expenditure in the promotion of the objects of the association was £11,000, and liabilities to the extent of £2,000 incurred for work in progress. By the aid of this money central stations have been induced to spend £110,000 in advertising and canvassing, with a result that the equivalent 8-c.p. lamp connections added were about 5,500,000, or, in other words, apparatus having a total demand of 140,000 kw. This necessitated a capital expenditure of approximately £2,700,000 for the necessary generating and distributing plant required to supply these additional connections, and an income to the central stations for current sold of £1,400,000—an expenditure which would fully justify the disbursement of a much larger sum than £11,000. So great has this success been, that the campaign for 1907 is to involve a total expenditure of £32,000. As a result of the work of the association, 163 American central stations have inaugurated showrooms, 193 have commenced the systematic distribution of magazines and advertising matter, 223 have started newspaper advertising, 181 began the operation of their own electric sign, 165 have added 331 canvassers. The increase in the lamp business was 25 per cent. over that of 1905, as contrasted with an increase of 8 per cent. in 1905 over 1904, and 5 per cent. in 1904 over 1903. In whatever way these results are analysed, it must be admitted that this plan of co-operative commercialism has opened up an avenue for increasing the sale of electric current, apparatus, and supplies, which is very highly efficient.

This story of success is one that should set British electrical manufacturers and central-station managers seriously thinking as to whether it would not be of great advantage to form a somewhat similar association in this country, not necessarily along the same lines as the American association, but modified to suit the needs and customs of an older civilisation. The electrical industry cannot even in these days of general prosperity be said to be, as a whole, in a very satisfactory financial position as far as profits on capital invested are concerned. The undeveloped field for the use of electrical apparatus is great, so surely any successful means of development must place all concerned with the electrical industry in a much better position. The argument may be brought forward that the Americans are more progressive than ourselves, and also that they do not suffer from gas competition. This is not a fact, but only a general impression, which is true only of the larger cities, such as New York, Chicago, Philadelphia, and Boston. It does not take a very lengthy residence in places other than these large cities before it is realised that there are many Americans who are far from progressive, and that gas competition is, indeed, a very serious factor in the older cities. In many parts of the States there is also the competition of cheap natural gas. The income *per cap.* of the average American city is only a trifle higher than

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that of the average English town, and it is only within the last year or two that American central stations have realised that it was as essential to sell electricity along very much the same modern business lines as they would sell any other commodity. It is interesting to note also that this awakening has largely been brought about by the efforts of the Co-operative Electrical Development Association. If the scheme is a good one, and it certainly seems to be so, the apathy of individuals who stand in the way of carrying it out must be overcome—the trouble involved in so doing will be well worth the effort. If necessary, the work must be started without their aid—the results obtained will do much to finally convince them. The American association has had many difficulties of this nature, which are gradually being overcome; undoubtedly the difficulties will be even greater here, but the potentialities of the general idea of popularising the use of electricity for light, heat, and power are so great that it is well worth while overcoming them.

ANOTHER AID TO THE VENTILATING ENGINEER: A RECORDING ANEMOMETER.*

BY J. ROGER PRESTON (ASSOCIATE).

I suppose most of you have a certain amount of testing to do in connection with the velocity of air under varying conditions, and realise sometimes very forcibly how inconvenient the ordinary anemometer or air-meter may be. Let us take an instance. Supposing you are called in to give an opinion on the ventilation of a large hall. You understand that the ventilation is not very bad, but still unsatisfactory. On arriving you find there are two fans, one in the extract shaft and one in connection with the inlets; the conditions generally are very variable, there being several doors and windows which may be open or shut under normal conditions, according to the eccentricities of the occupants. There appears to be a fair amount of air passing through the shafts, so that before giving an opinion you are wishful to obtain all the data you possibly can within a reasonable time. I say reasonable, because many people, and public bodies too, seem to think that an engineer can walk into a building, the ventilation of which is defective, and tell at a glance what is the matter, though they could not make a bigger mistake. However, they cannot all afford the sitting of a Royal commission. In connection with the CO_2 and other tests, you will desire to know the amount of air passing through the various shafts, and how it is affected by varying conditions. You think the matter over and decide you would like the following data. The amount of air passing through extract shaft with extract fan going, windows shut, door shut: as No. 1, but with inlet fan stopped; as No 1, but with extract fan stopped; as No. 1, but with door open; as No. 1, but with windows open. You may require the inlet fan running with all the doors and windows open, or the extract fan only running with the doors and windows open, and many other tests which would suggest themselves to our mind.

Let us assume you are going to carry out the above with an ordinary air-meter. What you have to do is something like this: Open the shaft, take the reading of the meter, place meter inside the shaft, keeping your finger on the starting catch till your watch gets to some definite time, start meter and close the opening in the shaft quickly, so as to get the most correct reading you can. After waiting a predetermined time, you again open the shaft and make a dive with your finger for the catch, so as to get the meter stopped, the opening in the shaft, owing to the inrush of air, affecting the reading. This shaft, probably, will be dark inside, and in your hurry you will find in practice your finger in contact with the vanes at first instead of the catch, which, obviously, won't improve

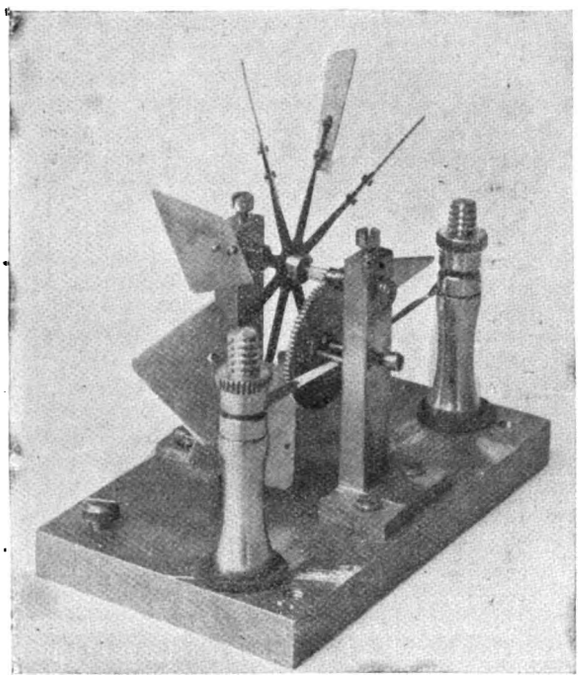

FIG. 1.

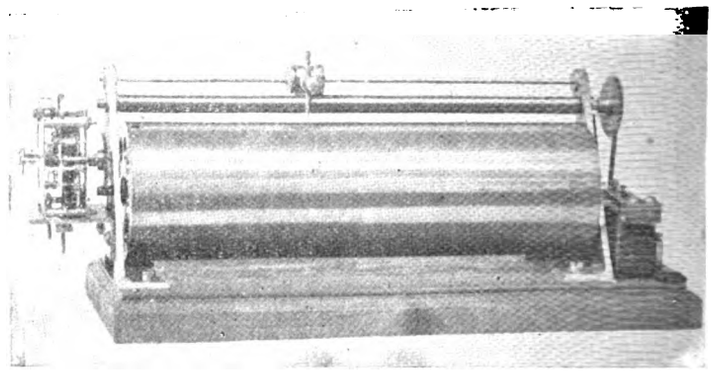

FIG. 3.

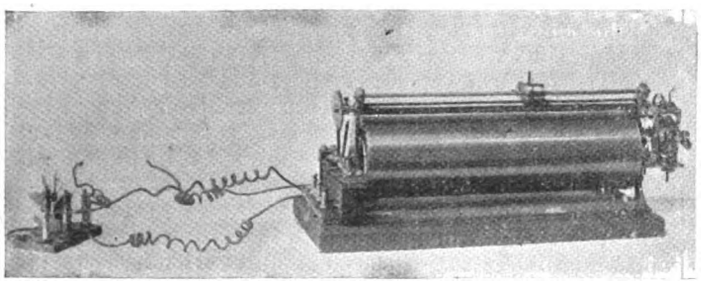

FIG. 2.

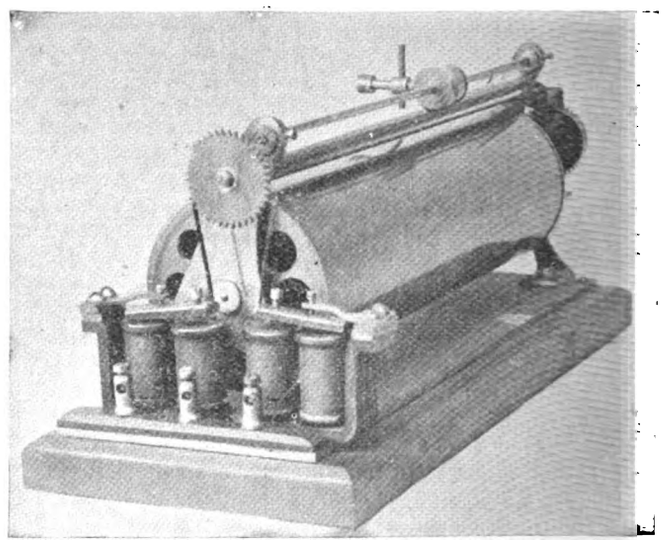

FIG. 4.

* Paper read before the Institution of Heating and Ventilating Engineers, and awarded first prize in the Assistants' Prize Competition, 1906-7.

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the working of the instrument. You now withdraw the meter, take the reading, subtracting the previous reading, without it is of the zero setting type. You next tramp downstairs and stop the inlet fan. Climb the stairs again. This performance will have to be gone through for every single test. Very much of this, especially if it is a long way from one point to another, is calculated to try the patience of most men, however anxious they may be to get sufficient data, and any of us who have had testing to do must realise how very easy it is to make mistakes, either in the reading of the meter or the time, however careful

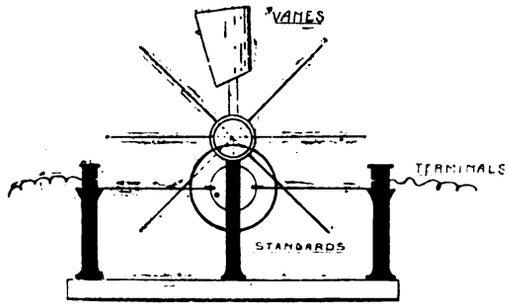

FIG. 5.

we may be; at least, when we get home, and the readings worked out, we sometimes find rather surprising results, and then we wonder whether we have taken every reading quite correctly.

It was to overcome these difficulties that caused me to give the subject consideration about two months ago, and to set about to devise some method of overcoming them, at the same time being much encouraged by this coming competition. I settled in my own mind the arrangement, to be of practical use, must have the following points: it must be of a type recording the time, velocity of air passing and the direction of same, the recording part to be

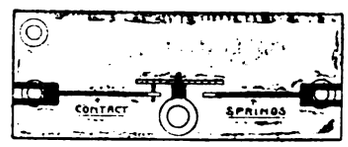

FIG. 6.

outside the shaft, have no very delicate mechanism to get out of order or difficult to repair, portable, and reasonable in cost. After describing the instrument and explaining the diagrams taken direct of the drum, I will endeavour to show how the foregoing tests mentioned could be carried out with correctness and a minimum of labour. The number of revolutions and direction made by similar vanes to those used in the ordinary air-meter are transmitted electrically to a carriage carrying a pencil or pen over a drum revolving once round in a predetermined time by clockwork, this carriage travelling along the drum in proportion to the speed of the vanes, and backward or

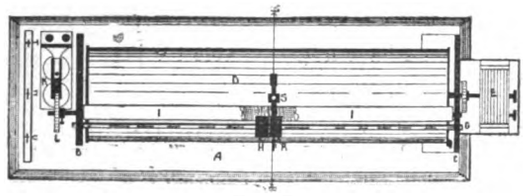

FIG. 7.

forward, according to the direction in which the vanes are travelling.

Figs. 1 and 2 show the transmitting apparatus itself, also coupled to the recording apparatus, while Figs. 3 and 4 are two views of the recording apparatus. The study of these photos will give a general idea of the apparatus, and enable the sketches to be more easily followed. You will notice the photo of the transmitting apparatus does not quite agree in detail with the sketches. This is due to it being made of whatever was handy. I may say that, apart from the actual vanes, the making was all done in our own shops by an intelligent apprentice, with the assistance of a local watchmaker for the delicate parts, such as pivoting the vanes, etc. Fig. 7 is a plan of the recording apparatus, which I will explain first. A is a base-plate on which the standards, B and C, are fixed; D is a drum or cylinder with pivots which revolve in the standards, B and C. This drum is connected with the clock, E, which causes it to revolve once in 10 minutes; this is arranged by having a wheel on the minute spindle geared into another fastened on to the drum spindle in a ratio of 1 in 6. Over this drum is a traversing carriage, F, which slides on a guide spindle, G. The carriage is screwed at H for part of its length, and engaged with the shaft, I, which is screwed the whole length between the standards,

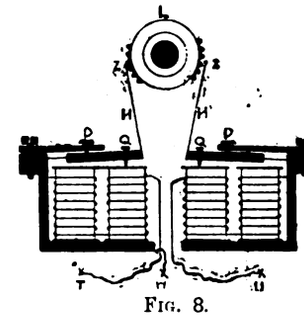

FIG. 8.

20 threads to the inch. The shaft is free to revolve in the standards, motion being given to it by the electric magnets, K, of which an elevation is given on Fig. 8. The wheel, L, which is fastened to shaft, I, has 40 teeth in its circumference. Z Z (Fig. 8) are pieces of wire fastened to the springs, H, shown in elevation, and are so arranged as to trip over the teeth of the wheel one way, but push it forward the other way. Let us assume that a current is sent through the left-hand magnet, the armature is drawn down, and at the same time the wire, Z, at the end of spring, H, has been tripped over a tooth of the wheel, L. On the current being cut off, the armature is sprung back to its original position by the spring, the wire, Z, rising at the same time and pushing up a tooth before it, thereby revolving the toothed wheel in a right-hand direction one-fortieth of a revolution. Assuming that a current was sent through the right-hand magnet, it will be readily seen that the wheel will be revolved the same distance to the left hand. One important point is that the wire, Z, when in their normal state, should stand just clear of the teeth, so as to allow the teeth to go either way. P P and Q Q are regulating screws. Referring again to the carriage, F (Fig. 7), it is shouldered down at R, the pencil-holder or pen revolving upon it, a section of which is shown (Fig. 9). The pencil is pressed upon the drum by the weight of its holder, S. We have now seen how the motion may be transmitted from the magnets to the carriage carrying the pencil, which in its turn marks the paper, which may be wound round the drum. We also

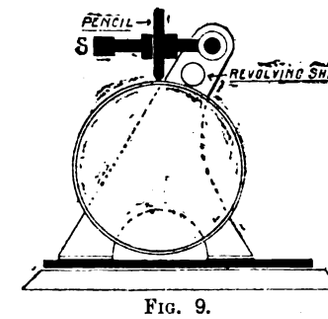

FIG. 9.

notice that by sending the current through the left-hand magnet the shaft, I, revolves to the right, carrying the pencil towards the standard B, but by diverting the current through the right-hand magnet the shaft is turned to the left, and the pencil carried towards the standard C. The magnets are wound as shown (Fig. 8), the beginning end of each being fastened to the metal frame, the other ends to the terminals, T and U, respectively, W making contact with the metal frame. The terminals are fastened on hardwood strips, as shown.

The arrangements of vanes and contacts on the transmitting apparatus are very simple The vanes are fastened on to a shaft which is pivoted between two standards, as

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will be seen from photo (Fig. 1), the shaft carrying a small toothed wheel geared into a larger one in ratio of 1 to 10; on the larger wheel is a platinum pin, shown in photo and in section (Fig. 6). When the vanes are in motion the wheel carrying this pin revolves once round for every 10 revolutions of the vanes, the pin coming into contact with the springs which are fastened to the terminals as shown; these springs are covered on the top side with paper or other insulating material, so that the pin only makes contact with the metallic part of the spring when coming from underneath. It will be obvious, therefore, that if the vanes are travelling to the right hand, the large wheel, owing to the gearing of same, will be travelling to the left, the platinum pin making contact only with the underside of the right-hand spring, and if the direction of vanes are reversed the pin will only make contact with the underside of left-hand spring. It is obvious, therefore, that the current can be diverted through either terminal, according to the direction of the vanes, and that by connecting these two terminals to the two outside terminals on the recorder, the magnets are controlled by the direction in which the vanes are travelling.

Fig. 2 shows the transmitter connected up to the recorder, the two pillar terminals on the transmitter being connected with the two outside terminals on the recorder, the small terminal on transmitter and the centre terminal on recorder

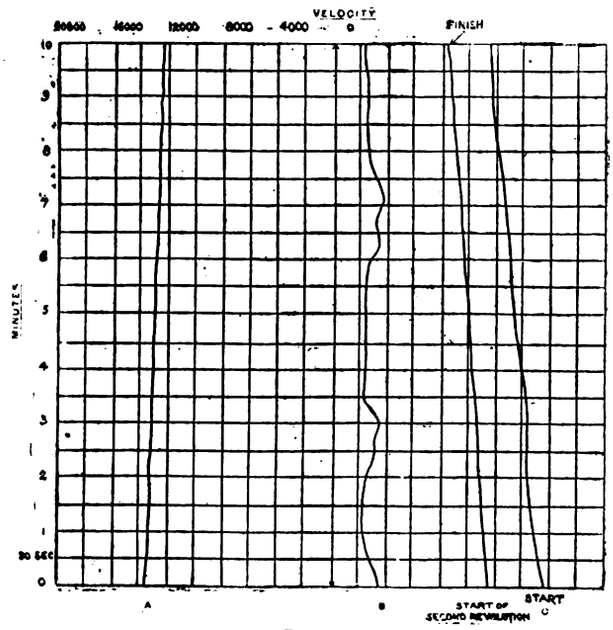

FIG. 10.

going to the batteries which are not shown. It is intended for the whole apparatus to fit into a box with dry cells underneath. I may say that the magnets take very little current. A small switch will be desirable between the recorder and transmitter, so that the magnet can readily be put in and out of action. The paper which is wound round the drum may be fastened in a variety of ways: a handy way is to have the paper cut a little longer than the circumference of the drum, so as to allow of a little lap, this lap being coated with gum similar to a newspaper wrapper, and a perforated line so as to allow of easy removal however it may be arranged; there must not be a decided ridge in the circumference, as the drum may require to revolve many times during a series of tests. The paper may be ruled and divided up according to individual requirements. The ruling on the one at the end of the drawings will be found useful. The drum is 10in. in circumference, and of such a length as to allow the pen to move through a space of 10in. Taking the drum as moving once round in 10 minutes, 1in. will equal one minute, $\frac{1}{12}$in. five seconds. The movement of pencil will be as follows: Two revolutions of vanes equals one foot of air, 10 revolutions of the vanes equals one contact owing to the wheel carrying contact pin having 10 times the amount of teeth of wheel on shaft carrying the vanes. One contact moves the shaft connected with carriage carrying pencil round one-fortieth of a revolution, owing to the wheel on shaft having 40 teeth in its circumference. Forty contacts, therefore, move the shaft one revolution. The shaft having 20 threads to the inch, it will require 800 contacts to move the pencil 1in., which is equal to 8,000 revolutions of vanes. If, therefore, two revolutions equal 1ft. of air, 8,000 revolutions will equal 4,000ft. of air, which will equal 1in. on the paper. If, as example shown (which is not fully ruled), the inches are divided into 10 parts, each part will equal 400ft. of air. You will notice that the number of feet is marked both ways from the centre. The idea to start at the centre was that the vanes were liable to go both ways. If you are certain the air is travelling in one direction only, it would be as well to start at the end, as it will enable you to get more diagrams on the same paper.

In Fig. 10 A, B, C are diagrams off the drum, a pen being used instead of a pencil. A shows the air has been travelling mostly in one direction only, and also at a fairly steady rate of about 1,000ft. in 10 minutes. B illustrates the effect of the vanes going both ways; this was to a certain extent prepared for the purpose of illustration, as it was rather difficult just to get a current of air varying at a moment's notice C is a larger diagram extending over two revolutions of the drum or 20 minutes; it will be noticed the direction keeps the same, though the velocity of the air varies. It will be obvious that when the paper is taken off the drum the start of the second revolution is on the same edge as the start at first. If the velocity of the air is slow, it will be obvious that you can get a much longer test or series of tests on the same paper, owing to the pencil not moving along the drum as fast in proportion to the time as if the velocity were high. Now let us assume we are going to carry out the tests mentioned at the beginning of the paper. We have the transmitter, recorder, and batteries in a suitable box coupled up ready for use. After opening the shaft we put the transmitter inside, close the shaft, leaving a small hole for the fine flexible wire with which the recorder would be coupled to the transmitter. We now start the clock, if not already going, and pull the drum round a little from the beginning of the paper, so that the clock can catch up to the drum so as to get rid of any back-lash in the teeth. When the drum is going steady, wait till the start of paper comes under the pen, then drop pen down, at the same time close the switch setting in action the magnets. We know now that the air is being registered on the paper, so that we can take a walk round, stop the inlet fan a little, open the doors, shut the windows, or do anything else we like; the only thing we have to note is the time and duration of these actions, knowing that any variation these have made in the amount of air passing will be faithfully registered on the paper, and knowing the time we started the recorder we can trace the time and variations when we get home, and if there are any surprising results we shall be spared the worry of wondering if we have taken the reading correctly, besides having saved ourselves much running about. I should very much have liked to have given you more diagrams from tests in everyday practice, but owing to the short space of time between my conception of the idea and the completion I have not been able to.

ENGINEERING AND MACHINERY EXHIBITION. III.

The large machinery and apparatus which is to be seen at Olympia Exhibition—which closes on the 19th inst.—may overshadow some of the smaller exhibits. To some extent this is inevitable. But visitors should make it a point to pay particular attention to those exhibits of smaller magnitude, many of which are full of novelty and utility, and present features of interest and instruction.

Mention should be made of a stand, the exhibits on which, if somewhat unpretentious, are, nevertheless, of the utmost importance, and of especial interest to electrical engineers. We refer to the exhibits of Aerators, Limited, "Prana" Sparklet Works, Upper Edmonton, London, N. (Stands 135 and 152). Chief among the latter are the

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specimens of "Prana" alloy die finished castings in alloys of varying specific gravities for complicated mechanical parts. "Prana" castings can be used in place of expensive machined-up brass and iron castings in all automatic machine work, and are especially suitable for such, as they offer great facilities for lightness in construction, whilst at the same time retaining the full strength of the more expensive heavier metals. They are also specially adapted for telephone and electrical instrument work, and are pre-eminently suitable for damper boxes, dash-pots, moving coil, switches, etc., where very complicated parts necessitating great accuracy for fitting up are required. Visitors to Olympia will also see further applications of these castings. The "Magnoid" process for repairing castings is also shown by the Magnoid Company, Limited, of 12, Camomile-street,

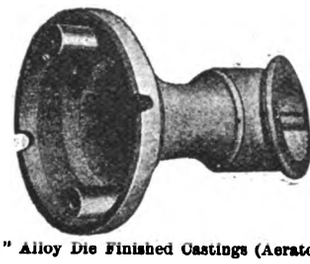

FIG. 1.—"Prana" Alloy Die Finished Castings (Aerators, Limited).

London, E.C. We pass from these exhibits to the stands occupied by the United States Metallic Packing Company, Limited, Soho Works, Thornton-road, Bradford, and 17, Victoria-street, Westminster, S.W. (Nos. 159 and 178). There is here a varied display of this well-known packing, designed to reduce the friction on the piston and valve rods to a minimum, and reducing wear and tear on the engine. Specimens are shown of packings which have been in service 16½ years without renewal. Another interesting exhibit is that of the C. and I. hand electric drill, shown by the same firm, a feature of which is that it dispenses with flexible and telescopic shafts. An illustration of this drill is shown in Fig. 2, and it can be coupled to an ordinary lampholder

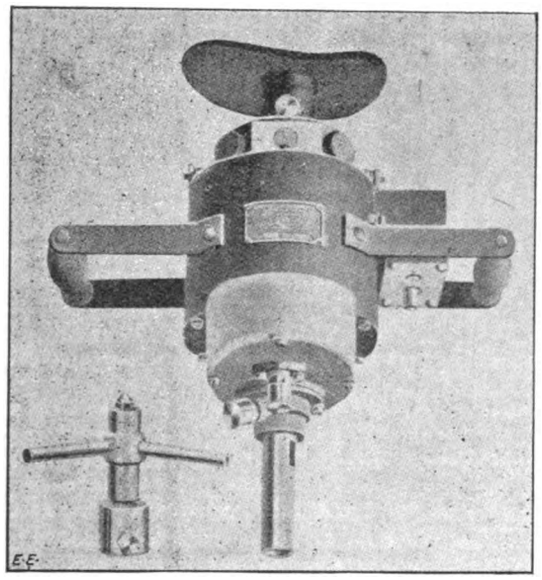

FIG. 2.—C. & I. Hand Electric Drill (United States Metallic Packing Co).

or wall plug. The motor is series wound, giving varying speeds according to the size of the drill and the pressure used. It is ¼-h.p., four-pole type, with laminated pole-pieces. The weight of the complete drill is 28lb. The Combination Metallic Packing Company, Gateshead-on-Tyne, are showing various types of packing, chief among which is the design of turbine packing; also a modified design which is suitable for centrifugal pumps and revolving rods, such as is used in electrical stations. Some excellent specimens are to be seen at the exhibition, illustrating the steps that have been taken to perfect the process of electric welding. The "Prescot" welder (Fig. 4) made at Prescot by the British Insulated and Helsby Cables, Limited, is shown in operation at Stand 273 by the Bates and Peard Annealing Furnace Company, Limited, Hayton, Liverpool. The weight of the welder illustrated is 320lb. It will weld copper and brass up to ·400in. diameter, or iron and steel up to ·750in. diameter. At this stand are also shown, besides the Bates and Peard annealing furnace, gear wheels made from compressed paper, which are also made by the British Insulated and Helsby Cables, Limited, and which go by the name of "Prescot" pinions. These pinion wheels are made by a

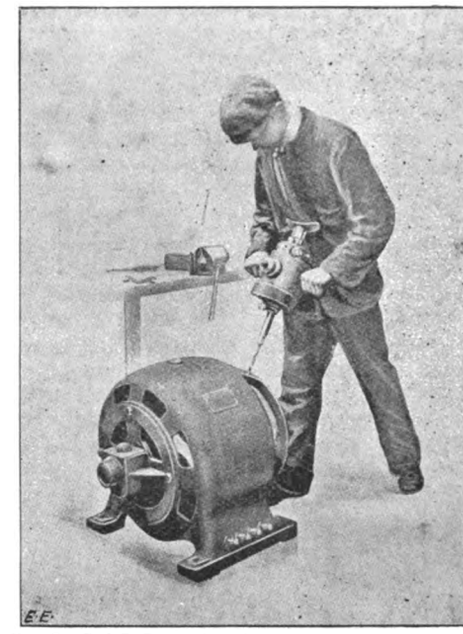

FIG. 3.—C. & I. Drill (United States Metallic Packing Co).

special process, as a result of many years' experience, with high-grade papers, and constitute about the quietest running gear which can be obtained. Messrs. E. A. Brandon and Co., 33, Devonshire-chambers, Bishopsgate, London, E.C., are showing "Sheradised" exhibits—*i.e.*, to demonstrate the method of protecting steel or wrought and cast iron from rust by the process known as "Sheradising."

The Mordey-Fricker Electricity Meter Company, Limited, 82, Victoria-street, Westminster, S.W., have a good show of electrolytic prepayment electricity

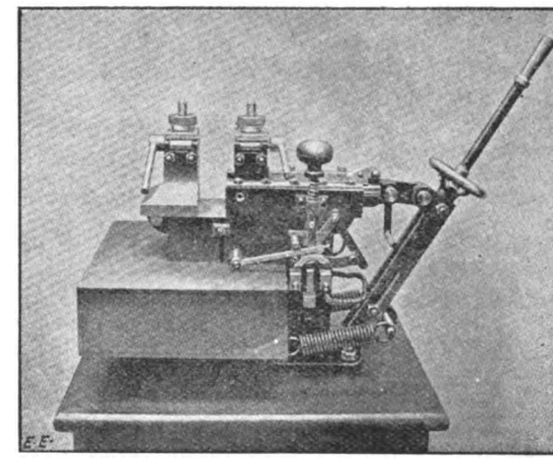

FIG. 4.—The Prescot Welder (British Insulated and Helsby Cables, Limited).

meters. This consists of a copper voltameter, through which the whole current to be measured is passed. The anode is a thin, wide copper ribbon fed into the electrolyte by a sprocket roller actuated by a coin-operated handle. A definite feed is given for each coin. When the immersed portion thus prepaid is consumed by electrolysis the circuit is opened at the surface of the liquid. There is no other switch. Accuracy results from the fact that a given number of ampere-hours always causes a given weight of copper to be eaten away. The meter can be calibrated for any price per unit, and the price can be altered at any time by using a strip of different thickness. No counter is necessary, the consumption of current or total number of coins paid being shown by numbers printed on the copper roll seen through a glass window. The meters are made to take pennies, sixpences, or shillings, also various foreign

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coins. The company also show for the first time a new form of the Mordey-Fricker clock-type meter, intended especially for small users of alternating current, but also applicable for direct current, and Fricker's well-known maximum demand indicators.

A varied display of electric fans and accessories is contained on the stand of Messrs. Bergtheil and Young, Limited, 12, Camomile-street, London, E.C., but special interest attaches to the "Bandy" electric punkah. The quadrant marked "A" on the sketch (Fig. 5) is of soft padded leather or other suitable material. The pinion on the motor, lettered "B," can also be of soft material. The motor is shunt wound, and runs at a constant speed, with the following result. Due to the spring lettered "C," which always tends to pull the quadrant to the central position, the quadrant, when at rest, engages by friction with the pinion. When this starts revolving, it creates a swinging or pendulum action on the punkah, and, at the point where the quadrant leaves the pinion, due to the angle it takes on leaving, a flick is given which causes the quadrant to swing a considerable distance free entirely of the pinion. Due to the angle at which this pinion is set, it is bound, on the return journey, to engage with the opposite side of the pinion to that from which it went forward, and so a constant free swing is produced, similar to the free swing given by the human punkah wallah.

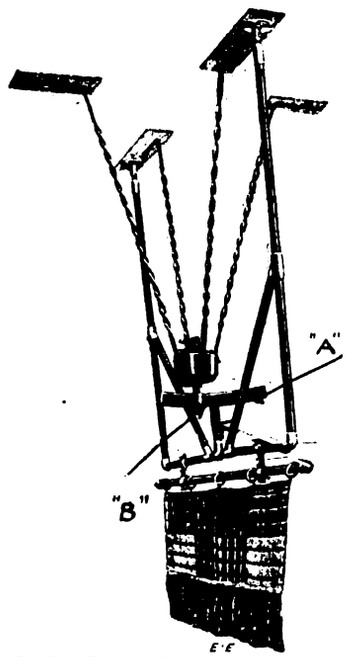

FIG. 5.—"Bandy" Electric Punkah (Bergtheil and Young, Limited).

It can be adapted for use in almost any position, drawing rooms, ships' saloons, restaurants, etc, and Messrs. Bergtheil and Young are at the moment engaged in fixing some of these punkahs in the dining saloons of some steamers belonging to one of our largest steamship companies. The "Bandy" special new type alternating-current motor for lift work, fans, etc, is also of interest; it fulfils practically the same conditions as are now obtainable from continuous-current motors.

Portable electric hoists of the "Yale and Towne" type, equipped with direct-current series-wound motors, form a feature of the stand occupied by the Fairbanks Company, 78-80, City-road, London, E.C., while the Easton Lift Company, Limited, Broad Sanctuary-chambers, Westminster, London, S.W., are showing a selection of electric passenger and goods lifts. We might mention that the contract for supplying 20 electric lifts at the new London terminus at Victoria for the London, Brighton, and South Coast Railway has been secured by Messrs. Easton's. Roller bearings are shown at a stand occupied by the Hyatt Roller Bearing Company, 47, Victoria-street, London, S.W., and at the stand of the Empire Roller Bearings Company, Limited, 15, Victoria-street, London, S.W. Messrs. John Hopkinson and Co., Limited, Huddersfield, have a selection of valves on view. Special attention should be directed to the Hopkinson-Ferranti stop valve shown in Fig. 6. This has been introduced to enable valves to be used having operative working parts half the ordinary diameter, and so constructed that they will pass an amount of steam equal to the full carrying capacity of the pipe without appreciable drop in pressure. The object has been accomplished by forming the working parts of the valve in the throat of a "converging diverging" nozzle of correct design, and by special construction of parts to give a smooth passage for the fluid when the valve is full open. The effect of this construction is to convert a portion of pressure energy of the steam as it travels into the converging nozzle, A, into kinetic energy, the steam increasing in velocity and dropping in temperature and pressure. At the high velocity thus acquired it passes through the controlling part or valve proper. It now enters a diverging nozzle at high velocity, and in its passage converts its kinetic energy into increased pressure and temperature, until at leaving the nozzle at C it has returned to the same conditions of pressure, temperature, and velocity with which it entered the converging cone, A, at the inlet side of the valve. In a test recently made with a 6in. Hopkinson-Ferranti stop valve fitted to a 1,500-kw. turbine it was found that the valve passed over 26,000lb. of steam per hour at 180lb. pressure, which clearly proves its high efficiency.

Messrs. E. Green and Son, Limited, Wakefield, are showing a model fuel economiser (quarter actual size), containing 96 tubes, arranged on the modern principle in two groups with facilities for access to all parts. This model is fitted complete with top and bottom branch pipes, blow-off and safety valve, and scraper gear, the latter in motion, being

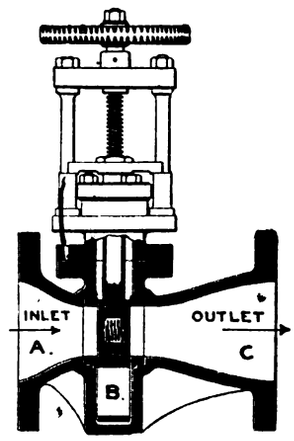

FIG. 6.—Section of Hopkinson-Ferranti Patent Stop Valve.

driven by small electric motor. The Hudson Economiser Company (1907), Limited, Gloucester House, 2, Bishopsgate-street Without, London, E.C., have on view a Hudson patent feed-water heater and economiser, complete with automatic float, and a working model of Brown's patent cooling tower, made either chimney, open, or fan type, among their exhibits. The exhibits of Messrs. McPhail and Simpson, Limited, Wakefield, are of particular interest, especially the specimens of superheater tubes which have been at work continuously night and day for 10 years in a Babcock and Wilcox boiler, and which have been cut out for exhibiting. This was the first superheater ever attached to a water-tube boiler. The tubes are quite sound, and not in the least deteriorated from their long use in the exceedingly high temperature, the steam passing from them being over 700deg. F. The Kennicott Water Softener Company, 18 and 19, Great St. Helens, London, E.C. have also a stand where records may be consulted of the performance of Kennicott water softeners, which are in use at Finchley and Cheltenham electricity works, and elsewhere. Messrs. Thwaites Bros., Limited, Bradford, Yorks, have a fine stand, on which we noticed a high-class horizontal air compressor direct geared to electric motor, and complete with air receiver, and a Thwaites patent variable-delivery three-throw electrically-driven pump. This pump is so arranged that its delivery can be varied from nothing to full duty whilst running, without alteration to the length of stroke or efficiency. This result is obtained by controlling the suction valves. All the motors on this stand have been made by the Phœnix

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Dynamo Manufacturing Company, Limited, of Bradford. Messrs. J. Defries and Sons, Limited, 146 and 147, Houndsditch, London, E.C, are showing a selection of "Wirt" brushes for motors and dynamos, and the "Meteor" flame arc lamp for alternating and continuous currents—8, 10, and 12 amperes.

The stand of the Linolite Company, 25, Victoria-street, Westminster, London, S.W., is one of the most interesting. There is a "Gravitemp" time switch (Fig. 7) which shows the instrument set for action. Then there is the well-known "Tubolite," which is now so conspicuous in shop windows. Tubolite is a practically continuous straight line of incandescent carbon filament of the usual and well-tried type. The filament is contained, in lengths of about 8½in., in straight glass tubes, ⅞in. in diameter, having one terminal at each end. The standard lamp is 12 c.p., taking 3·75 watts per candle-power, and has an average life of 1,000 hours, with a decrease of only 14·5 per cent. of the light in that time. The lamps are placed end to end in a semi-circular, channel-shaped, highly-polished aluminium reflector, 2¼in. wide by 1in. deep, having an efficiency of 81 per cent., compared with 92 per cent., the efficiency of highly-polished silver, the most nearly perfect (though too expensive) reflector there is. The two edges of the reflector are rolled into small beads, each of which carries one of the wires, which are thus protected from injury.

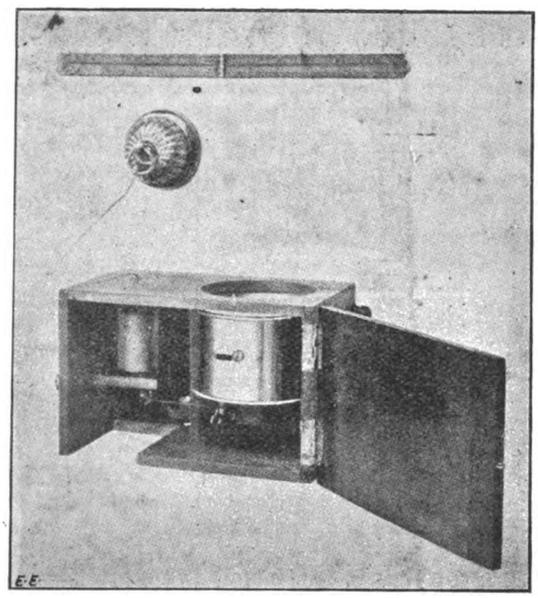

FIG. 7.—"Gravitemp" Time-Switch (The Linolite Co.).

The lamps are held firmly, and in the position for maximum efficiency, in the reflector by aluminium holders, having centre contact plungers. The light is distributed over an angle of 140deg. Throughout half of this angle the light is from 2 to 2½ times as great as the candle-power marked on the lamp, and for 100deg. it is 50 per cent. to 150 per cent. greater. Tubolite is fixed into position either by small screws through the reflector, or by plated-hinged clips, or by aluminium chain slings, the latter two devices permitting the Tubolite to be instantly adjusted to almost any angle. The weight of the complete fitting, including lamps, is only 6oz. per foot run, and it costs only 1d. per yard per hour for electric energy at 6d per Board of Trade unit. It is eminently suitable, on account of its compactness, efficiency, simplicity, and safety, for shop-window and cornice lighting.

Mr. Bernard Metz, of 3, Great Winchester-street, London, E.C., is showing the Percival self-sustaining arc lamp winch, with which our readers are now familiar. The brilliantly-illuminated stand of the Foster Arc Lamp and Engineering Company, Limited, Worple-road, Wimbledon, London, S.W., cannot be missed, and the visitor will see there a selection of Foster patent enclosed arc lamps, miniature arc lamps, double-carbon flame arc lamps, and magazine flame arc lamps. There are two stands at which movable electric fittings are displayed, and neither should be missed; these are the stands of Laurie and Inglefield's patent travelling electric lights and stretching pendants (London agents: Messrs. Robert A. King and Co, 66, Victoria-street, S.W.), and Messrs. John Dugdill and Co., Failsworth, near Manchester. Summance Abady CO_2 recorders are shown by Messrs. Alex. Wright and Co., while Messrs. Sanders, Rehders, and Co. are showing a selection of "Sarco" recorders, etc. Finally, mention should be made of the rare display of crystals of crude carborundum at the stands of the Carborundum Company and the Vincit Company, Limited, 117B, Queen Victoria-street, E.C.

SOME TRAMWAY ACCIDENTS AND THEIR MORAL.

So far as it is possible to judge from the evidence available, the fatal tramcar accident at Birmingham last week belongs to that increasing class in which the prime cause of accident is simply human weakness, or, as seems to be the case here, with an admixture of negligence. The facts are reported briefly as follows. The driver of the car in question discovered on his first journey that the magnetic brake did not act satisfactorily on hills, and reported the fact to the inspector. Nevertheless, the latter, instead of ordering the car to be immediately returned to the depôt, thought he would try the brake himself, and on the next journey took charge of the car. While descending a hill, the steepest gradient of which was 1 in 17, the car got out of hand, and the inspector, who was driving, tried ineffectually to apply the magnetic brake, which he had been able to operate on the previous hill, though not properly. When the brake failed, he applied the back power. The car attained a great speed, and the inspector threw off his parallel brake and applied the hand-brake, but they were on the top of the bend at the foot of the hill before it would retard the car, which fell over on its side. There was water on the rails at the curve and the wheels skidded. In examining the car after the accident a fracture was found, the effect of which would be to destroy partially the continuity of the electrical circuit for the magnetic brakes. A representative from the tramways department stated at the inquest that this fracture was entirely responsible for the unsatisfactory condition of the magnetic brake, which he held to be the cause of the accident. Of course, there will have to be a Board of Trade inquiry, when fuller details will be ascertained. But sufficient is already known to point to error of judgment in not returning the car to the depôt as soon as the brake was found to be defective. At any rate, this accident in no way points to the unsuitability of electromagnetic brakes on gradients. It will be remembered that two similar accidents of a similar character occurred on one evening in July on the Sunderland District Electric Tramways. The latter took place on a hill, the gradients of which vary from 1 in 30 to 1 in 10·89. The line on which the accidents occurred appeared to be in good order, the rails not being much worn; the outer rail at the curve, however, had not got any superelevation—in fact, the inner rail being slightly the higher of the two. The cars which met with derailment were double-decked, single-truck cars, fitted with a motor on each axle, provided with a hand-brake working blocks on all the wheels, and with the Westinghouse magnetic track brake working a slipper between the wheels on each side of the car; the length of each wheel base was 6ft.; each car was fitted with two sanding arrangements at each end. At the time of the accident the rails were very greasy. In each case the accident was attributed by the driver to the failure of the magnetic brake. But Lieut.-Colonel von Donop, who held an inquiry on behalf of the Board of Trade, thinks otherwise. In his report, which appeared the other day, he says, with regard to the first accident, "both the front and rear controllers of the car, as well as the brake gear itself, were so damaged by the accident that the condition of the magnetic brake could not be practically tried after the accident. Godwin" (the driver) "had, however, been in charge of this car for about four hours previous to this occurrence, and had found nothing amiss with the braking arrangements of it; he had previously on the same day brought the car down Mill Hill Bank by means of the magnetic brake, and he had controlled the car by that

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means without any difficulty; he states also that just before descending the bank on the last occasion he had brought the car to a stand by the application of that brake. It appears, therefore, to be very improbable that the magnetic brake could have so suddenly failed." On the other hand, the inspector thinks that the accident was due to the driver's neglect to carry out instructions. One of the company's rules for the use of the magnetic brake when coasting down gradients lays down that at the commencement of the descent the controller handle should first be placed in the last—*i.e.*, the seventh—braking notch, and that it should be allowed to remain in that position until the car has gained sufficient speed to put the brake in operation; the handle should then be moved back one notch at a time until the car is coasting down the incline at the desired speed. When a car is running at a very low rate of speed, it is only when the handle is on the seventh notch that the magnetic brake will have effect, and the reason for commencing the descent with the handle in that notch is therefore clear. The driver disregarded this rule altogether; he first placed the controller handle in the neutral position, and on starting he at once moved it to the third notch. With the handle in this notch the magnetic brake would not come into action until a considerable speed had been attained. Had he kept the magnetic brake in the third notch, the inspector thinks the brake would have acted in time, but the driver evidently got alarmed, and he made matters worse by taking the brake off altogether. The car was by this time on the steep portion of the incline, and doubtless was gaining speed very fast. In the second case, too, the magnetic brake of the car was examined immediately after the accident, and was found to be in all respects in first-rate order. But Colonel von Donop is inclined to think that the driver did not make sufficient allowance for the greasy state of the rails; he consequently allowed his car to approach the derailed one at rather too high a rate of speed, and he then found that he was unable to check his own car without skidding the wheels. These accidents serve to show, further, the great part which a motorman's nerve and self-control has to do with the safe working of a tramcar, while one of them points to the importance of the outer rail of curves having a fair superelevation over the inner.

ELECTROMAGNETIC CONTROL OF MOTOR VEHICLES.

It is not at all surprising that attention should be turned to electrical means for controlling the speed of motor vehicles, and that electrical arrangements for the transmission of power to such vehicles should be resorted to with a view to obtaining better results than is now possible. There have been many workers in this field, and recently a patent (No 11,462) was granted to one of them, Mr. Arnaldo Paolo Zani, electrical engineer, of the English Electrical Works, Preston, whose invention relates to eletromagnetic devices for varying the speed of power shafts driven electromagnetically, by a prime mover running at constant speed. In the particular example of such power transmission apparatus two pairs of co-operating dynamo-electric elements are shown, one element of one pair being attached to the prime mover and the other to the power shaft, and one element of the second pair being at rest and the other attached to the power shaft; separate excitation is provided for both pairs of elements, necessitating the use of an auxiliary exciter.

The power transmission plant to which the invention is applicable is shown in Fig. 1. The armature, *a*, is similar to the armature of an ordinary direct-current machine, and is mounted on the shaft of the prime mover. In electromagnetic relation to this armature is placed a field magnet, *b*, of any desired number of poles, this field magnet being fixed to the driving power shaft, *c*, and rotating with it. The power shaft also carries a second armature, *d*, which is fastened to it in any suitable manner and rotates in electromagnetic relation to a second field magnet, *e*, which is not rotatable. The rotating field magnet, *b*, is provided with slip-rings, *f f*, by which the exciting current is introduced, and the brushes, *g g*, carried by the rotating magnet, *b*, and bearing on the commutator of the first-mentioned armature, *a*, are also connected through slip-rings, *h h*, to the brushes, *i i*, of the second armature, *d*.

In order to vary the speed at which the power shaft is driven in this arrangement, it is only necessary to vary the excitation of the fields, *b* and *e*, and the invention lies in the means adopted for effecting this.

According to one modification of the invention as shown in Fig. 2 the fields, *b* and *e*, are excited by means of a battery, *m*, having a number of cells in series, the positive

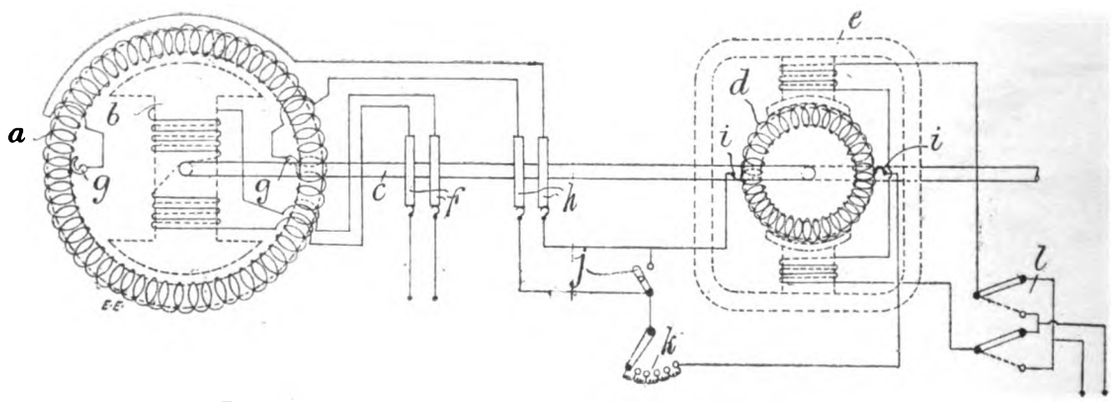

FIG. 1.—Type of Transmission Plant to which Mr. Zani's Invention is applicable.

and negative plates being connected to an arc of separate terminals, 1, 2, 3, 4, 5, and 6, adapted to make contact in turn with a key, *n*, connected between a pair of terminals, one from each of the field magnets, *b e*. The other terminals of the two field magnets are connected to positive and negative plates, *o p*, at the two ends of the battery. It will be seen that by this arrangement by moving the key, *n*, over the arc of terminals the excitation of the field magnets may be varied simultaneously, the excitation of one of the field magnets being increased while that of the other is decreased, and *vice versâ*.

In the arrangement shown in Fig. 3 the energy for excitation of the fields is taken from mains, *r s*, and in this case connected switches, w^1 w^2, are used. These switches are adapted to pass over arcs of contacts, *v u*, respectively, and the two fields are connected to these switches and to the mains, *r s*. This arrangement, therefore, serves to control the excitation in the two fields simultaneously by means of a pair of connected rheostats formed by the switches, w^1 w^2, with their arcs of contacts, *v u*, and their resistances.

In order to start the power shaft, the field of the field magnet *b* should be very weak, as the E.M.F. generated at the brushes of the armature *a* should be small, and only sufficient to circulate the necessary current in the armature *d*, as there is no counter E.M.F. at starting. The torque exerted between the first magnet, *b*, and the armature *a*, and which is directly transmitted to the power shaft, *c*, is thus very small. In order to increase the total effective torque on the power shaft at starting, therefore, it is convenient to insert resistances, and this is done by means of the variable resistances, *k*, in series with the armature *d*.

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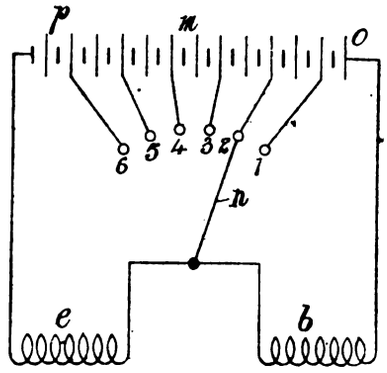
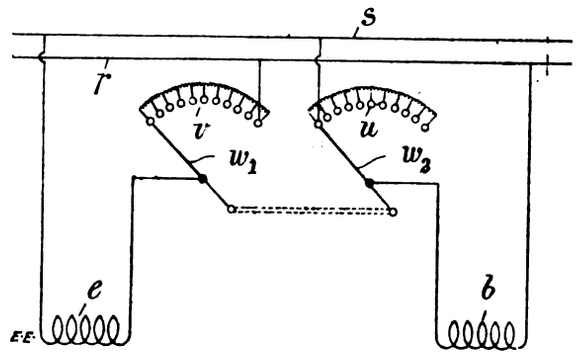
It is thus possible to obtain a higher voltage between the brushes, *g g*, of the first armature without exceeding a safe value of current. There is also obtained a useful torque between the armature *a* and field magnet *b*, on account of the increased strength of the field. The resistances, *k*, will be cut out when the speed comes up.

In the application of this invention to heavy vehicles in which a high rate of acceleration is maintained, the power transmitted gradually increases, and reaches a maximum which may be above the output of the prime mover employed. In this case a storage battery may be connected across the brushes of the armature *d* to supply power automatically when required. The current from the battery should circulate only in the armature *d*, this being effected by properly proportioning the apparatus.





FIGS. 2 AND 3.—Two Methods of Controlling the Excitation of the Fields of the Transmission Plant.

When the speed of the power shaft is very near that of the prime mover, the field *e* will be weak and the field *h* strong. The short-circuiting switch, *j*, can then be closed, cutting out the armature *d* completely. The field *b* will then rotate with a speed slightly below the speed of the prime mover, the slip between the two generating enough E.M.F. to cause the current to flow from the brushes, *g g*, across the short-circuiting switch, *j*. This current reacting on the field *b* will supply the necessary torque in the power shaft, *c*, and if the resisting torque on the power shaft is variable, the slip between the field magnet and armature will adjust itself automatically to meet the variations. When running in this manner the only losses which are present in transmission are copper losses in the armature *a* and field magnet *b*, there being practically no iron losses in the first armature on account of the low periodicity due to the small slip.

If the polarity of the field magnet *e* is reversed by the switch, *l*, or if the brushes, *g g*, of the first armature are reversed, the first armature and field magnet act together as a generator, while the second armature and field magnet act as an electric motor. In this case there will be no positive torque transmitted to the power shaft by the generator, but a negative torque which must be made up by an increased torque on the motor part of the system. The transmission in this direction is not so economical as in the other case, but the speed is not limited to the maximum speed of the prime mover, but can be increased at will. Reversing the polarity of the second field in this manner supplies a convenient method of reversing the rotation, as the efficiency is quite satisfactory for most practical applications.

But in a provisional specification (No. 12,340) Mr. Zani describes an improved means for controlling the speed of the driven power shaft by varying the field strength of the system by shunting the fields through a single set of resistances.

Referring to Fig. 4, which illustrates diagrammatically Mr. Zani's improved method of control applied to electromagnetic power transmission apparatus of the type referred to above, the armature *a* revolves with the prime mover, the field *b* being fixed to the power shaft, while the field *c* is fixed and the armature *d* revolves with the power shaft. These four elements are connected in series, a reversing switch, *e*, being provided to reverse the armature *d*. In this form of transmission apparatus, as is well known, the current generated by reason of the slip between the armature *a* and field *b* drives the armature *d*, and the total torque on the power shaft will be the sum of the torque transmitted through the field *b* and the electrically-transmitted torque, so that only a portion of the power transmitted is converted to electrical energy and reconverted; also, the speed of the power shaft for any given adjustment of the fields is independent of the resisting torque if the ohmic losses are neglected. In applying his invention to this form of power transmission apparatus he provides a shunt having four or other number of resistances, r^1, r^2, r^3, r^4, connected to a row of contacts, 1, 2, 3, etc., in the manner illustrated. Opposite the contacts, 1, 2, etc., are contact bars, *f*, *g*, *h*, adapted to be connected to one or other of these contacts by a sliding connection. The contact *f* is connected to one terminal of the field *b*, while the contact *g* is connected to the opposite terminal of the field *c*; a contact, *h*, opposite the last contact, 10, is connected to the series circuit between the armatures, *a* and *d*.

It will be seen that in this controlling apparatus when the sliding contact connects the contact 1 to the contact bar *f*, the field *b* is short-circuited, while on moving the sliding contact downwards, first the field *b* is shunted by an increasing resistance, then the field *c* is shunted first by a high resistance, which is decreased in steps until, when 10 is connected to *g*, the field *c* is short-circuited, and when 10 is connected to *h* the generator, *a* and *b*, is short-circuited.

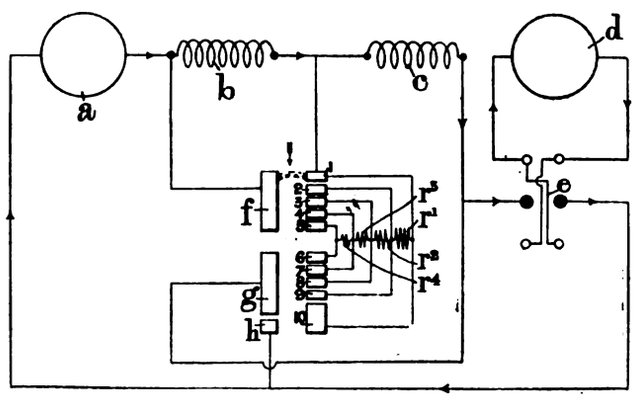


FIG. 4.—Speed Control through Resistances.

By the above described method of connection Mr. Zani claims to obtain the required regulation of the speed of the power shaft, when the contacts *h* and 10 are connected, the field *c* and armature *d* are out of action, the power shaft being driven by the torque between the armature *a* and field *b* acting as a magnetic clutch. If further variations of speed are required the speed of the prime mover may be varied, this giving corresponding variations in the speed of the driven shaft. In order to indicate the torque transmitted there may be inserted in the armature circuits an ammeter specially calibrated or an instrument having two coils acting one on the other, one of said coils being traversed by a current proportional to the main current and the other by a current proportional to the magnetising current on the first field. In this way a ready indication of the torque actually transmitted by the prime mover may be obtained.

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POSSIBILITIES.

Mr. Matthews, in his paper read at Birmingham, touches upon a most important topic, and one that will bear discussing for ever. There are two sides to this question, and those on opposite sides will never agree. Nor is there a middle line of accord. After all, the real history of, say, the electric lighting movement covers only a quarter of a century. Has the progress during that period been as rapid as might have been expected considering all conditions? The answer to that question depends upon which side you stand. Then, again, with this lapse of time should progress proceed with arithmetical progression or ought we to expect geometrical acceleration! Similar questions can be applied to electrical power distribution, which, however, is a still newer industry. Then, again, in all these discussions as to progress we must differentiate between a district or country already supplied by some illuminant or power giver and a district or country not so supplied. If the latter district is of the go-ahead character, it is but just to assume that the demand for the most modern appliances will be greater than in the former district, where the older appliances will not be replaced till the newer have been proved up to the hilt. These dogmatisms are easily seen to be correct by comparing, say, a new ironworks in Austria with an older works at home. The former will be electrically equipped everywhere. Everything is driven by electromotor and lighted by electric light. Hence a moral, which Mr. Matthews's paper assists to inculcate. Constant, unremitting attention by manufacturers and central-station engineers should be given to everything that is new, whether new houses, hotels, or factories. Never rest till the mains are laid and the buildings wired. We are not for many reasons going to criticise Mr. Matthews's suggested association, nor do more than point out that manufacturers' or other class interests can only be considered and pushed in combination to a limited extent. Past that we come into the region of trusts, and leave that of competition. We must confess to not quite understanding some of Mr. Matthews's allusions. Take as a sample the following: "The manufacturers of electrical apparatus, too, need to be more thoroughly awakened to the advantages that will accrue to them from a more extensive use of electricity, for their efforts at the moment—owing possibly to a jealous fear of their competitors—are not being exercised in altogether the right direction. They do not look sufficiently far ahead. They are now occupying themselves chiefly in urging upon their customers the merits of that particular apparatus which they manufacture. If, in addition to this, they could be induced to put before the public the general advantages of electricity for those main purposes for which their apparatus is manufactured as an auxiliary, then the more general use of electricity would create a greater demand for what they wish to sell, and their business would be more prosperous than was previously the case." The manufacturer's object is certainly to make and sell enough of the apparatus in demand to keep his works going, and if Mr. Matthews means that in addition he is to carry on experimental work to improve the known apparatus as used for definite purposes, we agree. His ordinary business necessitates that he should, to obtain orders, maintain the advantages of the use of electricity. It would be no use to praise gas for motive power and try to sell electric motors. The very fact of being an electrical manufacturer proves that he believes and pushes the advantages of electricity. Whether our manufacturers make known the value of their goods in a proper manner we beg leave to doubt, and we think we could conclusively prove the contrary. During the past year, for example, we have

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known about large orders from, among other places, New Zealand and Burma. The latter is an example of inability to hold to clients, the clients going to another firm. The former business is of another character. The central-station officials should, as we say, persistently keep touch with the new, the manufacturers likewise; and the new to them is largely in the neutral markets of our Colonies and foreign non-manufacturing countries. There is just one other point we wish to mention, and a tale told before may be used again for this purpose. A traveller of Bryant and May's once told us he had no difficulty in approaching people for orders—or, for the matter of that, in getting a fair amount of orders—because the name and productions of the firm were always before the eyes of the public. Electrical manufacturers, on the contrary, are spasmodic in the matter of keeping their names before the purchasing public. Germans and Americans beat us hollow in this respect.

THE AMERICAN SPIRIT.

We trust we are not libelling a great nation in diagnosing the prevailing spirit of American publicity as one of arrant self-satisfaction. Now, it is precisely that quality in an advertisement which the English public will not tolerate. It is consistent with the general frame of mind of the Briton, that when he intends to place an order he likes to feel that he is conferring a favour; therefore, the secretary of a big company will sign himself "yours obediently," when, as a matter of fact, he knows he is nothing of the sort. Advertisers, therefore, who are attracted by the glamour of loud shouting about American publicity results should beware of forgetting the essential difference between English and American temperament, and should tone down their advertisements in accordance, otherwise the result will not only be disappointing from a financial point of view, but will be not far removed from ludicrous in effect.

We have before us an example of the type of advertisement to which we refer, and which appeared in daily newspapers of this country. The effect may be either classed as sublime or ridiculous according to the temperament of the reader.

NOTICE OF REMOVAL.
MR. BLANK,
Electrical Engineer and Contractor,
of.....
begs to announce that he has found it necessary to *remove to larger and more commodious premises at* ..... where he will be in a position to cope with his rapidly increasing business.

Mr. Blank's reputation is based upon the solid foundation of 30 years' practical experience in all kinds of electrical work, during which time he has done work at Royal palaces and many ducal mansions, and successfully carried out some of the most complicated contracts in .....

Mr. Blank's reputation as a practical electrician requires no canvassers or outside assistance. Practical men don't require this; their work speaks for itself, and a lengthy list of satisfied clients is a valuable asset many people envy.

Mr. Blank takes this opportunity of expressing his sincere thanks to his many customers for their kind patronage, and trusts to receive a share of their future favours.

To the general public he begs to intimate that he is ready to quote and give practical advice upon every kind of electrical work, the more complicated the better.

He is willing to refer intending clients to people of standing who have in despair come to him for advice.

Note the address: .....

We have, of course, suppressed all clue as to the identity or location of the member of the electrical contracting fraternity who advertises in this way, but we feel sure that our readers will agree with us in supposing that if the advertisement had been a little less flambuoyant greater credence to the statements made therein would have been given by the average reader. We adduce this example to emphasise as strongly as possible the danger of adopting the American style. It will not do in England.

LIVERPOOL AND DISTRICT ELECTRICAL ASSOCIATION.

On Saturday, the 5th inst., the members of the above association paid a visit to the Widnes and Runcorn Transporter Bridge. The bridge being worked by electrical energy, an inspection was first made of the generating station; this consists of a gas-engine (70 b.h.p.), dynamo, booster, and accumulator battery of about 246 cells, with a well-fitted switchboard. There is also a duplicate 70-b.h.p. gas-engine and dynamo. The party then proceeded for a detailed round of examination of the construction of the bridge proper, ascending into the towers, and also on to the girders. A trip was then made across the river and back by the transporter car, when it was apparent to all how well the car was under control, thus ensuring the safety of the public. It might be mentioned the car is capable of carrying at one time four two-horse loaded wagons and 300 passengers, and the platform is suspended from the girders by a trolley driven by two electromotors of about 35 b.h.p., being provided with efficient automatic and hand brakes, and runs beautifully smooth. The party then dispersed after a most pleasant and interesting afternoon, the very best thanks being due to Mr. John Henderson, the general manager, and his assistants for the most kindly manner in which they had entertained the party, and also supplied so much interesting information, and the best thanks of the association and wishes for the prosperity of the bridge were conveyed to that gentleman by the hon. secretary and treasurer, Mr. Samuel Frith, of Bootle.

"KALKOS" WIRING SYSTEM.

It has been the practice of the well-known consulting electrical engineers, Messrs. Handcock and Dykes, for some years past to specify tinned brass tubes for conduit wiring. They have done this chiefly in order to avoid trouble due to moisture in the humid atmosphere of these islands condensing inside tubes of a metal less sensitive than brass to changes in the air temperature. The several methods designed to overcome this "sweating" are a practical recognition of the ill consequences which it must ultimately have on the insulation of the enclosed wires. But besides offering an effective check to a most insidious enemy of high insulation resistance, it is claimed that the use of tinned brass tubes also provides a simple means of securing continuous earthing. Reverting to the first point, it has not been Messrs. Handcock and Dykes's practice to rely entirely upon the "non-sweating" attribute of the tinned brass tubes to ensure a constant state of dryness—rather have they rendered security doubly sure by using these tubes in conjunction with practically air-tight switch, plug, and fuse boxes. They have employed the system for the wiring of numerous insurance buildings, banks, asylums, and other important institutions for the past 10 years, during which period it has, we understand, enjoyed almost entire immunity from trouble due to wires failing. In fact, inspection of the wires put in 10 years ago has failed to disclose an appreciable deterioration of the same. Having thus proved its merits, the system is to be commercially exploited by the Sun Electrical Company, Limited, of 118-120, Charing Cross-road, W.C., who have evolved a complement of standard fittings of very serviceable and, in some respects, unique design. In brief, the "Kalkos" conduit system now introduced to the trade consists of specially-drawn brass tubes, tinned inside and out, socketed together with slip sockets, and soldered. All fittings, such as switch boxes, elbows, tees, ceiling rose boxes, etc., are also tinned, so that the matter of soldering and making the circuit continuously metallic is an easy one. At present the two main sizes of tubes stocked are approximately just over $\frac{3}{8}$in. and $\frac{1}{2}$in inside diameter; the small size being

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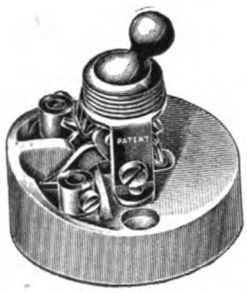
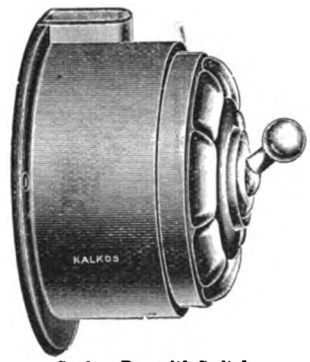
principally used for concentric work where the tube is used as the negative return, while the larger size is employed for the ordinary two-wire system. It is noteworthy that the tubes are tinned by immersion (not electrolytic), and do not oxidise or corrode. They are easily and quickly



"Kalkos" Switch.

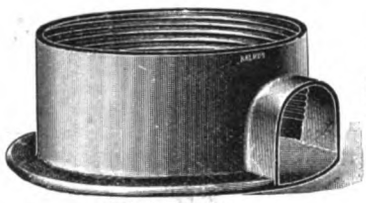


Surface Box with Switch.

connected by butting two ends together, slipping one of the special socket pieces over the joint and applying the blow lamp to form a perfect electrical and mechanical connection. The smooth surface of the tubes enables the wires to be drawn in and out with great ease, even after they have been installed many years, and the size of the

Insulating Bush for Switch.

Adjustment Ring.

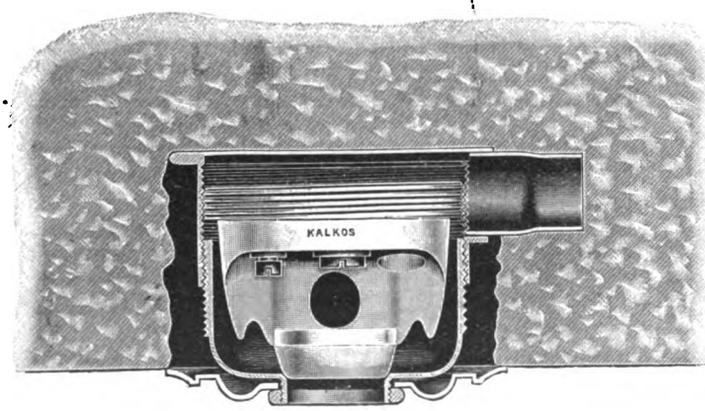


Switch Base Box.

Flush Cover with Ring to take Switch Plate.

Various Parts of Flush Switch Box.

tubes can be kept down, thus enabling them to be laid in the thickness of the plaster. Referring to the accompanying illustrations, it will be seen that the chief endeavour of the designer has been to give each fitting a certain versatility. Thus the standard box for buried work serves to contain either a switch, joint, and plug socket, or ceiling rose, and



Section View showing Flush Ceiling Rose Box in Position. Complete with Ceiling Rose and Flush Plate.

may be fitted with any desired pattern of fancy cover plate, whilst still retaining the various fittings in a practically air and water tight box. Moreover, owing to the space available between the base of the switch and the bottom of the boxes, switch boxes can be used as distribution or joint boxes, thereby enabling the number of boxes to be reduced to a minimum and permitting joints to be easily and quickly got at, at any time, by unscrewing the cover and taking out the switch, when the wires behind are exposed without having to disturb floors or decorations. A useful feature of the special box for flush work is the adjustment ring, whereby a full $\frac{5}{8}$in. of adjustment can be obtained. This gives the wireman a good chance when the plasterer has exceeded, as he frequently does, the estimated depth to which he will cover, and which has in the past given rise to a great deal of extra work in order to bring up the switch plates square and flush on the surface. Perhaps a more important advantage is that, irrespective of the angle at which the box is set in the plaster, the surface plate can always be fitted flush with the face of the wall. The saving which can be effected in the cost of installing "Kalkos" due to the features mentioned in the foregoing places the system, it is claimed, on a par with a screwed barrel system, despite the higher price of the brass tubes and fittings.

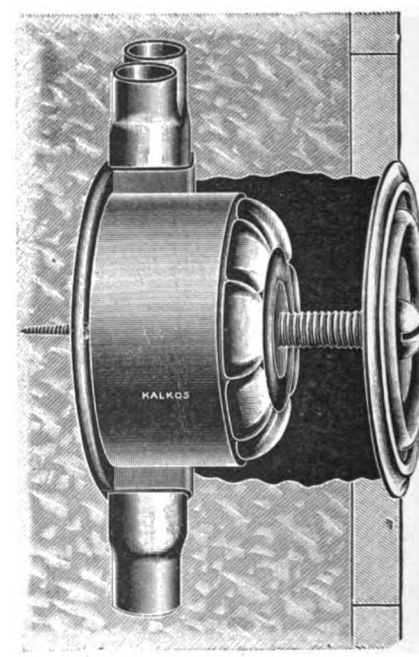
It is further claimed that the advent of "Kalkos," requiring no special concentric attachments, provides a perfect system of concentric wiring whether for concealed or open work. One wire only is required, the return being

Surface Ceiling Rose Complete.

Method of Adapting Standard Wall Plug.

by means of the brass tube, thus effecting a saving not only of half the wire in an installation, but enabling tubes of only $\frac{5}{8}$in. internal diameter to be used. Installations on this system have been at work for several years past in asylums, factories, country houses, and places having independent generating plant. It is especially useful in works using three-phase plant, the motors working at 400 volts and the lighting being connected between either wire and the earthed point of the star at a pressure of 230 volts.

We may add, in conclusion, that we have seen samples



Method of applying Junction Box to Flush Work.

of both tubes and fittings The latter are made up of stampings, and bear evidence of careful design and manufacture.

LUMINOUS ELECTRIC RADIATORS.

The catalogue of luminous electric radiators just issued by the Dowsing Radiant Heat Company, Limited, of 24, Budge-row, London, E.C., reminds us that the season for heating appliances is opening. Fans have had their innings—albeit a very poor one—during what was supposed

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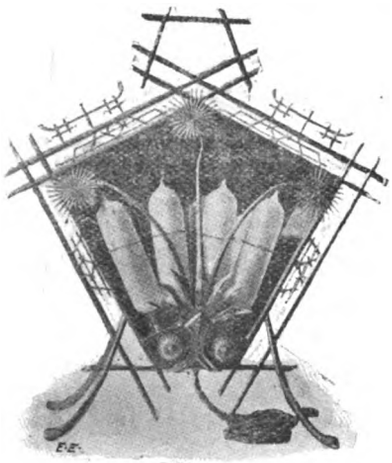
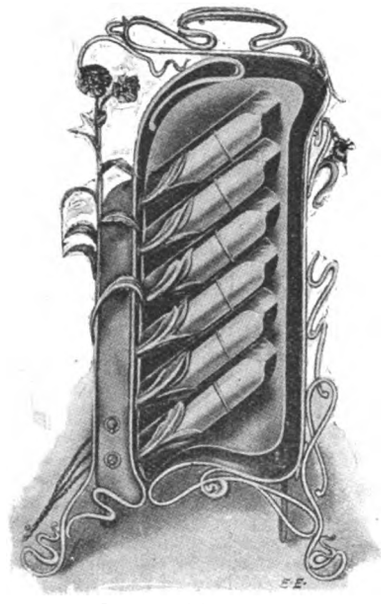
to be summer. Now it is the electric radiator's turn, and there is little fear but that it will continue its steady rise in popular favour. Not only are its cleanliness and artistic



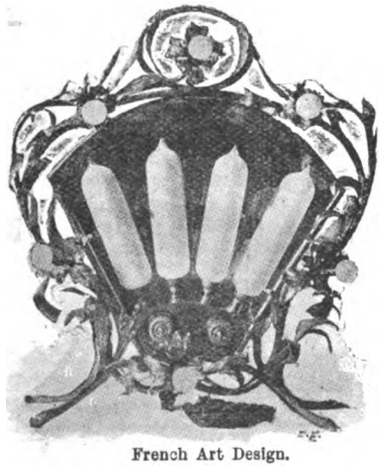
Artistic Spanish Design.

possibilities abundantly manifest, but it can be regarded no longer as an extravagant luxury. The enterprise of station engineers has banished the latter charge, making it possible to heat our rooms efficiently with the minimum of trouble



Ornamental Spanish Design.

and without ill consequences. The luminous type of electric radiator has proved especially attractive to the buying public for reasons not far to seek. It is the brightness of an open fire which makes it so dear to us



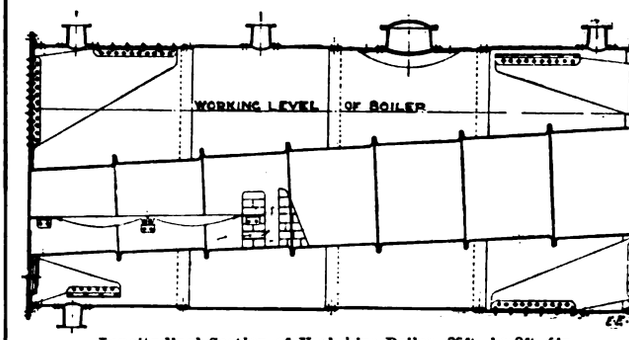
French Art Design.

all, and the luminous radiator substitutes an effect which is equally pleasing and infinitely more efficient. The average Englishman wants his heat from a visible source. Well, he can have it so by using a luminous radiator, of which type the Dowsing Company offer a large selection. Some of these radiators are of ornate design, while others are fanciful, as witness the accompanying selection. Electric radiators are a line which we strongly recommend dealers to push. They are always an attraction in a show window, and where displayed will sell themselves, which is really the main thing from a business point of view.

THE YORKSHIRE BOILER.

Royal letters patent for a new design of steam generator, which is now called the Yorkshire boiler, were granted in June last, and as this boiler has now been working under practical conditions over two months our readers will doubtless be interested in the results which have been attained The Yorkshire boiler, the longitudinal section of which is shown in the diagram, is fitted with two furnace flues which expand from the furnaces to the downtake flues, thus locating over the fires the maximum heat of water and the minimum at the opposite end of the boiler. It is claimed by the patentee, Mr. W. H Casmey, that the expanding of the furnace flues has the effect of slowing down the velocity of the hot gases by offering to them a larger area of heating surface per foot run of flue at the lower temperature, and thereby secures uniform ebullition throughout the boiler, under which conditions the transmission of heat is more than double that secured when the flues are surrounded by still water.

The first Yorkshire boiler was built by Messrs. Hewitt and Kellett, Bowling Ironworks, Bradford, and is fixed at the works of Messrs Ira Ickringill and Co., Bradford, and has now been under steam about two months. The



Longitudinal Section of Yorkshire Boiler, 20ft. by 8ft. 6in.

boiler now working is 20ft. long and 8ft. 6in. in diameter, has 730 square feet of heating surface and a ratio of heating surface to grate area of 20 to 1, and works at 120lb. pressure, and when tested for duty it evaporated 14,500lb. of water per hour, and during the efficiency test when burning 20lb. of slack per square foot of grate evaporated 10·2lb. of water per pound of combustible.

VENTILATION OF FACTORIES AND WORKSHOPS.

Report of Departmental Committee.

Serious mistakes are frequently made in the design of means for securing adequate and effective ventilation of factories and workshops, so that some general guidance as to the best application of means for securing ventilation should go a long way towards avoiding such mistakes, which not only endanger life but hinder the growth of industrial development upon the proper lines. It is for this reason that particular attention should be devoted to a study of the reports issued by the Home Office Departmental Committee appointed as far back as 1900 to inquire into the matter. And not only is the subject of special importance to all engaged in the electrical industries, for those owning factories may be affected by the committee's recommendations, but additional importance is lent thereto by the fact that the reports give conclusive evidence of the superiority of electricity for lighting, through the absence of impure fumes; and, further, that in the means which are proposed for remedying the state of affairs there is created a favourable opening for the

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development of the application of electricity to fan driving. The committee was appointed in July, 1900, by the following minute, signed by the late Viscount Ridley (then Home Secretary):

"I appoint Dr. John Scott Haldane, F.R.S., and Mr. E. H. Osborn, engineering adviser to the chief inspector of factories, to be a committee to inquire into and report upon (*a*) the means of ventilation in factories and workshops, with especial reference to the use of fans; (*b*) the use and construction of respirators for the protection of workpeople exposed to dust or dangerous fumes."

Our readers may remember that the committee's first report was issued in 1903, and that it dealt with the removal by general ventilation of the more ordinary impurities arising from the presence of persons and lights.

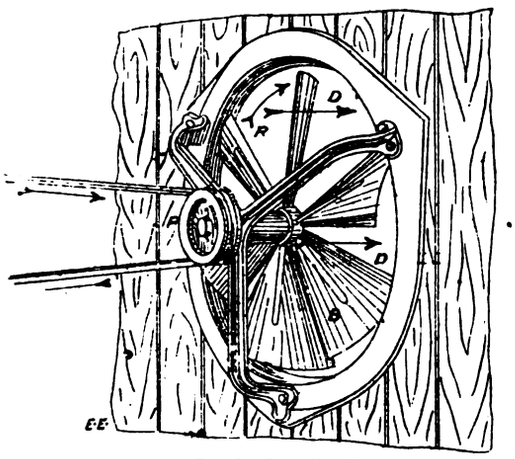

FIG. 1.—Propeller Fan.

It is, nevertheless, of interest to recall at this moment certain observations contained in that report. Thus, after dealing with the inconvenience caused by air vitiation and heat from gas jets (where these are used), the report states: "By the use of the incandescent electric light all the inconvenience due to air vitiation and heat from gas jets can be avoided, though the extra expense as compared with incandescent gaslight is considerable. The arc electric light, so shaded that only reflected light falls on the employés and machines, is in some cases very advantageous." Much of this is very true, but since the date when this observation was made many improvements have been effected in the systems of electric lighting, which have resulted in far-reaching economies; there were then no metallic-filament lamps, no flaming arcs, and no mercury-vapour and other lamps which have since been introduced, and are especially adapted for use in factories and workshops; since the date of that report considerable advance has been made in the science of illuminating engineering, which is proving a potent factor towards economy in electric lighting, while in the case of the larger factories, whose machinery is driven by electric power generated by private plant on the premises, current for lighting obtained from the same source. So that, while from a hygienic standpoint the admitted advantages of electric lighting have been still further improved, from the point of view of cost these improvements have been so great, that the committee's observation as to the comparative expense of gas and electric lighting needs modifying. Dealing with accidental impurities, the committee point to the danger of ordinary lighting gas or gas used for driving engines. They say:

Ordinary lighting gas contains about 7 per cent. of carbonic oxide. Carburetted water gas, which is often mixed with the ordinary gas, contains about 30 per cent. of carbonic oxide; Dowson and producer gas also contain about 30 per cent., while pure water gas contains nearly 50 per cent. As anything more than about ·03 per cent. of carbonic oxide will produce headache, etc., after several hours' exposure, and as little as ·2 per cent. carbonic oxide is dangerous to life, it is evident that, even apart from the risks of explosion or fire, escape of gas should not be permitted in factories and workshops. Very special care is needed with pure water gas, producer gas, Dowson gas, etc., as they have only slight smell. It occasionally happens, also, that coal gas, when it escapes from a broken pipe underground, is to a large extent deodorised in passing through the ground, so that the smell is only slight when it is present in a dangerous amount.

We now pass from this report to the second report, which was recently issued, and which deals principally with the selection and application of fans to ventilation. The following extracts from this report may prove of service to those who are not already familiar with the principles involved, and to electrical engineers in particular:

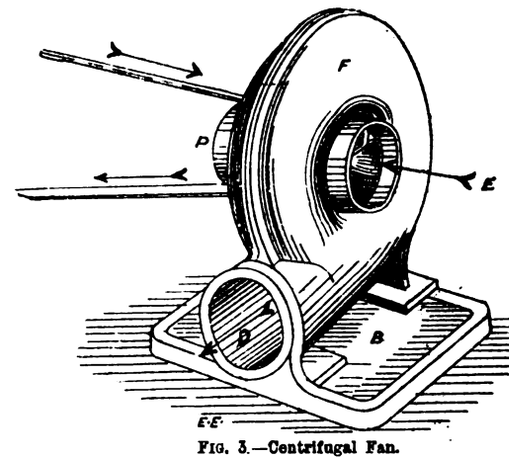

FIG. 3.—Centrifugal Fan.

Selection of Fans.—Although fans of excellent construction, and driven either electrically or by pulleys, can now be very easily obtained, it must be clearly borne in mind that different types of fan are made for different kinds of work, so that a fan which is very well suited for one purpose may be quite unsuited for another. Broadly speaking, fans may be divided into (1) low-pressure fans, those designed for moving air against very slight resistances (the difference of pressure on the two sides of the fan not exceeding, say, ½in. of water as measured by a water-gauge); and (2) high-pressure fans, working against resistances which may mount up to several inches of water. The resistance due to the passage of a given volume of air through the fan itself is, size for size, very much smaller in the former than in the latter class. Hence, if a high-pressure fan is used to drive air against a low external resistance, practically the whole of the power expended may be wasted in overcoming the internal resistance of the fan. On the other hand, if a low-pressure fan be used against a high external resistance the quantity of air passed will be very small, and the power will be thrown away in friction and the production of eddies about the fan.

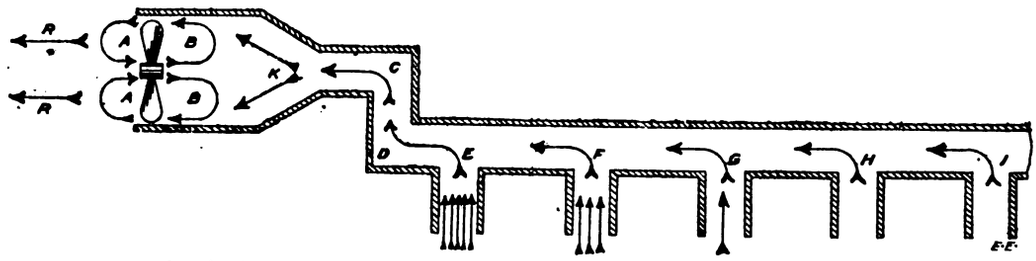

FIG. 2.—Arrangement of Propeller Fan and Ducts, showing a series of defects described.

Low-Pressure Fans.—When air requires to be moved against very slight pressure, the so-called "propeller" fan is usually employed, although low-resistance centrifugal fans can also be advantageously used in some cases. In the propeller type of fan the blades are arranged similarly to those of the screw propeller of a steamship, the air being driven forward by their revolution (Fig. 1). By this means enormous volumes of air can be delivered through the fan with a very small expenditure of power, provided there is little or no resistance on either side. For a good type of propeller fan working under practical conditions, with unimpeded flow of air, Mr. W. G. Walker gives the following convenient formula as the result of a number of experiments:

$$\text{Horse-power} = \frac{Q^3}{D^4} \times 0{\cdot}0000115\ ;$$

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where Q = quantity of air discharged in cubic feet per second; D = diameter of fan in feet. Thus with a discharge of 12,000 cubic feet per minute, or 200 cubic feet per second, and a 4ft. fan, the horse-power required would be $\frac{200^3}{4^4} \times 0{\cdot}0000115 = 0{\cdot}35$.

This example will give an idea of the very large volumes of air which can be moved by a propeller fan with a trifling expenditure of power, provided there is no resistance. The air delivery by a propeller fan varies in direct proportion to its rate of revolution, while the power needed to drive it varies as the cube of its velocity. Hence, for a given expenditure of power much more air is propelled with a low than with a high rate of revolution. In practice, however, it is best to run a fan at a considerable velocity, otherwise the flow of air may easily be greatly diminished, or even reversed, by the influence of wind. With increasing resistance the air delivered by a propeller fan rapidly falls to almost nothing, although considerable power is being expended in driving it. The waste of power is due to the fact that air passes back through the centre of the fan, where the velocity of the blades is low, and the work done by the tips of the blades is absorbed in merely expelling this same air (Fig. 2). The resistance may be due (apart from the influence of wind or of insufficient inlet openings to the room) to constriction of the ducts, inlets, or outlets connected with the fan, to sharp bends or rectangular junctions with branch ducts, and to friction along the sides of ducts. If the sectional area at any part of a duct conveying air to or from a fan be reduced to less than the sectional area of the fan (Fig. 2), it is evident that the linear velocity of the current at this point will be correspondingly greater than at other points in the duct. But the work expended in setting air in motion varies as the square of the velocity, and any considerable narrowing of a duct thus introduces a resistance which a propeller fan cannot overcome, with the result that the power applied to the fan is wasted. It is a common mistake to suppose that by constricting a duct leading to or from a propeller fan a materially greater velocity of air current can be obtained. The influence of the constriction is simply to diminish the flow of air. Another source of resistance is any sharp bend in a duct. A rectangular bend (Fig. 2) practically doubles the pressure needed to merely set the air in motion in the duct, and a rectangular junction with a branch duct has a similar effect. A loss about half as great also occurs at the inlet opening of a duct unless it is trumpet shaped. Resistance due to friction along the walls of a duct is proportional to the total internal surface of the duct, and to about the square of the linear velocity, but inversely proportional to its sectional area. It becomes a serious item if long and narrow ducts are employed, and such ducts should always be avoided where propeller fans are used. Frictional resistance depends also upon the roughness of the internal surface of a duct, and these surfaces should be as smooth as possible. The narrowing of ducts by deposits of dust should also be carefully avoided, and the better to ensure this, when ducts are being constructed ample provision should be made at suitable points for the easy removal of dust and other accumulations. Fig. 2 shows an extremely bad arrangement of ducts connected with a propeller fan. The narrowing of the duct at K reduces the flow of air to about a tenth of what it would otherwise be. A further considerable loss is caused by the rectangular bends at C and D, and at E, F, G, H, I. The size, and the arrangement at right angles to the main duct of the branch ducts, E, F, G, H, and I, is such that the air flow through them is very unequal, the flow through I being a mere fraction of what passes through E. The fan is wasting its work in churning air round, as indicated by the arrows A and B.

High-Pressure Fans.—Where air currents of high velocity are needed—as, for instance, in exhausting the dust from wheels used in dry grinding, or where narrow or tortuous ducts cannot be avoided—it is necessary to have fans capable of working effectively against considerably resistances. For this purpose centrifugal fans are usually employed. In the centrifugal fan the air inlet is at the centre of the fan, which is enclosed in a metal case (Fig. 3), and the air is driven outwards in a tangential direction by the revolution of the blades into a space between their periphery and the case. As the outline of the case is somewhat like that of a snail's shell, this space gradually increases in cross-section towards the air outlet, so that the air passing outwards between the blades can escape freely at all parts of their revolution, and travel round the case to the outlet. A trumpet-shaped prolongation of the latter increases the efficiency of an exhaust fan. According to the details of construction, centrifugal fans may be suited to deliver, with a given expenditure of power, either large volumes of air against a relatively low resistance, or smaller volumes against a relatively high resistance; and in selecting a fan the volume of air required and the resistance against which it has to work must be carefully considered. Centrifugal fans suited to work against the higher resistances have also a relatively high internal resistance, so that if they are set to work against a low resistance in ducts, etc., the energy is wasted on the internal resistance. Details with regard to the capacities of various types of fan may be obtained from the makers, who should specify the volumes of air delivered, as measured by an anemometer, with different resistances measured by a water-gauge, together with the corresponding horse-powers required to drive the fan. The resistances which have to be overcome by pressure fans are, of course, due to the same causes as in the case of propeller fans; but in practice the factors involved often differ in relative importance in the two cases. Thus the ducts connected with a pressure fan are usually longer in proportion to their cross-section, so that resistance due to friction is more important. There may also be many unavoidable bends in them. They are usually best made of metal pipes with smooth internal surface, all sharp rectangular bends or junctions being avoided, and no leakage permitted: unless these points are attended to, resistance due friction, etc., may mount to a very serious extent. On the other hand, the comparatively small resistances due to such causes as wind pressure, restricted inlet openings to a room, etc., are of much less importance than when a propeller fan is used.

The report concludes with a chapter on the volume of air required and the arrangement of inlets and outlets, together with another on the use of respirators. It is signed by Dr. J. S. Haldane, Mr. E. H. Osborn, and Dr. James Ritchie.

LONDON COUNTY COUNCIL.

Tramway Extensions.

When this Council reassembled on Tuesday last after the summer recess, it had under consideration the report of the Highways Committee recommending that parliamentary authority should be sought next year for the construction of various new tramways. The proposals of the Highways Committee, which are estimated to entail an expenditure of £300,000 (including the cost of street widenings), were published in detail in the *Electrical Engineer* for Aug. 9 (p. 206), but briefly summarised, they may be stated as follows:

1. Connecting line between Gray's-inn-road and Caledonian-road over King's Cross (Metropolitan) Station; estimated cost, £6,850.
2. Single line of tramways, *via* Swinton-street, to connect the existing lines in King's Cross-road with the existing lines in Gray's-inn-road; estimated cost, £5,840.
3. Single line from Essex-road, *via* Englefield-road and Stamford-road, to Kingsland-road, estimated cost £19,509; single line from Kingsland High-street to Mare-street, *via* Ridley-road and Dalston-lane, estimated cost £29,589; and junction line between Kingsland-road and Dalston-lane, estimated cost £700.
4. Junction line between Mitcham-road and Tooting High-street; estimated cost, £3,870.
5. Connecting line in Southwark-street from Blackfriars-road to Southwark Bridge-road; estimated cost, £23,304.
6. From the present horse tramways terminus at West Norwood to the Crystal Palace, single lines, *via* (*a*) Chatsworth-road, Idmiston-road, and Rosendale-road to Park-road, and (*b*) Robson-road; double line, *via* Park-road, South Croxted-road, and Dulwich Wood park; and single loop line, *via* Dulwich Wood-park, College-road, Crystal Palace-parade, and Farquhar-road, at an estimated cost of £66,623.
7. Double line from the authorised tramways in London-road, Forest Hill, to the Crystal Palace, *via* Sydenham-hill and Crystal Palace-parade (double line).

On the recommendation of Mr. W. W. Thompson, the chairman of the Highways Committee, leave was given for the withdrawal of recommendation No. 7.

Mr. C. U. Fisher thereupon moved the omission of recommendation No. 6 (which was supported by Mr. St. J. Morrow), on the ground that the frontagers on the proposed route had not been consulted, that some of the streets were very narrow, and that there was no local demand for the tramways. Other members, however, stated that there was a general desire for these tramways, and Mr. Thompson, in replying to the discussion, said it was the desire of his committee to link up the Council's tramways systems with the systems of other tramway undertakings in the suburbs, and he was afraid that in carrying out that policy it would be necessary at times to tread on the toes of many people in the suburbs. He asked the Council to take the broad view of the necessity of securing through routes wherever necessary and possible.

In the end the recommendation was agreed to, and the Council also agreed to an application to Parliament for authority to enable the Council to reconstruct the existing tramways in Lea Bridge-road, and to extend such lines *viâ* that road to Upper Clapton-road.

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OPENINGS FOR CONTRACTORS.

ABERDEEN—Two dwelling-houses on the east side of Devenha-gardens East; architects, Messrs. D. and J. R McMillan. Ten dwelling-houses on the south side of Cromwell-road; architect, Mr. John Milne. Alterations and additions in connection with bakery at Schoolhill and Harriet-street; architects, Messrs. Wilsons and Walker. Dwelling-house on the north side of Rubislaw Den North; architects, Messrs. D. and J. R. McMillan. Alterations to Union-street for the Empress Café Co.; architect, Mr. J. Rust.

ABERTILLERY—Corporation electricity scheme (£10,000).

ABOYNE—Erection of St. Thomas's Church (£10,000).

ALDENHAM—House, Mornington-road, Radlett. Miss Collins.

ALDERSHOT—Erection of convenience for Urban District Council.

ALLOA—School for Borough School Board (£10,000). Architects, Messrs. Kerr and McCulloch.

AYR—Eight dwelling-houses in Felvidere-terrace (£1,200); architect, Mr. W. Cowie. Alteration to shop, Newmarket-street (£260); Mr. Fleury Meng.

BANGOR—Library and technical institute for Urban District Council (£2,500).

BARNETBY—Two houses. Architect, Mr. W. Cuthbert.

BASSENTHWAITE—Three houses at Castle Hill. Architect, Mr. F. Nash.

BEAUFORT—Repairs to Beaufort Arms Hotel. Architect, Mr. C. H. Elford, Aberdare.

BEDS—Erection of two shelters at Eaton Bray Council School (£108).

BEESTON—Plans for 16 houses and shops have been passed by the Urban District Council.

BEDLINOG—Twenty houses for Cwmfelyn Workmen's Building Club. Architects, Messrs. Jones and Howard.

BELFAST—Extension of Corporation electricity undertaking (£75,000).

BEXHILL—Town hall extensions (£2,750).

BINGHAM—Electricity undertaking (£81,900).

BLISWORTH—School for Northampton Education Authority.

BLYTH—Primitive Methodist church, Coburg-street (£500).

BOURNEMOUTH—Two houses, Victoria Estate, Winton, for Mr. J. Joy; two houses and shops, Southbourne-grove, for Mr. Mariner; house, Fenton-road, for Mr. H. Hook; house, Oxford-avenue, for Messrs. Arnould Bros.; shop, Southbourne-grove, for Messrs. Street and Sons; house, Grand-avenue, for Mr. F. Cole; house, Calthorpe-road, for Mr. A. Smith; two houses, Frederica-road, for Mr. H. Elliott; three houses, Fitzharris-avenue, for Mr. G. Wilcox; house, Herbert-road, for Mr. R. F. Seward; house, Ackland-road, for Mr. S. Watton; three houses, Ackland-road, for Mr. W. H. Beaty; house, Nursery-road, Moordown, for Mr. G. Head; house, Muccleshell-road, for Mr. A. H. Miller; six houses, Alma-road, for Mr. C. Hunt; house, Malvern-road, for Mr. W. Bover; five houses, Muccleshell-road, for Mr. E. Simmonds; four houses, Castlemain-road, for Mr. J. Kine; house, Markham-road, for Mrs. K. Adams; six terrace houses, Stourvale-road, for Mr. Mr. Butler; two houses, Heathwood-road, for Mr. Holly; house, Kimberley-road, for Mr. E. Nicklen; two houses, Grantham-road, for Mr. G. A. Drake; house, Beaufort-road, for Mr. B. Webb; house, Fitzharris-avenue, for Mrs. M. E. Lawrence; house, Grand-avenue, for Mr. R. Holly; two houses, Bemister-road, for Mr. E. Harlow; house, 44, Southern-road, for Mr. S. Deller; St. Alban's Church, Charminster-road, for Rev. S. C. Lowry.

BRADFORD—Extension of laundry for City of Bradford Co-operative Society.

BRANKSOME—Alterations to Council schools (£1,290).

BREDBURY—Alterations to engineering works.

BRISTOL—Extension of Corporation electricity works (£34,600).

BUGBROOK—Alteration to Council schools (£900).

BURSCOUGH—Fitting of Council offices (£187).

BURY—School by Education Committee (£14,000).

BUSHEY—Erection of Council offices and buildings.

BUSK—Building of spinning mill by the Manor Mill Co.

CARDIFF—Lunatic asylum at Whitchurch (£50,500).

CARNARVON—Improvement at abattoir for Council (£450).

CASTLERAHAN—Erection of labourers' cottages (£35,980).

CHESTERFIELD—Electricity undertaking (£5,000).

CHIPPENHAM—Business premises in High-street (£3,000). Architect, Mr. T. Holloway.

CLAYTON-LE-MOORS—Erection of Council school.

CLEADON—Erection of Council school.

COALVILLE—New school for Leicestershire Education Committee. Architects, Messrs. McCarthy and Co., Central-chambers, Coalville.

COATBRIDGE—Large offices at Calder for architect. Messrs. Baird and Sons.

COLCHESTER—New asylum by County Council (£270,259).

COLNEY HATCH—New buildings at asylum for London County Council (£26,310).

COUPERHEAD—Three houses on the estate. Mr. Wm. Marshall.

COVENTRY—Erection of chapel-of-ease for St. Thomas's parish.

CRAMLINGTON—Council school for Northumberland Education Committee.

CRUMLIN—Workmen's institute (£3,000).

CWM—Erection of schools for Education Committee.

CWMPARK—Erection of parish hall. Architect, Mr. J. Rees.

CYMMER—250 cottages for Glyncorrwg Building Club.

DARLINGTON—Ten houses, Fulford-place. Architect, 128, Thomson-street, W.

DARLINGTON—Extension of locomotive works, North-Eastern Railway (£60,000).

DARWEN—Eleven houses in Catterall-street for Mr. E. Hayworth; four houses in Harwood-street for Mr. J. Hodkinson; 25 houses in Garnett-street and Norris-street for Messrs. Marsh and Fretwell; additions to Britannia Cotton Mills for the Darwen Spinning and Manufacturing Co.; extension to workshops in Pitville-street for Mr. J. Westwell; plans for an estate at Barley Bank for the Rev. W. A. Duckworth.

DEWSBURY—Extension to Corporation's electricity mains (£227).

DONCASTER—Additions to Institution for Deaf and Dumb.

DOVER—Nineteen houses, Old Park-road. Mr. G. Keeler.

DUDLEY—New library in St. James's-road for Corporation.

DUKESTOWN—Alteration to schools for Monmouthshire Education Committee.

DUMBARTON—United Free Church, Bridge-street (£5,000).

DUNDEE—Dwelling-house, Arnhall-gardens, for Mr. H. J. McGrady; additions to laundry, etc., Barrack-road, for the directors of the Dundee Royal Infirmary; alteration on property, 16, Cowgate, for Messrs. Fleming Bros.; villas for Messrs. Gavine and Galloway, Dalgleish-road; alterations of dye works, Hilltown, for Messrs. Stevenson Bros.; additions and alteration on villa, Lintrathen-street, for Mr. T. C. Craig; physics laboratories for the council of the University College.

EARLSWOOD—Erection of classroom for Monmouthshire Education Committee.

EAST BARNET—Erection of mortuary for Urban District Council.

EBBW VALE—Erection of school and caretaker's house for Education Committee.

ECCLES—Five houses, Vicar-street. Mr. J. Simpson.

EDENDERRY—Labourers' dwelling scheme for Rural District Council (£14,060).

EDINBURGH—Villas at Lismore-crescent for Messrs. Fraser and McBeath; houses at Canaan Lodge, Canaan-lane, for Mr. W. L. Stewart.

ELLON—Extension of post office buildings.

EWLOE GREEN—Elementary school for Flintshire Education Committee.

EXETER—Enlargement of city asylum (£7,500).

FAREHAM—Five new cottages in Colenso-road for Urban Council.

FINCHLEY—Pumping station for Council.

FOLKESTONE—Houses in Coombe-road. Mr. E. Simmons.

FRYDDYN—Elementary school for Flintshire Education Committee.

GARNFACH—Erection of classroom for Monmouthshire Education Committee.

GRANTHAM—Alterations to fire-engine house for Corporation (£279).

GRETTON—Erection of school for Northampton Education Committee (£3,075).

GOYTRAY—Erection of classroom for Monmouthshire Education Committee.

GRIMSBY—Erection of fever hospital for Town Council.

GULLANE—Additions to parish church (£700).

HALIFAX—Alterations to Phoebe-lane Mills. Architects, Messrs. S. Robinson and Sons.

HAM Erection of Board room for Urban District Council.

HAMILTON—Offices for the Miners' Union (£3,000).

HANLEY—Shelters and conveniences for Corporation.

HARBORNE—Fire station for Corporation (£9,000).

HARROW—Two houses Devonshire-road by Mr. W. H. Watts; two houses ditto for Mr. C. Westcott, by Messrs. Marsh and Crooke; two houses ditto by Mr. A. J. Smith; shop, Bowden-road, for Messrs. King and Haskell, by Messrs. Clark and Co.; classrooms to school house, Peterborough-road, by Messrs. W. Johnson and Co.; shop, Station-road, for Messrs. W. and E. Long, by Mr. A. Sykes.

HAVANT—Extensions to isolation hospital for Hospital Board.

HAWORTH—Erection of police station.

HERONSGATE, NEAR RICKMANSWORTH—House for Mr. Dinslage.

HEYWOOD—Erection of school (£9,150).

HIGHGATE—Erection of municipal dwellings for Borough Council (£39,690).

HOLT—Alterations to parish church (£689).

HULL—Erection of science buildings, Hymer's College.

KEITH—Additions to grammar school for School Board.

KILLALA—Schome for labourers' dwellings for Rural District Council (£17,460).

KINGSTON—Office and lodge for the Guardians.

KINGUSSIE—Villa to be erected on the East-terrace for Miss Bell, Glenfeshie. Architect, Mr. Alex. Mackenzie, C.E.

LLANBADARN—Enlargement of post office. Architects, Messrs. Jones and Sons.

LLANELLY—Erection of mortuary.

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LLANDRINDOD WELLS—Additions and alterations to Gwalia Hotel for the Gwalia Hotel, Limited.
LLANGOLLEN—Alteration to National Schools.
LLANTYSILIO—Erection of elementary school for Education Authority.
LEEDS—Extension of tramway system (£42,313).
LEITH—Extension of tramway system (£76,000).
LEVENSHULME—Erection of St. Andrew's Church.
LEPTON—Erection of mill. Architect, Mr. J. Berry, Huddersfield.
LITTLEOVER—Addition to parish church (£1,700).
LOCHGELLY—Town Hall in High-street for Corporation (£2,000).
LONDON, E.—Extension of electrical installation for Stepney Borough Council (£57,000).
LONDON, N.E.—Erection of municipal buildings for Bethnal Green Borough Council.
LONDON, N.E.—Pavilion at the Hackney Infirmary (£21,050).
LONDON, N.W.—Erection of Baptist church, Cricklewood (£6,000). Architect, Mr. A. Keen.
LONDON, N.W.—New station at Brondesbury-park for the North London Railway Co.
LONDON, S.E.—Erection of sub-station for London County Council at Tooting (£4,307).
LOUGHTON—Erection of Council school (£1,048).
LOWESTOFT—Corporation secondary school.
MAGHERAFELT—Erection of 179 labourers' dwellings for Urban District Council (£36,186).
MAGHULL—Home for epileptics (£8,000).
MANCHESTER—Erection of Gorton baths (£1,000).
MANSFIELD WOODHOUSE—Elementary school for Education Authority.
MARDEN—Improvements to school by Hertford Education Authority.
MARLAND-CUM-SUDDEN—Erection of church and vicarage.
MARTON—Erection of Wesleyan chapel.
MEXBOROUGH—Secondary school for Education Authority.
MIDDLESBROUGH—Public convenience (£700).
MILTON—Additions to lunatic asylum for Portsmouth Town Council.
MONTON—House and shop. Mr. T. Mitchell.
MORRISTON—Baptist chapel school (£400).
MORLEY—Secondary school for Education Committee (£14,560).
MOUNT BELLEW—Erection of labourers' dwellings for Urban District Council (£21,459).
NANTYGLO—Erection of two classrooms, etc., for Monmouthshire Education Committee.
NAUNTON—Alterations to Baptist church (£170).
NEWARK—New grammar school (£16,000).
NEWCASTLE—Corporation housing scheme (£8,748).
NEWCASTLE—Alterations to city hospital by Corporation (£1,400).
NEWLYN—Hall and classrooms, St. Peter's School.
NEWQUAY—Erection of church.
NEWRY—Labourers' dwellings for Rural District Council (£5,735).
NOTTINGHAM—Corporation depôt (£11,500).
OULTON BROAD—Erection of school for Urban District Council.
OUNDLE—Erection of villa, Clapthorn-road. Architect, Mr. J. T. Robinson.
PAISLEY—New Y.M.C.A. institute (£16,000).
PANTEG—Two houses at New Inn for Mr. E. Sainsbury.
PATRICROFT—Extensions to mill; Messrs. H. Leigh and Sons. Seven houses, Arthur-road; Mr. A. Lockwood.
PETERBOROUGH—Alteration to public library. Architect, Mr. J. Fordham.
PETERHEAD—Erection of fish saleroom for Harbour Board.
PICKERING—Alterations to workhouse for Guardians (£300).
PLYMOUTH—Erection of free library, art gallery, and museum. Architects, Messrs. Thornely and Rooke.
PONTFADOG—Erection of elementary school for Education Authority.
PONTYPRIDD—Erection of Young Men's Christian Association buildings (£12,000).
POOLE—Two houses, Marnhull-road, for Messrs. Mears and Ayles; five houses, Hamworthy-road, for Messrs. Baker and Pearcy; house, Longfleet-road, for Messrs. Betteridge and Featherstone; house, Uppleby-road, for Mr. H. Shearing; 13 terrace houses, Shillito-road, for Mr. C. D. Miles; house, Wellington-road, for Mr. Archibald Smith; two houses, Sandbourne-road, for Mr. J. Bush.
POOLE—Public offices (£2,600).
PORTH—Two houses for Trustees, Welsh Wesleyan Church; workshop for Porth County School.
PORTSMOUTH—Extension of infirmary for the Guardians.
RATHFRILAND—Alterations to bank. Architects, Messrs. Watt and Tulloch, Belfast.
REIGATE—Schools at Hooley (£9,000).
ROADE—Wesleyan chapel (£760).
ROYTON—Erection of public baths by the Urban District Council (£4,500).
RUGBY—New theatre, Albert-street (£10,000).
RUNCORN—Public bath by Corporation (£1,400).
SALFORD—Fire brigade premises (£2,650).
SALTBURN—Erection of cemetery lodge for Urban District Council (£460).
SAXTON—Alterations to parish church.
SEDGEFIELD—School at Chilton-lane for Guardians.
SHEFFIELD—Erection of Wesleyan mission hall, Norfolk-street.
SHIREBROOK—Roman Catholic church, Langwith-road (£2,200).
SHOPLAND—Council school and teacher's residence (£2,358).
SILSDEN—Fire station for Urban District Council (£1,000).
SLAITHWAITE—Four dwelling-houses. Architect, Mr. A. Shaw, Golcar.
SOMERSET—Elementary school at Somerset Bridge.
SOUTH BANK—Council chamber and offices (£1,500).
SOUTH BYKER—Church in Walker-road (£3,000).
STAFFORD—Isolation hospital for Town Council (£2,250).
STEEPLE LANGFORD—Alterations to East End Inn. Architect, Mr. J. Harding, Salisbury.
STOCKTON—Erection of theatre seating 2,500.
STOKE—Receiving home, nursery, cottages, and laundry for the Guardians.
STORTHES HALL—Buildings at County Asylum (£7,914).
STROUD—Secondary school for Board of Education.
STUNING—Improvements at parish church. Architects, Messrs. Clayton and Black.
SUNDERLAND—Branch library, Villette-road; iron church, Corporation-road.
SUTTON COLDFIELD—Enlargements of schools (£2,650).
SWINDON—Two houses and shop, Montague-street, for Mr. L. L. Thomas; 18 houses, Station-road, for Mr. F. Colborne; six houses, Omdurman-street, for Mr. H. C. Cook.
TALLISTOWN—Erection of schools for Education Committee.
TAUNTON—Fitting of Council school (£1,000).
TENDRING—Alterations to laundry by Board of Guardians.
THORNBURY—Alterations to the workhouse for Guardians.
THRAPSTON—Erection of Council school (£3,000).
THUNDERSLEY—Erection of school and teacher's house (£2,425).
TONYREFAIL—Erection of 50 houses for the Cold Ely Valley Building Club.
TOTTINGTON—Six houses in Scobell-street; Messrs. J. Chesters and Co. Eight houses in Booth-street; T. Kenny. Workshop in back, Leeman's, Hill-street; Messrs. Holt and Mellor. Chip shop in Booth-street; Messrs. Holt and Mellor.
TREDEGAR—Premises for Co-operative Society.
TUNBRIDGE WELLS—Extensions to electricity works.
UNSTONE—Erection of parish church.
WABERTHWAITE—Additions to school for Managers.
WAKEFIELD—Ballroom, refreshment rooms, etc., Lofthouse Park.
WATFORD—Four cottages, Primrose-hill, for Mr. A. Timberlake.
WENTBRIDGE—Elementary school for Education Committee.
WHITCHURCH—Extensions to market for Corporation (£1,200).
WILLENHALL—Erection of schools for Staffs County Council.
WINSLOW—Alterations to electric light engine-house; alterations to a house at Stewkley for Rev. C. Wright.
WINTON—Alterations to hotel. Messrs. Walker and Homfray.
WOODBRIDGE—School for East Suffolk Education Committee.
WOLVERHAMPTON—Nurses' home, South Staffs General Hospital; erection of Welsh chapel in Bath-road (£1,900).
WORCESTER—Extension of electricity mains for Corporation.
WORKSOP—Erection of post office.
WREXHAM—Extension of lighting plant (£500).
YELVERTOFT—Alteration of Council school (£335).
YEOVIL—Laboratory and cookery school at Yeovil High School.
YORK—Three shops; Messrs. Tetley and Sons, Holgate-road. Shop; G. W. Harding, Coppergate. Four houses, Norfolk-street, Bishopthorpe-road; New Wesleyan chapel, Chapel Clifton.
YOULGRAVE—Enlargement of Wesleyan chapel. Architect, Mr. G. Allsop, Bakewell.

FORTHCOMING EVENTS.

FRIDAY, OCT. 11.

Northampton Institute Engineering Society.—At 5.45 p.m., "The Scope and Future of Engineering," Dr. C. V. Drysdale.

THURSDAY, OCT. 17.

Rugby Engineering Society.—"Steam Turbines, with special reference to the Willans-Parsons Type," Mr. E. R. Briggs.

FRIDAY, OCT. 18.

Institution of Mechanical Engineers.—At 7.30 p.m., at Storey's-gate, S.W., "The Indicated Power and Mechanical Efficiency of the Gas-Engine," Prof. Bernard Hopkinson.

Junior Institution of Engineers.—At 7 p.m., at the Westminster Palace Hotel, annual general meeting, and 8 p.m., paper by Prof. W. E. Lilly, D.Sc., on "The Economic Design of Hollow Shafts."

Chemical Society.—At 9 p.m., at 21, Albemarle-street, W., "Organic Synthesis and its Relation to Biology," by Prof. Emil Fischer, F.R.S. (Faraday lecture).

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LEGAL INTELLIGENCE.

CLAIM FOR DAMAGES FOR TRAMWAY COLLISION.

At Oldham County Court last week Judge Bradbury heard the claim brought by a carrier against the Middleton Electric Traction Co. for damages sustained by the collision of his lurry with an electric tramcar owned by the defendants.

PLAINTIFF stated that he was proceeding with his lurry on the Thornham-road from Manchester to Castleton on July 30, and while he was in the loop near the Junction Inn a tramcar came up behind him, and, hitting the corner of the lurry, knocked it on to the footpath, and threw the horse down. There was not room for the tramcar to pass the lorry in the loop. After the collision the horse took fright.

On behalf of the defence, it was urged that the driver rang his bell three times, and the driver of the lurry very generously pulled up just at the entrance to the loop in order to allow the car to pass. When the motorman saw the lurry pull up he went forward, and when he was nearly past the lurry the horse took fright, and went on into the loop, where it was impossible for it to pass the car.

Mr. F. ENDEAN, manager of the tramway company, said he saw the car after the accident, and examined it for the purpose of discovering whether there were any injuries from the collision. He found a scratch in the middle of the car about 9in. in length. From the appearance of the scratch he judged that there could have been no impact, because the panel was only $\frac{3}{16}$in. thick, and had there been an impact the panel would certainly have been broken in.

HIS HONOUR adjourned the case in order that the plaintiff might call the man who had repaired the lurry and any other evidence he liked to prove that the lurry was smashed on that particular journey.

HAIGH v. LEEDS CORPORATION.

At the Leeds County Court last week the Leeds Corporation were sued by Mr. D. D. Haigh for damages through the negligence of one of their drivers on an electric car. The accident occurred on Jan. 17 last, when a tramcar was passing Bennett-road on its way to Headingly. The plaintiff came out of Bennett-road driving a pony and cart, and intended crossing the Otley-road where the tramcar was running, but just when he was on the line the car smashed into him, breaking the axle of his cart and doing him considerable injury; he was laid up for six weeks, and said he would never be able to follow his occupation any more, as he has lost his nerve.

For the defence, it was contended that when persons knew that tramways were constructed and running in certain roadways, it was their duty to use the greatest care to protect themselves, and, further, that tramways having a statutory right to run, and being limited to their course, persons driving vehicles should give way to the cars and not rush in front.

The Judge came to the conclusion that the plaintiff had got too far to turn back, and the driver of the car should have pulled up earlier. He therefore found for the plaintiff, and allowed £21 damages.

COMPANIES' MEETINGS AND REPORTS.

WILLANS AND ROBINSON.

The half-yearly meeting of Willans and Robinson was held on Wednesday at the Cannon-street Hotel, E.C., Mr. M. Robinson, the chairman, presiding.

The CHAIRMAN, in moving the adoption of the report, said that the marked improvement in the results was primarily due to the late reduction of capital, which had not only enabled them to distribute the profits made but, by removing for the present the necessity for further writing down the reduced valuation of the Queensferry property, had added substantially to their profit. The new business at Rugby was doing well, the profit for the two half-years ended June 30 exceeding £41,000. The price of all materials used in the engineering trade was very high. Competition was greatly increased, and continued to cut down prices and profits, with growing harm to the trade and little gain to anyone. They had avoided the reckless tendering which was unfortunately so common, but had carried off by far the greater part of the publicly advertised contracts for steam-turbines, though their prices were rarely the lowest. They proposed to pay a 10 per cent. dividend, which was a promising beginning after the reorganisation of the capital.

CLEVELAND AND DURHAM ELECTRIC POWER.

The first annual general meeting of the Cleveland and Durham Electric Power was held on Wednesday at Newcastle.

Mr. CHARLES EMMOTT, the chairman, said that when the statutory companies' undertaking was taken over in July of last year the business secured by it was only equivalent to 1,000 h.p. Now the contracts closed amounted to 12,000 h.p., and negotiations were proceeding with prospective consumers whose requirements were equivalent to 25,000 h.p. Only the fringe of the business had been touched. The total requirements in the Company's area reached about 225,000 h.p., the whole of which could in the course of time be dealt with on terms which would both be profitable to the Company and show substantial savings to the various power users. No power user in the area would find it profitable to put down his own plant rather than take power from the Company. The Company's relations with local authorities in its area were satisfactory. The Middlesbrough Corporation had taken a large proportion of its supply from the Company in bulk. An agreement was approaching completion with the Corporation of Hartlepool which would enable the Company for 42 years to actively develop power and lighting business in Hartlepool. The Company was willing to negotiate with the Corporations of Stockton, West Hartlepool, and also Darlington. A matter of great importance to the Company was the application of electricity to rolling mills. Recent advances in that direction represented a most important development in the application of electricity to motive power purposes that had taken places in the last five years. It now appeared certain that electricity would replace steam for all rolling-mill work in the course of the next few years. As the Cleveland district produced between one-third and one-half of the iron of the United Kingdom, that development would have extensive and very favourable bearings on their Company's progress. They hoped before next year to have connected with the Company's system two large rolling mills, each of over 1,000 h.p.

The report was adopted.

DUNDEE AND BROUGHTY FERRY TRAMWAYS.

The annual meeting of the shareholders of this Company was held on Monday, when the CHAIRMAN (ex-Provost Brownlee) proposed the adoption of the annual report. He said the Company had been very unfortunate in the matter of weather, and that had made the greatest difference to their drawings, but they hoped for better results in the coming year. With regard to a request made a year ago to open a working account, he said the directors considered it would be better that that should be allowed to lie dormant. The town had now taken over a portion of the county at the east end, and, according to an agreement, they would be entitled to take over the tramway within the part taken in in 10 years, but, of course, for the structural value. That would take away a bit of the best part of their line.

Mr. GEORGE BALFOUR (London), who seconded, said that no doubt a scheme would be devised before that time whereby the position of the Company would not be affected.

In reply to a question, it was stated that when the town took over any of the tramway, the debenture holders' interest would not be guaranteed by the town. The sum paid for the structural value would, he fancied, belong to the debenture holders.

The report was adopted.

EDISON AND SWAN UNITED ELECTRIC LIGHT.

The report of the Edison and Swan United Electric Light Co. for the year ended June 30, 1907, to be submitted to the meeting on the 16th inst., states that the net revenue account shows that the sum of £54,236 has been brought from profit and loss account. Interest on debenture stocks has absorbed £16,390; £11,000 has been set aside as depreciation on freehold and leasehold property, plant, machinery, and tools; £1,476 has been applied in writing down values of stocks; and the sum of £1,355 has been reserved on account of bad and doubtful debts. An amount of £7,500 has been added to the reserve fund. The result as shown in the net revenue account is a credit balance of £16,514, to which must be added the sum of £9,007 brought forward from the previous year, thus making a total of £25,521, out of which the directors recommend a dividend for the year on the "A" shares at the rate of 4½ per cent., being 4s. 2d. per fully-paid "A" share and 2s. 6d. per part paid "A" share, amounting to £15,978, leaving a sum of £9,543 to be carried forward. During the year £6,100 of the Company's debenture stocks have been purchased and cancelled, resulting in a profit of £582. This amount has been appropriated as a reserve against stock depreciation. Cost of establishing the business, goodwill, etc., £390,432, has been brought forward at the figure standing in the last balance-sheet. The freehold and leasehold property, plant and machinery have also been brought forward at the value stated in the last balance-sheet, with the addition of the amount expended to June 30, 1907, less depreciation charged in net revenue account. There has been expended on capital during the year £7,657. The shares of the Altrincham Electric Supply have been taken at par, as in previous years. This concern continues to show satisfactory progress, and has paid a dividend at the rate of 5 per cent. on its shares for the year ended Dec. 31, 1906. Its indebtedness to this Company has been reduced during the year by £341.

MELBOURNE TRAMWAY AND OMNIBUS.

The report of the Melbourne Tramway and Omnibus Co. for the year ended June 30 last, presented to the meeting at Melbourne on Aug. 13 last, states that the balance shown after paying £57,600 in dividends for the year, making the necessary reserves, and including £25,711 brought forward from last year, is £40,391. From this the directors propose to pay a bonus of 3 per cent., leaving to carry forward £25,991. The traffic receipts for the year show an increase of £39,513. On the other hand, this increased traffic, representing the carrying of nearly seven millions more passengers, together with the advance in the rates of wages mentioned at the last annual meeting, has considerably increased the expenses.

CLEVELAND AND DURHAM ELECTRIC POWER.

The first annual report of the Cleveland and Durham Electric Power Co. states that the ordinary shares in the Cleveland and Durham County Electric Power Co. and the Northern Counties Electricity Supply Co. have been acquired at a cost of £611,373, and £28,770 has been expended in the construction and equipment of sub-stations, etc. A loan of £106,772 has also been advanced to the

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Northern Counties Electricity Supply Co. The net revenue for the past year amounted to £10,978. A final dividend of 2½ per cent. is proposed on the preference shares, making 5 per cent. for the 12 months, and leaving £3,227 to carry forward. Electricity in bulk is now being taken at Bishop Auckland, Hebburn, and Felling, and a similar supply will soon be available at Blyth, Spennymoor, Hartlepool, and Consett. Mains have now been laid in Middlesbrough, Thornaby, Stockton, on the north bank of the Tees, and throughout a large portion of the Cleveland iron mines district and the coalfield in the Auckland district. An extension of the mains system to the Hartlepools, *via* Seaton Carew, is now in progress. Agreements have been arranged with the Corporations of Middlesbrough and Hartlepool. The former are to take a bulk supply, and the latter are transferring their electric lighting provisional order to the Cleveland and Durham County Electric Power Co. for 42 years.

NEW COMPANIES REGISTERED.

Java Rubber Plantations.—Registered Oct. 2. Capital, £35,000 in £1 shares. Objects: to acquire and work the Soember Tengah Estate. Agreement with Rubber Estate Agency. Minimum cash subscription, 19,500 shares. Registered office: 59, Eastcheap, E.C.

Main Roads Development, Limited.—Registered Sept. 16. Capital, £5,000 in £1 shares. Objects: to acquire any lands and buildings in Middlesex, Bucks, and Berks, or elsewhere, and to construct, improve, and maintain roads, footpaths, tramways, light railways, motor and cycle tracks, etc. No initial public issue.

Alaknunda Copper Syndicate.—Registered Sept. 25. Capital £6,750. Objects: to adopt an agreement with R. M. Nash for the acquisition of a certain mining licence and the right to a lease of property in Devangur, British Garnwal, United Provinces of Agra and Oudh, India. No initial public issue. Registered office: 20, Bucklersbury, E.C.

Langdon-Davies Motors (Canada), Limited. — Registered Sept. 12. Capital, £1,000 in £1 shares. Objects: to carry on the business of producers of and dealers in electric and other motors, gas, oil, petrol, and other engines, motorcars, dynamos, apparatus, accessories, and fittings, etc. No initial public issue. The Langdon-Davies Motor Co., of Southwark, S.E., have consented to this registration.

Flottman Engineering Co.—Registered Oct. 2. Capital, £3,600 in £1 shares. Objects: to take over the business carried on at 36 Park-place, Cardiff, as the Flottman Engineering Co.; to enter into an arrangement with H. Flottmann and Co., of Bochum, Germany, for the sale of rock drills and air compressors manufactured by the said company; and to adopt agreements with A. Sgonina and with H. Flottmann and Co. No initial public issue.

Lanadron Rubber Estates.—Registered Oct. 4. Capital, £320,000 in £1 shares. Objects: to acquire about 1,581 acres of land at Muar, Johore, Malay Peninsula, to acquire the business of planters of rubber and other produce carried on by the Lanadron Estate, Limited; about 7,200 acres of land, also at Muar, and the business carried on by the Jementah Rubber Co.; and about 2,000 acres of land in the same locality, or a permit or right to select the same, belonging to F. Pears. Registered office: 6, Lloyd's-avenue, E.C.

B. D. K. Co., Limited.—Registered Sept. 10. Capital, £26,525 in 25,000 "A" preference shares of £1 each and 5,500 "B" preference shares and 25,000 ordinary shares of 1s. each. Objects: to adopt agreements with the Transcontinental Construction and Contracts Corporation and with T. Kirkpatrick, and to acquire and work railways, rolling-stock, bridges, viaducts, culverts, sidings, tramways, roadways, waterways, British, foreign, and colonial contracts, electrical generation, traction, and supply works, etc. No initial public issue. Registered without articles of association. Registered office: 45, Leadenhall-street, E.C.

Kearney High-Speed Railway Co., Limited.—Registered Aug. 29. Capital, £11,000 in 10,000 ordinary shares of £1 each and 20,000 founders' shares of 1s. each. Objects: to adopt an agreement with E. W. C. Kearney for the acquisition of certain patents and rights; to construct, alter, equip, lease, purchase or otherwise acquire, maintain, and work high-speed, light, service, tube, and other railways and tramways, whether served by electrical, steam, animal, or other power, and particularly high-speed railways on the Kearney system. Minimum cash subscription, 100 ordinary shares. Purchase consideration for patents, etc., 20,000 founders' and 500 ordinary shares. Registered office: 17, Old Queen-street, Westminster, S.W.

Liens Registered.

Selby Motor and General Engineering Co., Limited, Selby.—Discharge registered Oct. 1 of debenture dated Jan. 2, 1907, for £1,500.

Electrical Publishing Co., Limited, London, W.C.—Lien registered Oct. 2 for £25 6 per cent. debenture, part of £1,500. Amount previously issued, £600. No trustees. Charged on the undertaking, business, and assets.

Richmond Laundry Motor Garage and Engineering Co., Limited.—Issue on Sept. 25 of £1,500 5 per cent. debentures, being the whole of a series created Dec. 17, 1906, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Holders: W. Cherry, T. Cherry, and W. H. Coates, all of Richmond, Yorks.

Egyptian Delta Light Railways, Limited.—A trust deed, dated Sept. 17, 1907, to secure a further £20,000 debentures (supplemental to trust deeds dated March 25, 1897, July 25, 1900, and March 7 and June 8, 1904, securing in all £460,000), has been registered. Property charged: the company's undertaking and property, present and future, subject as to property purchased from La Compagnie des Chemins de Fer Economiques de l'Est Egyptien, to £242,180 3½ per cent. debentures, and as to property purchased from the Metropolitan and Cairo Helouan Railway Société Anonyme, to £E.96,000 4 per cent. debentures. Trustees: Sir Gerald Fitzgerald, K.C.M.G., 18, Cadogan-gardens, S.W.; and Sir John R. Heron-Maxwell, 9, Wilbraham-place, London.

PERSONAL.

Mr. F. E. Drury, of Keighley, has been appointed assistant in the civil and mechanical engineering department at Halifax Technical College, at a salary of £130 per annum.

Messrs. Creightons, Limited, of Carlisle, have appointed Messrs. Ward and Goldstone, of Salford, as their sole selling agents for electrical wood casing and troughing for south of Carlisle.

Mr. Alan N. Banister, engineer and manager of the Norwich Tramways, has been presented with a pair of silver vegetable dishes and silver and ivory fish knives and forks in case, on the occasion of his marriage.

The Brighton Corporation have appointed Mr. Claughton, assistant superintendent, as superintendent in the place of the late Mr. Sharpe, his salary to be increased from £231 to £260. The salaries of Messrs. Gibbons, Watson, and Whiting, the three shift engineers, have been increased from £2. 10s. to £2. 15s. per week.

The following points were scored during last season by the clubs affiliated to the Electric Supply Cricket League, the winners of the cup being the St. James's and Pall Mall Electric Cricket Club, who finished with 17 points. The other club's scores were as follows: St. Pancras Electric Cricket Club, 13; Kensington and Knightsbridge Electric Cricket Club, 13; St. Marylebone Electric Cricket Club, 9; Central Electric Cricket Club, 8; Chelsea Electric Cricket Club, 0.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Antwerp.—The Municipality invite tenders for one 30-ton electric crane. Deposit £280. Tenders by Nov. 12.

Wrexham.—Tenders are invited for one 50-kw. steam set for the Electricity Department. Tenders by Oct. 22.

Limerick.—Tenders are invited for switchboard extensions for the Corporation Electricity Department. Tenders by Oct. 15.

Southampton.—The Electricity Committee invite tenders for cables. Particulars from the Borough Electrical Engineer.

Antwerp.—Tenders are invited by the Municipality for lighting by electricity of the Place de Meir Hall. Tenders by Oct. 18.

Spain.—Concession of Seville telephones. Particulars from the Post and Telegraph Department, 10, Cerretas, Madrid. Tenders by Oct. 15.

Madrid.—The Post and Telegraph Department invite tenders for the establishment of the Alicante telephone system. Tenders by Oct. 17.

Paris.—Tenders are invited for tubing to protect cables. Particulars from the Posts and Telegraph Department, 103, Rue de Grenelle. Tenders by Oct. 15.

Pontevedra (Spain).—The Municipality invite tenders for the installation and supply of electric lighting and power for 20 years. Tenders by Oct. 29.

Western Australia.—The Albany Municipality invite tenders for the lighting of the town for 15 years. Particulars from the Town Clerk. Tenders by Nov. 18.

Warrington.—The Corporation invite tenders for paper-insulated cables. Particulars from the Borough Electrical and Tramway Manager. Tenders by Oct. 22.

Toro (Spain).—Electric lighting and power supply installation for 10 years for the Municipality. Particulars from the Ayuntamiento Constitucional. Tenders by Oct. 30.

Lewisham.—The Guardians invite tenders for the supply and fixing of an electric cable in the laundry at the workhouse. Tenders to the clerk, Mr. C. Mott, by Oct. 14.

Bradford.—The Corporation invite tenders for the supply of uniform clothing for the tramway employés. Tenders to Mr. Frederick Stevens, town clerk, Town Hall, by Oct. 10.

Madrid.—The Public Works Department invite tenders for the construction of electric tramways in Barcelona. Particulars from Direccion de Obras Publicas. Tenders by Oct. 24.

Grimsby.—Tenders are invited by the Corporation Electricity Department for additional switchboard panels. Particulars from the Borough Electrical Engineer. Tenders by Oct. 21.

Madrid.—Tenders are invited by the Post and Telegraph Department for the privilege of exploiting Valledolix telephone system for 10 years. Deposit, 10,000 pesetas. Tenders by Oct. 18.

Melbourne.—The Postmaster-General's Department invite tenders for 11 sets and a common-battery switchboard, and 3,000 subscribers telephones, etc., for the Windsor exchange. Tenders by Jan. 7.

Napier (New Zealand).—The Town Council invite tenders for lighting and power plant and an electric tramway equipment. Particulars from Mr. F. Bowen, town clerk. Tenders by Dec. 31.

Birmingham.—Tenders are invited for the supply of 49,000 tons of coal to the generating stations of the Corporation Electric Supply Department. Tenders to the City Electrical Engineer by Oct. 12.

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Sydney.—The Postmaster-General invites tenders for the supply of wire insulators, fittings, etc. Particulars from the Commonwealth Offices, 72, Victoria-street, Westminster, London, S.W. Tenders by Nov. 6.

Melbourne.—The Deputy Postmaster-General invites tenders for the supply of 50 wall sets for telephones. Particulars from the Commercial Intelligence Branch of the Board of Trade. Tenders by Dec. 10.

Paris.—Pumping plant and electric dynamos and motors for the Municipal Waterworks Department. Estimate, £36,000. Particulars from the Canals and Waterways Department, Hotel de Ville, Paris. Tenders by Oct. 24.

St. Marylebone.—Tenders are invited for the supply of flame arc lamp carbons. Specifications, etc., from the resident electrical engineer, Mr F. A. Wilkinson, 19 and 20, York-place, W. Tenders to the Town Clerk by Oct. 16.

Buenos Ayres.—Tenders are invited for the construction of underground electric tramways. Particulars from the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London. Tenders by June 1, 1908.

Tunbridge Wells.—Tenders are invited by the Corporation for the supply, delivery, and erection of the work in connection with the installation of a 500-kw. turbo-alternator, condenser, and pipework in sections. Tenders by Nov. 1.

Glasgow.—Tenders are invited for the supply of uniform clothing for the employés of the Corporation tramways department. Particulars from Mr. James Dalrymple, general manger, 46, Bath-street, Glasgow. Tenders to the Town Clerk by Oct. 21.

Stepney.—The Electric Light Committee invite tenders for work in connection with the Council's projected new generating station at the riverside at Blyth's Wharf, Limehouse, and sub-station at Osborn-street, Whitechapel. Tenders by Nov. 11. See advertisement.

Adelaide.—The Deputy Postmaster-General for Queensland invites tenders for a common battery switchboard and 3,000 subscribers' telephones. Specification No. 166. Particulars may be obtained from the Commonwealth Offices, 72, Victoria-street, London, S.W. Tenders by Jan. 8, 1908.

Rangoon.—For pumping plant for Rangoon Municipality. Particulars, etc., of Messrs. Ogilvy, Gillanders, and Co., London agents to the Rangoon Municipality, Suncourt, 67, Cornhill, London, E.C., accompanied by a remittance of 10s., which will not be returned. Tenders to the Agents by Oct. 31.

Leyton (Essex).—The Urban District Council invite tenders for the supply of lathe and other machine tools. Specification, etc., £1. 1s., from Mr. F. Harman Lewis, electrical engineer to the Council, at the Electric Light and Power Works, Cathall-road, Leytonstone. Tenders by Oct. 29.

Willesden.—The District Council invite tenders for the supply of a three-ton electrical travelling crane, suitable for electricity to be supplied at 480 volts direct current, the jib having a working radius of 20ft. Particulars from Mr. O. Claude Robson, M.I.C.E., Public Offices, Dyne-road, Kilburn, N.W. Tenders by Oct. 15.

Glasgow.—Tenders are invited for a seven-ton and/or five-ton electric derrick crane, for the Corporation. Specifications may be obtained on application at the Resident Engineer's Office, Partick Pumping Station, Dumbarton-road, Partick. Tenders to Mr. A. W. Myles, town clerk, City Chambers, Glasgow, by Oct. 12.

Birmingham.—The Corporation invite tenders for the supply of 49,000 tons of coal to the generating stations of the electric supply department for delivery between October, 1907, and October, 1908. Particulars from Mr. R. A. Chattock, M.I.E.E., city electrical engineer and manager, 14, Dale-end, Birmingham. Tenders by Oct. 12.

Victoria.—The Deputy Postmaster-General at Melbourne invites tenders for the supply and delivery at Melbourne of 11 sections of a common-battery switchboard and 3,000 subscribers' telephones and other apparatus for telephone exchange, Windsor, in accordance with Victorian specification No. 148. Tenders by Jan. 7.

Adelaide (Australia).—Tenders will be received up to noon on Nov. 9, addressed to the Chairman, Municipal Tramways Trust, Adelaide, for the supply and delivery c.i.f. Port Adelaide of steel rails and fishplates for tramways. Specification, etc., from the Agent-General for South Australia, Threadneedle House, 28, Bishopsgate-street Within, London, E.C.

Alexandria.—Tenders are invited for the following electrical equipment for the port of Alexandria: five large and seven small trans-shipping engines, six cranes of four tons, 36 cranes of two tons, 25 windlasses, various small plant and necessary accessories, and the construction and installation of a central power station. Particulars from M. le Directeur des Ports et Phares, Alexandria. Tenders by Nov. 1.

RESULTS OF TENDERS.

Wigan.—The Tramways Committee have accepted the quotation of Walker Bros. for the supply of a motor tower wagon.

Fareham.—The Urban District Council have accepted the tender of Mr. Swain for new driving ropes for the electricity works.

Hull.—The Tramways Committee have accepted the tender of the Hickleton Main Colliery Co. for coal at the power station at 14s. 9d. per ton.

Stoke-on-Trent.—The Town Council have accepted the tender of the Florence Colliery Co. for the supply of washed beans at 11s. 6d. for the electricity works.

Colchester.—The Town Council have accepted the quotation of E. B. Gray for the supply of the motors necessary for working the mechanical stokers for £79.

Stepney.—The Electricity Committee recommend the acceptance of the tender of Mr. W. Badger for the supply and erection of a coal bunker and conveyor at £253.

London, S.W.—The London County Council have accepted the tender of G. Munday and Sons, London, at £4,153. 13s. 3d., for the erection of Tooting sub-station.

Battersea.—The offer of the British Thomson-Houston Co. to substitute two 20-h.p. motors for the existing motors upon payment of £96 is recommended for acceptance.

Luton.—The Electric Light Committee recommend the acceptance of the tender of G. W. Buckingham, Luton, for work connected with the boiler setting, flues, and trenching work for £252.

Worcester.—The City Council have accepted the tender of the South Wales and Cannock Chase Coal and Coke Co. for the supply of coal during the year ending Sept. 30, 1908, to the electricity works at Powick.

Bristol.—The Electricity Committee have accepted the tender of the Princess Royal Colliery Co., Cheese-lane, Bristol, for the supply of unwashed small coal (bituminous or semi-anthracite) for six months from Sept. 30.

Salford.—The Town Council have accepted the following tenders for the supply of coal to the electricity works during the ensuing 12 months: Clifton and Kearsley Coal Co., 17,000 tons; A. Knowles and Sons, 10,000 tons; Pearson and Knowles Coal and Iron Co., 5,000 tons.

Dundee.—The Electricity Committee recommend the acceptance of the following tenders for the plant of the new electrical generating station: Messrs. Willans and Robinson, Rugby, for complete electric generating plant, including condenser, £19,200; Messrs. Babcock and Wilcox, London, for boilers, stokers, economisers, and coal handling plant, £14,735; and Messrs. Babcock and Wilcox, for brickwork settings for the boilers and economisers, £2,125.

Recent Contracts.—Messrs. C. Pullan, 52, King's-arcade, Bradford, have received the following contracts: lighting installation from private plant, consisting of nearly 600 lights and a few arc lamps, for J. Brownhill and Co., Denby Dale; complete lighting installation for wood-working shops, timber yard, and offices, including generator and switchboard, for J. Charnock and Sons, Halifax; and complete installation of photographic arc lamps, multiple Nernst lamps, and incandescent lighting for Mr. D. R. Thompson, Bradford.

Beckenham.—The Urban District Council have accepted the following tenders: Lucy and Co., Oxford, lead service boxes, 8s. each. Cable Accessories Co., Tividale, Tipton, high-tension three-way boxes, £4. 10s.; high-tension straight-through boxes, £2. 15s. Johnson and Phillips, Old Charlton, Kent, frames and covers, three sizes, 8s. 3d., 6s. 3d., 5s. 3d.; three-way boxes, £3; four-way boxes, £3. 19s. 3d.; three-way boxes with frames and covers, £5. 10s. 6d.; four-way boxes with frames and covers, £6. 6s. 9d.; double disconnecting service boxes, £1. 1s.; two-wire house service cut-outs, 7s. 6d. per set. Bishop and Austin, London, non-disconnecting service boxes, 12s. each.

BUSINESS NOTES.

TRACTION.

Gillingham.—The Town Council have notified the tramway company that if covers are not provided for top seats in wet weather complaint will be made to the Board of Trade.

Brisbane Electric Tramways Investment Co.—Traffic receipts of the Brisbane tramways for the month of September amounted to £12,660. Corresponding month last year, £11,579. Increase, £1,081.

Wigan.—At a recent meeting of the Wigan Tramways Committee Mr. J. Slevin, engineer and manager, suggested a bonus scheme for motormen and conductors with over 12 months' service. It was resolved that the scheme be deferred until the next meeting.

Birmingham.—We are informed that the Board of Trade have appointed Lieut.-Colonel H. A. Yorke, C.B., R.E., to hold an inquiry into the circumstances of the tramway accident which occurred on the 1st inst. at the junction of Warstone-lane and Icknield-street.

Wood Green.—An agitation has been started in the neighbourhood of Wood Green, Southgate, and Winchmore Hill protesting against the excessive tram fares upon the line opened there recently. If the tramway company do not reduce the fares, it has been decided to approach the Board of Trade in the matter.

Longton.—The town clerk has reported to a meeting of the Improvement Committee that, in accordance with instructions, he has communicated with the Potteries Electric Traction Co. with reference to the nuisance caused by noisy cars on the Longton lines, and had received a reply that steps had been taken to remedy the matter.

Oxford.—The Oxford and District Tramways Act, 1907, provides for the construction of the works sanctioned within three years, and if not so completed and equipped and opened for traffic within that period, the company will pay, or cause to be paid, to the Corporation as liquidated damages the sum of £25 in respect of every week after such default is continued.

Belfast.—The tramway manager has reported upon the authorised extension of tramways as far as Wolfhill-avenue, the cost of which would amount to £9,500. He considered, however, that the extension could not be carried out safely unless considerable modifications were made in the original plans. It was agreed to place all particulars upon the agenda paper for next meeting in order to have the matter fully considered.

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Oldham.—A memorial signed by 100 residents in the Moorside district was read at the meeting of the Oldham Tramways Committee, asking the committee to extend the tramway service from Moorside to the borough boundary at Grains Bar. After consideration, it was ultimately decided that Mr. Slattery, the tramway manager, should prepare particulars relating to the application.

Manchester.—A meeting of the General Purposes Committee of the Manchester Corporation will be held on Wednesday, Oct. 16, for the purpose of considering the report of the Parliamentary Sub-Committee, which recommends that a Bill be promoted in the next session of Parliament containing powers among which is to authorise the construction of tramways in Princess-road, Moss Side, and for other general purposes.

Worthing.—The General Purposes Committee of the Worthing Town Council have had before them a petition signed by occupiers of houses in the Steyne requesting the Council to cause the discontinuance of the running of motor 'buses along that street. The town clerk has been instructed to arrange for a consultation between representatives of the two companies concerned and the committee in relation to the respective routes.

Swansea.—On the 2nd inst. an alarming collision occurred between two electric cars at the end of Bryn-road, Brynmill, Swansea. One car was coming in the direction of the town, when, the points failing to act, it ran into another car waiting at the corner. The driver was thrown out by the force of the impact, and sustained a fractured arm and injuries to the head. Other occupants of the cars were shaken, but happily none were hurt.

Aberdeen.—The Council have decided that from and after Dec. 1 the general manager of the tramways shall have the charge of the whole tramway undertaking, with the exception of the permanent way and the overhead electric equipment and feeder cables; and that the Council's resolution of May 5, 1903, in regard to the equipment and repair of the cars, and the memorandum of the general manager's duties, be altered accordingly.

Nottingham.—An alarming tram accident occurred at Nottingham shortly after six o'clock on Saturday night. A crowded car conveying passengers to the Goose Fair from Bulwell dashed into a stationary car at the bottom of Derby-road, near the centre of the city, and the impact was terrific. Six passengers were injured. Greasy metals were responsible for the mishap, the wheels skidding on the steep decline. No blame is attached to the driver, who is a careful and steady man.

Exeter.—To the meeting of the City Council the Tramway Committee reported having ordered 12 car seats to be fitted with the Thompson dry seat for the inspection of the committee. The Chairman said the weather had seriously affected the receipt of tramways throughout the South of England, and Exonians might congratulate themselves that they had taken £700 more than in the corresponding half-year. Of course, last year the Alphington-street extension was not in existence.

Dover.—At the last Council meeting the general manager presented the following figures relative to the tramway receipts: Week ending Sept. 14, 66,729 passengers, £282. 19s. 3d. receipts, against £298. 16s. 9d. last year; Sept. 21, passengers 61.943, receipts £259. 4s. 3½d., against £270. 12s. 4d. last year; Sept. 28, passengers 64,493, receipts £268. 3s. 9d., against £268. 0s. 3½d. last year. Aggregate for the last six months from April 1, £6,617, compared with £7,537 in the same period of 1906.

Westinghouse Electric and Manufacturing Co.—The *Kolnische Zeitung* learns from Paris that the Société Générale is taking over from the Westinghouse Electric and Manufacturing Co. 14,000,000fr. 5 per cent. 10-year notes with a three months' option to a further sum of 6,000,000fr. The proceeds are to yield 7,000,000fr. additional money to the French company, and to afford funds to the Russian company in connection with the introduction of electric traction on the tramways in St. Petersburg.

Camberwell.—The Borough Council have decided to adhere to their resolution to oppose the London County Council's proposals to run tramways on the overhead system through Camberwell to the Crystal Palace. A committee suggested an alternative route to the one by Sydenham-hill, and against the new route, which was *via* Croxted-road, the residents petitioned, and it was ultimately decided to recommend to the London County Council a third route by way of Rosendale and Hamilton roads.

Bournemouth.—The traffic manager reported to the Tramways Committee at their meeting that the Poole cars required further renovating and repairing, and that there were still four cars which had not been commenced, and it was recommended that the necessary repairs, estimated at a cost of £3,000, should be carried out and charged to capital account. The Council have considered the matter, but as the committee have exceeded their estimate the question has been referred back to them for further report.

Whitechapel.—There is every probability that the electrification of the East London trams along the Whitechapel and Mile End roads will soon be undertaken. The Works Committee of the Stepney Borough Council have intimated to the London County Council that they have no objection to any system of electric traction, other than the overhead, with the safety and stability of which the Board of Trade are themselves absolutely satisfied. The London County Council, it will be recalled, have decided to put down the experimental surface-contact system along the Whitechapel-road.

Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board.—At the monthly meeting of the Board the commercial manager submitted wages sheets for the preceding four weeks, showing that the wages paid during that period amounted to £1,295. 9s. The commercial manager reported that the traffic receipts for the four weeks ended Sept. 14 amounted to £3,519. 13s., and that the total receipts to that date from March 31 last were £19,839. 10s. 9½d. The commercial manager submitted a detailed report as to traffic receipts and working expenses for the calendar month of August.

Edinburgh.—The Tramway Committee of Edinburgh Town Council had several matters affecting the system before them at their last meeting. It was reported that the Board of Trade had consented to the speed of the cars worked from Henderson-row being raised from eight to nine miles an hour. This includes the Mound to Tollcross route. A conference with the Leith Committee as to extensions of the Leith system to Granton and Portobello is to be held shortly. It was agreed to ask the tramway company to restore the workmen's cars on the northern route, complaints on the subject having been received from a large firm.

Dewsbury.—At a meeting of the Soothill Nether District Council the seal of the Council was affixed to an agreement with the National Electric Construction Co. for the construction of that part of the Dewsbury to Ossett tramways which comes within the authority's area. It was stated that the work would be commenced within a month's time, and probably finished by Whitsuntide. The line will run direct from Dewsbury to Ossett *via* Wakefield-road, with a loop line through Earlsheaton, and will link up Dewsbury with the Wakefield tramways which run to Ossett. There is at present direct tramway access between Dewsbury and Bradford.

Sedgley.—The Dudley, Sedgley, and Wolverhampton Tramway Co. have discontinued half fares for children travelling on the tramway between Sedgley, Dudley, and the Fighting Cocks. The action of the company has caused much indignation in the Sedgley district, as it is considered to be unreasonable to pay full fares for children under 12 years. Although the managers of the company are acting within their legal rights, having given the requisite notice of the change, which has already taken place, we understand complaints have been made to the Sedgley District Council with a view of steps being taken for the reduced fares for children being continued.

Hull.—The city engineer has been instructed by the Tramway Committee to proceed with the preliminary work for an extension of the tramlines along Jameson-street from King Edward-street to Paragon-street and into Carr-lane, with the object of providing a circular route to and from Paragon Station. The city engineer advised that if the committee determined to lay lines in Jameson-street to George-street, it would have to be a double set of lines, and not a single. The question will be again considered before the Corporation make the application for powers for further tramway extensions. The extension of tramways from the Newland-avenue terminus to the Beverley-road on the Cottingham-road is to be proceeded with.

Bradford.—The inhabitants of Wibsey have been placed in direct tram communication with the centre of Bradford. The new tramway, which is a double track the whole distance, measures from the old terminus at Little Horton to Fair-road, Wibsey, 1,661 yards, or rather less than a mile. The total distance from the city to Wibsey is 2 miles 1,132 yards, and the fare—a provisional one for three months—is 1½d. from end to end, with an overlapping stage of 1d. from Wibsey to Park-avenue. The scheme, which was estimated to cost £13,500, has been carried out under the supervision of the city surveyor (Mr. J. H. Cox). A commencement was made on Aug. 22 last, and the scheme was completed on the 4th inst., this being a record for speedy tramway construction so far as Bradford is concerned.

Bacup.—At the last meeting of the Council the town clerk reported the result of the meeting which the sub-committee had with the Rawtenstall Corporation on the acquisition of the Rossendale Valley tramways, and it was resolved that the sum of £5,700 be offered the Rossendale Valley Tramways Co. for their undertaking within the borough, also that in the event of the Rawtenstall Corporation not expressing their satisfaction that the Bacup Corporation has power under their agreement to purchase the Rossendale Valley tramways within this borough upon the terms provided by Section 43 of the Tramways Act, 1870, the town clerk be instructed to take such steps as may be necessary for the promotion of a Bill in the next session of Parliament for the purpose of acquiring such power.

Clayton-le-Moors.—At the last meeting of the Council the Chairman said it had been suggested to him that the attention of the Accrington Corporation ought to be called to the fact that the distance between Eagle-street, Accrington, and the tramway terminus at Clayton-le-Moors was under two miles, and that the Corporation might reasonably be asked to take into consideration the revision of fares. The popular idea in Clayton-le-Moors was that the through fare from Clayton-le-Moors to Eagle-street should be 1½d. each way, with 1d. stages equidistant between the two places. It was asserted that the proposed change in fares would not cause any loss in revenue, and would be more reasonable than the former charges. The Council decided to approach the Accrington Corporation in respect to the matter.

Glasgow.—The tramway station at the corner of Cathedral-street and Castle-street, Townhead, opposite the Royal Infirmary, was on the 8th the scene of an accident. Two cars were standing, and the motorman of one of them left his car to indicate the time on the "Bundy clock" placed on the railings that surround the infirmary grounds, when he was knocked down by the new motor engine of the fire brigade, which was on a trial run. The motor had been stopped owing to the crowd of tramway passengers on the street, and had just restarted. The car driver was carried into the infirmary, where he was found to have sustained, besides other injuries, a compound fracture of the right leg. The Tramways Committee have decided that the men employed on Sundays at Pinkerton power station shall be paid at the double time rate.

West Ham.—The South-West Ham Free Church Council recently asked the West Ham Corporation to consider the practicability of establishing a "double-shift system" on its tramways on Sunday, so that the tramway employés who so desired might have a better oppor-

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tunity than at present of attending divine worship on Sunday. In accordance with instructions, the tramways manager, Mr. H. E. Blain, has prepared a report on the matter, in which he expresses the opinion that the possibility of rearranging the traffic duty sheets in order to establish the system proposed is impracticable. With the existing staff one-third of the men are off duty the whole day on Sunday, so that each man is off duty every third Sunday. It is found in practice that large numbers of the men ask for their rest day to be given them on a day other than Sunday.

Penge.—The Works Committee of the Council recommended that representations be made to the tramway company with a view to altering the stopping place near the end of Maple-road. The committee further recommended that in view of danger and obstruction to traffic caused by tramcars and omnibuses both stopping by the Pawleyne Arms in Croydon-road, endeavours should be made to make arrangements for the omnibuses to stop on the opposite side of Beckenham-road in Green-lane. The committee having pointed out the convenience to many residents of Penge of a through service of cars without changing at the Robin Hood, had received a reply stating that the results of the working of this service of cars were so unsatisfactory that the company decided to discontinue the service after a fortnight's trial—to all of which the Council agreed.

Richmond (Surrey).—The General Purposes Committee of the Corporation have issued an important report with regard to tramways. They state that they are of opinion that a system of tramways for Richmond and Barnes is feasible, and that, after careful consideration and advice from experts, it will be possible to evolve a practical and satisfactory scheme for a line from Richmond to Hammersmith Bridge. They are also of opinion that, owing to the terms for crossing Kew Bridge, and to the existing powers for electrifying the tramway track in Kew-road, the proposed line through Sandicombe-road should be postponed for a year. The committee refuse at this juncture to express an opinion as to whether it would be better for the Corporation and the Urban District Council of Barnes to erect and work the lines themselves, but they recommend the Council to approve the general principle.

Middlesbrough.—The announcement made by the Stockton and Thornaby Electric Tramways Co. that on and after Oct. 5 cars would run between Newport-road and Middlesbrough Station *via* Parliament-road has been received by residents on the route with the greatest pleasure. The district around Parliament-road is one which of late years has grown rapidly, and as a large number of business men have taken up their residence there it has been felt that the tramway company should endeavour to make provision accordingly. The rails have been laid for years, and not once but many times has regret been expressed that they were not utilised on behalf of the public. Some time ago the Town Council drew the tramway company's attention to the matter, and they have apparently convinced the directors that there is a public demand in this quarter.

Blackburn.—An alarming collision between a tramcar and a wagonette occurred the other night at Whalley-road, by which eight persons were injured, two seriously. A three-horse wagonette containing 18 men was returning from a drive to Mytton, when the hat of one of the passengers blew off. The driver pulled up to recover it, and at this moment an electric tramcar, which had left the Wilpshire terminus a minute before, crashed into the vehicle at a speed estimated at between 12 and 14 miles per hour. The force of the collision was so great that the wagonette was hurled bodily to the side of the road and practically wrecked. Twelve of the passengers were thrown violently into the roadway, and the driver, James Robinson, fell with the reins round his neck, and was nearly choked before being rescued. The driver of the tramcar, William Bowskill, also sustained severe injuries, the cab in which he was standing being smashed.

Sunderland.—The Railway Department of the Board of Trade have issued the report of Lieut.-Colonel P. G. von Donop on the result of his inquiry regarding two accidents which occurred on the evening of July 29 on the Sunderland District Electric Tramways. In the first case seven passengers were injured through the driver losing control of a car descending Mill Hill Bank, so that it ran off the line at a curve near the bottom of the hill and collided with a stone wall. The rear of the car remained foul of the line, and later in the evening another car failed to stop in time to avoid coming into collision with the first car, and six passengers were slightly injured. As regards the first case, the inspector thinks the driver neglected to carry out instructions and to make proper use of his brakes in time, so that the car attained such a great speed that nothing would stop it, and the derailment was almost inevitable. The second car, he also thinks, approached the other at rather too high a speed to be pulled up in time on the greasy rails. To prevent similar accidents in the future the inspector suggests another compulsory stopping place, and the outer rail at the curve being raised at least an inch over the inner.

London County Council Tramwaymen.—At the invitation of the Highways Committee of the London County Council, a deputation of the Council's employés on the tramways systems waited upon that body in order to lay before them their views upon the recent order of the Council ordering all tramwaymen to undergo a thorough medical examination. The men's chief complaint has been that the examination has been conducted under objectionable conditions. After hearing the men's views as put forward by Mr. Watson, Mr. White Thompson (the chairman of the Highways Committee) admitted that the doctor, in carrying out the medical examination in the way he had done, had not acted according to their wishes. It was not their intention that the men's feelings should be hurt. The Council, however, considered that in the interests of the public a medical test should take place, and he suggested a modified form of examination. He further gave an assurance that any man who failed to pass that test would be found some suitable employment, and under the best possible terms, but he would give no definite promise that the wages would not be decreased. The men pledged themselves to nothing, but they will lay the suggestions before their fellow-workmen.

Bury.—At a special meeting of the Tramways Committee on Sept. 30, the chairman explained the service proposed to be given upon the Radcliffe sections during the winter months, as detailed in the report prepared by the manager. In the course of this the manager said that the great advantage of altering the running of the Bury-Stopes cars is the large reduction in car mileage—*i.e.*, 30,412 car miles per annum—which will actually reduce the working expenses £823. 13s. 2d. per annum. A deputation from the Radcliffe Urban District Council was received. Various details in reference to the intended alterations were discussed with the deputation, who afterwards expressed approval of the scheme, thereupon retiring from the meeting. Resolved, that the services, stages, and fares, as set out in the manager's report, be adopted for the winter service on the Radcliffe tramways. The committee then dealt with the question of Sunday labour in the tramways department, and for their information the chairman stated the views of the recent conference, as well as detailing the wages and conditions of labour upon the Bury system. After discussion, it was resolved that this committee were of opinion that it would not be judicious for the tramway employés to be paid at the rate of time and a quarter for Sunday labour.

Scheme for Purchase of Tramways.—A letter from Mr. Norman A. Thomson, A.M.I.E.E., consulting electrical engineer, has been before the Edinburgh Town Council. It stated that he had been considering a scheme for electrifying the Corporation tramways in conjunction with a financial firm of very high standing. He would be glad to know if the Council would consider selling the present tramways to a new tramway company, and grant them a concession for working the same for a period of 60 years, and, if so, what sum in cash down would the Council require for this. A new company would convert the present lines to electric traction, and simultaneously would put down extensions, probably aggregating some nine miles of double track. The system adopted would be the overhead trolley, and all capital required would be found by the new company. The selection of the routes to be extended simultaneously with the conversion of the new tramways, and the lengths of these extensions was probably a matter which could be adjusted to meet the views of the Council. He added that the present tramway company were approached on the matter several months ago, and it was ascertained that they did not wish to stand in the way of the scheme at all, provided the terms to themselves were satisfactory.

Handsworth.—The tramway company have decided to restore the old 1d. stage to Hockley Brook, and make Vyse-street, as formerly, the starting point of the overlapping 1d. stage to Stafford-road. There will also be a corresponding revision of the workmen's return fares, but the ordinary fare from Colmore-row to New Inns will continue to be 2½d. In June last the chairman of the Birmingham Electric Traction Co., which controls the tramways of the Black Country, stated at the annual meeting of shareholders that in consequence of there being no dividend this year it would be necessary to increase the fares. Effect was given to this decision so far as the cable route was concerned in July, when the fare from Colmore-row to New Inns was raised from 2d. to 2½d. The increased fares and the reduced stages were generally regarded among Handsworth residents as unreasonable, and large numbers of those who had hitherto used the cable cars decided to walk, or cycle, or travel by other routes. The railway traffic between Handsworth and Birmingham increased considerably, while large numbers patronised the electric cars of the Birmingham Corporation on the Lodge-road route. It was stated at the end of July that the takings of the City of Birmingham Tramway Co. on the cable car route had been reduced by £20 a day, and the falling off has apparently not been materially diminished since then. The restoration of the 1d. fare to Hockley Brook will probably cause many of those living near the city boundary and on Soho-hill to return to the trams, but it is doubtful whether this concession will be sufficient to allay the feeling of resentment in the public mind.

LIGHTING AND GENERAL

Nelson.—The electrical engineer's report for the past month shows that the total number of units generated was 73,071.

Woolwich.—The London County Council have agreed to lend the Borough Council £1,755 for electric lighting purposes.

Fulham.—The London County Council have agreed to lend the Borough Council £7,377 for an extension to the electricity works.

Hammersmith.—The Borough Council have decided to supply electricity to the Franco-British Exhibition at an expenditure of £14,000.

Barry.—An expert engineer has met a deputation of the Barry District Council and had a consultation with a view to the lighting of town by electricity.

Dublin.—A new company has been registered for the supply of electrical power and energy in Dublin, and the counties of Kildare, King's, and Queen's.

Falmouth.—Owing to the threatened increase in the price of gas, the Council have decided to secure information as to the cost of lighting the streets by electricity.

Whiteabbey.—The Belfast P.L.G. Board is considering a scheme for the electric lighting, etc., of the abbey and its grounds, Whiteabbey. The estimated cost is £3,410.

Bingham.—A Local Government Board inquiry will be held on Oct. 15 into the application of the Council for sanction to borrow £81,900 for the electricity undertaking.

Chesterfield.—The Local Government Board will hold an inquiry on Oct. 17 into the Council's application for sanction to a loan of £5,000 for their electricity undertaking.

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Whitby.—The Urban District Council have decided to rent premises for purposes of an electricity showroom, and also to procure a combustion recorder for the electricity station.

Carmarthenshire.—The County Council have granted permission to the Postmaster-General to erect poles for a telegraph line from Llandefeilog to the junction near Kidwelly.

Northallerton.—At the last meeting of the Urban District Council the clerk reported that the electric lighting company were not at present prepared to make an offer for the sale of their business.

Wallsend.—A plan showing manhole and line of cables proposed to be laid in the roadway at the south side of Hadrian road for the electric supply company has been considered and approved by the Town Council.

Partnership.—The *London Gazette* announces that the partnership between J. Lawson and F. Stobbart, carrying on business as electric light and power engineers at 24, High-row, Darlington, has been dissolved by mutual consent.

Direct United States Cable Co.—The directors of the Direct United States Cable Co. have declared an interim dividend of 4s. per share, free of income tax, being at the rate of 4 per cent. per annum, for the quarter ended Sept. 30, 1907.

Bristol.—The Docks Committee have acceded to an application by the Telephone Co. for permission to erect kiosks for penny-in-the-slot telephones at certain places around the city docks and at Cumberland Basin, subject to the usual terms and conditions.

Beckenham.—The Council have decided to extend the cable in Aldersmead-road at an estimated cost of £21, and have instructed the resident engineer to report upon a suggestion for facilitating the purchase of lan.ps by consumers from the Council.

Longton.—The output from the Corporation electricity works for the four weeks ending Sept. 19 was 11,612 units, against 8,028 for the corresponding period of last year, being an increase of 45 per cent. During the past four weeks 114 additional lamps have been fixed.

Bradford.—The Corporation Electricity Committee have agreed to supply current in bulk to the Bradford Dyers' Association to be distributed by them to some of their branches in Thornton-road and its vicinity, on terms and conditions set out in certain correspondence.

Dundalk.—The Urban District Council are taking steps to promote a Bill in Parliament for the purpose of increasing the borrowing powers of the Council in order to properly and efficiently carry into effect the Council's provisional order with respect to the electric lighting of the town.

Edison and Swan United Electric Light Co.—The directors have decided to recommend the payment of a dividend for the year ended June 30 at the rate of 4½ per cent. per annum, being 2s. 6d. per share on the "A" shares partly paid and 4s. 2d. per share fully paid, each less income tax.

American Electrical Industry.—Manufacturers of electrical appliances in various parts of the United States are just now suffering from a wave of depression. The General Electric Co. at Schenectady has been compelled to discharge 2,000 of its employés owing to slackness of orders.

Bermondsey.—The Electricity and Street-Lighting Committee report that since the last meeting additional consumers have been connected to the mains equalling 250 8-c.p. lamps. The lamps connected to the premises of private consumers number 83,317, and public lamps 4,662.

British Aluminium Co.—The directors have declared an interim dividend of 7 per cent. per annum on the ordinary shares, and they have authorised the payment of six months' interest at 5 per cent. per annum on the conversion shares, and at 4 per cent. per annum on the funding certificates in respect of the year 1907.

Wireless Telephony.—Mr. De Forest, the inventor of a system of wireless telegraphy, has been conducting tests in wireless telephony on board the battleships "Virginia" and "Connecticut." It is announced that the tests proved so satisfactory that the U.S.A. Government will cause all battleships to be equipped with the system before they begin their cruise to the Pacific on Dec. 15.

Watford.—The Town Council have received a report from the Electric Lighting Committee giving the result of the deliberations of a conference between the gas company, the borough engineer, and the Electricity Committee which shows that the cost to light 65 lamps with gas would be £2. 15s. 6d. per post, as against £2. 2s. 6d. by electricity. The Council have decided to adopt electricity.

Rickmansworth.—The Northwood Electric Light and Power Co. have written to the Urban District Council giving notice of their intention to apply forthwith for a provisional order authorising the supply of electricity for public and private purposes within the urban district, and requesting the Council to give their consent to the granting of such an order. The matter has been referred to committee for consideration.

Wednesbury.—The Council have decided to make application to the Local Government Board for their sanction to a loan of £2,819. 10s. 2d, made up as follows: £1,619 10s. 2d. for expenditure already incurred for electrical cables, services, and meters to March 31, 1907; and £1,200 for electrical cable extensions and services to be expended from March 31, 1907, such sum to be carried to a suspense mains and services account.

Notice of Dividends.—The *London Gazette* states that a first and final dividend of 2s. 4½d. in the £ has been declared in the estate of G. Robson and J. Robson, electrical engineers, and trading as Robson, Robson, and Co., at Empire-buildings, Newgate-street, Newcastle-on-Tyne. A first and final dividend of 7s. 9d. in the £ has been declared in the separate estate of G. Robson, electrical engineer, 53, Falmouth-road, Heaton, Newcastle-on-Tyne,

Cheltenham.—The monthly report of the borough electrical engineer shows that on Sept. 17 there were 927 consumers, with an equivalent of 62,356 8-c.p. lamps connected to the private supply mains, the corresponding figures for last year being 861 and 59,180 respectively. In view of the present condition of the coal market, the committee have been authorised to obtain prices for the supply of coal for storage, and to accept a satisfactory tender.

Monmouth.—Mr. H. R. Hooper was the inspector appointed by the Local Government Board to hold an enquiry at the Shire Hall, Monmouth, on the 3rd inst. into the application of the Town Council to borrow £10,000 for the purpose of defraying expenses already incurred in connection with the electric lighting undertaking. He urged that Monmouth was in a financial difficulty, and after calling for reports, etc., adjourned the enquiry until Nov. 5.

Kendal.—The deputy town clerk read a letter at the Council meeting from the Telephone Co. regretting that the Corporation had not been able to see their way to having a connection established on the measured-rate system, which they felt would have been considerably cheaper for the Corporation. The company were, however, prepared to establish the additional extension required on the tariff estimate. It was resolved that the Council desire the extension to be carried out at once.

Epsom.—The electrical engineer has been instructed by the Lighting Committee to report as to the cost of lighting the town by electricity, as compared with the lighting by gas, for the information of the committee. A list of public lighting extensions and improvements, at a cost of £98. 5s., was approved for inclusion in the next estimates, with £56. 15s. 9d. chargeable to the district fund account for the estimated additional cost of current for the new lamps for the ensuing six months.

Clonakilty (co. Cork).—A meeting of the people of this town was held last week to consider the advisability of settling on some definite scheme for the lighting of the town. Mr. J. C. O'Sullivan, J.P., presided. Several schemes had been before the town for some time. The representatives of the Alliance Electrical Light Co. and of an oil-gas company submitted their schemes for the lighting of the town. After an exhaustive discussion, the final decision was postponed till the end of this week.

Swindon.—At the last meeting of the Electricity Committee accounts to the amount of £1,764. 2s. 11d. on the electric lighting account, and £382. 2s. 5d. on the tramways account were examined, and it was resolved that the same be forwarded to the Finance and Law Committee for payment. The borough accountant reported a credit balance at the bank on the electric lighting account of £978. 15s. 3d., and a credit balance on the tramways account of £1,932. 7s. 5d.

Liverpool.—A meeting of the Liverpool Select Vestry has been held, at which Mr. Horrigan submitted a report giving the result of the working of the electric generating plant which was installed at the workhouse a year ago. The experiment had proved most satisfactory, and during the 12 months a saving of over £1,200 had been effected as compared with the charges previously made by the Corporation. Mr. Horrigan was thanked for his report, and also for the work he had done in connection with the carrying out of the scheme.

Stockton.—The Electricity Committee last week reported to the Council their refusal to an application from the Cleveland and Durham County Electric Power Co. to be allowed to supply electricity to the works and premises of the N.E. Breweries Co. in Bridge-road. The application of the tramway company for a stand by supply of electricity was acceded to on condition that the company pay £10 per annum for five years, and a charge of 2d. per unit for all electricity supplied. The tender of Messrs. Worth, Mackenzie, and Co. for scrap cable was accepted.

Liquidations.—According to the *London Gazette*, the Conduit and Insulation Co. has been wound up voluntarily, and Mr. C. J. March, 3, Church-court, Old Jewry, London, appointed liquidator. The creditors of the Electrical Ore Finding Co. are required to send all particulars of their claims to Mr. J. D. Norris, Suffolk House, Laurence Pountney-hill, London, by Nov. 19; and the creditors of the English Electric Carbon Co. are requested to send particulars of their claims to Mr. J. S. Wynne, 6, Coedyfelin-road, Brymbo, near Wrexham, by Oct. 19.

Bradninch.—In all probability the electric lighting scheme will be successfully carried through. More than half the capital required has been promised by residents in the locality, and no doubt those who so far have held aloof will help the affair financially and otherwise when they consider how very cheaply the current can be generated. It is proposed at first to supply the current at 6d. a unit for lighting purposes, and for less than half this amount for motive power in the daytime. After the installation has got into working order it is proposed to reduce the cost per unit.

Bexley.—The Electric Lighting Committee reported at the Council meeting that they had received a report from the engineer with regard to a suggested reduction in the charge of 6d. per unit for private electric lighting. They had fully considered the matter, and having regard to the engineer's report, and especially in view of the great increase in the price of coal, were unable to recommend the Council to make any reduction in the price charged. The clerk was authorised to sign, on behalf of the Council, an agreement with the Receiver of Metropolitan Police respecting electric fire calls at Bexleyheath.

Bury.—During September connections equal to 26 8-c.p. lamps have been made to the Corporation mains. From the engineer's statement, comparing the number of units generated during September, 1907, with the number generated during the same period of 1906, it appears there has been an increase of 7,858, the figures being: September, 1907, 31,180, of which 5,174 were used on works, 6,161 by the waterworks motor, and 19,245 by public lighting and private con-

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sumers. The work in connection with the renewing of a portion of the storage battery by the Chloride Electrical Storage Co. had proceeded very satisfactorily.

Bournemouth.—At a meeting of the Corporation Finance Committee a letter from the town clerk of Royal Leamington Spa was read, asking the Council to consider the new schedule of rates for telephone exchange service recently adopted by the National Telephone Co. A letter from the district manager of the company was read, stating that the new rates had been in vogue practically throughout the country, including Bournemouth, and new orders are not now accepted at unlimited rates, but that it is not proposed to interfere with existing subscribers so long as they retain their present installations. No action was taken.

Middlesbrough.—The Middlesbrough Electricity Committee have agreed to extend the electric cable to new villas to be erected at Grovehill. The electrical engineer (Mr. H. M. Taylor) has reported that "settlements continue to take place at the boiler foundations and the end wall of the building in Washington-street," and adds, "the cost of repairs to same is becoming a very serious item." During September the total costs of the works amounted to £750. 10s. 8d., or 1·41d. per unit, compared with £591. 9s. 1d., or 1·25d. per unit, in the corresponding period of last year. The total profit for the month, exclusive of interest, etc., was £549. 13s. 6d., against £562. 8s. 3d. a year ago.

Sowerby Bridge.—At the meeting of the Electricity Committee the sub-committee presented their report with regard to the Sowerby Bridge Electrical Order, 1900, and recommended: "That the Council transfer their electrical order to the Electrical Distribution of Yorkshire on the terms and conditions named in their letters of July 5 and Aug. 19, 1907, on the 21 years' basis, with some revision of Clause 3, and that the clerk be instructed to communicate with the Board of Trade with regard to the same, and that the Electricity Sub-Committee be continued and empowered to negotiate." The committee have recommended the adoption of the report to the Urban District Council.

Dudley.—At a meeting of the Streets, Tramway, and Lighting Committee of the Town Council, the engineer presented the following particulars of the working of the electrical undertaking for the four weeks ended Aug. 24, 1907: Units generated—trams, 73,768 (corresponding period last year, 83,557); private lights, 16,509 (23,852); private motors, 23,313 (30,800); public lights, 7,598 (7,082); station use, 1,846 (2,848)—totals, 123,034 and 148,139. There were connected to the mains the equivalent of 45,741 8-c.p. lamps. Total consumers, 323; motors, 99—amounting to 683¼ b.h.p. The question of improving the public lighting of the borough having been referred to this committee to report upon, the committee appointed a sub-committee.

Fraserburgh.—At the last Council meeting the Provost said, while he entirely favoured the taking over of the gasworks by the Town Council, yet the councillors owed a duty to the town. Some expert should be employed to advise them as to whether it would be most beneficial to the interests of the community to take over the gasworks or to introduce electric lighting. They as a council would be wanting in their duty if they were not in a position at the forthcoming election in December to be able to lay some expert information before the ratepayers. Personally, he had a strong preference for electric lighting, and he believed it was the light of the future. Eventually the whole matter of public lighting was remitted for the consideration of a special committee.

Tonbridge.—The Electricity Committee has reported eight new applications, the total connections to date being 8,827. The auditor in his report suggests that despite the considerable difference which at present existed in practice with respect to the bringing of accrued sums, due in respect of payment of principal and interest into the expenditure of the year, it is desirable that this should be done, so that the undertaking might be charged with the full burden of the year's expenditure. It was recommended that the auditor's suggestion be adopted. The figures shown in the report were some of the most flattering which had yet been presented, as not only was the undertaking paying its way, but it was showing a legitimate profit. The report has been adopted by the Council.

Dundee.—The caution of Dundee Electricity Committee in relation to the placing of contracts for the cables in connection with the new generating station has met with its reward. For some time offers have been under consideration, but none up to the present have commended themselves, the opinion being that manufacturers had not reduced their price to an extent commensurate with the fall in the copper market. If ring there was, and the existence of such was alleged, it has broken down. The Electricity Committee has now, subject to the approval of the Town Council, allocated the contract to the British Insulated and Helsby Cables. It is learned that the price is more than £1,000 under what was quoted when first tenders were received from the cable manufacturing companies.

Gillingham.—At the last Council meeting the engineer reported that the equivalent of 117 8-c.p. lamps had been connected since the previous meeting, making a total of 27,240 lamps and 306 consumers, and that an application had been received from the Southern Amusements Co. for the equivalent of 384 8-c.p. lamps for the Hippodrome. The engineer also reported the resignation of Mr. E. E. Hamer, shift engineer, and it was resolved to advertise for a successor at £1. 7s. 6d. per week, to be increased to £1. 10s. in six months. The town clerk reported that he had been approached by the Kent Electric Power Co. with a view to their supplying the Council with electric current in bulk, and it was recommended that the company be requested to put forward their suggestions in writing, or to interview the committee.

Glasgow.—At the meeting of the Glasgow Town Council on the 3rd inst. Mr. Scott Gibson asked if the town clerk would give a statement as to the deficit on the Corporation telephone scheme. He understood the town clerk had an exhaustive statement on the subject prepared, and full information ought to be given to the public. He believed the deficit amounted to some £16,000 or £17,000, and he wanted a statement with the full legal authority of the town clerk behind it. The public had every right to know how the deficit occurred. Bailie Stewart, presiding, said there was no doubt about the deficit. It exceeded £16,000, and was less than £17,000. They could not say exactly within a few pounds. The convener gave assurance that a statement would be made, and the subject dropped.

Aberdeen.—It was reported at the last meeting of the Electric Lighting Committee that during the month of August there had been generated at the electricity works 417,210 Board of Trade units, compared with 354,789 during August of last year. An application by the Fires and Lighting Committee for additional lighting in Gray-street was submitted, and it was agreed to lay down new mains at an estimated cost of £35. Two applications were made by employés who had served under the department for a considerable number of years for retiring allowances, and it was agreed to give 8s. 6d. a week in one instance and 5s. a week in the other, both to be continued during the pleasure of the Town Council. A sub-committee was appointed to examine and take any action regarding proposed draft regulations by the Home Office for the use of electrical energy.

Tunbridge Wells.—Mr. H. R. Hooper has held a Local Government Board inquiry into an application for a new loan of £9,600 for electric light extension purposes. The Town Clerk stated that the population of the borough had risen from 33,373 at the last census to about 35,000 at the present time. He further observed that the electric light undertaking at Tunbridge Wells had been continually progressive. The works were commenced in 1891, and the total cost had been £81,475, and £22,941 had been redeemed. There were 812 paying consumers. There had been no new loans applied for for 6½ years. He referred to the success of the undertaking as Corporation property, and said it was thought needful to have further capital. Hence the application for the £9,600 to increase the capacity of the plant. There was no need to enlarge the buildings. During the luncheon interval Mr. Hooper visited the borough electricity works near Grosvenor Bridge, and Mr. Boot, the engineer, showed and explained the sections and departments of the plant. Mr. Hooper highly praised what he had seen, and congratulated the electrical engineer, remarking that he had seen few works better equipped and managed than those at Tunbridge Wells.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a settling day in Consolidated African Copper Trust's 50,000 preference shares of £1 each, 5s. paid, Nos. 1 to 50,000; New Mysore Manganese Co.'s 100,000 shares of £1 each, fully paid, Nos. 1 to 100,000, and 50,000 shares of £1 each, fully paid, Nos. 100,001 to 150,000; and Perak Rubber Plantations' 25,000 vendors' shares of £1 each, fully paid, Nos. 50,001 to 75,000. The committee have also been asked to allow Hastings and District Electric Tramways Co.'s 40,000 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 1 to 40,000 (renewed special application), to be quoted in the official list. The committee have appointed Oct. 10 as special settling day in Matale Ceylon Rubber Co.'s 15,000 shares of £1 each, fully paid, Nos. 15,001 to 30,000; Platinum Corporation's 59,255 ordinary shares of £1 each, 10s. paid, Nos. 1 to 59,255, and 36,244 deferred shares of 1s. each, fully paid, Nos. 1 to 36,244; and Sungei Salak Rubber Co.'s 41,000 shares of £1 each, 10s. paid, Nos. 14,001 to 55,000; and Willans and Robinson's funding certificates for £34,999. 13s. The committee have also ordered American Telephone and Telegraph Co.'s 131,551 400dol. capital stock in shares of 100dol. each to be quoted in the official list.

Lowestoft.—At the last Council meeting the Electric Lighting Committee reported that there are now connected to the mains 797 consumers, representing 38,942 8 c.p. lamps. Since the last meeting 13 consumers, representing 512 8 c.p. lamps, have been connected. This represents an increase of 107 new consumers in 11 months. The engineer submitted a report as to the supply of Oulton Broad with electricity, and the committee approved same to be submitted to the Oulton Broad Urban District Council, and afterwards to a joint meeting of the sub-committee (appointed by the Town Council) and of the Oulton Broad Urban District Council for its consideration. The question of the further street-lighting by electricity (referred by the General Purposes Committee to this committee) was considered, and the engineer reported the streets in which mains are now laid. He was directed to place four lamps in Regent-road experimentally, and report further on the matter at the next meeting. The town clerk reported that the Local Government Board had sanctioned the borrowing by the Council of the following sums: £6,250, new feeder to Kirkley, new feeder to Old Nelson-street, distributor to Kirkley, short feeder to Bridge, oil filter to be repaid in 20 years; £5,000, services and distributors (20 years); £1,500, meters (five years); £1,200, public lighting (10 years); £3,000, motors (10 years). With reference to free wiring, the Board have this matter under consideration and will address a further communication to the Council at an early date. The electrical engineer submitted plans of streets in which electric mains are now laid, and reported on lighting those streets by electricity, and it was resolved to request the Electric Lighting Committee to submit a scheme and estimate for the lighting of those streets, and also for the lighting of the whole borough.

Liverpool and District Electrical Association.—The members paid a visit to the Widnes and Runcorn Transporter Bridge on Saturday. The party were met on arrival by Mr. John Henderson, the general manager. An inspection was first made of the generating station, after which the party proceeded for a detailed round of examination of the construction of the bridge proper, ascending into the towers, and also on to the girders. A trip was then made across the river and back by the transporter car, when it was apparent to all how well the car was under control. The car is capable of carrying at one time four two-horse loaded wagons and 300 passengers, and the

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platform is suspended from the girders by a trolley driven by two electric motors of about 35 b.h.p. The best thanks of the association and wishes for the prosperity of the bridge were conveyed to Mr. Henderson by the hon. secretary and treasurer, Mr. Samuel Frith, of Bootle.

Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board.—At a meeting of the Generating Station Committee the commercial manager submitted wages sheets for the preceding four weeks showing that the wages paid by this committee during that period amounted to £330. 15s. 3d. It was resolved that the application from the manager of the Stalybridge Theatre be left in the hands of the chairman and engineer with power to act, and that a sub-committee be appointed to consider and report as to the extensions required for the Ray Mill and the question of further borrowing powers. The clerk read a letter from the Local Government Board enclosing sanction to the borrowing of a further sum of £3,908 for electricity purposes, and it was resolved that the commercial manager be instructed to communicate with the Local Government Board with a view to obtaining an extension of the period for the repayment of the loan.

Hull.—At a meeting of the Hull Electric Light Committee it was stated that in response to the usual advertisements for a supply of coal only three offers had been received, and these showed an advance of nearly 50 per cent. on the old contract. At the request of the Local Government Board, the electrical engineer had prepared an estimate of the requirements of the committee for the next three years. These he placed at £31,200, and application for sanction to borrow that amount will be made. In order to bring their pay up to 6d. per hour, three men employed at the generating station were given an advance of 6d. per week. The engineer reported that on Sunday, Aug. 25, a short-circuit occurred on the old Callender-Webber distributor cable on the south side of Prospect-street. That short-circuit caused an accumulation of gas, which eventually lighted and completely burned the main out at that part. As the main had been laid about 14 years, and did not embody those principles which tended to give the greatest freedom from difficulties, he had it relaid with lead-covered armoured cable extending direct into the earth. Owing to its defective condition, he had also renewed in a similar manner the piece of distributor on the east side of Savile-street extending from New Cross-street to Dock-street.

Marconi Stations.—The arrangements for the wireless telegraph service between Great Britain and Canada are being pushed forward with all possible dispatch, and it is expected, according to Mr. Marconi, that the first messages will be sent on Oct. 14, as already announced. Time was when about £1 a word was charged for cabling between London and New York. The price has been gradually reduced to 1s. a word, and it is said that a smaller charge than this would involve a loss, as there are about 16 cables across the Atlantic, each one of which costs about a million pounds, upon which interest has to be paid. The Marconi wireless stations will, it is claimed, get all the traffic they need at a cost of £110,000 against the million-pound cable. The consequence is that the new service will be much cheaper—5d. per word for ordinary messages and 2½d. for Press work for a start. A greater speed is also claimed for wireless telegrams. During the past 10 years there has been no appreciable increase in speed in the cable messages. Physical laws indicate the impossibility of increased speed without increased thickness, hence the outlay of large sums of money. There is no physical law of this kind, at all events, to consider with the Marconigrams. The fastest reading instrument is a "sounder." If a "recorder" can be used the speed will be instantly increased.

Worcester.—At the last meeting of the Worcester Chamber of Commerce the secretary stated that a letter had been received from the London Chamber asking the local chamber to support a protest against the regulations of the Home Office respecting electricity generating plant. The protest pointed out that electric plant in factories was under the Board of Trade regulations, and it was quite unnecessary to have more stringent regulations. The secretary said he had made inquiries of local manufacturers, and they did not seem to object, because they were already subject to the Board of Trade regulations, which were very exhaustive. Mr. Seaman (of Messrs Hoenan and Froude's) said there was nothing in the regulations to object to, but they brought into the factory an inspector who was an unskilled electrician. Already factories had to meet the fire offices and the Board of Trade, and then they very often had their own special regulations. Another separate set of regulations was unnecessary, especially as electricity was yet in its infancy, and the regulations might interfere with the experimental work which was essential if, as traders, they were to hold their own. The factory inspector would take quite a different view from that of the Board of Trade and the fire offices, and there would arise a very serious difficulty in the electrical industry in the future, although the regulations were not in themselves objectionable. He would like the chamber to support the protest. Mr. Southall said the main objection seemed to be that there were two different authorities when one competent inspector ought to be able to see that everything was right. On the motion of Mr. Abell, seconded by Mr. Harris, it was resolved to upport the protest of London.

PROVISIONAL PATENTS, 1907.

SEPT. 30.

21619. Improvements in apparatus for supplying sand to the tracks of railways in front of the driving wheels, and especially those of electric cars. David Book Keeports, 18, Fulham-place, Paddington, London.

21623. Improvements in electric striking mechanism for timepieces. Max Moeller, Thanet House, Temple Bar, London. (Complete specification.)

21644. Improvements in vacuum cleaning machines driven by electrical or other power, which can also be worked by hand or foot, in part applicable to other purposes. Charles Vernon Boys, 66, Victoria-street, Westminster.

21646. Improvements in storage batteries. Joseph C. Cook and Edward Sokal, Birkbeck Bank-chambers, Southampton-buildings, London. (Complete specification.)

21651. Improvements in receivers for wireless telegraphy. Marconi's Wireless Telegraph Company, Limited, and Arthur Millar Young, 24, Southampton-buildings, London.

21670. Improvements in and relating to the control of electric motors. Allgemeine Elektricitäts-Gesellschaft, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Oct. 1, 1906, being date of application in Germany.) (Complete specification.)

OCT. 1.

21699. Improvements in or relating to magnetos and connections therefor in explosion engines. Edouard Denieport, 111, Hatton-garden, London. (Complete specification.)

21702. Improved ready means for insulating. William Vincent Solomon, Billiter House, Billiter-street, London.

21741. Improvements in apparatus for regulating the supply of gas or electricity for heating purposes. Viggo Valdemar Julius Andresen, 4, South-street, Finsbury, London.

OCT. 2.

21761. Improvements in electromagnetic sparking plugs, and means for distributing the operating electric current thereto. Samuel Griffin, Kingston Ironworks, Bath.

21773. Improvements in or relating to storage batteries. Stanley James Watson and George Herbert Smith, 306, High Holborn, London.

21802. Luminous substitutional resistance for arc lamps or other forms of electric lamps. Aubrey Fletcher and Frederic Fletcher, 36, Lavender-grove, Dalston, London.

21811. Improvements in speed-limiting devices for electric motors. Benrather Maschinenfabrik Actien-Gesellschaft, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Oct. 3, 1906, being date of application in Germany.) (Complete specification.)

OCT. 3.

21827. Improvements in and relating to single-phase alternating-current commutator motors. Marius C. A. Latour, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Oct. 3, 1906, being date of application in France.) (Complete specification.)

21834. Improvements in electrolytic processes and appliances. William George Heys, 51, Deansgate-arcade, Manchester. (Hans Sierau, Germany.)

21842. Adjustable electric lamp-shade holder. Ernest George Samuel Kellond, 49, Fairfax-road, South Hampstead. (Complete specification.)

21860. Improved method of insulating transformers and other electric apparatus. Siemens Bros. Dynamo Works, Limited, Queen Anne's-chambers, Broadway, Westminster. (Siemens-Schuckertwerke, G. m. b. H., Germany.) (Complete specification.)

21861. New or improved electric switchboard cable connector. Sandor Rosenbaum, 55, Market-street, Manchester. (Date applied for under Patents Act, 1901, Oct. 3, 1906, being date of application in Germany.) (Complete specification.)

21862. Armature for magneto-electric igniting apparatuses. Rudolf Rickmann, 70, Chancery-lane, London. (Complete specification.)

21885. Improvements in making electric accumulators. Max Clemens Richard Liebmann, 1, Great James-street, Bedford-row, London.

OCT. 4.

21904. Improvements in automatic electric circuit breakers. August Eckstein, Arthur Cecil Heap, and David Barclay Mellis, Waverley Mill, St. Simon-street, Salford.

21911. Improved compounds for electric insulation, varnishes, paints, and the like. Joseph Theodor Szek and Céleste Joly, 53, Chancery-lane, London.

21928. Improved globe or shade holder for inverted incandescent and other gas lights, and for electric lights. Henry Gething Richardson, 128, Colmore-row, Birmingham.

21937. Improvements in electrically-propelled vehicles. Karl Paul Hermen Richter and Edward Francis Thefs, 88, Chancery-lane, London.

21938. Improvements relating to electrical switches. David King Morris and George Anslow Lister, 18, Southampton-buildings, London.

21950. Improvements in telegraphic code appliance. William Charles Dotesio and George Henry Powell, 55, Chancery-lane, London.

OCT. 5.

21982. Improvements in trolley heads. Jesse Carr Drewet, 7, Havelock-street, City Auckland, New Zealand. (Complete specification.)

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21966. Improved adjustable holder for telephones. James John Chiswell, 85, Mortimer-road, Willesden, London.

21984. Improvements relating to telephone receivers and transmitters. John Garner Douglas, 9, Tempest Hey, Liverpool.

22000. Improvements in or relating to electric cranes and other electric hoists. Henry Pieper, 24, Temple-row, Birmingham. ((Date applied for under Patents Act, 1901, Oct. 6, 1906, being date of application in Belgium.) (Complete specification.)

22035. Improved vapour incandescence lamps. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, London. (Washington Licht Ges., Germany.) (Complete specification.)

22036. Improved process of and means for manufacturing filaments for illuminating and heating purposes. William Edward Lake, 7, Southampton-buildings, London. (Georges Michaud and Eugene Delasson, France. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Oct. 24.)

1906.

14804. Telephonic exchange switchboards. Graham.

19398. Refractory conductors for use in electric lamps, furnaces, or other apparatus. British Thomson-Houston Company. (General Electric Company.)

21290. Insulating composition for use as a filling material within troughs and other conduits containing electric cables. Johnson and Titley.

21505. Manufacture of electric conductors of refractory metal, applicable more especially for use as incandescing bodies in electric lamps and other apparatus. British Thomson-Houston Company. (General Electric Company.)

21509. Manufacture of electric conductors of refractory metals. British Thomson-Houston Company. (General Electric Company.)

21510. Electrodes for electric arc lamps, and methods of making the same. British Thomson-Houston Company. (General Electric Company.)

21604. Fittings for electrical conduits. Brooks and Read.

21623. Receiving devices for electric telegraphs. Kitsee.

21872. Telephonic store service and credit-checking apparatus. National Cash Register Company. (National Cash Register Company.)

22113. Party-line telephone systems. Select Telephone Manufacturing Company and Bruce.

22217. Electric motor controlling apparatus. Krizik.

22944. Contact-breaking appliances used in electric ignition apparatus of internal-combustion motors. Austin Motor Company and Austin.

24727. Electric bells. Bevis and Mitchell.

26663. Terminal connections for electric conductors. Osmond.

1907.

453. Controllers for the trolley poles of electric cars. Edwards.

640. Liquid electrical controllers. Richardson, Cooke, and South Durham Steel and Iron Company.

2551. Arrangement for indicating and recording permanently the maximum demand for electrical energy on any circuit. Lackie and Steele.

4499. Troughing or conduit for underground electrical conductors. Dussek and Dussek.

7815. Method for producing undamped electric oscillations by means of the flame arc produced by electric arc lamps or the like. Thompson. (Ges. für drahtlose Telegraphie.)

9726. Wireless telegraphy. Murgas.

10136. Interrupter for magneto-electric ignition apparatus. Unterberg and Helmle. (Date applied for under International Convention, Aug. 11, 1906.)

10514. Electrical contacts. Robertson and Klatzl.

10537. Telephone transmitters. Houghton.

10709. Electromagnetic brakes for railway and other vehicles. Braun. (Date applied for under International Convention, May 18, 1906.)

11952. Electrical fuse. Charters and Jones.

12053. Ventilating dynamo-electric generators, motors, and the like. Siemens-Schuckertwerke Ges. (Date applied for under International Convention, May 31, 1906.)

14756. Secondary batteries. Ziegenberg. (Date applied for under International Convention, Aug. 10, 1906.)

14762. Secondary batteries. Ziegenberg. (Date applied for under International Convention, Aug. 11, 1906.)

15551. Electricity meters for use with alternating currents. Haddan. (Bergmann Elektricitätswerke Akt.-Ges.)

16529. Alternating-current electric motors of the commutator type. Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, July 19, 1906.)

18227. Holders for electric incandescent lamps. Davis.

COMPANIES' STOCK AND SHARE LIST.

Name	Amount paid.		Last price.
Commercial and Industrial.	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	–	¼-⅝
—— Ord., 1 125,000	1	..	¼-½
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	5/32-9/32
British Aluminium Co., Ordinary, 2,001-40,000	5	..	4-5
—— 7 per cent. Cum. Pref., 1-40,000	5	..	4⅞-5⅛
—— "A" 6 per cent. Cum. Pref., 1-20,000	5	..	4¼-5
—— 4 per cent. Funding Certificates, 1-20,000	5	..	3⅞-4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	100-103
—— 5½ per cent. Loch Leven Deb (Reg.), Red., 1-3,000	100	..	98-99
British Insulated and Helsby Cables, Ord., 1-100,000	5	–	6¼-7
—— 6 per cent. Cum. Pref., 1-100,000	5	–	5⅞-6¼
—— 4½ per cent. Mortgage Debentures	100	–	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	–	85 89
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	3	–	1-1¼
—— 4 per cent. Mortgage Debenture Stock	100	–	62 67
Brush Electrical Engineering, Ordinary, Nos. 1-106,751	2	–	¼-⅜
—— Non. Cum., 6 per cent. Pref.	2	–	⅝-1¼
—— 4½ per cent. 1st Debenture Stock	100	–	85-86
—— 4½ per cent. 2nd Debenture Stock	100	–	67-70
Callender's Cable, Debentures	100	–	105½-107½
—— Ordinary	5	–	9¾-10¾
—— 5 per cent. Pref.	5	–	5¼-5⅝
Consolidated Electrical Co., Ordinary, 1-110,000	1	..	7/16-9/16
Crompton and Co.	5	..	1⅞-2
—— 5 per cent. Debentures	100	–	96-99
Dick, Kerr, and Co., Ordinary, 1 250,000	1	..	1¼-1⅝ xd
—— 6 per cent. Cum. Pref., 1-305,000	1	..	1-1¼ xd
—— 4½ per cent. Debenture Stock, Red.	100	..	101-104
Edison and Swan United, "A" Shares, 1-99,261	5	–1	1/16-1 5/16
—— "A" Shares, 01-017,139	5	–	2¼-2⅜
—— 5 per cent. Debentures	100	–	83-92
—— 4 per cent. Deb. Stock, Red.	100	–	83-85
Electric Construction, Nos. 1 to 112,100	2	–	⅛-⅜
—— 7 per cent. Cumulative Pref.	2	–	¾-1
—— 4 per cent. Perp. 1st Mort Deb.	100	–	77-81
Electrolytic Alkali Co., Ordinary, 1-202,218	1	..	3/16-5/16
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	–	—
General Electric Company (1900), 5 per cent. Cum. Pref.	10	–	8 8¼
—— 4 per cent. 1st Mort. Deb. Stock	100	–	80-85
W. T. Henley's Telegraph Works, Ordinary	5	–	11-12
—— 4½ per cent. Preference	5	–	5-5¼
—— 4½ per cent. Debentures	100	–	105½ 107½
India Rubber, Gutta Percha, and Telegraph Works	10	–	14½ 15¼
—— 4 per cent. Debentures	100	–	95-97
National Electric Construction Co., 1-170,000	1	..	13/16-15/16
Parker, Thos., Limited, Ordinary	10	–	10-10½
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5	..	—
Telegraph Construction and Maintenance	12	–	30½-32½
—— 5 per cent Bonds	10	–	99½ 02½
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	..	8½-9½

Electric Lighting and Supply.—

Name.	Amount paid.		Last price.
	£		£
Adelaide Electric Supply Co., 6 p. c. Cum. Pref., 1-10,000	5	..	4¼-5
Bournemouth and Poole, Ordinary	10	–	9¾-10¾
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	–	9¾ 10¼
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	–	9¾-10¼
—— 4½ per cent. Debenture Stock, Red.	100	–	99-102
Bromley (Kent) Electric Light and Power Co.	5	–	4⅝ 5¼ xd
—— 4½ per cent. 1st Debenture Stock, Red.	100	–	98-100
Brompton and Kensington, Ordinary	5	–	7½ 8
—— 7 per cent. Preference	5	–	7⅛-7⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	–	6¼ 7⅛
—— Nos. 80,001-100,000	4	–	6¼ 7¼
Cambridge Electric Supply Company, £10 Ord.	8	–	12¼-13¼
Canadian General Electric Co., Common Shares	$100	..	108-112 xd
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	–	99 102
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	–	3⅝ 4¼
—— 4½ per cent. Cum. Pref., 1-80,000	5	–	3⅝ 3¾
—— 4 per cent. Debenture Stock, Red.	100	–	96 99
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	–	3⅝ 3¾
—— ditto (1905) 40,001-80,000	5	–	3¼-4¼
Chelsea Electricity Supply	5	–	5¼ 6¼
—— 4½ per cent. Debentures	100	–	102-105
Chicago Edison Co, 1st Mt. 5 p. c. 30-yr. Gld. Bds., Red., 1-1,200	$1000	..	96-99
City of London, Ordinary	10	–	9-10
—— 6 per cent. Cumulative Pref.	10	–	10½-11¼
—— 5 per cent. Debenture Stock	100	–	122-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	–	97-100
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1,633	50	–	50-53
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100	..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5	..	4¼-5
—— 5 per cent. Preference, 1-50,000	5	..	4¼-5
County of London Electric Supply, Ordinary	10	–	6¾-7¾
—— 6 per cent. Cum. Pref.	10	–	10-11
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	–	106-109
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	–	96-99
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5	–	¼-1
—— 6 per cent. Cum. Pref.	5	–	1¼-2
—— 4½ per cent. First Mort. Deb	100	–	76-81
Electrical Development Co. of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, '0,751-15,75)	—	..	75½-77½ p.c.
Electric Lt. & Traction Co of Aust., 6 p c Cm Pf., 1 30,000	5	–	2¼ 2⅝
5 per cent Debenture Stock Red	100	–	85½ 89½
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red.	100	–	94-96
Folkestone Electric Supply, Ord. Nos. 1-10,000	5	–	4¾-5¼ xd
—— 4½ per cent. First Deb. Stock, Red.	100	–	96-99
Hove Electric Lighting, Ord., 1-13,000	5	–	6¾-7¼
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100	..	101-104
Isle of Wight Elec Lt. and Pwr., 4½ p.c. Db. Stk. Red.	100	–	94-97
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	–	—
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5	–	8¼-9¼
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	–	93-102
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9¾-10¼
London Electric, Ordinary	3	–	11-12
—— 6 per cent. Pref.	5	–	4¼-4¾
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	–	89-93

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Name.	Amount paid.		Last price
	£		£
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock., Red. (Prov. Certs.), all paid	100	–	94-97
Metropolitan Ordinary, 100,001-300,000	5	–	5¼ 5¾
—— – 4½ per cent. First Mortgage Debenture Stock	100	–	103-107
—— – 4½ per cent. Cum. Pref.	5	–	4⅝ 5¼
—— – 5½ per cent. Mortgage Debenture, Red.	100	–	87-92
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds. 1935, C 1-1,000 ($500), D 1-5,000 ($500), M 1-4,400 ($1,000	–	..	72-74 p.c.
Mexican Light and Power Co., Capital Stock	$100	..	46-48
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 $500), 4,001-14,000 ($1,000)	–	..	81½-83½
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	–	–	96-98
Newcastle upon-Tyne Electric Supply, Ordinary, 1-57,000	5	–	6¼ 6⅜
—— do. 57,001-75,000	5	–	6¼-6⅜
—— do. 75,001-87,500 (issued at 22½ prem., 16s. paid)	5	–	6¼-6⅜
—— 5 per cent. Pref., 1-57,000	5	–	5 5⅛
—— do., 75,001-87,500 (issued at 10s. prem., 4s. paid)	5	..	5-5⅛
Notting Hill Electric Lighting	10	–	11 12
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	–	96 97
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	–	5¼ 6
—— 4 per cent. Debenture Stock	100	–	95 97
River Plate Electricity Co., Ord., 1-119,687 & 120,501-120,507	1	..	½-¾
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	..	¼-1
—— 5 per cent. Debenture Stock, Red	100	..	95-98
Rosario Electric Co., 6 per cent. Cum. Pref., 1-20,000	5	..	4¼-5¼ xd
—— 6 per cent. Cum. 2nd Pref., 1-15,000	5	..	4¼-5¼ xd
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	100	–	96 98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	–	..	99-101 p.c.
Smithfield Markets Electric Supply, Ord. 1-12,000	5	–	½-1½
—— – 4 per cent. Debenture Stock	100	–	71-75
South London, Ordinary	5	–	1¾ 2⅜
South Metropolitan Electric Light and Power, Ord.	1	–	½ ¾
—— – 7 per cent. Cum. Pref.	1	–	1-1½
—— – 4½ per cent. 1st Mort. Deb.	100	–	99-101⅝ xd
St. James's and Pall Mall, Ordinary, 101-20,080	5	–	7¼ 8¼
—— – 7 per cent. Pref.	5	–	6⅞ 7⅜
—— – 3½ per cent. Deb.	100	–	86 91
Urban Electric Supply Co., Ordinary, 8-30-007	5	–	1⅜ 2¼ xd
—— – 5 per cent. Cumulative Preference, 50,001-80,000	5	–	1⅛ 2¼ xd
Westminster, Ordinary	5	–	8¼ 9½
—— – 4½ per cent. Cum. Pref., 110,101-138,251	5	–	4¼-4⅜

Electric Tramways.—

Name.	Amount paid.		Last price.
	£		£
Anglo-Argentine, 5½ per cent. Cum. Pref., 1-260,007	5	–	5 15/16-6 3/16
—— Ord.	5	–	7⅜ 8 xd
—— Permanent 6 per cent. Debenture Stock, 1888	100	–	131-134
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	–	102-105
Barcelona Tramways, Ord., 1-20,000	10	–	—
—— – 6 per cent. Cum. Pref. Shares, 1-10,000	10	–	—
—— – 5 per cent. Deb., Red., 1-600	100	–	—
—— – 4½ per cent. Red. Deb. Stock	100	–	—
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606.	1	–	11/16 13/16
—— – 5 per cent. Cum. Pref. Shares, 1-59,394	1	–	¼-1
Birmingham and Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100	..	91-93 xd
Blackpool and Fleetwood Tramroad	10	–	13⅜-13⅝
Bombay Elec. Supply & Trams. Co., 6 per cent. Cum. Pref.	8	..	7½-8
—— 4½ per cent. Deb. Stock, Red.	100	..	94-96
Ibbane Tramway Invest., Ord., 1-75,000	5	–	3 5/16-3 9/16
—— – 5 per cent. Cum. Pref., Nos. 1-75,000	5	–	4¼-5⅛
—— – 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	–	96-100
British Columbia Electric Railway Co., Ord. Def.	100	–	130-135
—— – Ord. Pref.	100	–	113-117
—— – 5 per cent. Cum. Perpetual Pref. Stock	100	–	104-107
—— – 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	–	100-103
—— – 4½ per cent. Vancouver Power Deb.	100	–	102-104
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	–	1¾-2¼
—— – 6 per cent. Cm. Pf., 30,001-60,000	10	–	5½ 6
—— – 5 per cent. Perpetual Debenture Stock	100	–	97-100 xd
—— – 4½ per cent. 2nd Deb. Stock	100	–	78-81
Bueno Ayres and Belgrano Trams.	6	–	4 7/16 4 11/16
—— – "A" 5 per cent. Cm. Pf., 1-40,000	5	–	4⅜-4½ xd
—— – "B" 5 per cent. Cm. Pf., 1-27,500	5	–	4⅜ 4½ xd
—— – 5 per cent. Deb. Stock, Red.	100	–	105-115
—— – Prov. Cert., all paid	100	–	102 105
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100	–	92-97
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb. Bonds, Red., 1-1,500	100	..	99-103
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	..	98-103 xd
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	91-94
Calcutta Tramways, 1-105,000	5	–	7-7½
—— 105,001-157,610	5	–	5-5½
—— – 4½ per cent. 1st Deb. Stock, Red.	100	–	102-106
Cape Electric Tramways, Nos. 1-480,000	1	–	¼ ⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	–	4¼ 4⅜
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100	–	98 101
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	..	5¼-5⅜
—— 4 per cent. Deb. Stock, Red. 1985	100	..	98 102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	00	–	94-98
Cork Electric Tramway and Lighting Co., Ordinary	10	–	13-14
—— – 6 per cent. Cum. Pref.	10	–	12¾-13¾
—— – 4 per cent. Debentures	100	–	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	–	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	–	12¾-13¾
—— – 3½ per cent. Mort. Debs., 1-3,000 Red.	100	–	90-95
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100	..	97-100 xd
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6,957	$1,000	–	82-87
Imperial Tramways, Ordinary	all	–	18-19
—— 6 per cent. Cum. Pref.	all	–	14-14½
—— 4½ per cent. Deb. Stock	100	–	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c Cum. Pref., Nos. 30,001-60,000	5	–	⅞ 1⅛
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	–	66-71
Kalgoorlie Electric Tramways, 1-250,000	1	..	5/32-5/32
—— 5 per cent. "A" Deb. Stock	100	..	89-93
—— 6 per cent. "B" Deb. Stock	100	..	77-81
Kidderminster and District Lighting and Traction, Pref.	5	–	10 10½
Lancashire United Tramways Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	–	94-97
—— £236,500 2nd Mort. Deb. Stock	–	–	—
—— £33,330 Deferred Deb. Stock (all fully paid)	–	–	—
Lisbon Electric Tramways Limited, Ord., Nos 1-594,188	1	..	1-1¼
—— 6 per cent. Cum. Pref., Nos. 1-425,553	1	–	1-1¼
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100	..	92-97
London United Trys. (1901), 5 per cent. Cum. Pref.	10	–	7⅜ 8⅜
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	–	82 86
Madras Elec. Trams. (1904) 5 per cent. Deb. Stk., Rd.	100	–	96-9

Name.	Amount paid.		Last price
	£		£
Manila Elec. R.R. and Ltg. Corp., 5 p.c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1, 00	–	90-92
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 23,436-25,000	..	..	4¼-5 xd
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	96-99 xd
Metropolitan Elec. Trams., Defd., 1,000,001-1 314,016	1	–	1/16 3/16
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	–	27/32-29/32
—— 4½ per cent. Deb. Stock, Red.	100	–	94-97
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	–	..	79-81 p.c.
Milwaukee Electric Rail and Light, 5 per cent. 20-yr Con Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	–	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 001-2,000	100	–	101-103
New General Traction, 6 per cent. Cum. Pref., 1-10,000. 34,001-74,000	5	–	¾-1⅛
Oldham, Ashton, and Hyde Tramway, Ordinary	10	–	2
—— 6 per cent. Cum. Pref.	10	–	8⅜-9
Perth Elec. Tramways (W. Aus.), 5 per cent. 1 Mrt. Deb. Stk.	100	–	101-105
Potteries Electric Traction, Ordinary, 1-245,000	1	–	¼-½
—— 5 per cent. Cum. Pref., 300,001-545,000	1	–	¼-½
—— 4½ per cent. Debenture Stock	100	–	95-98
Provincial Tramways Co., Ordinary, 1-28,912	10	..	4⅜-5⅛
—— 6 per cent. Cum. Pref., 1-10,000	10	..	10¼-11¼
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-30,000	5	..	5¼-5⅜
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	97-99
Sao Paulo Tramway, Light, and Power Co.	$100	..	108-113 xd
—— 5 per cent. 1st Mort. Deb., Red. 1929, 1-11,000	$500	..	93-95 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1	..	¼-1
—— 4 per cent. Deb. Stock, Red. 1940	100	..	80-84
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs., Red., 1-1,600	100	..	84-88
Yorkshire (West Riding) Elec. Tram. Co., Ord., 70,001-110,000	5	..	1-1¼
—— 6 per cent. Cum. Pref., 1-46,261	5	..	3¼-3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	87-90

Electric Railways.—

Name	Amount paid.		Last price
	£		£
Central London, Ordinary	100	–	153-155
—— 4 per cent. Pref.	100	–	88-90
—— " " deferred	100	–	45-48
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	–	102-105
City and South London, Consolidated Ordinary	100	...	45-47
—— 4 per cent. Debenture Stock	100	..	102-105
—— 5 per cent. Pref. Stock '91	100	..	116-119
—— " " " '96	100	..	113-116
—— " " " '01	100	..	113-116
—— " " " '03	100	..	108-111
Liverpool Overhead, 5 per cent. Pref.	10	–	10-10¼
—— Ordinary, 1-50,000	10	–	3¾-4¼
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	–	–	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	–	...	55-58

Telegraphs and Telephones.—

Name.	Amount paid.		Last price.
	£		£
Amazon Telegraph Co., 1-25,000	10	–	3-3¼
—— 5 per cent. Debs., Red., within 1-1,069	100	–	85-88
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000	$1,000	..	90-92
Anglo-American Telegraph Co., Ordinary	100	..	54-57
—— 6 per cent. Preferred Ordinary	100	...	97-100
—— Deferred Ordinary	100	...	15¼-16
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100	...	99-102
Chili Telephone Co., 1-44,000	5	...	6¾-7¼
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100	...	90-92 xd
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	...	6¼-7¼
—— 10 per cent. Preference, 1-6,000	10	...	15¾-16¾
Direct Spanish Telegraph Co., Ordinary	5	...	3¼-3½ xd
—— 10 per cent. Cum Preference	5	...	9-9¼
—— 4½ per cent. Debs., 1-600	50	...	98-101
Direct United States Cable Co.	20	...	12¼-13¼
Direct West India Cable Co., 4½ per cent. Debs., Reg. within 1-1,200, Red.	100	...	100-102
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100	...	97½-100½
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8,000, 1913	25	...	100-102
Eastern Extension, Australasia and China, 1-300,000	10	...	11¾-12¾
—— 4 per cent. Mort. Deb. Stock, Perp.	100	...	100-103
Eastern Telegraph Co., Ordinary Stock	100	...	130-135
—— 3½ per cent. Preference Stock	100	...	85-88
—— 4 per cent. Mortgage Debenture Stock	100	...	100-103
Great Northern Telegraph Co. (of Copenhagen)	10	...	34-36
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1,200, Red.	100	...	100-102
Indo-European Telegraph Co.	25	...	55-57
Marconi's Wireless Telegraph Co., 1-256,127	1	...	13/16-1 1/16
—— 256,128-384,190	1	...	¾-1
Monte Video Telephone Co., Ordinary, 1-72,680	1	..	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492		...	¾-1
National Telephone, Preferred	100	...	106-108
—— Deferred Stock	100	–	106-108
—— 6 per cent. Cum. First Pref.	10	–	10¼-12¼
—— 6 per cent. Cum. Second Pref.	10	–	10-12
—— 5 per cent. Non. Cum. Third Pref.	5	–	5¼-5⅝
—— 3½ per cent. Deb. Stock, Red.	100	–	86-88
—— 4 per cent Deb. Stock, Red.	100	–	101-103
Oriental Telephone and Electric Company	1	..	1¼-1⅜
—— 6 per cent. Cum. Pref.	1	..	1 3/16 1 5/16
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100	...	97-100
United River Plate Tele. Co., Ordinary, 1-100,000	5	...	7-8
—— 5 per cent. Cum. Pref., 1-40,000	5	...	5-5¼
—— 5 per cent. Debenture Stock, Red.	100	...	—
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	...	98-101
West African Telegraph Co.	10	...	10-10¼
West Coast of America, 1-30,000 and 53,001-53,008	2½	...	1¼-1⅜
—— 4 p.c. Debs., 1-1,500, Gua. by Western Telegraph	100	...	97-100
West India and Panama Telegraph Co., Ordinary	10	...	7/16 9/16
—— 6 per cent. Cum 1st Preference	10	...	7¼-7⅜
—— 6 per cent. Cum. 2nd Preference	10	...	6¼-7¼
—— 5 per cent. Debs., Red., 1-800	100	...	99-102
Western Telegraph Co., 1-207,930	10	...	12¼-13¼
—— 4 per cent. Debenture Stock, Red.	100	...	100-103

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.							Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1907.	1906.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Oct 2	1,411	2,104	- 693	- 1,665h	25½	25	May 31	64,071	15,530,351	1,379,723	0 98	11·14	2,512	6·45
Ayr Corporation	,, 5	323	228	+ 95	—	8	8	,, 15	14,328	3,316,380	353,945	1	9·71	1,830	5·16
Baker Street and Waterloo Ry.	,, 5	2 516	1,645	+ 870	+12,495	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 6	1,113	1,117	- 4	- 433	3 53	3·53	March 31	55,025	11,145,531	1,309,903	1·18	10·08	2,338b	6·03
Birmingham Corporation	,, 5	5 301	—	—	—	56½	—	,, 31	17,133	4,709,798	266,526	86	14·5	8,866	—
Blackburn Corporation	Sept. 25	1,213	1,067	+ 146	+ 1,750	24	24	,, 25	48,875	8,661,720	986,953	1·35	11·89	2,036	7·44
Blackpool Corporation	Oct 3	1 423	1,228	+ 197	- 1,685	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	,, 3	784	744	+ 40	- 1,1.4	16½	16½	Dec. 31	31,846	2,325,677	579,264	3·28	13 19	—	7·27
Bolton Corporation	,, 5	2,276	2,145	+ 131	+ 633	42	40	March 31	95 766	20,205 196	2,161,130	1·13	10 63	2,394	6·14
Bournemouth Corporation	,, 2	1,713	1,675	+ 38	+ 9·9	17·41	16·82	,, 31	55,276	10,058,288	1,121,623	1·32	11 83	3,226	7·19
Bradford Corporation	,, 5	4,787	4,561	+ 226	+ 1,614	95	95	,, 31	230,085	47,108,000	5,053,392	1 172	10 927	2,396	—
Brighton Corporation	,, 6	923	987	- 64	- 2,747	9½	9½	,, 31	50,339	11,321,160	1,152,828	1 06	10·48	,914·8	8·0.4
Bristol Tramway Company	,, 4	5 237	5,247	- 110	—	51½	51½	Dec. 31	259,799	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	,, 5	1,378	1 372	+ 6	—	40	40	March 31	57,992	11,092,704	1,197,772	1·31	11 61	5,388	8 17
Burton Corporation	,, 6	316	312	- 25	- 393	8½	8½	,, 31	17,950	3,878,269	454,082	·07	9·21	2,0 8	6·76
Cardiff Corporation	—	—	—	—	—	32 62	†32·26	,, 31	112,209	24,134,363	2,770,049	1·12	9·72	3,782	9·44
Carlisle Tramways Company	Sept. 7	193	239	- 36	- 505	8·5	8·5	Dec. 31	10 713	2,935 002	359,756	—	7 14	—	5.18
Central London Railway	Oct 5	5,312	6,326	-1,014	-10,597	6	6	,, 31	347,588	4,875,547	1,261,214	1 86	65·10	57,931	35·80
Charing X, Euston, & Hamp. Ry.	,, 5	2,640	—	—	—	8	—	—	—	—	—	—	—	—	
City and South London Railway.	,, 6	3,001	2 641	+ 360	+ 7,076	6¼	6¼	,, 31	—	—	—	—	—		—
Colchester Corporation	,, 2	240	233	+ 7	—	8	8	March 31	10,588	2 457,653	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	,, 3	529	507	+ 22	- 7·6	15½	15½	Dec 31	24,895	5,814,376	882,256	1·01	6·64	—	4·68
Croydon Corporation	,, 4	1,503	—	—	—	14 c	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 4	271	272	- 1	- 15	7 23	7·23	March 31	—	—	—	·94			
Dover Corporation	,, 5	244	257	- 13	- 934	4½	4½	,, 31	11,250	2 853,200	284,343		9·49	2,500	
Dublin and Lucan Electric Ry.	,, 4	138	125	+ 13	+ 173h	6½	6½	Dec 31	6 358	402,611	110,738	3 79	13·78	942	7 33
Dublin U.T.	,, 4	6.761	5,188	+1.573	+24 279	48½	48½	,, 31	267,489	50,050,949	7,077,372	1·18	9·07	691	5 55
Dundee City Tramways	,, 2	1,180	1,167	+ 13	+ 484	22	22	May 15	50,154	13 086 396	1,005 911	·906	1·96	2,180	7·42
East Ham Corporation	,, 5	944	935	+ 9	- 268	14	14	March 31	56,652	3,689,658	863,816	64	·0 18	2,994	6 79
Glasgow Corporation	,, 5	19,689	17,851	+1,838	+ 6,375h	79½	79½	May 31	756,480	195,767,519	17,946 595	—	0 12		—
Gloucester Corporation	July 10	278	304	- 26	—	15	15	March 31	15,465	3,902,077	563,595	·10	6·68	959	5·32
G.N., Piccadilly, and Brompton.	Oct. 5	4 340	—	—	—	9	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	37	37	,, 31	74 019	17,849,642	1,540 707	—	1·53	2,085	8·56
Huddersfield Corporation	,, 5	1 557	1,580	- 23	+ 1,985	35	35	,, 31	69,938	12 838,150	1 665,262	1·24	9 71	1,923	—
Hull Corporation	,, 5	2,4·6	2,335	+ 51	+ 3,3 8	26	26	,, 31	112,651	27,10 ,921	2,910,698	1	9 29	—	—
Ilford Corporation	—	—	—	—	—	10½	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 2	152	143	+ 9	+ 211	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	11,586	3,626,656	419,800	·737	6 62	1,480	5·22
Lancashire United Tramways	,, 2	1,446	1,425	+ 21	+ 51,026	38½	28	—	—	—	—	—	—	—	—
Leeds Corporation	,, 5	6,635	6,429	+ 206	+ 7,445	89½	89½	March 25	298,233	64,223,666	7,121,038	1 10	10·02	351	—
Leicester Corporation	,, 5	2,228	2,350	- 121	—	42	42	Dec. 31	26,011	12 039,252	1,229,507	1	9·79	—	4 82
Liverpool Corporation	Sept. 28	11,420	11,177	+ 243	+ 7,488	104	104	,, 31	547 625	116,642 663	12.166 419	—	—	—	—
Liverpool Overhead Railway	Oct. 6	1,482	1,423	+ 59	+ 1,36 h	6·65	6 65	June 30	81,302	11,171,865	1,0c4 275	—	—	—	—
London County Council	Sept 28	32,958	25,904	+7,054	+134,738	98	98	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 28	262	242	+ 20	—	6	6	Sept. 30	14,511	3,128,867	359,435	1 08	9·68	2 630	6·48
Maidstone Corporation	—	—	—	—	—	2	2	March 31	4,740	850.121	112,227	1 33	10 13	2,370	—
Manchester Corporation	Oct. 5	15,423	14 872	+ 551	+30,409	149	149	,, 31	631,956	126,900,875	14,123,124	1 19	10·73	4,299	6·99
Metropolitan District Railway	,, 6	3,006	8,179	- 173	- 9·8	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 6	15,495	15,286	+ 209	+ 5,276	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 5	139	157	- 19	- 9	2¾	2¾	,, 31	6,159	1,992,647	206,358	82	7 14	2,239	—
Newcastle-on-Tyne Corporation	,, 5	4,039	4,119	- 30	+ 306	50	50	,, 31	197,849	43,06 ,934	4,326,182	1 07	0·98	3,957	7·0
Newport (Mon.) Corporation	June 29	639	628	+ 11	+ 1,397	15½	15½	,, 31	30.356	7,252,535	783 435	—	9 29	—	6·4
Oldham Corporation	—	—	—	—	—	34	34	,, 25	65 553	15,466,245	1,504,740	1 16	10 45	1,886	—
Portsmouth Corporation	May 25	2,330	1 578	+ 752	+ 632	23½	28½	,, 31	95,702	19.625,329	197,499	1·17	11 63	—	—
Reading Corporation	Oct. 3	644	664	- 20	- 707	33½	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	11·29	21·29	,, 31	14,881	2,837,110	386,547	1·24	9·24	1,102	7 92
Rotherham Corporation	—	—	—	—	—	9½	9½	,, 31	23.569	5,251,472	593,054	1 07	9 53	2,612	7·49
Salford Corporation	,, 7	4,725	4,610	+ 115	+ 3,480	70¾	70¾	,, 31	214.111	39,213 560	4,894,550	1·28	10 29	—	—
Scarborough Tramways Co.	—	—	—	—	—	4½	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 6	5,720	5,505	+ 214	+ 6,983	35¾	35¾	,, 25	210,5·5	63 952 283	,049,899	903	9 543	3,653	5 94
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,365	9 294,771	1,108,369	1·27	11·02	—	7·83
Southend-on-Sea Corporation	,, 2	451	407	+ 44	- 171	9	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	,, 31	39,550	6,766,031	1,027,730	—	9 23	—	4 75
Sunderland Corporation	,, 6	1,357	1,414	- 57	- 550	20	20	,, 31	64,858	15.364 463	1 495,785	1·004	10·36	—	6·37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	4,937	1,315,757	102,751	0·87	11 53	1,371	—
Torquay Tramways	Oct 3	277	—	—	—	5 16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 5	834	825	+ 9	+ 555	12 68	12·43	,, 31	43,607	7,995,451	862,12	9·27	12·14	3,132	7·59
Warrington Corporation	—	—	—	—	—	9	9	,, 31	17,057	4,418 225	403 363	—	9 85	—	6·33
West Ham Corporation	,, 3	2,358	2,358	—	+ 1,403	14·7	14 7	,, 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	Sept. 25	324	838	- 14	+ 256	20	20	,, 31	41,905	8,847,066	950,338	—	10 583	2,062	6·1o

† And 96 miles of interlacing track. a Train mile. b Per mile of single track. c Miles of route. h Half-year's figure. k Double track.

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NOTES

Halifax Tramcar Accident.—The Halifax Corporation has only just recovered from the effects of the fatal accident which occurred on the tramway service last year to be faced by another fatal accident, which, from the vague reports that have appeared in the dailies this week, resembles the former accident in certain features. The accident occurred on Tuesday morning at Sowerby Bridge. The ill-fated car had just ascended a very steep hill known as Bolton Brow when something went wrong. It is stated that the electric current failed, and that the car began to run back. The trolley pole was caught at the first turn and torn clear of the car, which at once became unmanageable. Leaving the metals, it ran into a building on the roadside. A shop front was smashed in, and the vehicle reeled back and became a complete wreck. The driver was powerless to check the car when it had once started down the hill. The conductor, who was killed, applied the brakes, but to no purpose. The inquest opened on Tuesday, but details will not be forthcoming until Lieut.-Colonel Druitt has held the local inquiry which the Board of Trade have appointed him to hold. It may, however, be stated that the rails were wet and slippery, thus accelerating the descent of the car on the hill.

Tungsten Ores.—Much importance attaches to the mining of the minerals from which electric lamp filaments are made, and developments in the mining centres are closely followed by electrical engineers. At the same time, it is of interest to note what fluctuations the prices of certain ores have undergone of late. A few years ago wolfram ore could not be sold at £15 a ton, and the world's output was only about 300 tons. But since then there has been a steady growth of demand, and the output last year was about 3,500 tons, whilst the price had risen to £150 a ton. It is found for the most part in Boulder County, Colorado, although some is obtained in Northern Queensland, and a little in Cornwall, where, however, the ore deposits of wolfram, as a rule, are small and irregular. Tungsten of soda is prepared from wolfram, and is used with starch for rendering light fabrics, such as muslin, uninflammable. It is also the chief substance from which tungsten acid is derived, and metallic tungsten is prepared from it. In recent years this has been largely used in Sheffield for hardening high-speed and special tool steels, some of which contain up to 20 per cent. of tungsten. The rareness of the metal and its high price—metallic tungsten has been selling at £450 a ton—have prevented its being largely used, but large deposits of wolfram are being opened up in Colorado, and a company is being formed in Manchester and Sheffield for working some of these deposits. If larger supplies could be obtained at a lower price, tungsten would doubtless be much more extensively used.

Steel Conduits.—There is under contemplation in the States the revision of underwriters' rules relating to the use of steel conduits, and underwriters' laboratories of Chicago are sending out inquiries to manufacturers, contractors, and users of steel conduits and fittings with a view to obtaining some guidance as to the direction in which the revision should take place. A number of questions have been put to various people, the chief of which are the following: In what respect, if any, does the ordinary form of enamel on rigid conduit prove an unsatisfactory covering for the steel pipe? Does galvanised rigid conduit possess advantages or disadvantages as compared with enamelled conduit? If so, what and for what special uses? Does the enamel ordinarily used on conduit and fittings (junction, outlet, and panel boxes) prevent or render difficult strict compliance with the following rule of the National Electrical Code? If so, what commercially practicable means can be found for obtaining better conductivity? Definite information is also being sought as to the use of conduit in cement or concrete. The conditions liable to cause deterioration of conduit, either rigid or flexible in cement or concrete, are also being inquired into. One question asks whether flexible conduits or armoured cables placed in wet concrete admit water to the interior while concrete is setting to a degree sufficient to cause trouble, and, if so, opinions as to the precautions to be taken are invited. Among other questions is one relating to means for the protection of conduits from rapid deterioration caused by the action of acid fumes and gases, while others ask that defects in the present types of conduit fittings should be pointed out and remedies suggested. When the replies are all sent in and arranged in tabulated form, they will arouse no little interest, even among contractors and others on this side of the water.

Submarine Telegraphy.—At the Engineering and Machinery Exhibition at Olympia last week, Mr. Chas Bright explained the principles of submarine telegraphy to a large and appreciative audience. In the course of his lecture Mr. Bright described the methods of transmitting electrical signals through cables, mentioning that nowadays the speed of working is only limited by the type of cable in accordance with traffic requirements, with a view to showing that wireless telegraphy for commercial purposes has a considerable task ahead before it could compete successfully with cables. A description was given of the various stages of construction in a cable from the copper conductor and insulator to the iron sheathing, showing the great improvements that have been effected in the quality of material, etc., since the first lines were laid, though the general principles of construction were peculiarly the same. There are, he said, some 257,000 miles of cable in all at the bottom of the sea, representing over 52 millions sterling, each line costing about £200 per mile to make and lay. The average useful life of a cable nowadays may be anything between 30 and 40 years according to circumstances. The social, inter-imperial, political, and strategic importance of cables was then discussed as well as the tariffs, which in the case of the Atlantic lines (of which there are 16) have been reduced from an initial £1 per word to the present-day 1s. a word. With reference to the strategic value of cables from the naval aspect, Mr. Bright mentioned that a battleship, costing a million of money, is wasted if not in a proper position at a critical moment owing to the lack of cable communication. This cost is, perhaps, great, under the circumstances, compared with that, for instance of an Atlantic cable costing half a million, but the lecturer pointed out the two are necessities of the age, and further suggested that we might some day discover so, if we fail to keep before us our national and imperial interests.

The History of Magnetism.—The earliest references to the properties of the magnet occur in the annals of the Chinese nation, who used it as a means of guiding the wayfarer over the vast and trackless plains of Eastern Asia, long before it was applied to maritime purposes. To the Emperor Hoang-Ti, who lived 2,000 years before our era, is attributed the invention of a chariot upon which stood an elevated figure pointing to the south, independently of any position of the chariot. Nearly 10 centuries later, we find the learned Tchéou-Koung presenting and teaching the use of tchi-nânkiu, or chariot indicating the south, to some envoys from Youá-tchâng, a southern maritime province. The compass, or, as it is even now called in Chinese, tchi-nân, appears to have been first used at sea by this

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remarkable nation about the third century of our era, during the Tsin dynasty. When the compass became known in Europe is disputed; Gilbert refers its introduction to Marco Polo about 1260, but it is probable that earlier accounts of it were brought from the East by the Crusaders, an accurate description of it occurring in a poem entitled "La Bible," written by the minstrel Guiot de Provence, about the year 1190. A Latin letter, ascribed to Peter Adsiger, 1269, preserved among the manuscripts of the University of Leyden, contains the following remarks on the declination of the needle: "Take notice that the magnet, as well as the needle that has been touched by it, does not point exactly to the poles, but that part of it which is reckoned to point to the south declines a little to the west, and that part which looks towards the north inclines as much to the east. The exact quantity of this declination I have found, after numerous experiments, to be 5deg." The discovery of the dip of the needle is due to Robert Norman, a nautical instrument maker at Wapping, near London, who is described by Gilbert as "a skilful sailor and ingenious artificer." He found that, after being touched by a magnet, the needle always appeared heavier at its northern end, and making an instrument to determine the greatest angle formed with the horizon, he observed the inclination in 1576 to be 71° 50′. In the early part of the following century the variation of the declination was clearly ascertained, and was attributed by Bond, a teacher of navigation in London, to the motion of two magnetic poles. In the year 1600 was published the celebrated treatise "De Magnete" by Gilbert, of Colchester, who was pronounced by his great contemporary, Galileo, to be "great to a degree that might be envied."

Foreign Trade Returns.—The Board of Trade returns as to our foreign trade show no declension during the past month, and bring the total for the nine months to unprecedentedly large proportions. Electrical commodities have been subjected to the usual fluctuations, as will be seen from the following figures. The sum total of imports of telegraph cables and apparatus for September amounted to £93,147, a decrease of £1,379, or 1·4 per cent., compared with the same month of the preceding year. The total imports for the nine months of this year amounted to £937,533, an increase of £73,167, or 8·4 per cent., compared with 1906. Under the heading of articles wholly or mainly manufactured we find that of wire (including telephone and telegraph wire) 3,222 tons, valued at £37,769, were imported during September, compared with 4,124 tons, valued at £42,921, in the same month of the preceding year. The imports for the nine months 1907 and 1906 amounted respectively to 45,159 tons, valued at £485,376, and 44,122 tons, valued at £450,656. Electrical machinery was imported last month to the extent of 570 tons, valued at £53,297, compared with 543 tons, valued at £44,783, in September, 1906. The value of the 5,582 tons of electrical machinery imported during the nine months of this year is returned as £446,641, compared with £435,152, the value of the 5,372 tons imported last year. Turning now to exports, we find that under the heading of telegraph cables and electrical apparatus there was an increase during the past month of £154,466 compared with September, 1906, the figures for the past month being £276,576. On the other hand, the export for the nine months shows a decline of £233,760, the figures being £1,703,030. Both in quantity and in value does the export of wire (including telegraph and telephone wire) show an increase last month, the figures, 5,094 tons, valued at £90,883, comparing favourably with 3,445 tons, valued at £61,915. The export of this commodity for the nine months of this year has thus been brought up to 40,316 tons, valued at £733,837, compared with 32,638 tons, valued at £40,316, last year. The export of all kinds of electrical machinery also shows a good advance, the figures for last month being 1,067 tons, for which a value of £88,243 is returned, compared with 614 tons, valued at £51,941. For the nine months the following figures are given: 1907—quantity 9,901 tons, value £733,958; 1906—quantity 8,469 tons, value £611,675. The export of electrical goods (not including machinery) of foreign and Colonial origin last month reached a value of £24,251, compared with £17,951, bringing the total figures for the nine months up to £123,669, compared with £81,673 last year.

Metallic-Filament Lamps. — A process for the manufacture of metal filaments for incandescent electric lamps is described in a patent (No. 13,596) recently granted to the British Thomson-Houston Company. The invention relates to non-ductile filaments of a refractory metal, such as tungsten or molybdenum, made from plastic threads, and containing the metal or a compound and a binder, which are mounted for subsequent treatment upon the supports for the finished filaments. Each support consists of a glass stem, 2 (Fig. 1), carrying nickel wires, 3, 4, arranged in pairs to avoid sharp bends in the filaments. The plastic thread is looped loosely as shown, allowing for subsequent contraction, the lower hooks permitting the filament to be withdrawn from them if necessary.

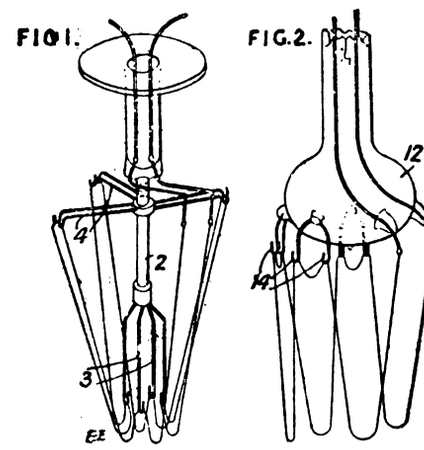

Fig. 2 shows a modification for a vertical lamp, in which a bulbous support, 12, with hooks, 14, is employed. In the case of tungsten filaments, a paste of the metal and glucose, with oxides if desired, may be used to form the plastic threads, and these may be secured to the leading-in wires by a paste of tungsten oxides and glucose. The threads are dried by heating in a resistance furnace to about 250deg. C., and are then carbonised in a second heater at about 350deg. C., after which each support is placed in a bulb. After exhaustion of the bulbs, the filaments are heated by current to reduce oxides if present and to drive off part of the carbon. The remaining carbon may be removed by heating, first in an oxidising atmosphere to oxidise the surface of the filaments, and then more strongly in a reducing atmosphere, when the carbon reduces the oxidised surface.

Street-Lighting.—No doubt the approach of the lighting season has afforded the excuse for our gas friends to conduct their recent campaign in favour of gas lighting with that vigour and disregard for accuracy which we are now accustomed to expect from that quarter. Figures have been published intended to show the economy of gas lighting, which at a first glance seem very convincing, but which on more minute examination prove nothing except that they show how wide in its applications is the remark of a famous statesman who, on a memorable occasion,

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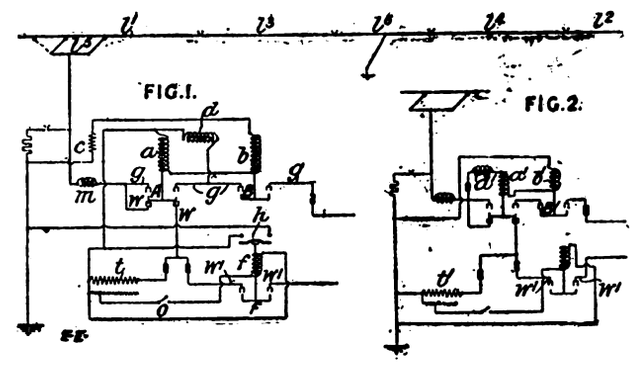
declared that his figures were to be taken as illustrations and not as facts. Certain district and parish councils contract each year or so for the lighting of the area under their control, and in many cases electricity, gas, and other illuminants enter into competition. Now, lest there are some public bodies who are likely to be influenced by the exhortations of the gas journals, it is as well to produce some evidence tending to prove the economic advantages of public electric lighting, and to show its increasing popularity. The investigations at Bristol, Wolverhampton, and elsewhere into the relative advantages of gas and electricity for lighting have resulted very largely in the favour of the latter. In addition to these, however, we would like to give wider publicity to the tables which Mr. H. T. Harrison has compiled for the current year's *Proceedings* of the Incorporated Municipal Electrical Association from returns made by members of the association and by managers of supply companies, which, we think, go a long way towards controverting the statement, often brought forward by those interested in the supply of gas for public lighting, to the effect that electric lamps are not suitable for this purpose. Gas lamps in the 150 towns covered by the returns number 253,400, electric lamps in the same number of towns number (arc lamps 15,880, incandescent 29,930) 45,810. The revenue from gas public lighting in the 150 towns amounted to £684,180, and from electric public lighting £340,277. The total candle-power of gas lighting equalled 10,136,000, and of electric lighting 11,024,500. The average cost per annum in 150 towns was: for gas, 16·4d.; electric, 7·4d. For the sake of comparison, the average gas lamp was taken as giving 40 c.p., which, allowing for the fact that a large percentage of flat-flame burners are still in use, was ample allowance. The average arc lamp was taken as giving 600 c.p., and the average incandescent electric lamp at 50 c.p. Of course, the value of the data is considerably depreciated by the inadequacy of the returns, but the figures are interesting, and show that the total candle-power of electric lighting is considerably in excess of gas lighting, while the average cost per candle-power per annum is more than 50 per cent. less in the case of electric light as against gas.

Machinery Breakdowns.—The reports which Mr. Michael Longridge, as chief engineer, presents each year to the British Engine, Boiler, and Electrical Insurance Company are of much value, and his report for the year 1906 is no exception. Many of the breakdowns which are reported upon are of the old familiar types; but no harm is done in presenting them once more in their modern appearance, and a very useful end will be served if the experience of the past will be taken advantage of by the younger workers, and the mistakes and difficulties of their elders avoided. In a previous issue of this journal we dealt with the report in the electrical machinery section. But the other sections into which Mr. Longridge's report is divided are of no less interest. The rate of breakdowns among steam-engines has, as in the previous year, been unusually high—namely, 1 in 8·1 of the engines insured. Among gas and oil engines the rate was lower—namely, 1 in 12·4. For this difference there are several good reasons, the principal of which are: (1) gas-engines have fewer parts than steam-engines; (2) these parts are on the average much smaller than the parts of steam-engines of the class which are insured; (3) gas-engines cannot be habitually subjected to stresses much heavier than the parts were designed to bear. In the tables presented by Mr. Longridge it is noticeable that the unusually high percentage of breakdowns of steam-engines is attributed to the effects of wear and tear; thus 23·3 per cent. of the breakdowns occurred at the valves and valve gear, 12 per cent. at spur gearing, 9·9 per cent. at air-pump motions, and so on. On the other hand, the percentage ascribed to weakness, bad design, workmanship, and materials is unusually low. Can this be the first fruits of our vast expenditure on technical education? As to gas and oil engines, 23 per cent. of the breakdowns are attributed to old defects or deterioration by wear and tear; 24 per cent. to weakness, bad design, workmanship, or material; 19 per cent. to negligence of owners or attendants, and in 34 out of every 100 accidents the causes have not been ascertained. It is a striking testimony to this company that no life has yet been lost by the explosion of a boiler it had certified. The serious defects reported in 1906 were: corrosion and grooving, 123 cases; fractures, 37 cases; mountings out of order or inoperative, 5 cases. The numbers of explosions, collapses, and mishaps to boilers on land reported on by the Board of Trade during the 23½ years ending December, 1905, amounted to: (1) explosions, 234; (2) collapses of flues, 289; (3) explosions and mishaps to boilers used for heating buildings, 43. The total deaths numbered: (1) 167; (2) 145; (3) 4. The figures for 1906 were as follows: (1) numbers 4, deaths 2; (2) numbers 3, deaths 1; (3) numbers 2, deaths 1. The average figures show that the loss of life from boiler accidents is small, and considering the difficulties with regard to boiler design this must be taken as satisfactory.

Overhead Conductors for Electric Traction.—A patent granted to the Allgemeine Elektricitäts-Gesellschaft relating to the overhead conductor system for electric railways and tramways consists, briefly, of means for employing high-tension alternating current and low-tension continuous current with a single bifid collector. According to the patent specification, the high and low tension line sections, l^1 and l^2, as shown in Fig. 1, are



separated by insulated dead sections, l^3 and l^4, of greater length than the trolley span, l^5. Blow-out insulators are preferably inserted between the sections, and an earthed section, l^6, is used to protect the low-tension lines in case of failure of the insulators. The car is made to coast over the dead sections during which times the switches A, B, F (Fig. 1) fall by gravity or springs to the positions shown, thus breaking the circuit from the trolley through the conductors, g, which supply the continuous current to the motors, and connecting the trolley through wires, w, with the primary of a transformer, t, which has for its function the operation of a switch, F, which will close the circuit through the conductors, w^1, that supply the alternating current to the motors. When the high-tension section is reached the magnetising current of the transformer, t, passes through the lightning inductance coil, m, contacts, w, solenoids, a, b, and resistance, c, to earth, and is insufficient to operate the plungers of the coils a, b. Closure of the switch o in the secondary circuit of the transformer energises the coil f and closes the switch F, thereby enabling current to pass through contacts w^1 to the motors or controlling gear. Simultaneously, the switch h short-

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circuits the coils *a*, *b*, leaving the transformer on the full voltage and available for lighting or other use. At the low-tension sections the direct current flows through the switch A, transformer, *t*, and coils *a*, *b*, as above described, and is sufficient to raise the plungers of the switches A, B, and complete the motor circuit through the contacts, *g*. The coils *a*, *b* are energised through the choking coil, *d*, which protects them should the switch A remain in its upper position on entering a high-tension section. In the arrangement shown in Fig. 2 the transformer, t^1, is placed in parallel with the coils a^1, b^1, which, in this case, are protected by a choking coil, d^1. The double-break switches, B, B^1, may be replaced by single breaks.

Publications Received.—"Electrical Traction," by Prof. Ernest Wilson and Francis Lydall (London: Edward Arnold, 41 and 43, Maddox-street, Bond-street, W. Two volumes, 15s. each net). The first edition of this work appeared in 1897, but since then the progress in this branch of electrical engineering has been so great that the enlargement of the original work is amply justified. Vol. 1 deals with the application of direct-current electricity to traction both for tramways and for railways, and vol. 2 is devoted to the similar application of alternating currents. Although this forms a natural division of the subject, the installations in which direct current is employed are so much more numerous than those using alternating currents that the division is somewhat unequal, and vol. 1 much more bulky than vol. 2. Instead of directly advocating any one of the various systems of electrical traction, the authors endeavour to point out impartially the advantages and disadvantages inherent in each, and they present much valuable information as to design, efficiency, and reliability in such a way as to facilitate the work of responsible engineers.—With the appearance of the September issue, vol. 39 of the *Journal* of the Institution of Electrical Engineers is now complete. The papers included in the latest issue are as follows: "Telephonic Transmission Measurement," B. S. Cohen and G. M. Shepherd; "The Present State of Direct-Current Design as influenced by Interpoles," F. H. Page and F. J. Hiss; "Hot-Wire Wattmeters and Oscillographs," J. T. Irwin; "A New Type of Induction Motor," L. J. Hunt (Manchester); "Further Notes on Electrical Conductivity," W. Browning (Students'); "Electric Valves," E. W. Moss (Students'); "The Induction Motor," R. Rankin (Students'); "The Equipment of Steam-Turbine Generating Stations," R. S. Kaula (Students').—We have received vol. 4 of the *Proceedings* of the Rugby Engineering Society (price 10s. 6d.). This volume contains the papers read before the society last session, among which are noticed: "Some Experiments with a Steam Calorimeter," F. J. Kean; "Electrically-Driven Rolling Mills," G. M. Brown; "A High-Speed Planer," C. Moody; "Some Problems in Electric Railway Engineering," F. W. Carter. The first-named paper secured a "B.T.H." premium prize.—The *Official Circular* of the Tramways and Light Railways Association for October contains matters of current interest to the members of the association; a reprint, from the *Street Railway Journal*, of an article on tramcar braking in Quebec; the official report to the Board of Trade on the accident which occurred at Sunderland on July 29 last; two papers read before the Municipal Tramways Association last month—one by Mr. R. L. Acland on "Long Wheel-Base Trucks" and one by Mr. A. L. C. Fell on "Rail Corrugation."—The October issue of the American *Physical Review* contains the following communications: "The Influence of Molecular Structure upon the Internal Friction of certain Isomeric Ether Gases," F. M. Pedersen; "The Distribution of Energy emitted by a Righi Vibrator," C. R. Fountain and F. C. Blake; "Measurement of Electrolytic Resistance," W. T. Franklin and L. A. Freudenberger; "A Study of the Reversible Pendulum," J. C. Shedd and J. A. Birchley.

Arbitration in Industrial Disputes.—Industrial peace is scarcely of less importance to the happiness and comfort of the nation than is international peace, and any means, therefore, that tends to promote peace and concord in the industrial world is to be welcomed as a preventive against strikes and lock-outs, which inflict such grievous suffering on capital and labour alike. There is much scope for the agency of a third party in endeavouring to conciliate the two conflicting parties, and here Parliament has stepped in with advantage. The Conciliation Act of 1896 gives the Board of Trade certain powers or duties in cases where a difference exists, or is apprehended, between employers and workmen, and a report just issued by the Board contains an interesting and encouraging account of two years' work under that admirable Act. The provisions of the Act empower the Board (*a*) of its own motion to inquire into the causes and circumstances, or (*b*) to take steps to enable the parties to meet together, or (*c*) on the application of either employers or workmen to appoint a "conciliator," or board of conciliation, or (*d*) on the application of both parties to appoint an arbitrator. The report contains a table which shows the number of disputes settled by conciliation or arbitration during each of the past five years. The number of disputes settled in 1906 (46) was nearly double the number so settled in the previous year, and was the highest in the five years under review. The number of workpeople affected by those disputes amounted to 14,366. The most important function of the Permanent Board of Arbitration and Conciliation, however, is not the settlement of strikes and lock-outs, but their prevention, by the discussion and settlement of differences which might otherwise lead to a stoppage of work. The number of Boards known to have taken action in the year 1906 was 93, and the number of cases considered by them was 1,561, as compared with 1,726 cases considered by 66 Boards in 1905. Of the 1,561 cases considered in 1906, 473 were settled by the Boards or their committees, and 224 by arbitrators or umpires appointed by them. Of the 697 cases only 12 involved a stoppage of work, none of which occurred in the engineering industries. In the engineering industries a number of local and central conferences were held under the conciliation clause of the terms of settlement of 1898. Twenty-seven cases were considered at central conferences, in 17 of which an agreement was arrived at. In addition, numerous local conferences were held, and as a result of these and the central conferences advances in wages were granted to engineers in 17 districts. Among the other questions which engaged the attention of the local and central conferences, mention may be made of the following: payment for night shifts, questions of demarcation, rating and manning of machines, premium bonus system, hours of labour, and overtime rates. On the whole, the awards appear to incline towards the men's claims, though there were many cases in which the awards did not favour the employés. In one of the latter, a dispute between the Manchester Corporation and its tramway men, the arbitrator dismissed the men's claim, declaring that, if granted, it would not only "entail a heavy charge upon the ratepayers," but also give the men "a benefit quite out of proportion to that to which they are reasonably entitled."

Electric Heating.—If in the past electric heating and cooking have been neglected as a branch in which central-station and contractors' businesses were capable of development, such a taunt scarcely applies to the present day, for there are unmistakable signs of activity in this depart-

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ment of electrical work. But the possibilities can only be realised by at first judiciously selecting those domestic features which lend themselves most easily, and with greater economy, to the introduction of electricity, and confining attention upon means for the development thereof before spending time and money trying to introduce complete electric cooking kitchen outfits. The chief object aimed at should be to dispel the exaggerated notions of the expense attached to electric cooking which the average householder entertains, and this is only possible by pushing the simpler cooking devices among those who are already using electricity for lighting in such a manner that the actual amount and cost of current consumed in cooking will be palpable to the householder Thus, having gained an *entrée* into the kitchen, and demonstrated the hygienic and economic advantages of electric cooking, the applications should find little difficulty in extending under the pressure of efficient canvassing. Happily, the particular attention which manufacturers are giving to the details of electric cooking outfits is likely to help still further in the development of electric cooking and heating. Many manufacturers guarantee their products for quite a long time, but one of the drawbacks is that enamel is largely used in the manufacture of cooking devices, and, owing to the unsatisfactory nature of enamels at high temperatures, chipping and cracking are unavoidable. A problem that has also to be faced in complete cooking outfits is whether the utensils should be separable from the heating elements, and the provision of good plugs and receptacles for the use of heavy currents as are required in electric cooking. Various apparatus designed for boiling and frying which we have seen denote a considerable improvement upon former types. In most cases frying pans and the like are air-jacketed, and the arrangements are such that a uniform temperature is obtained over the whole of the surface on which the heat is required. The risk of breakdown due to accidental overheating is consequently diminished. One of the most popular and successful of electric heating applications is in the case of flatirons. Their convenience and cleanliness outweigh the cost of operation, so that their use in commercial laundries is to be commended. From the report of such a laundry using electric irons we gather that "20 per cent. more work can be done by electric heat, and all the work is of one lustre of finish." In another case 30 per cent. more work per operator could be performed. One of the most difficult problems in the whole range of household applications is the heating of water for washing by electricity. This is because of the large amount of energy required. With small quantities of hot water required in small families it may be feasible, but in large establishments the heating of large quantities of water electrically can scarcely be recommended at present. Time, however, will bring improvements in its train; and with the specially low prices charged for current for electric heating and cooking, the elimination of the objectionable features attendant on the use of coal, gas, and oil stoves, the high heat efficiency of electric as compared with other forms of heating, the development of this branch of business promises to be of importance to the central station and the contractor.

The Absorption of Gases by Charcoal.—An interesting discussion was introduced in Section A of the British Association meeting at Leicester on the above subject by Miss I. Homfray Miss Homfray submitted an account of some experiments which were devised, at the suggestion of Sir W. Ramsay, to throw some light on the question of the absorption of gases in charcoal. The gas which appeared most suitable for the purpose, on account of its molecular simplicity and chemical inertness, was argon. The apparatus used was similar to a constant-volume gas thermometer, the bulb containing 3 grm. of charcoal. This was connected with a gas burette, a gas reservoir, and a Sprengel pump, all connections being of glass and sealed. Various constant-temperature baths were used, ranging from boiling-water to liquid-air temperatures, and successive quantities of argon were admitted from the burette, the pressures being read at each temperature. Isothermal curves were then plotted, taking pressures as ordinates and concentrations, corrected for dead space and reduced to standard conditions as abscissæ. From these curves points of equal concentration were read off and a fresh series of curves were obtained, having pressures as ordinates and absolute temperatures as abscissæ. Such curves have been termed by Ostwald "isosteres." Each curve corresponds thus to a vapour-pressure curve in the univariant system of a vapour in contact with its own liquid, and is analogous to it in form. Ramsay and Young's law for the ratios of absolute temperatures of two vapours at the same pressure was then applied to these results in the form:

$$\frac{T_0}{T_1} - \frac{T_0'}{T_1'} = K\,(T_0 - T_0'),$$

where T_1 T_1' are the absolute temperatures read from one of the isosteres curves corresponding to two pressures, and T_0 T_0' the absolute temperatures of any other vapour taken as standard at the same two pressures. Water, oxygen, and argon were successively taken as standards, and the equation was found to hold for all concentrations. A series of straight lines, one for each concentration, was thus obtained. It has been shown by Prof. Porter that Ramsay and Young's law may be directly derived from Bertrand's vapour-pressure formula $P = G\left(\frac{T-a}{T}\right)^n$ provided that the constant n is the same for all vapours. For a large range of vapours it is found that if $n = 5{\cdot}0$ very good correspondence is obtained, and this was found also to be the case with the results of the present experiments. Values of the other constants, a and g, were calculated for each concentration as well as for argon vapour itself. An attempt has been made to correlate these constants with the numbers representing the actual concentrations, and, in order to introduce the argon-vapour constants at a finite concentration, these were calculated in terms of weight of argon in 100 grm. of the mixture—a method frequently used in the case of solutions. The concentrations experimentally reached varied from ·317 to 7·089 per cent., the vapour, in the absence of charcoal, being represented by 100 per cent. For convenience, the logarithms of the concentrations were plotted against values of a and G respectively, and a smooth curve was obtained terminating at 100 per cent. in the constants for argon. Equations were then obtained which express with considerable accuracy these curves, and when introduced into Bertrand's equation the corresponding temperatures or pressures, calculated for any concentration, are in very fair agreement with those experimentally found, except for exceedingly small concentrations. These equations are:

$$a = 13{\cdot}12 + \frac{250}{24}\left\{\log\frac{100}{C}\right\}$$

$$\log g = {\cdot}1085 - {\cdot}012\left\{\log\frac{100}{C+1}\right\};$$

where $g = (G)^{\frac{1}{5{\cdot}6}}$. The values 13·12 and ·1085 are the values respectively of a and $\log g$ for argon vapour. The equations given in this paper are in much better agreement with observation than the usually applied logarithmic or exponential equations for the isothermals.

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ELECTRICALLY-DRIVEN PUMPING PLANT AT THE LINDAL MOOR MINES.

Mining engineers, not only in this country, but also abroad, will be interested in the pumping installation which has been put down by the Electrical Company, Limited, of 121-125, Charing Cross-road, London, W.C., at the Lindal Moor Mines, near Ulverston, Lancs., for Messrs. Harrison, Ainslie, and Co., Limited. Through the courtesy of the proprietors we were enabled to inspect this installation on the occasion of its official opening by Lord Muncaster last week. It is the most comprehensive plant of its kind yet erected in Great Britain, and embodies some unique features, including the direct application of high-tension current to portable motors, and special arrangements for starting these motors under a lower pressure so as to obviate a too sudden accretion of load on the generating plant.

Briefly, the problem which presented itself for solution was that of coping with the maximum inflow of water plus the accumulation of years, and the scheme adopted incidentally reflects the ready adaptability of electricity to conditions which had spelt the failure of previous attempts, as will be seen later on. The initial power required for the pumping operations is, of course, much greater than will suffice to deal with the inrush of water only. In a few months' time it is expected that the accumulated water will be sufficiently reduced in quantity to liberate the bulk of the available power for other purposes than that of pumping. Meanwhile, however, the full output of the generating plant is depended upon for the one purpose. It was only by adopting plant of proved reliability that a large reserve of power could be dispensed with. As it is, there is no stand-by, unless we accept as such the old pumps whose capacity long since proved unequal to the task in hand. Personally, we have little doubt but that this faith in the ability of the new plant to run without breakdown for the necessary period will prove amply justified, since no firm has had more experience with the class of work in question than the Allgemeine Elektricitäts-Gesellschaft, with whom the Electrical Company, Limited, are affiliated.

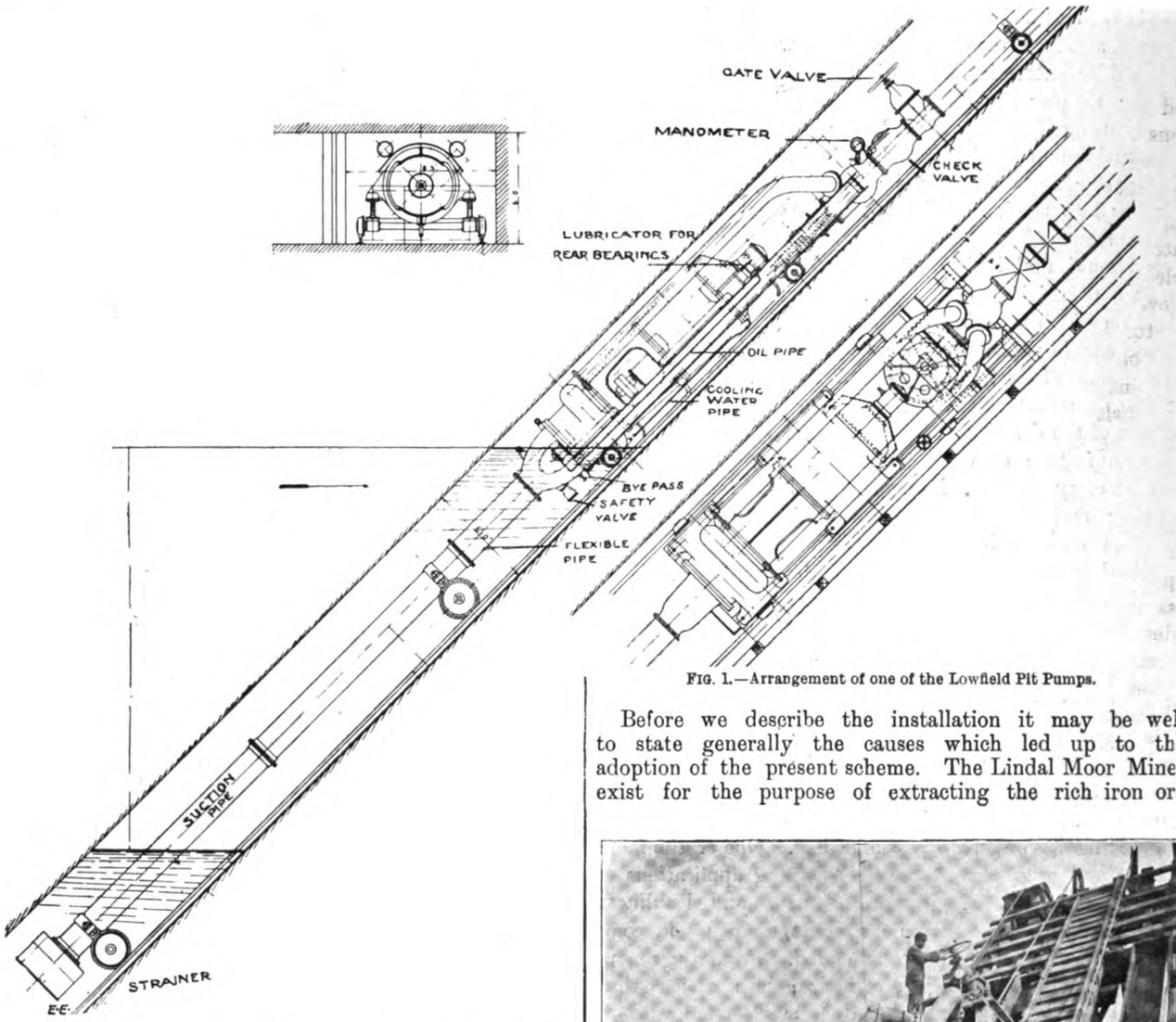

FIG. 1.—Arrangement of one of the Lowfield Pit Pumps.

Before we describe the installation it may be well to state generally the causes which led up to the adoption of the present scheme. The Lindal Moor Mines exist for the purpose of extracting the rich iron ore underlying the property. In four of the pits pumping operations ceased in December, 1903, due primarily to breakdowns and the inability of the then existing plant to cope with the inrush of water as the mines were developed. These pits are connected together underground either

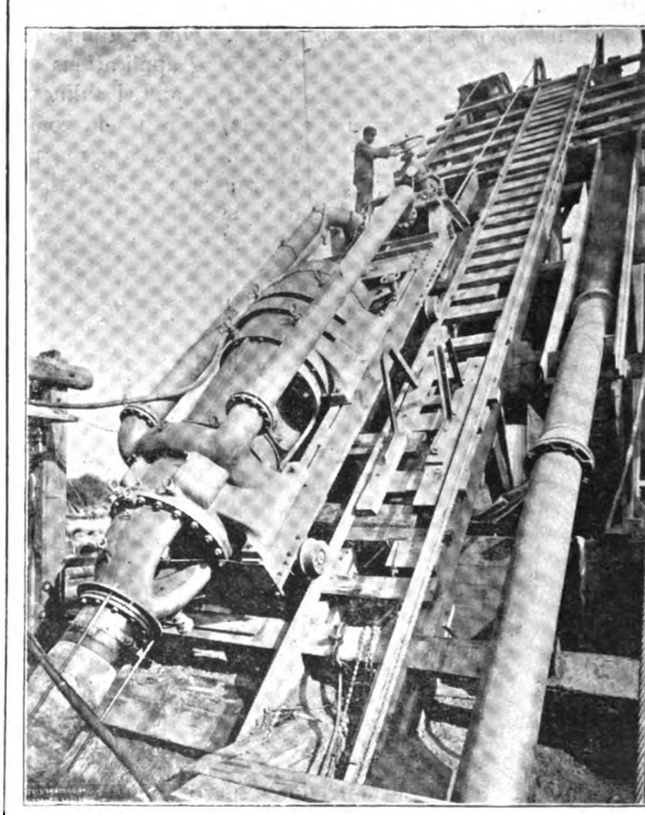

FIG. 2.—One of the Lowfield Pit Pumps ready for lowering.

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artificially or through the crevices incidental to the carboniferous limestone or other natural drainage, and

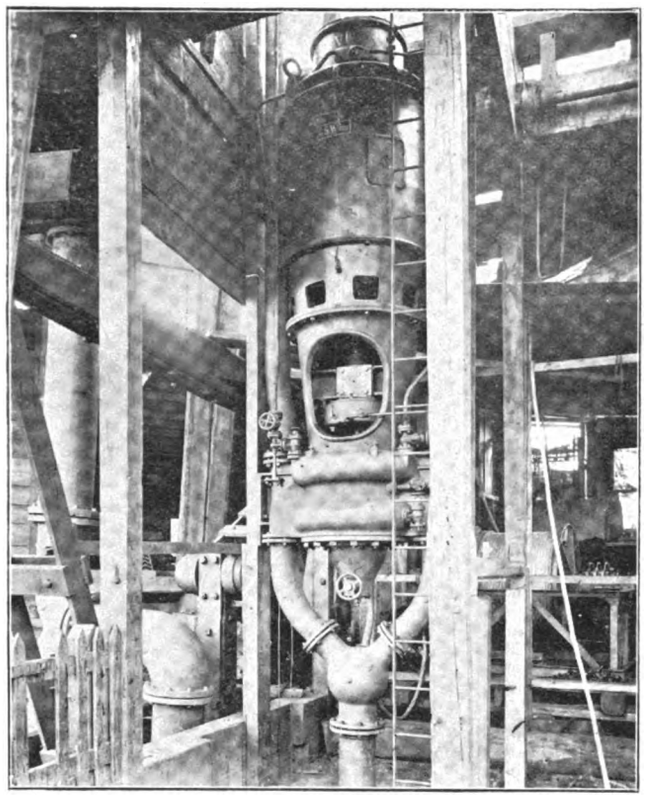

FIG. 3.—One of the Diamond Pit Pumps ready for lowering.

were known to contain large ore bodies of great value. Accordingly, Mr. Henry Ward, of 110, Cannon-street, E.C., was consulted as to the best method of rendering the

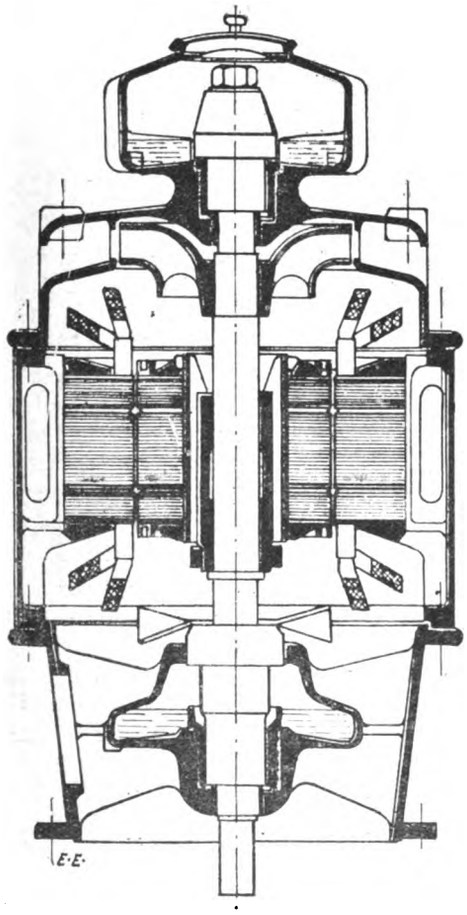

FIG. 4.—Section of Ventilated Enclosed High-Speed Vertical Three-Phase Motor.

pits again a source of revenue to the shareholders. At the time the pumping operations ceased the maximum inflow of water amounted to nearly 7,000 gallons per minute, though the normal dry-weather flow was only about 4,000 gallons per minute. Some 3,300 gallons per minute were pumped out by the old plant from two of the pits in question, one being the Lowfield pit, 675ft. deep, and the other the Diamond pit, 612ft. deep. A further quantity of 3,300 gallons per minute was pumped out from the two Berkune pits, which are respectively 300ft. and 495ft. in depth. Owing to the small dimensions of the shafts available for pumps in these four pits, great initial difficulty had to be overcome in designing plant which could be efficiently handled, and it was not until five or six schemes had been proposed and rejected that a satisfactory solution was arrived at. Further, it was a very difficult matter to design plant of the restricted dimensions capable of making an impression upon the water, and it was only

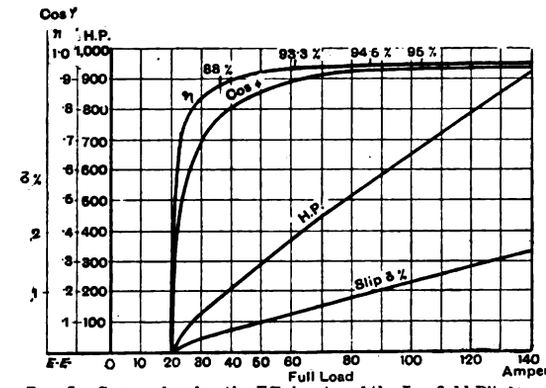

FIG. 5.—Curves showing the Efficiencies of the Lowfield Pit Motors, 750 h.p., 3,150 volts, 50 ⁓.

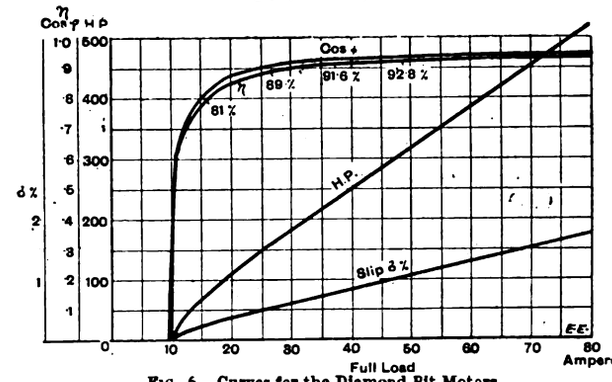

FIG. 6.—Curves for the Diamond Pit Motors, 315 h.p., 3,150 volts, 50 ⁓.

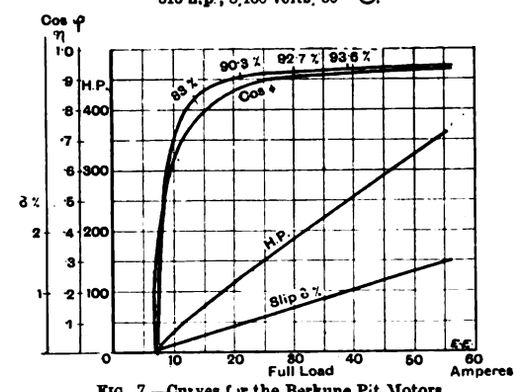

FIG. 7.—Curves for the Berkune Pit Motors, 250 h.p., 3,150 volts, 50 ⁓.

the possibility of using electricity in conjunction with high-velocity pumps which induced Messrs. Harrison, Ainslie, and Co. to seriously reconsider the project for pumping the mines dry. A brief consideration of the dimensions of the shafts must suffice to impress the difficulty of designing plants, having the requisite capacity, to fit them. Thus there were available at the Lowfield pit two shafts each 8ft. 4in. by 6ft. approximately down to a depth of 378ft. from the top, below this depth one shaft 9ft. 6in. by 6ft. approximately; Diamond pit, two shafts each 6ft. by 6ft. across; Berkune pits, two shafts 5ft. 3in. by 3ft. 5in. approximately. To meet this difficulty, a special arrangement of high-speed centrifugal pumps and direct-coupled electric motors was eventually devised. The scheme having thus been decided upon, a contract for the complete plant was placed with the Electrical Company, Limited, as already indicated.

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Now we can proceed to details. In each of the Lowfield shafts, which are inclined at an angle of 43 per cent. (see Figs. 1 and 2), a centrifugal pumping set has been erected capable of delivering 4,000 gallons of water per minute against a total head, including friction, of 395ft. On reaching a depth of 378ft., where the two shafts join, these pumps will be connected in series, and the design is such that when working in series they can together deliver the full quantity of 4,000 gallons per minute against a total head of 780ft. One of the pumps is so designed that it can be eventually altered for duty as a permanent fixed pump to deliver 3,000 gallons of water per minute against a manometric head of 525ft., and the other can also work as a fixed pump, when it will deal with 2,100 gallons against a manometric head of 700ft. These two pumps are of the one-stage type, each having high-grade cast-iron case impellers, guide wheels of special bronze, and steel shafts. They have planed feet for resting upon a carriage constructed of structural iron which runs on rails having a gauge of 6ft. 6in. Each pump has two wrought-iron delivery pipes, which are connected at the top by means of a Y-pipe supporting a rising main 14in. diameter, and is further provided with a rope sheave 4ft. diameter mounted on suitable brackets. Direct coupled to each of these two pumps is a motor capable of a continuous output of 750 b.h.p. when working on a circuit of 3,000 volts 50 cycles per second, the speed of the combined set being 1,485 r.p.m.

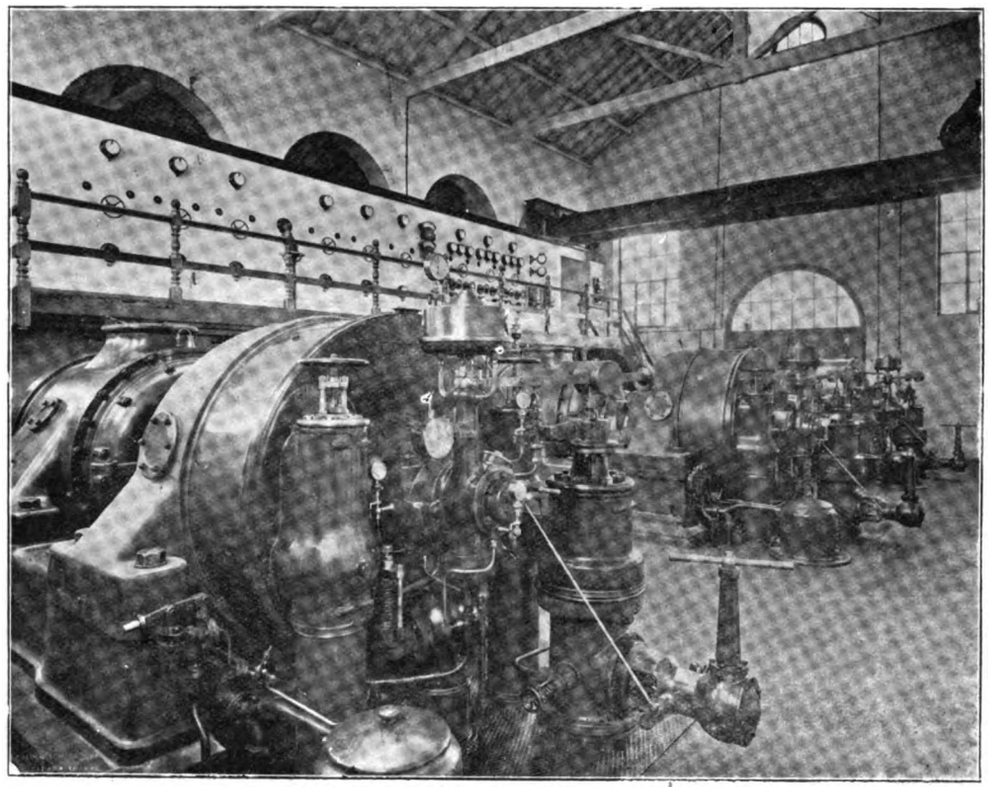

FIG. 8.—Interior of Generating Station, Lindal Moor Mines.

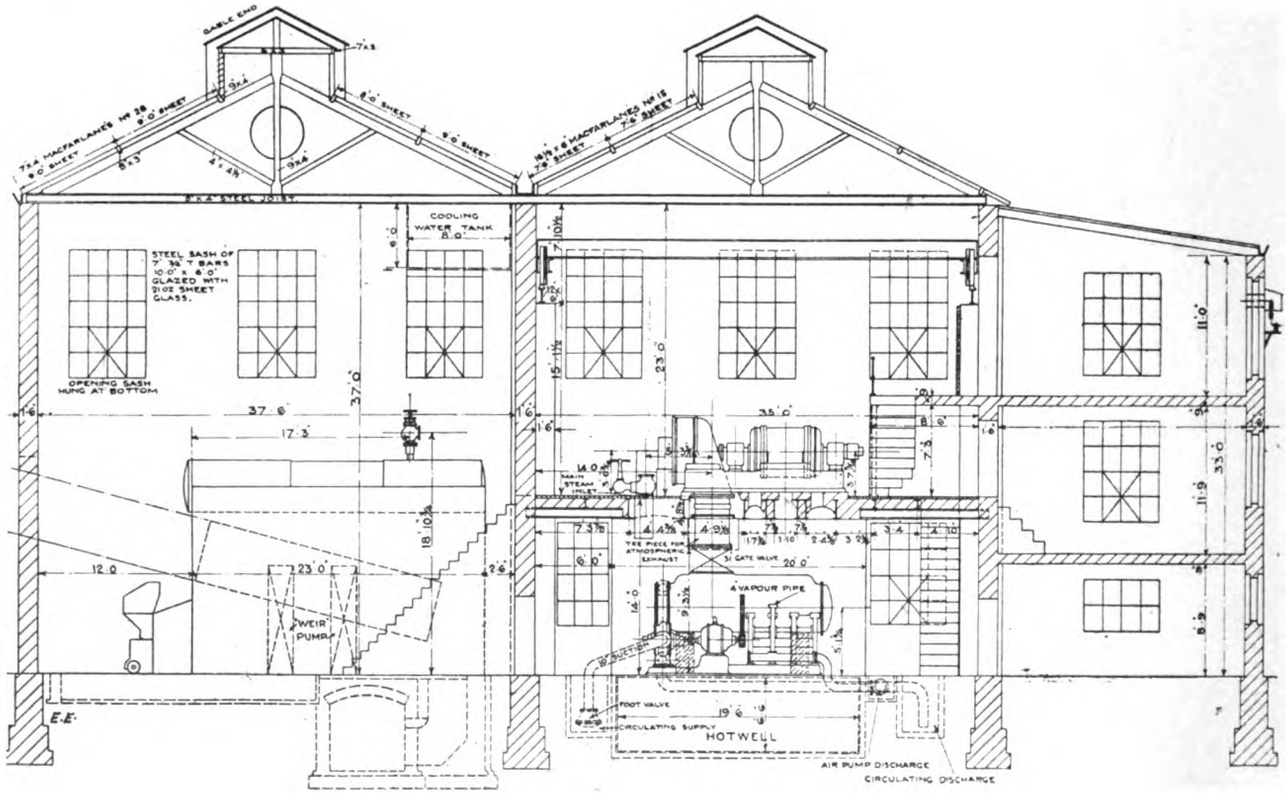

FIG. 9.—Section through Engine Room and Boiler House, showing Arrangement of the Plant.

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In the two Diamond shafts two vertical sinking pumps are provided, each of which is capable of raising 1,000 gallons of water per minute against a total head, including suction, delivery, and pipe resistance, of 680ft. These pumps are fitted with direct-coupled motors, each having an output of 315 h.p. at 1,480 r.p.m. One of them is shown ready for lowering in Fig. 3. The pumps are of the three-stage type, and in this case they are fitted with self-acting oil lubrication, elastic couplings, and a cast-iron intermediate piece for connecting and centering the pumps with

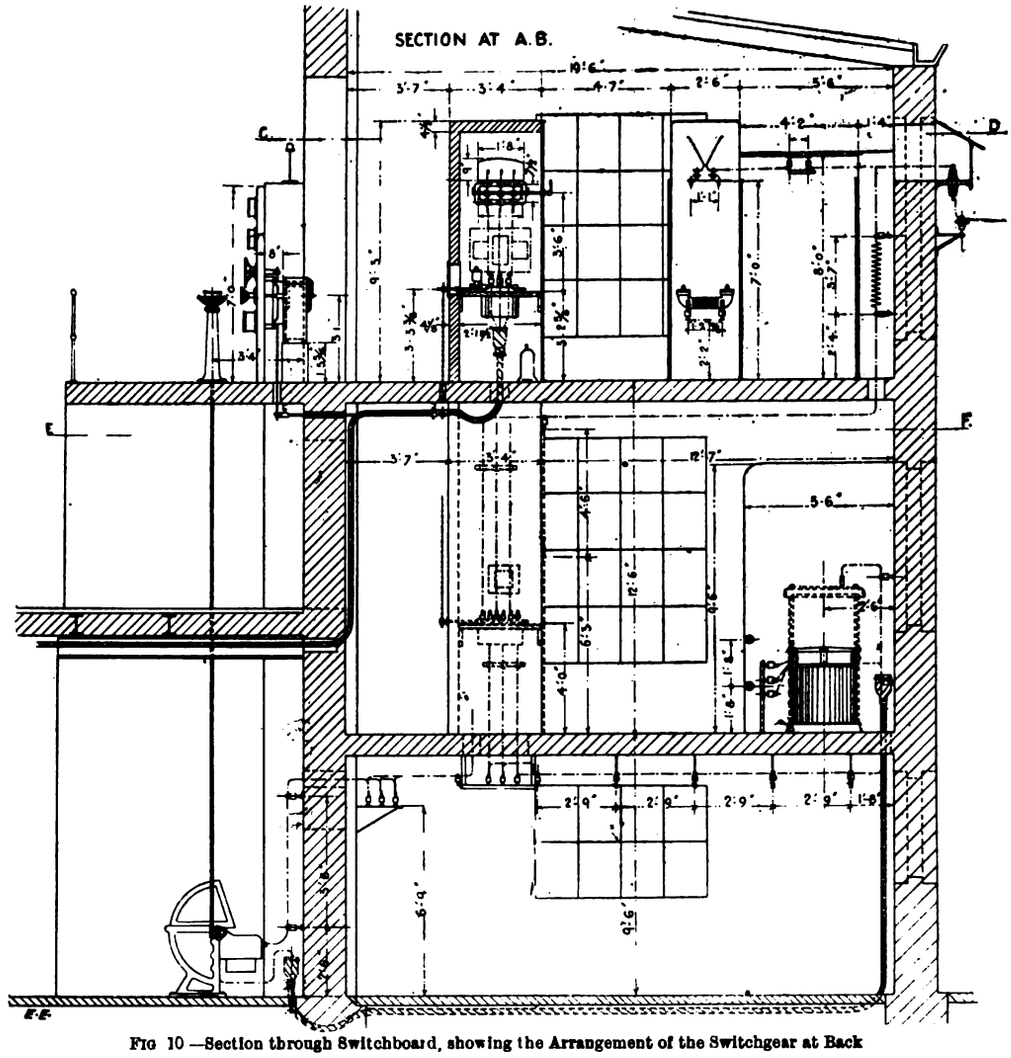

FIG 10.—Section through Switchboard, showing the Arrangement of the Switchgear at Back

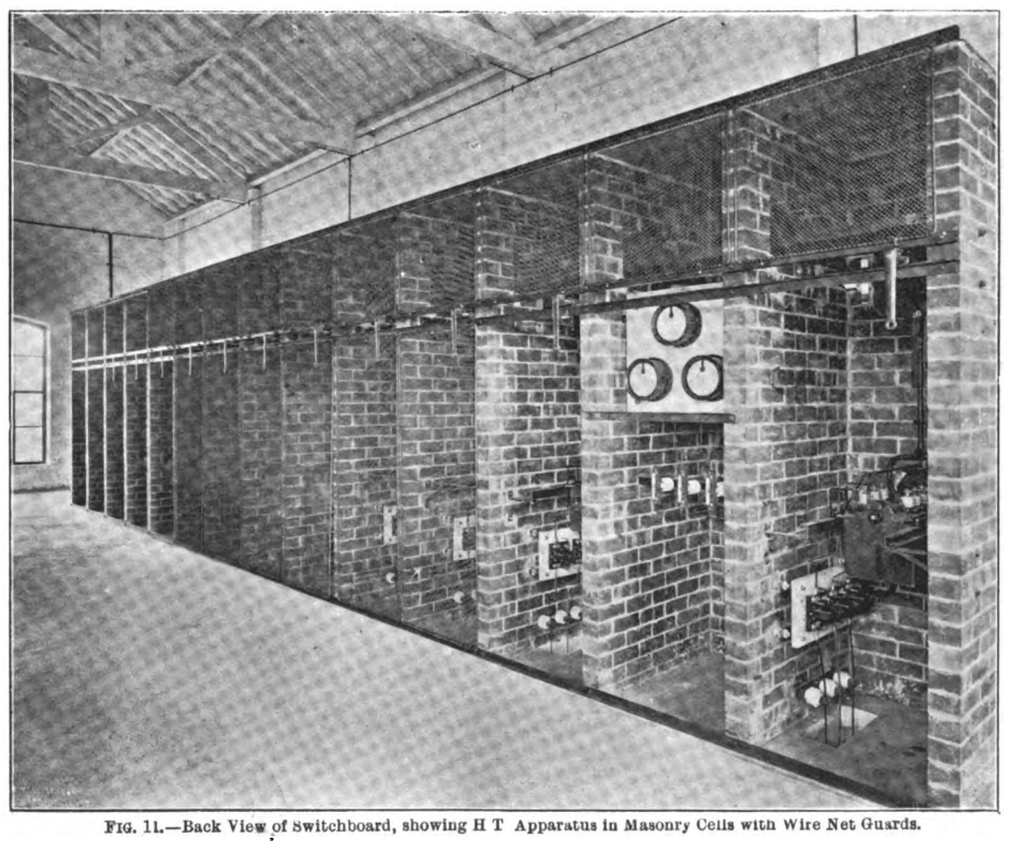

FIG. 11.—Back View of Switchboard, showing H T Apparatus in Masonry Cells with Wire Net Guards.

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the motors. A breeches pipe is provided in each case, with a wrought-iron suction pipe 250mm. internal diameter, foot valve, and strainer; also two wrought-iron delivery pipes connected at the top by a Y-pipe which supports the rising main. Each set is complete with check valve, by-pass, and gate valve 225mm. diameter. Likewise, in this case each pumping set is entirely enclosed in a framing of structural iron, and a suitable rope sheave is provided for carrying the weight of the entire pump with its motor, together with the electric cable and wrought-iron delivery pipe of 200mm. diameter when filled with water under normal working conditions. On the side of each set is a service ladder with a wooden platform at the top and bottom.

In the two Berkune pits are provided two pumping plants of similar construction to those in the Diamond shafts, but in this case each pump is designed for delivering 1,000 gallons of water per minute against a total head of 540ft., the motor having an output of 250 h.p., and the speed of each set being 250 r.p.m. These pumps are of the five-stage type. The arrangement of valves and pipes is the same as for the Diamond pumps. The suction pipe is of 250mm. and the delivery pipe of 200mm. diameter. The steel cables by which the pumps are lowered into the pits are fastened at the pit heads, from which point they go down their respective shafts, round the rope sheave of each pump, and up again to the top of the shafts, where they are wound round the winches provided for the purpose of raising and lowering. The delivery pipes for the vertical pumps are each stayed in position by means of the steel-wire ropes which pass up and down either side, stay rods being provided at various points with suitable guides through which the cables pass. The weight of each of the Lowfield pumps complete with its motor, suction and delivery pipe, suspension cable, electric cable, and its own column of water is about 75 tons. With a view to affording rapid sinking operations, the Diamond and Berkune pumps have been designed so that during the first half of the operations of draining only some of their impellers will be in use. By this means the pumps will initially raise nearly 200 per cent. of their normal output, and when the halfway stages are reached the full number of impellers will be brought into action.

From the above it will be seen that the total initial quantity of water with which the whole plant will be able to deal is about 15,000 gallons per minute, this being reduced to 8,000 gallons per minute as the pumps reach the lower levels. The centrifugal pumps have all been provided and built by Messrs. Sulzer Bros., of Winterthur, who have had a unique experience in the building of high-lift centrifugal pumps for heavy duty. The motors are of very special design for working under the abnormal conditions, and are constructed with particularly narrow dimensions to admit of their passing down the existing pumping ways. They are all fitted with short-circuited rotors, and the cases are arranged with ample ventilation, a forced circulation of air being maintained by means of fans fitted on the motor shafts, as shown in the section (Fig. 4). Although the motors are of the ventilated enclosed type, there is ample protection by means of suitable hoods against falling water or fragments, etc. A special feature is that the high-tension current of 3,000 volts is taken directly to the motors without intervening transformers, all terminals and live parts being securely protected in such a manner that there is absolutely no risk of danger to the men in charge. The

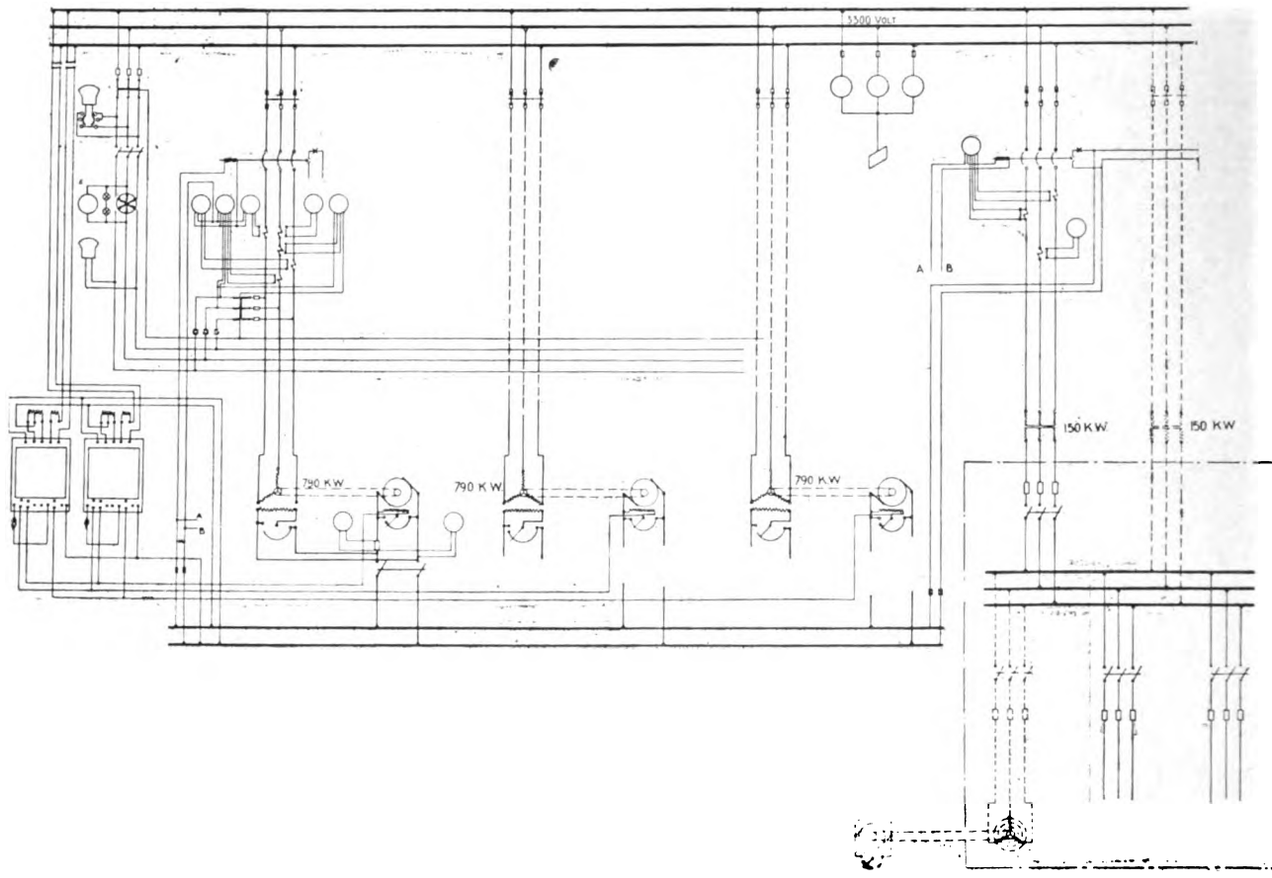

FIG. 12.—Diagram of Switchboard Connections.

combined efficiencies of the pumping sets are: Lowfield, 73 per cent.; Diamond, 67·75 per cent.; Berkune, 72 per cent. Curves plotted from the results of careful tests are shown in the accompanying Figs. 5, 6, and 7.

In order to provide power a central generating station has been built on a suitable site not far from Lindal Station on the Furness Railway, where there is a sufficient supply of water for condensing purposes. The distances from the station to the pits are respectively as follow: to Lowfield, 980 yards; to Berkune, 800 yards; to Diamond, 1,720 yards. A three-phase alternating-current system has been adopted, and, in order to transmit the required power without undue loss and at the same time have a working pressure which could be used direct in the motors without transformers, a pressure of 3,300 volts with a periodicity of 50 cycles per second was chosen. The current is generated by three steam turbo-generators (Fig. 8) of the horizontal type, designed and constructed on the A.E.G. principle, each set being capable of a continuous output of 1,140 kw., 3,300 volts, 50 cycles per second when running at 3,000 r.p.m., and supplied with steam having a pressure of 200lb. per square inch at the stop valve, superheated to

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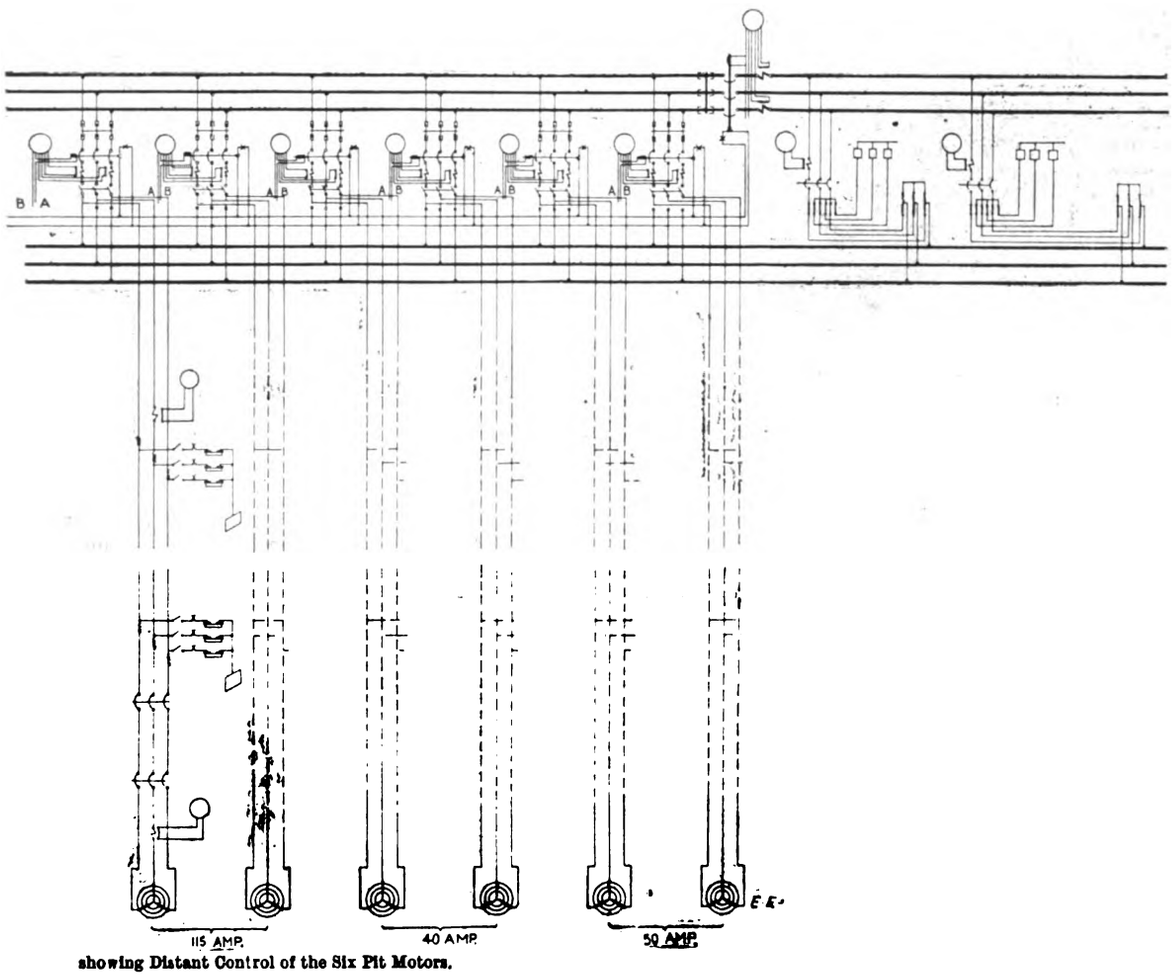
a temperature of about 600deg. F. Each turbine exhausts into a surface condenser of Messrs. Worthington's manufacture, specially designed for maintaining the high vacuum which is necessary for the efficient working of turbine plant.

It may be mentioned here that the A.E.G. turbine is of the velocity type, steam being expanded and its pressure energy transformed into velocity energy in two stages, each pressure stage having two velocity stages. The steam is expanded from boiler pressure down to about atmospheric pressure in the first set of nozzles, from which it passes through the first set of blades and guides. It is then further expanded from atmospheric pressure down to the pressure of the condenser in the second set of nozzles, whence it passes through the second set of blades and guides directly to the condenser. In the turbine proper, therefore, there exist no high steam pressures or temperatures, and the pressure on both sides of the turbine wheel is practically the same. Thus there is no risk of steam leakage through the clearance spacings, and the latter may, therefore, be made large enough to obviate all danger of rubbing contact and stripping of blades. A further advantage is claimed in respect of the velocity principle in that the axial length of the turbines can be kept very small, which fact assists in maintaining great mechanical stability, and, further, valuable space in the engine room is saved. The generator is of a particularly solid and stable construction, the rotating field possessing the characteristic of a solid cylinder. By a special system of ventilation and by water circulation in a double casing round the carcase and bearings the generator is kept particularly cool, and runs practically noiselessly. Each turbo-generator has its own exciter direct-coupled to the main shaft, and by means of the "Tirril" system of regulation, which automatically adjusts the excitation, the terminal voltage on the generator is kept absolutely constant irrespective of load fluctuations.

The steam range, which has been erected by Messrs. Babcock and Wilcox, is of a simple design, and so arranged that each boiler and each turbine can be separately cut off. A separate steam separator is built into the steam range adjacent to each turbine. These separators are of the A.E.G. type, and are built to meet the special requirements pertaining to turbine installations, the design being such as to prevent any grit or fine boiler scaling passing from the steam range into the turbine nozzles. In the boiler-house there are three Babcock and Wilcox water-tube boilers, each having 4,020 square feet of heating surface. Each of these boilers is capable of evaporating under the most efficient conditions 15,000lb. of water per hour. The boilers are fitted with Babcock and Wilcox patent integral superheaters, each having 880 square feet of heating surface and capable of imparting 200deg. F. superheat to the steam produced. They are also provided with mechanical chain-grate stokers of the Babcock and Wilcox pattern, each having a grate area of 75·7 square feet, the three stokers being driven from one shaft by a small three-phase motor. The feed water is delivered by a Weir pump of the single-acting type through a Green's fuel economiser of 400 pipes, having electrically-driven scrapers. Fig. 9 shows the arrangement of the engine-room and boiler-house plant and condensers. The steam consumption obtained on test was about 15½lb. per kilowatt-hour with a vacuum of 95 per cent., and steam at a pressure of 200lb. at a temperature of 572deg. F. This figure compares very favourably with the efficiency guaranteed by the contractors of 18·2lb. per kilowatt-hour.



showing Distant Control of the Six Pit Motors.

The current from the turbo-generators and to the motors is controlled by means of a main switchboard of special cellular design (Figs. 10 and 11). This board is one of the first of its type erected in this country. No marble is used in the construction of the board, the front of same being of tiled masonry, upon which the instruments are mounted, the switches, etc., being operated through the medium of hand wheels. The connections are made to the switchgear by means of spindles passing through the tiled wall, these spindles driving either direct on to the switchgear or by sprocket wheels and chains. This arrangement ensures the entire isolation of the high-tension apparatus, and effectually minimises fire risks and danger to the staff. A special feature of the gear is that each of the six pit motors is individually under the control of the power-house

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engineer, the whole of the starting and stopping operations being carried out by means of the switchboard apparatus.

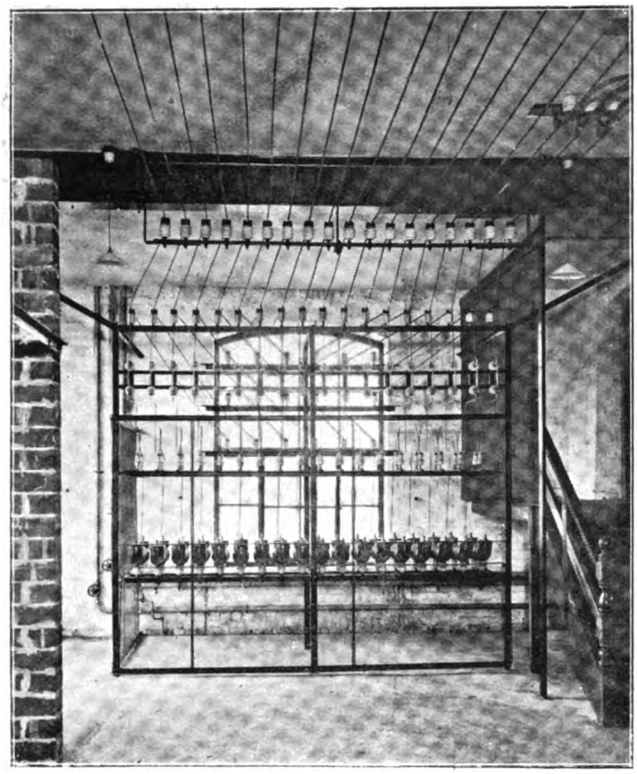

FIG. 13.—Arrangment of Lightning Arresters.

A word is necessary respecting the arrangement of the controlling device. Referring to the diagram of connections (Fig. 12), it will be seen that two sets of 'bus bars are provided behind the switchboard. One set is for running the motors under full pressure, and the other for gradually raising the pressure at starting. The starting is effected by means of two transformers connected in series—one being an auto-transformer which reduces the voltage to about half the working pressure, while the other has its primary connected in series with the auto-transformer and its secondary connected to the liquid resistance, which is gradually short-circuited on starting the motors. By this means the pressure on the motors is increased gradually, and all large current rushes which might in the ordinary way affect the voltage regulation of the station are avoided. As soon as the motors have been run up to full speed on the auxiliary 'bus bars, they are switched on to the main bars by means of change-over switches of the oil-break pattern. To protect the motors against overload, each line is provided with automatic maximum-current circuit breakers. The hand-wheels operating the oil switches are connected thereto by means of trip gear, this trip gear being operated by solenoids which are fed with current direct from the 'bus bars. The circuit breakers are controlled by relays which are fed through special current transformers from the mains, and as soon as the current exceeds a maximum value the relay closes the solenoid circuit on the oil switch. This solenoid releases the switch from the hand-wheel, and the switch is thrown open by means of powerful springs. The controlling relays can be set to act on various overloads as desired, and can either be fitted for instantaneous operation or with a time element which will allow them to act only after an overload has been on for some predetermined time.

The arrangement of the switching and controlling gear, it will be seen, dispenses with the large staff which would otherwise be required, since the whole of the operations of the plant are directly under the control of the engineer in charge of the station, the only apparatus at the pit heads consisting of an isolating switch in each case, with a voltmeter to indicate when the current is on or off. To permit of each motor being controlled from the engine-house, a separate transmission line constructed of bare copper is run from the generating station to the machine, these cables being suitably carried on porcelain insulators, tested to 10,000 volts, which are fitted on channel iron cross-arms erected on wooden poles. Where six wires only require to be carried single poles are provided, but in every other case the line is carried upon double poles spaced 8ft. apart. Our illustration (Fig. 13) shows the arrangement of the lightning arresters at the generating station. The cross-section of the transmission lines is: to the Lowfield pit, 50 square millimetres per phase; to Berkune and Diamond pits, 25 square millimetres per phase.

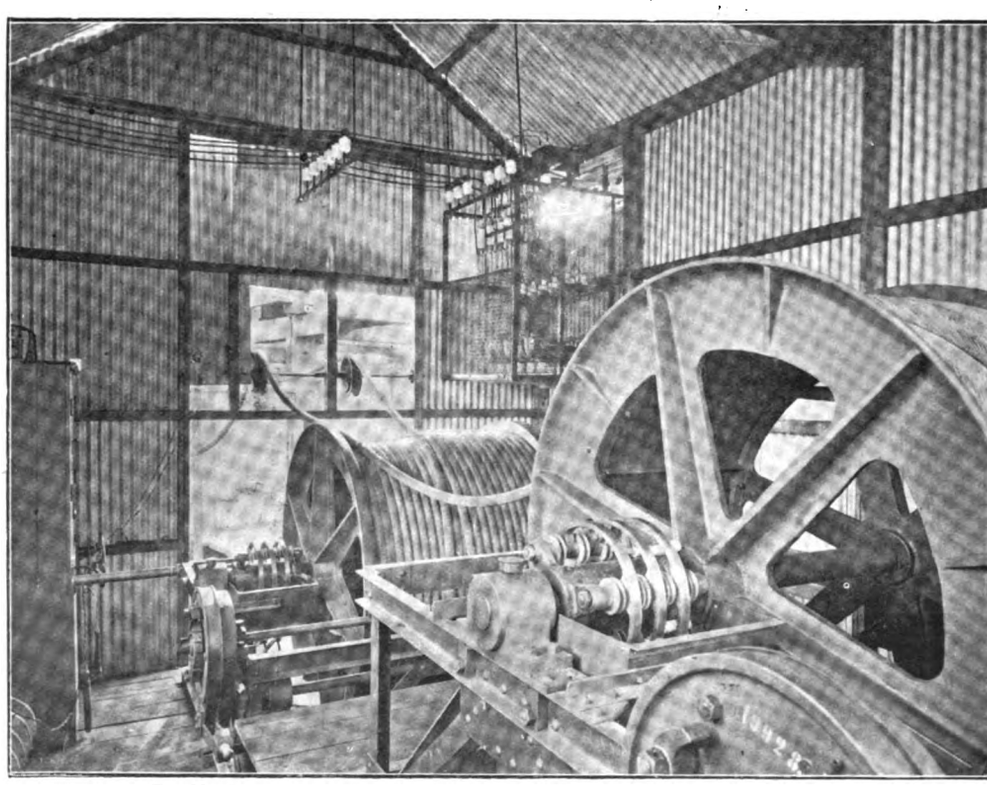

FIG. 14.—Interior View of Sub-Station at Pithead, showing Cable Drums for Electric Cable.

At the point where each transmission line terminates at the pit head sub-station, the bare copper cables are connected to high-tension vulcanised rubber cables through a junction box mounted on the transmission line pole. The

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high-tension cables are in their turn connected through the isolating switch and collecting brushes to the slip-rings of a specially devised cable drum (see Fig. 14). The cables which carry the high-tension current down the pits directly to the motors are of special flexible pattern for transmitting the required full power continuously. They are of the three-core stranded type insulated with pure and vulcanised rubber, the rubber being specially selected so as to render the cables entirely safe for a constant working voltage of 3,000 volts between phases. The three-core cable for each motor is wound on its respective cable drum, one end being connected to the slip-rings on its shaft, the other end being connected through a watertight junction box fitted on the side of the motor, direct to the motor terminals. By means of this arrangement the cable is paid out as the motor is lowered down the pit, and the whole of the live cables and terminals are effectually sealed and protected both mechanically and electrically. The isolating switches referred to above, which are fitted at the pit heads, are further arranged with mechanical devices, by means of which the men in the pits in charge of the pumps can in case of emergency immediately disconnect the motors from the mains.

A complete telephonic system has been installed between the power-house and the various pits, whereby the necessary communications can rapidly pass between the engineer in the power-house and his staff at their various stations.

The whole of the contract, from the boilers to the pumps, has been carried out by the Electrical Company, Limited, under the supervision of Mr. Henry Ward, M.I C E., consulting engineer to Messrs. Harrison, Ainslie, and Co, Limited.

For the contractors Dr. Herzfeld has supervised the electrical part of this unique installation, and our thanks are due to him for the very full and interesting details given in the foregoing. Needless to say, the success of the undertaking, of which there can be little doubt, will add enormously to the prosperity of the district by enabling the development of the Lindal Moor Mines property, which covers about 3,000 acres, on a scale hitherto impossible. We shall await these developments in the certainty that they will give a fillip to the wider application of electricity for similar purposes.

LARGE GAS-ENGINES IN GERMANY.

The Key Engineering Company's Tour.

[BY OUR SPECIAL CORRESPONDENT.]

(Continued from page 510.)

COLOGNE, *Oct. 12.*

The programme sent last week has successfully been carried out, with one or two small changes, with the result that all the party are better informed on the subject of large gas-engines than when we left England on Monday, Oct. 7. In the last four days we have inspected five different works where these engines are in use, and the total horse-power of these engines is considerable, as the following list will show :

Installation.	Number of gas-engines.	Largest engine. H.P.	Total. H.P.
Cie. des Forges et Aciéries, Homécourt ...	5	1,650	6,150
Stumm Iron and Steel Works, Neunkirchen	4	1,000	3,400
Government mines at Heinitz	2	1,200	1,800
Messrs. Ehrhardt and Sehmer's works, Saarbrücken	1	350	350
Hoesch Iron and Steel Works, Dortmund	10	2,200	10,100
Total.....	22	6,400	21,800

These figures indicate without further comment that the large gas-engine is no experiment in Germany, and the total would be increased if I had added the gas-engines used to supply from a distance the coal-pit winding gear we saw on Friday. A further proof of the same fact is that our hosts, Messrs. Ehrhardt and Sehmer, have now in hand the following repeat orders, the engines for which we were able to inspect either at their works or partially erected on site :

	Engines.	H.P. of engines.
Cie. des Forges et Aciéries, Homécourt.....	1	1,650
Government mines at Heinitz	1	2,000
	2	3,000

This represents a total of 11,250 h.p. more for the above plants in addition to a number of engines for other installations than those visited, and shows that there can have been no doubt as to the reliability of the engines. During the whole of the trip we only saw one engine out of (22) out of service. The exception was one of the engines at Heinitz, and it was shut down due to a bearing having fired, caused by dust in bearing through extensive building alterations. The trouble in this case was in no wise attributable to gas being the source of power. Again, while we have no wish to pose as judges of the relative merits of the rival types of gas-engines made in Germany, it was noticeable that when once an engine by Messrs. Ehrhardt and Sehmer had been tried alongside another, the repeat orders went to them invariably. As to constancy of running, it will be noticed that all the above plants are used on mines or in rolling mills, and hence they have to work day and night for weeks at a time. Some diagrams shown us as to the hours of running were interesting, but it hardly needs curves to give the result. From some of these we found that engines had been run for six months without standing more than 2 per cent. of the time for adjustment and repairs. Figures as to the cost of repairs were not available, but the trifling nature of the reasons for the stoppages indicated that these repairs could not have been expensive. Some of the engines had been working more than four years, so that the repair figures should have become normal.

The variety of methods of transmitting the energy produced by these engines will be seen from the following brief notes. At the Cie. des Forges et Aciéries at Homécourt all the gas-engines drive alternators, which were of the three-phase 500-volt type. The load consists of three-phase motors driving a continuous rolling mill and the pumps and other machinery about these large works, which were not open for inspection. The variations in the load were great due to the rolling mill, but there seemed to be no difficulty at all in working the alternators in parallel. A casual visitor to these works would think at first that they were steam-engines before him and not gas-engines. The largest alternators were of the Lahmeyer make. The 1,650-h.p engines (Fig. 1) have two cylinders 1,050mm. (3ft. 5⅜in) in diameter arranged in tandem, and the stroke is 1,200mm. (3ft. 11¼in.). The speed is 95 r.p.m.

On Wednesday, after a pleasant motor ride of some 14 miles from Saarbrücken, we saw the Stumm Iron and Steel Works, where the gas-engines drive the blowers for the blast furnace directly. The air pressure on the delivery is about 7lb. per square inch. The 1,000-b.h.p. engines have 850mm. (2ft. 9½in.) diameter cylinders, 1,000mm. stroke (3ft. 3½in.), and run at 100 r.p.m.

The Government own the mines at Heinitz, and have erected a large number of coke ovens which supply the gas to the engines. Here, again, alternators are employed, but the great distance over which the power is distributed necessitates high voltages. The 5,000-volt three-phase alternators work well in parallel, both with each other and with a previously erected steam plant some miles away. The 600-h p. engine is a single tandem, and the 1,200-h.p. set consists practically of two of the 600-h.p. engines in parallel. They run faster than those at the other works mentioned, as the speed is 150 r.p.m. The cylinders are 630mm. (2ft. ⅜in.) diameter, and 750mm. (2ft. 5½in.) stroke.

At Dortmund we saw the largest collection of gas-engines and the greatest variety in the types at work. Here, again, the latest additions and the largest were of Messrs. Ehrhardt and Sehmer's make There are two 2,200-h.p. engines (Fig. 2), which have been tested up to 2,250 h.p. each, and are, we believe, the largest two-cylinder gas-engines in regular work. They feed on blast-furnace gas and drive direct-current generators. From these, in parallel with other gas-driven sets, the works are supplied through a three-wire 500-volt network. The lighting is done at 250 volts. The engines have two tandem cylinders, each 1,100mm. (4ft. 3¼in.) diameter, with 1,300mm. (4ft. 3¼in.) stroke, and run at 94 r.p.m. The production of over 1,250 h.p. per cylinder is, we believe, the record.

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In some quarters it has been stated that the success of the large gas-engines in Germany is due to the low calorific value of the blast-furnace gas, and that with producer gas they would give trouble. The fallacy of this is shown by our trip, where we saw the engines at Heinitz working successfully on coke-oven gas with a calorific value of from 400 to 500 B.Th.U. per brake horse-power. Producer gas, as a rule, contains from 130 to 150 B.Th.U. and blast-furnace gas 90 to 110 B.Th.U. Mr. Sehmer told us that he made no change in the design or dimensions of the gas-engines to develop a given power from either of the three types of gas mentioned above. The engines are governed by varying the richness of the gas and air mixture, and this was quite sufficient to give satisfactory working when the calorific value of the gas was changed. Hence with the wet coke-oven gas at Heinitz more air and much less gas was used than at the other places where blast-furnace gas is used.

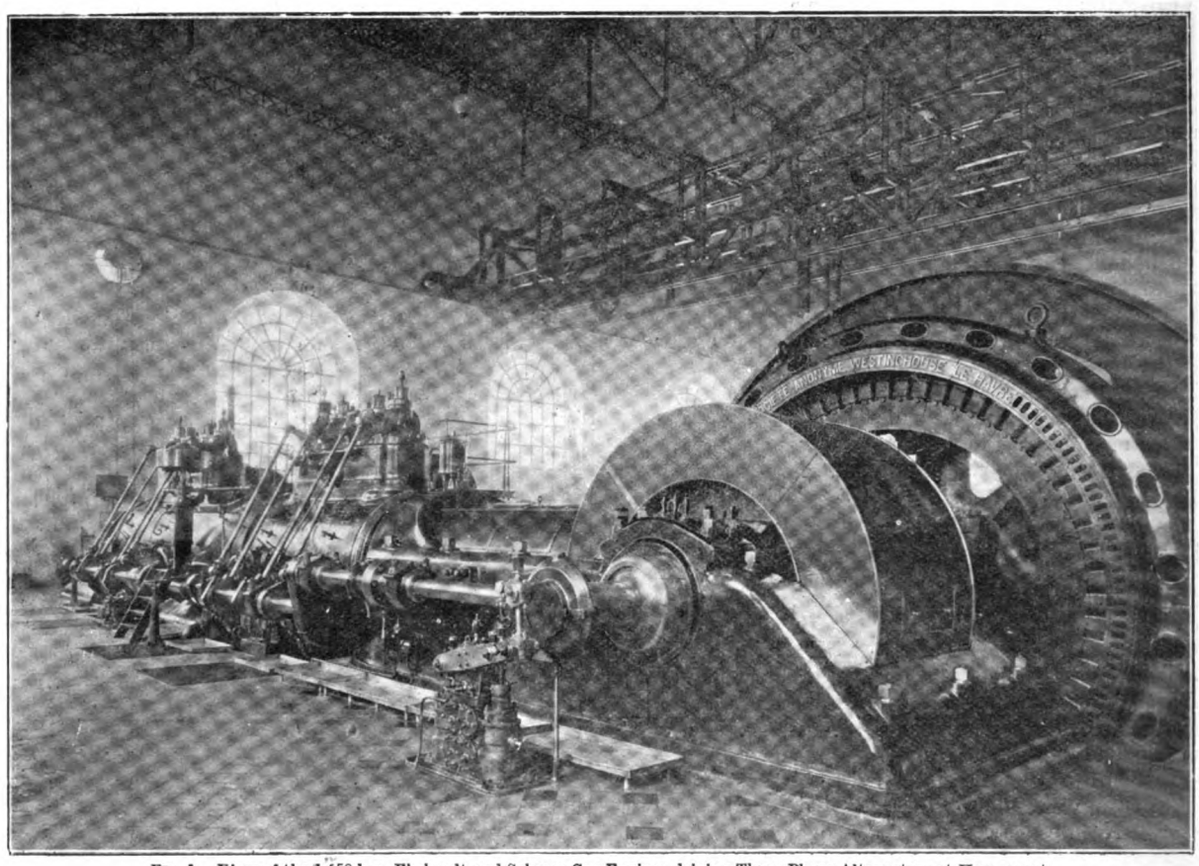

FIG. 1.—View of the 1,650-h.p. Ehrhardt and Sehmer Gas-Engines driving Three-Phase Alternators at Homecourt.

In the early days of large gas-engines trouble arose from the traces of dust in the blast-furnace gas after it had passed through the coke or other scrubbers used. This dust is extremely fine, and is now separated out by centrifugal action. In some cases water is sprayed on to the revolving scrubbers which whirl the gas around, but others give equally satisfactory results when dry. With producers and coke-oven gas the traces of tar, which in the form of

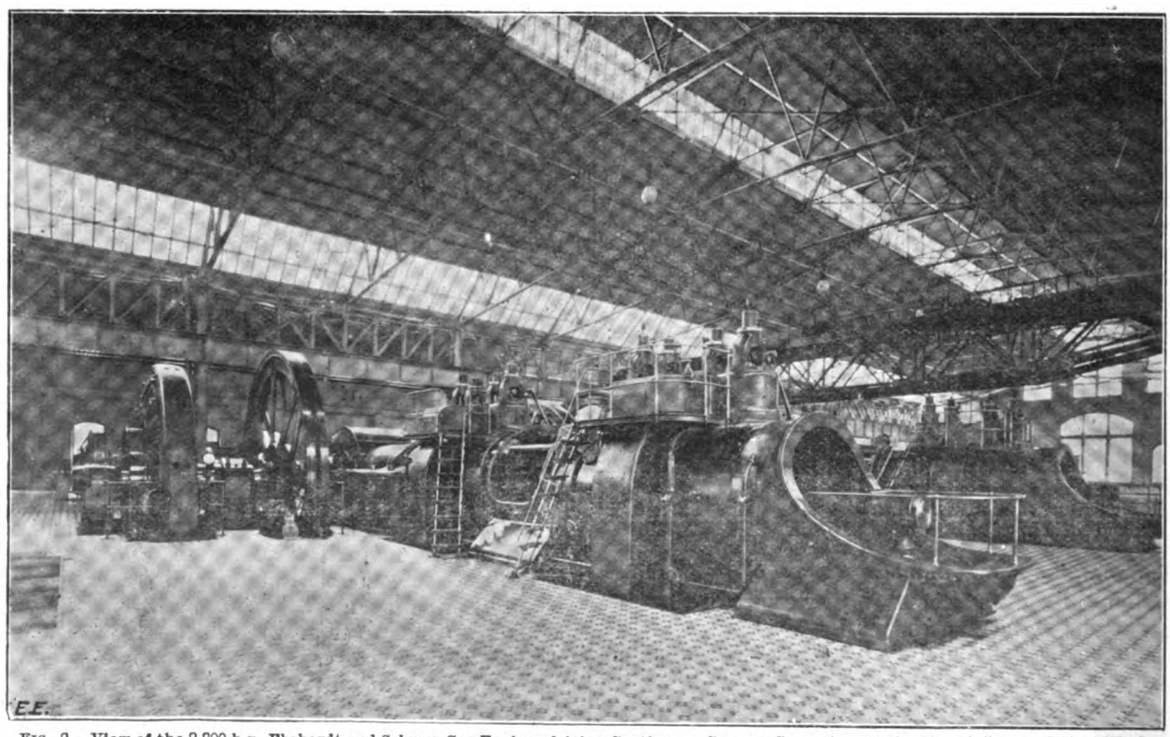

FIG. 2.—View of the 2,200-h.p. Ehrhardt and Sehmer Gas-Engines driving Continuous-Current Generators at the Hoesch Iron and Steel Works.

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fine smoke pass the purifiers, have given trouble, but these again yield to centrifugal separation.

engines, and by devoting their entire energies towards specialising these to bring them to their highest possible

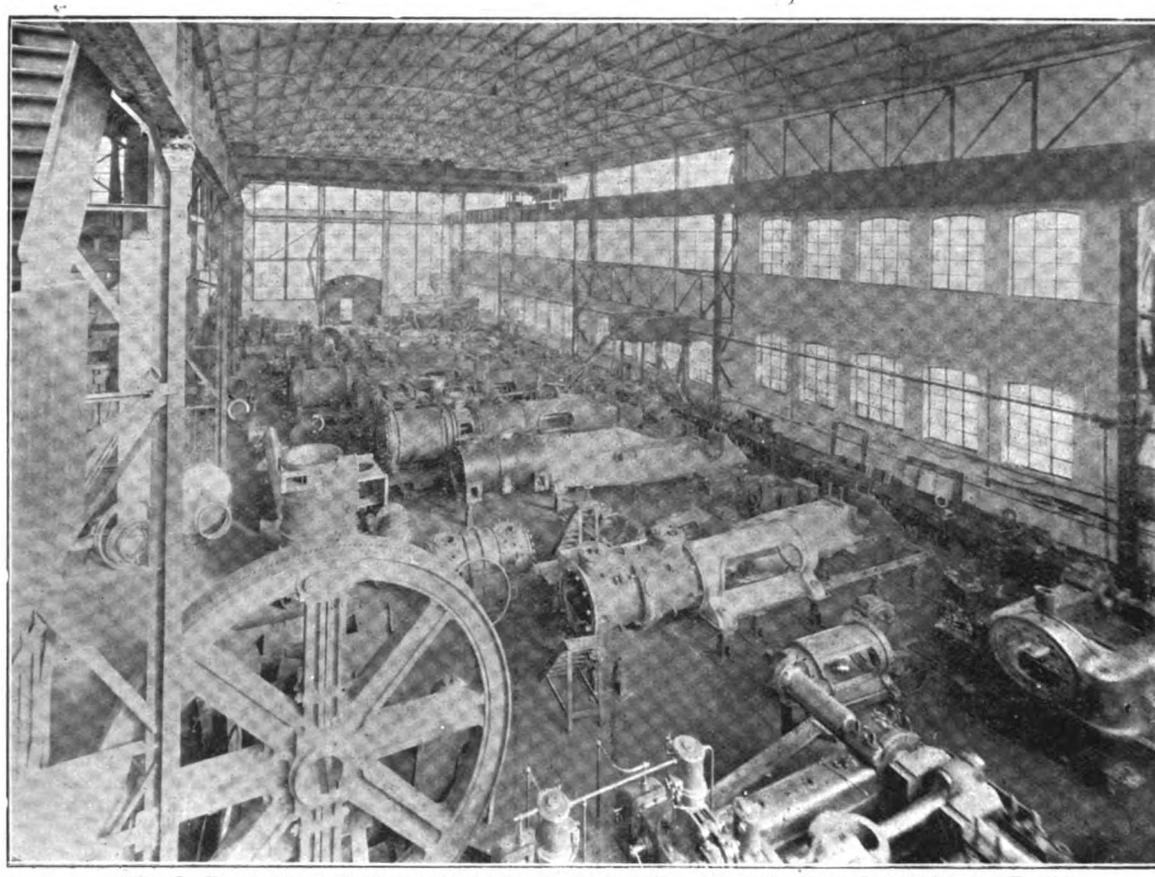

FIG. 3.—View in Messrs. Ehrhardt and Sehmer's Main Erecting Shop, showing Gas-Engine Parts in Course of Erection.

The details of the Ehrhardt and Sehmer engine cannot be described without drawings, which we hope to give next week, but a description of the works of the firm who entertained us so royally at Saarbrücken will help to

state of perfection. In order to add to the commercial efficiency of the works, the various workshops were furnished with the best tools procurable, and their relative position to one another was so arranged that the machine

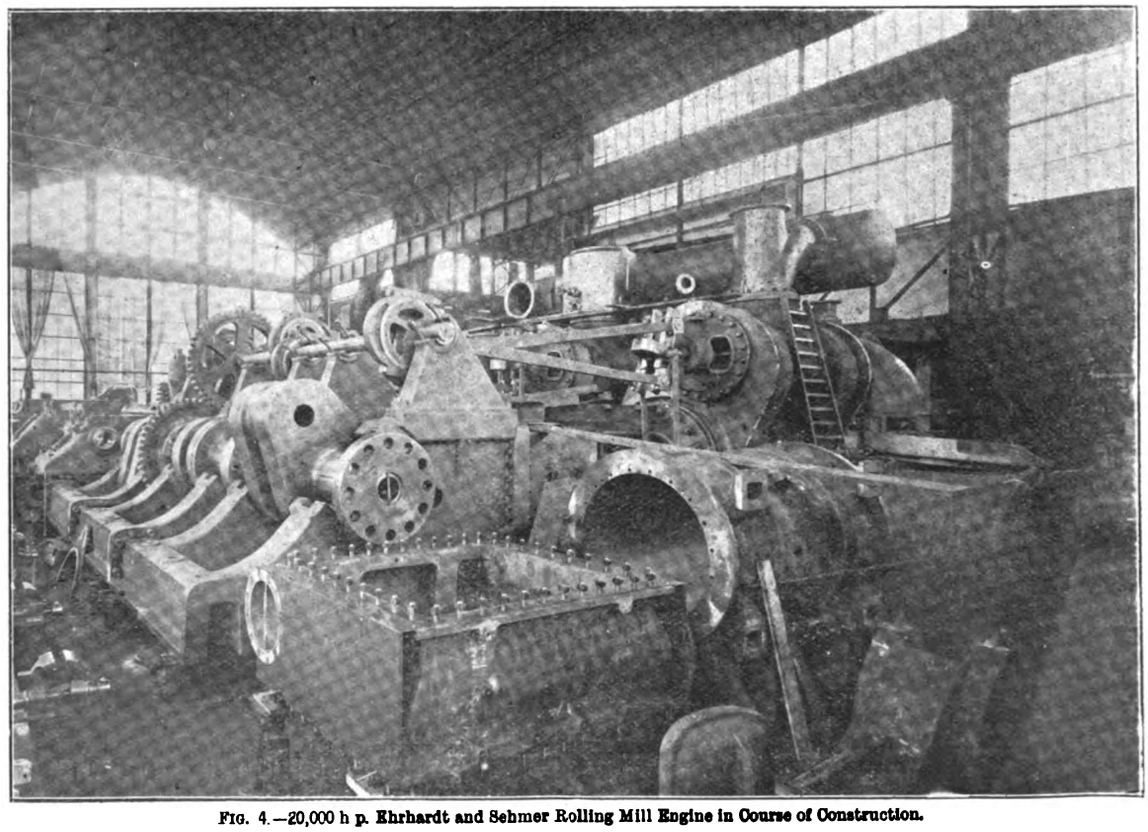

FIG. 4.—20,000 h p. Ehrhardt and Sehmer Rolling Mill Engine in Course of Construction.

explain how they obtained the engineering experience which enabled them to perfect their gas-engines. The works were established in 1876, and the proprietors then decided upon the construction of but few types of

parts, in their progress from the rough material to the finished article, should pass through a continuous row of workshops, so as to necessitate but little transport until they reached the erecting shop, where they would be con-

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verted into a complete engine. At the same time, however, the probability of extensive enlargement in the future was kept in view. The firm's specialities consist of rolling-mill, pumping, and winding engines, and large gas-engines. From the very beginning the following rule has been continually observed in the works: any experience won from day to day, both in the construction and in the working of complete engines, is only profitable if applied in every new construction. That the firm's productions keep pace with the latest requirements is proved by the frequent extensions which have been necessary since the works were founded. Their machinery has extended outside Germany into England, France, Russia, Belgium, Italy, Spain, America, Africa, and Asia (Japan). The engineering works to-day employ nearly 1,000 workmen and officials, and comprises an area of 130,000 qm. Fig. 3 is an interior view of the main erecting shop. The development of the individual types of engines will be found fully described in the following paragraphs.

Pumping Engines.—In the province of pumping engines, Messrs. Ehrhardt and Sehmer were the pioneers of subterranean pumping engines in the Saar mining district. In the year 1878 they erected two high-speed, compound pumping engines at the Gerhard Mine, Louisenthal, to raise 1·7 cubic metres of water a height of 215m. with 99 r.p.m. These engines proved their economic superiority over the surface engines in a most complete manner, so that the latter type is to-day almost entirely superseded. Assuming equal outputs for each class of engine, the subterranean pump requires scarcely half the outlay in capital, is much more reliable in working than the clumsy rod connections, is more easily kept in order, and more economical in steam consumption Since 1870 more than 170 pumping engines, with a total of, in round numbers, 32,000 h.p., have been constructed. Amongst these are single engines of 1,560 effective horse-power. The largest volume of water per engine is 20 cubic metres per minute. The highest point to which the water is raised is 650m. Pumping engines driven directly by electricity may be employed in subterranean workings, where the space for a plant is necessarily very small. To meet such cases Messrs. Ehrhardt and Sehmer have added the high-speed electrically-driven pump to their programme. The pump valves are self-acting, without any kind of valve gear, thus preventing a constant source of complications in working, are thoroughly exact, and altogether faultless in action. Their particular construction was decided upon after many years' experimenting, and they have shown themselves to be the best of all even under the most difficult conditions, such as foul and even water-contaminated iron salts. The pump is so constructed and designed that it may be kept at work for several days continuously without any special attention.

Winding Engines.—Messrs. Ehrhardt and Sehmer have generally constructed large winding engines on the twin and compound system, having the cylindrical rope drum situated directly on the crank axle. The engines possess distributing valve motion actuated by eccentrics and reversing slides.

Rolling-Mill Engines.—The rolling-mill engines built by the firm are (1) flywheel engines and (2) reversing engines without flywheels. The flywheel engines revolve in one direction only, are constructed in the single-cylinder and in the compound-tandem engine types, and generally possess their own condenser. They are chiefly employed for working three high trains for small and medium sections. The reversing engines have cranks set at an angle of 120deg. for direct driving of finishing rolls. The advantages of the three-cylinder reversing engine consists in its uniform revolution, its easy handling, its great initial momentum, and its small consumption of steam. The firm has up to date erected over 23 twin and 31 three cylinder reversing engines, and has, for example, delivered three twin and five three cylinder reversing engines to one single important rolling-mill concern, and is at present engaged on a 20,000-h.p. three-cylinder reversing engine (Fig. 4) for a Belgian steelworks; the engine stands at present in the erecting shop, and we inspected it on Wednesday, the 9th inst. It has one high-pressure cylinder 1,550mm. diameter (5ft. 1in.) and two low-pressure cylinders 1,750mm. diameter (5ft. 9in.). The stroke is 1,500mm. (4ft. 11in.), and it runs at 150 revolutions. The photograph of this rolling-mill engine (Fig. 4) does not give a good idea of its size, as there is no work standing on it. It is one of the largest engines built for use on land. The reversing gear acts on all the cylinders simultaneously, and a governor holds the speed to 150 revolutions when the blooms are not passing through the rollers.

(To be continued.)

COLONIAL NOTES.

South Africa.

Difficulties have arisen with regard to the carrying out of the proposed reorganisation and reconstruction of the electric lighting and tramway systems of East London. Our readers may recollect that a scheme was drawn up by Mr. J. Mordy Lambe, the town electrical engineer and tramways manager, and confirmed by the city electrical engineer of Cape Town (Mr. W. F. Long), and the borough electrical engineer of Durban (Mr. John Roberts), which proposed an expenditure not exceeding £50,000. This was in due course submitted to Mr. J. Denham, the Government electrician, who presented the following report thereon, which we abstract from the *East London Daily Dispatch*: "I am of opinion that it is quite unnecessary to spend such a large sum of money, and to erect an entirely new power station, when there is nothing fundamentally wrong with the present scheme. There is no reason for supposing that the new service will be a startling improvement on the existing one, nor that there will be any considerable increase in demand for electrical energy in consequence. The new scheme will at once be saddled with £3,000 a year interest on the loan, in addition to the standing charges, interest, etc., in connection with the present plant and buildings; therefore, there is every probability that the price per unit will have to be increased instead of reduced if the scheme is to be self-supporting. Even assuming that the machinery to be installed turns out to be the best and most economical of its kind, unless the consumption of energy paid for by the public is doubled or trebled (a very unlikely contingency), the scheme must still be a financial failure." The scheme as proposed is as follows: (1) to build and equip a new power station, entailing an expenditure of £35,000; (2) to lay additional cables and distribution mains, £7,500; (3) to double the tramway track in certain places and improve it in others, £5,000—amount to be expended, £47,500. The estimated revenue of the new scheme is £40,452, and the estimated costs £34,471. The gross profit is estimated at £17,602 and the net profit at £5,982, while it is expected to bring down the total cost per unit generated from 4·85d. (the present cost) to 2·6d.

The East London Council, acting on the advice of the electrical engineers who were consulted, have definitely decided to proceed with the scheme, and have resolved to deposit the necessary plans with the Government, in accordance with the Electric Light and Power Act of 1895. It is curious that under the terms of that Act the duties of the Government electrician are confined to securing the safety of the public in the working of electricity and tramway undertakings, so that his attitude might seem *ultra vires*.

Australia.

It seems that the telephone between Melbourne and Sydney is becoming increasingly useful, but it has not yet been ascertained if the business has reached a payable stage. During the week ended Sept. 6 the calls numbered 214. The total income was £48. 17s. 4d. The calls from the Melbourne end continue to be the most numerous.

Canada.

The party of journalists who are at present touring Canada, inquiring into the resources of the colony, continue to send home glowing accounts of the vast possibilities which are open to enterprises there. The enormous water power not unnaturally comes in for a good deal of attention. As one correspondent points out, according to a recent Government survey Ontario has waterfalls which if utilised would produce 3,000,000 h.p. Less than 300,000 h.p. has so far been utilised, so that there is running to waste 2,700,000 h.p., which is available to drive the machinery of the lumber and pulp mills, and the mines which shall yet be developed throughout the northern portion of the province. Several correspondents refer to the increasing adoption of electricity for manufacturing and commercial purposes within a radius of 150 miles of Niagara. In other parts of Ontario small places, little more than camps, are to be seen which have electric light and power. Mining machinery, saw-mills, and pulp mills are run by electricity in seemingly out-of-the-way places. As the timber and pulp-making concessions are taken up and the mineral deposits opened up the demand for power will increase, to say nothing of the requirements occasioned by the expansion of existing and the springing up of new manufacturing centres,

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LONDON COUNTY COUNCIL.

The Highways Committee have submitted a report showing the results of the working of the Council's tramways for the year ended March last. The committee state that the capital expenditure on the undertaking up to March 31, 1907, amounted to £6,946,310. 11s., of which £2,064,621. 4s. 5d. represents expenditure during the year 1906-7. The total debt repaid up to the same date amounted to £603,173. 7s. 9d. out of revenue, and £209,573. 5s. 7d. from the proceeds of sales of horses and old materials, etc. The debt outstanding on March 31, 1907, was £6,133,563. 17s. 8d., or, deducting £24,658 for the value of surplus land, £6,108,905. 17s. 8d. The total receipts from electric traction were £829,258. 10s. 5d., and the expenses £478,418. 11s., leaving a surplus of £350,839. 19s. 5d., which, after the deduction of £11,352. 7s. 7d. deficiency on horse traction, amounts to £339,487. 11s. Against this have to be set: debt charges, £324,656. 10s. 2d.; income tax (after crediting £8,575. 1s. 7d. for tax retained from interest on debt), £1,424. 18s. 5d.; interest on purchase money, £3,275. 18s. 1d.; parliamentary expenses, £4,780. 6s. 5d.; deficiency on Drake-buildings, £74. 1s. 1d.—total, £334,211. 14s. 2d.—which, after deducting net interest on cash balances, etc., £4,397. 17s. 4d., gives a net balance for 1906-7 of £9,673. 15s. The balance brought forward on the appropriation account on April 1, 1906, was £31,249. 6s. 11d., and the surplus revenue balance of £9,673. 15s. increased this to £40,923. 1s. 11d. Out of this sum £35,000 was transferred to the renewals reserve fund, and the balance of £5,923. 1s. 11d. is being carried forward in the accounts for the current year. The total of the tramways renewals reserve fund at the beginning of the year was £103,683. 14s. 7d. The fund has been credited during the year with dividends and interest, and with the sum of £35,000 above referred to, and amounted on March 31, 1907, to £141,855. 1s. 3d. The fund was not drawn upon during the year. The committee point out that on the working of the southern tramways during the year there was a surplus of £93,259 after paying interest and sinking fund charges. This would have been sufficient to set aside £63,470 for renewals, on the basis of 1d. a car mile run, and to carry forward a balance of £29,789. This surplus is very nearly absorbed by the loss on working the northern tramways during reconstruction, but the figures indicate that the results of working electric tramways show a surplus which will considerably increase as the various horse lines are electrified. The total operating expenses for electric traction were £478,418. 11s., including £6,053. 6s. 6d. for special charges, or 7·06d. a car mile run, as compared with 8·04d. a car mile in 1905-6. The total expenditure in connection with horse traction amounted to £596,697. 15s. 4d., or 10·33d. a car mile run. Considerable loss was sustained during the reconstruction of horse lines for electric traction, as not only were some of the routes entirely closed, but sections of other routes had to be closed, and so disorganised the whole traffic on important through routes.

The system on April 1, 1906, included about 30½ miles of electric tramways, and during the year a further length of about 28½ miles was opened, making a total of about 59 miles. During the year 183,062,068 passengers were carried on the electric cars and 131,165,027 on the horse cars, making a total of 314,227,090 on 30,130,297 car miles run. The average fare per passenger was 1·05d., as compared with ·99d. in 1905-6. The total number of units generated up to March 31, 1907, at the Greenwich generating station since its opening on May 26, 1906, was 25,009,345, and the cost amounted to about ·676d. a unit, including interest and sinking fund charges.

In the Finance Committee's report, the aim was to direct the attention of the Council to certain features in the accounts to which the committee thought it desirable that attention should be called. The committee point out that the surplus on working for the year, £339,488, is £49,912 less than the estimate prepared at the beginning of the year, but they are informed that this is accounted for mainly by the delay in starting the working under electric traction of the lines reconstructed during the year. The traffic receipts from electrical working averaged 11·95d. a car mile, and the total receipts, including advertisements, etc., 12·23d. a car mile, as compared with 12·37d. in 1905-6. The estimate of receipts—viz., 1s. a car mile—adopted for the purpose of calculating the probable financial results of new tramway schemes, appears to be justified. The estimate of 7d. a car mile for working expenses of new schemes is 0·75d. less than the actual figure during 1906-7, but this figure should be substantially reduced as the Greenwich generating station comes into fuller use. The estimate of 7d. a car mile is based on the power being wholly supplied from the Greenwich generating station. The earnings of the horse tramways averaged 9·83d. per car mile, or, adding sundry receipts, 10·13d. per car mile. The working expenses were 10·33d. The figures appear to point to the desirability, from a financial point of view, of the early reconstruction of the remaining horse lines for electric traction. On March 31, 1907, £83,008. 16s. 2d. of the tramway renewals reserve fund was invested in 3 per cent. London County Consolidated Stock. Since that date the Council invested a further sum of £20,000 in 3½ per cent. London County Consolidated Stock, and the committee are arranging for the investment of a further sum of £20,000 in the National War Loan.

PERSONAL.

Mr. A. E. Thomas, of the borough of Wrexham electricity works, has been appointed chief clerk of the Partick electricity works, Glasgow.

Mr. Whittington, of Norwich, has been appointed assistant electrical engineer to the electricity department of the Kilmarnock Town Council.

Mr. H. W. Marshall, of the consumers' complaint department of the Metropolitan Electric Supply Co., has been appointed as canvasser and agent to the electricity department.

Mr. J. R. Chapman, chief electrical engineer of the Underground Electric Railways Co. of London, has been elected a director upon the Board of the Metropolitan District Railway Co.

After representing some of the largest firms in the electrical trade for 15 years, Mr. Leoline Edwards, of St. Margaret's, Twickenham, is leaving this country for Australia on the 31st inst.

Mr. G. E. Smith, A.M.I.E.E., resident superintendent engineer of the Urban Electric Supply Co.'s works at Dartmouth and Newton Abbot, has been presented with an oak sideboard on the occasion of his marriage.

Messrs. T. Harding Churton and Co., Atlas Works, Leeds, have appointed Mr. Cecil A. Esmarch, M.I.E.E., of 17, Collingwood-street, Newcastle-upon-Tyne, to be their agent in Newcastle and district for the sale of alternating-current motors.

The Lynn Town Council have promoted Mr. C. Jackson to the vacant position of chief assistant to the electricity department in place of Mr. C. H. Klyne, resigned. Mr. A. Brown, of the Lincoln electricity works, has been appointed to Mr. Jackson's position.

The Union Electric Co., Southwark, London, S.E., have appointed Messrs. Congdon and Co., of 5, Newton-street, Manchester, as their agents for Lancashire and Cheshire for the sale of their dynamos, motors, switchgear, and measuring instruments.

Thermit, Limited, have been appointed sole agents for Great Britain and Ireland for the sale of Messrs. Edgar Allen and Co.'s patent anchor grips. Samples can be inspected at 27, Martin's-lane, Cannon-street, E.C., where inquiries should be addressed.

Mr. H. M. Hobart, M.I.C.E., Oswaldestre House, Norfolk-street, Strand, London, has taken into partnership Mr. A. J. Ellis, with whom he has been associated for several years, and his consulting engineering practice will in future be carried on under the name of "Hobart and Ellis."

Our readers will doubtless recollect that in connection with the "Harmsworth Self-Educator," which has just recently been completed, an examination, open to all readers, was held bearing upon the subjects dealt with therein, and we are pleased to note that the first place in "Electricity" has been taken by Mr. Samuel Frith, 77, St. John's-road, Bootle, who is a most enthusiastic amateur, and is also the promoter and the present hon. secretary and treasurer of the new Liverpool and District Electrical Association. For this success he is entitled to a ticket for a tour to Greece, Egypt, and Palestine, etc.

News has reached Darwen this week giving particulars of the death of a well-known townsman in the person of Mr. Samuel Shorrock, whose death in China caused a good deal of regret in the district. Mr. Shorrock, who succumbed to an attack of dysentry, first went out to China in 1897, starting business as a machinery importer and consulting engineer. Since 1903 he had dealt also in electrical supplies of every description, and as agent for Messrs. Bruce Peebles and Co. he was largely responsible for securing them the tramway concession. A native of Lancashire, prior to his arrival in Shanghai he was a member of the old-established firm of Messrs. J. and R. Shorrock, of Darwen. He followed affairs in Shanghai very closely, and but for his connection with the tramway company would have probably been elected to the Municipal Council. At the funeral there were present representatives of deceased's firm, the Municipal Council, Messrs. Bruce Peebles and Co., the British Consulate and Supreme Court, all the principal hongs, the Stock Exchange, many Masonic brethren, and others.

We regret to learn of the death of Mr. David E. Evans, of Baltimore, one of the most prominent engineers and contractors of that part of the country. Mr. Evans was born at Pontypridd on Nov. 15, 1849, and was educated in private schools, and was then apprenticed to the trade of engineer and machinist. At the age of 20 he was made master mechanic of the Taff Vale Ironworks of his native town. He afterwards became the chief engineer of the Cymmer Steam Coal Collieries, then superintendent for Llewellyn and Cubitt, engineers and machinists, in South Wales. During the Franco-Prussian war Mr. Evans served as second engineer on the steamship "English Lizzie," and ran the blockade in the River Elbe. In 1880 he went to America, entering the employ of the Brush Electric Light Co. at Cleveland, and in 1891 he organised the firm of David E. Evans and Co., engineers and contractors, and engaged in the general contracting business, giving special attention to the building of electric lines. Mr. Evans's death came when he was in his prime, at a time when he was engaged in numerous enterprises. He was a director in a number of companies, vice-president of the Old Town National Bank of Baltimore, and president of the Maryland Telephone Co. and the Baltimore Electric Light Co.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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PROFESSIONAL TRAINING.

Major O'Meara in his presidential address to the Post Office Electrical Engineers chose this subject for his text. It is ever with us—it is a question appealing to every professional man or youth desirous of entering the profession, and in some aspects it is ever changing. Who of us actively engaged in telegraphic work or professional training forty years ago dreamed then of the changes a lifetime would see? Name the leaders educationally and practically then—Kelvin, Clerk Maxwell, Fleeming Jenkin, Preece, Latimer Clark, Webb, Varley, Willoughby Smith, Saunders, etc. It is doubtful if anyone of these had the faintest conception at a period anterior to 1875 of the progress and development even then imminent. The ideal professional training then and the ideal professional training now have completely changed, except in a few particulars, of which later on, because the work of the ideal professional man has completely changed. Then the student was not attempting too wide a range if he expected to make himself acquainted not only with principles, but also with practical details. The development since then compels students to (1) obtain a thorough grasp of principles, (2) to specialise in one or other of half a dozen branches of the subject. Major O'Meara sees this clearly, and he says: "It is essential that one and all shall possess a thorough knowledge of the fundamental principles and laws upon which engineering science is based." All schemes of education should provide for the grasp of principles, but our experience is that this part of education is generally treated in far too flippant a manner. In the hurry and scurry of the beginning of the twentieth century specialisation is begun too early, and the poor unfortunate pupil is permitted to pick up principles as best he can. But the more interesting point in Major O'Meara's address is the order of importance of qualifications which make for success. Thus (*a*) personal equation. This is another way of saying that the artist, teacher, or engineer is born, not made. He must be born first, and inherently have the best germs of the personal equation. Education helps, largely helps, but does not make the man. (*b*) Commercial aptitude or, its equivalent, administrative ability. In this a proper course of training is the greatest factor. A quotation from Humphreys shows what is wanted in this direction. He says: "I contend that every engineer student should have some instruction in the principles of accounting, in depreciation, patent law, banking, specifications, and even sociology, etc." The latter again, is Hayford's suggestion, "Why not teach about men." Unfortunately, it is given to but few to choose and discard as they deem fit their men tools, so most responsible engineers and officials have not to choose, but to make the best use of the tools supplied. Lastly, (*c*) quality and extent of professional knowledge. As previously said, quality depends on real knowledge of principles, extent depends largely upon the personal equation and time. The race is not always with the swift. It would be interesting to know the percentage of students trained under some of our pushing teachers which really succeeds. Far too many we know gravitate into other fields of labour and many are examples of mediocrity hopelessly out of the running. There is no scheme of education that can provide for all the wants of civilisation or even for the professional electrical engineer. We are all workers. The whole profession consists of a number of sections, each, in colloquial parlance, being one notch above the other. No scheme of education is worthy the name unless it provides for the possibility of men rising from lower to higher sections of work, and each section, of course, needs a specialised training. We have never been able to believe that our technical schools

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or colleges are anything more than makeshifts. We had rather dogmatise, and say the man that ceases to learn ought to cease to live, but that would be wrong, as every round peg is fit for a round hole. The worker should be ambitious. In the first place, he should make himself thoroughly accomplished in his own special work, yet while doing this should aim at gaining a good insight into the necessary qualifications for the step upwards. So far as we can see, the only educational system which assists this is one that takes hold of a man from his early youth till the end of his working days. The getting into a works or a station is the first step; all other steps need assistance educationally, and the education should go on throughout the years till there is no further advance possible.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

STEAM TEMPERATURE FEED-WATER HEATERS.

SIR,—I have pleasure to enclose herewith results of a test recently made on the above by four independent steam experts, representing some of the largest steam-using firms in the country, which I trust you will find interesting. The test was made upon a 30ft. by 8ft. 6in. Lancashire boiler, fitted with two check-feed valves, one giving economiser feed direct and the other connected through the Wilkinson steam temperature feed-water heater. Counters were fixed upon the automatic stoker and feed pump to secure uniformity of feed, of fuel, and water. The fuel was weighed and the water gauged in large standardised tanks. To secure regularity of steam pressure, the safety valve on the boiler was kept slightly "blowing off." The work done by the boiler in each test was taken up electrically and metered. By varying the loads at the switchboard the "blowing off" was kept fairly regular.

	Economiser without heater.	Economiser with heater.
Duration of test	3 hours.	3 hours.
Coal burnt per hour	1,213lb.	1,120lb.
Coal burnt per hour per square foot of grate area	35·6lb.	32·9lb.
Water evaporated per hour	9,765lb.	10,230lb.
Water evaporated per hour per square foot of heating surface	8·87lb.	9·30lb.
Water evaporated per pound of coal	8·04lb.	9·13lb.
Equivalent evaporation from and at 212deg. F.	9·72lb.	11·03lb.
Absolute steam pressure (average)	150·8lb. sq. in.	150·4lb. sq. in.
Temperature of steam at above pressure by thermometer	361·4deg. F.	359·8deg. F.
Steam temperature after leaving superheater	487·3 ,,	490·4 ,,
Feed temperature from economiser	238·7 ,,	250·5 ,,
Feed temperature due to feed heater	—	360·8 ,,
Average CO_2 in furnace gases	13·2 per cent.	13·4 per cent.
Increased evaporation per pound of coal deducting 1 per cent. for the difference in temperature of feed water from economiser		12·5 per cent.
Saving in coal, making no extra allowance for a continuously clean and efficient boiler		11·0 ,,

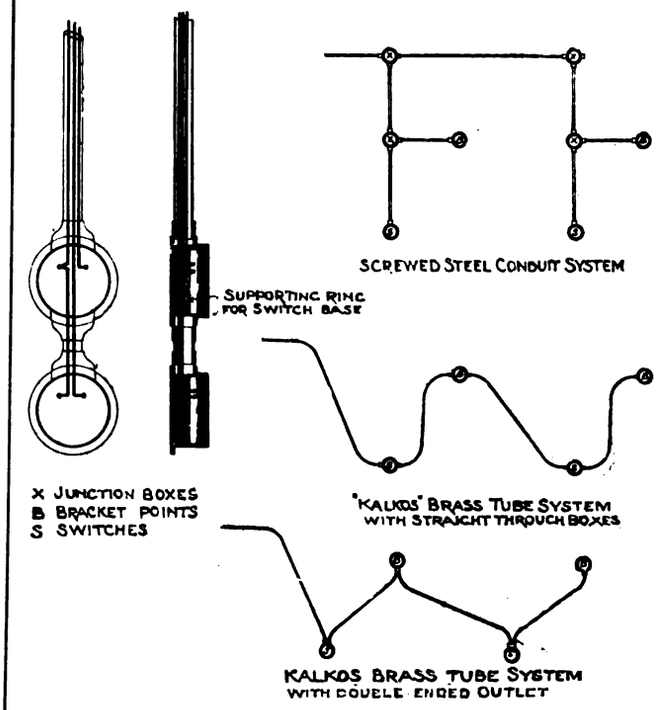
Several users of the heaters to whom I have sent copies of the test write to say that the results are confirmed by their own experience. I have also recently received a communication from a firm using the heater, in which they state they are getting an increased economy of 6·7 per cent., and at the same time an increased output of steam of 13 per cent.—Yours, etc.,

GEO. WILKINSON.

RE "KALKOS."

SIR,—Referring to the article on the "Kalkos" wiring system which appeared in your issue for the 11th inst., one function of the internal ring in the special box for flush work does not seem to be so clearly stated as it might be. These rings are not used merely for adjustment, but convert the box into a two-storey one, giving a passage behind the switch or plug for wires to run through from one box to the next, or from a switch box to a plug box, which, as far as we know, cannot be done by any other box on the market. This leads up to a great economy in carcase wiring. The ordinary practice is to run from a distribution board to a joint-box in the floor, or in many cases on the surface of the wall, or in other cases hidden away out of sight where no one knows where it is. From this box a tube drops to the switch box, and so on.

With Kalkos boxes the tube can run from the distribution board direct to the switch and from the switch direct to the light, looping out from either the switch or the point box to the next switch and point, and so on. The positive and negative wires both run through the switch-box, as indicated in the accompanying sketch, one running straight through below the switch. The bottom part of the switch box can also perfectly well be used to take joints, as the joint would be in a metal box with a porcelain cover to it, this cover being the base of the switch above.


SCREWED STEEL CONDUIT SYSTEM
SUPPORTING RING FOR SWITCH BASE
X JUNCTION BOXES
B BRACKET POINTS
S SWITCHES
'KALKOS' BRASS TUBE SYSTEM WITH STRAIGHT THROUGH BOXES
KALKOS BRASS TUBE SYSTEM WITH DOUBLE ENDED OUTLET

We trust we have made the point quite clear, and it is very important, as by wiring in this manner we find in actual practice that a considerable number of boxes and a considerable length of tubing can be saved over the old method. When wiring the writer's own house only a week or so ago, the wireman had started running on the upper floor in the old way before he received his instructions. On inspecting the work it was noticed, and the wiring already done was altered to the new method, with the result that a large number of boxes and a considerable quantity of tubing was saved. The advantage of using switch boxes as draw-through and joint boxes also is obvious, as the switches are in easily accessible places and joints can be got at at any time.—Yours, etc.,

HANDCOCK AND DYKES.

A RECORD RUN.

SIR,—We read from time to time in the pages of the *Electrical Engineer* of big things being done in nearly every part of the world, but it is very seldom there is an account of the doings electrically in the States of Australia, and it is not because I have an extensive plant to write about, but because of the record run that has been made with the small plant for the Municipal Council at Penrith, New South Wales. This plant was put down by H. H. Kingsbury in 1890, and consists of two 35-kw. alternators, by Thomson and Houston (American), with face-wound armatures, running at 1,500 r.p.m., driven by two horizontal compound engines with locomotive-class boilers. The boilers were discarded about four years ago, and replaced by a return-tube marine boiler of 100 h.p. The special feature of the running of this plant is that, although run every night, the armatures have not given out until three months ago, when the insulation was completely

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perished. When it is taken into consideration that the room where these machines are working is built of iron throughout, and that in a climate where it is no rare thing to have 110 and as high as 113 in the shade, and not drop below 100 in the night, it must be agreed that these machines have done a fair run under such conditions for 17 years. One of the exciters, running at 2,400, had a new commutator three months ago. The countershaft, running at 240, has never had a new brass nor metalled. The engines have cylinders of 11in. high pressure and 17½in. low pressure running at 120 r.p.m, and have never had a new brass or even metalled. New piston rings were put in the high-pressure cylinders three years ago, but the low-pressure are still running with the rings supplied by the makers, and the cylinders scarcely show a perceptible oval. So much for the faithful work of R. Hornsby and Co. This is only a small plant, but it has done big work, and is doing the same yet as it did at the start—in fact, very often more than it was ever intended to do. Now, if any of your readers have a better record to give than this I would like to hear from them.—Yours, etc., D. H. S.

Penrith, N.S.W.

THE MERCURY-VAPOUR CONVERTER OR RECTIFIER.

SIR,—*In re* the best answer to Question No. 999, appearing in your issue for Oct. 4, would you be so kind as to inform writer where one is able to obtain particulars, such as price and size, etc., of a mercury-vapour converter? I will look out for answer in your "Correspondence" column.—Yours, etc., H. P. S.

Hettstedt, Saxony, Oct. 10.

[We believe rectifiers of the type referred to by our correspondent are supplied both by the British Thomson-Houston Company, Limited, of Rugby, England, and the British Westinghouse Electric and Manufacturing Company, Limited, of Trafford Park, Manchester, who will doubtless be pleased to give all particulars required. The apparatus is extensively used in the United States for isolated plants and battery charging where small powers are required. Special attention has been given by the manufacturers to small mercury-vapour converter sets for charging ignition batteries, etc., and these are self-contained.—ED., *E. E.*]

GAS-ENGINES.

SIR,—I wish to obtain information on the construction and maintenance of large gas-engines, and shall feel greatly obliged if you will kindly inform me of any papers or books dealing with the subject. The engines with which I am engaged are used for driving dynamos. They were made by the Premier and Westinghouse Companies, and include units of 500 h.p., 750 h.p., and 1,000 h.p. each. I also desire to obtain information of other makes.—Yours, etc., R. T. G.

[Referring to our correspondent's last request, we shall be pleased to forward on to him any descriptive lists which makers have issued on the subject.—ED., *E. E.*]

POST OFFICE INSTITUTION OF ELECTRICAL ENGINEERS.

At a meeting of the Post Office Institution of Electrical Engineers held at St. Bride's Institute on Monday evening, Oct. 14, Major O'Meara, C.M.G., the president, delivered the inaugural address.

After referring to the retirement of Sir John Gavey, C.B, from the position of engineer-in-chief to the Post Office, and the honour of knighthood which had been conferred on him by the Sovereign, Major O'Meara said: No subject probably has been more discussed in engineering circles within recent times than that relating to the technical education of engineers and artisans. Many eminent men connected with the engineering profession have dwelt upon this question in their addresses, and have given expression to views which are well worthy our serious consideration. The subject is one of immense importance to us, affecting as it does the success of all our operations. Money can purchase the best of material, but to employ it to the greatest advantage requires that we shall have at our command well-educated officers to direct highly-trained workmen. To deal with the subject fully would necessitate many evenings being devoted to it. But many other important questions demand our attention, and I fully realise that we have not the time at our disposal to do more than just touch on the fringe of the subject to-night. I think we are all ready to admit that in our profession technical education cannot consist in learning by rote something in the nature of a series of prescriptions, one or other of which will later prove to be the solution of each of the various schemes which may be handed over to us to work out in the course of our careers. What is it, then, that the professional education of our engineers should aim at? To quote Pope:

> 'Tis education forms the common mind,
> Just as the twig is bent, the tree's inclined.

These lines apply as truly to professional as to general education.

We are associated with a branch of engineering in which advances have been, in the past, rapid and continuous, and, so far as I can see, the time to call a halt in connection with the march of progress and improvements has not come yet. Engineering already covers a very wide field, and every day the portion of it which the telegraph engineer has to deal with in his daily work is becoming greater in extent. It is not to be expected that individual officers can possess expert knowledge of all branches of engineering affecting their work, but it is essential that one and all shall possess a thorough knowledge of the fundamental principles and laws on which engineering science is based. And the minds of our engineers should be so formed by their professional education and training that in later years, no matter what the nature of the task presented to them for execution in the ordinary course of their duties, still they should be able to pick out intuitively the principal features of the problem before them, and if any of these are new to them, they should be in a position to obtain, by a process of accurate reasoning, a solution of these novel aspects. If courses of instruction are properly designed to develop the student's mental equipment on the lines indicated, then such as have been attentive and industrious in connection with their theoretical studies, and, in addition, have been observant when engaged on practical work, cannot fail to rise to the occasion when the demand is made on them.

Success does not depend entirely on book learning, important though this is: other qualifications are also necessary in our service as in all other callings. If I were asked what is required for success, I would unhesitatingly reply that according to my own experience the following is the order of importance of the qualifications which make for success: (*a*) personal equation; (*b*) commercial aptitude, or its equivalent, administrative ability; (*c*) quality and extent of professional knowledge. Some of you are, no doubt, surprised at the order in which I have enumerated the above qualifications. To these I would suggest that it would be well for them to examine the qualifications of acquaintances who have been successful in life, and whose characteristics they know sufficiently well. I will, indeed, be surprised if my own experience is not fully confirmed by those who carry out the investigation suggested.

Let us consider the above qualifications a little more in detail. Many elements go to make up the personal equation of an individual. To enumerate but a few of the important ones, I would mention initiative, mental capacity, industry, trustworthiness, resourcefulness, tact, judgment, perseverance, loyalty, and good address. Some of these qualities are, no doubt, a gift of nature; but, believe me, when they are not so provided they can be often acquired to some extent by cultivation. They are by no means all of equal importance, nor are they always of the same relative importance and value in every case. Rather does the rank and position of an officer determine the relative value of each of these qualities in any particular case. There is one element in the personal equation which I have not mentioned so far, but a reference to which I ought not to omit. I have in mind the power of an individual to solve the personal equations of his

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subordinates. This instinct is certainly required in some degree by all officers in responsible positions; and in the higher ranks the position of it is absolutely indispensable. I would commend to your notice an address given by Mr. J. Hayford in America, entitled "Why not teach about men, the most important and difficult tool an engineer uses?" You will find there much of interest to you He most truly remarks, "A correct judgment of men is more difficult to attain, but is also more important than a correct judgment of materials."

The second of the main considerations required for success mentioned by me was commercial aptitude. This qualification requires in its possessor the power to control the organisation under him in a manner to ensure that all the resources of men and material at his command are employed in turning out work of high efficiency at the most reasonable cost. To achieve this end waste in all its forms must be checked, and running costs must be strictly controlled. It is alone by attention to these matters that some return on the capital expended can be looked for, and an undertaking made a commercial success. In former times, when our duties were connected chiefly with the maintenance of the public telegraphs, and our officers were not brought into such contact with individual members of the public as is the case to-day, economy had certainly to be studied. In those days our organisation was not large, and, therefore, the control and check of expenditure could be very minutely exercised from headquarters. Economy claims our attention no less to-day than in former times, but our organisation has now become vast, and we are further charged with the duty of providing particular services to meet the requirements of individuals, some of whom naturally have fancies of their own. These factors cannot fail to render a very close check on expenditure increasingly difficult, and it has, therefore, become infinitely more important that officers of even very junior rank should pay a closer attention to those matters which are so intimately associated with the administrative side of our work, and thus add to the efficiency of the control and check on our expenditure—that is to say, we must look for the development of commercial ability at an earlier period in the careers of our officers now than was formerly the case.

The position in which I have placed the third of the main considerations affecting success must not be taken to imply that I depreciate the value of knowledge. This is by no means the case; on the contrary, I thoroughly endorse the advice contained in the following lines:

> Seek knowledge, as if thou wert here forever;
> Virtue, as if death held thee by the bristling hair.

It is pretty clear that one can never afford to cease one's studies. Experience has taught me that there is no short cut to knowledge; many long years ago, I fear, I cherished the delusion that such a short cut existed, and I consulted a brother officer in the hope that he would furnish me with a few useful tips which would have enabled me readily to successfully compete at a certain examination. His reply sorely disappointed me, for he informed me that it would be necessary for me to read widely, and read hard, if I ever hoped to accomplish my purpose. He increased my disappointment by forwarding me a large parcel containing publications and books full of notes made by himself. To-day I am ready to freely acknowledge that no advice which I have received in my life has been so profitable to me as that to which I have referred.

The advance in engineering knowledge continues steadily and rapidly, and the real difficulty which exists is that connected with the apportionment of a student's time, so that it shall be devoted in a satisfactory proportion to each of the various subjects affecting his profession in accordance with their relative value in his work. New matters are continually forcing their attention on ourselves, as well as on all others who are engaged in some branch or other of engineering, and it is, I must confess, somewhat difficult to decide on the subjects which should be included in the professional education of our officers. Hitherto, the engineering schools of this country have not provided a complete course of instruction for students desiring to adopt the career of a telegraph and telephone engineer. It is true that in many schools instruction is given in each of the individual subjects which are essential to a student wishing to follow our calling; still, I can quite imagine that the young aspirant to a telegraph engineer's career must find it somewhat puzzling to select exactly those subjects on which he can most usefully concentrate his attention. His difficulty, it is true, arises wholly from inexperience, for there is material to guide him in his choice of subjects; but, naturally, he can hardly be expected to look in the proper quarter for the inspiration he requires. The Indian Government for many years has provided a special course of instruction at the Royal Indian Engineering College, Coopers Hill,* for the engineers required in the Indian telegraph service; and the French and German Governments have met their own requirements by providing special courses of instruction for those officers already in their services who are intended to fill the superior engineering appointments in the telegraph departments of these countries.

Lastly, many of the engineering schools in America have also, in recent years, provided instruction of a specialised character for those of their students who wish to follow the career of a telephone engineer. There are many in the audience before me who, I feel sure, wish to become engineers in our own telegraph service, and I can give no better advice to them than that they should examine the courses of instruction planned by the Indian, the French, and the German Governments, and those of the American engineering colleges referred to. They will be wise, then, to arrange their own studies so as to include the subjects of the curricula mentioned. It will be found that in addition to such subjects as telegraphy, telephony, construction of aerial and underground networks, building construction, and steam-engines, the subjects of administration, finance, political and social economy, also form part of practically all the courses referred to by me. The importance of including subjects of a commercial as apart from a purely engineering character in the education of an engineer is, I am glad to find, now becoming very generally recognised, and I would call your attention to the following reference to this matter in an address given in America by President Humphreys, of the Stevens Institute, whose words were: "I contend that every engineer student should have some instruction in the principles of accounting, in depreciation, business law, patent law, banking, specification, and even sociology, and in connection with the business side of their training they should be made to see the importance of the correct use of language."

I feel that it is quite possible that there may be a few among the younger members of the institution present here to-night who will be wondering what value some of these subjects may have for them. For instance, as regards the principles of accounting, the argument may be advanced that we are employed in a Government department, that Parliament votes supplies which we have to spend on works decided upon by the Postmaster-General. Further, that our accounts have to be prepared in a particular way, so as to meet the regulations framed by the Lords of the Treasury, and, therefore, a knowledge of commercial accounting is likely to be of very little use, if at all, to our own engineering officers. Now, I feel that it is for the very reason that our accounts are prepared in a special way that a knowledge of the principles of commercial accounting is particularly valuable to our officers. Let me explain why. In connection with our telephone system we provide individual services, and, naturally, those availing themselves of such services are called upon to pay the full cost of the same to the department. The method in which our expenditure has to be recorded does not enable us to pick out at once from our ledgers the exact annual value of each service which the department provides, but a knowledge of commercial accounting, and of the basis on which the charges to the public should be framed, however, readily enables us to translate the various items recorded in our ledgers into the appropriate elements which represent the annual cost of each service from a commercial point of view. But there is much more than methods of book-keeping to be learnt from a study of commercial accounting: to take

* The Indian Government has lately decided to close this college, but the curriculum of the course may be found in the calendar of the Royal Indian Engineering College, Coopers Hill, published by Messrs. Harrison and Sons, 59, Pall-mall.

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but a few matters, I would mention methods of preventing fraud; systems of paying wages, both from the accounting and administrative standpoint; the organisation of accounts in relation to administration. Then, again, the value to our officers of some knowledge of business law and banking may not be quite clear. But I would remind you that nowadays we have to deal largely with contractors and others, and in the future we will have to do so more and more. Our relations in these cases must be governed by the same general principles as those which rule in ordinary commercial life. There are many pitfalls for the inexperienced man engaged in business, and it is necessary for every man to have some knowledge of the various ordinary legal points met with in business, in order that illegal acts may not be committed inadvertently. And further, when difficult questions arise, such knowledge will often indicate whether it is worth while to seek legal assistance in dealing with the matters involved. Again, at times, financial crises and questions bearing on the money market are likely to indirectly affect our interests, and as problems connected with such matters are studied in connection with banking, a knowledge of this subject will not come amiss. Further, officers who rise to high positions are often called upon to frame regulations for the administration of the branch under their control. It is, perhaps, on such occasions that the fullest advantage is derived from the knowledge of commercial law and many other business subjects. We can rarely go wrong if we imitate sound commercial methods in our own administrative decrees. The value to an engineer of a knowledge of depreciation, patent law, and specification is so self-evident as to call for no remarks from me. The subject of sociology, on the other hand, I feel that I cannot dismiss quite in the same way. Apart from its bearing upon our relations with those with whom we have to work, the subject is really one of the greatest interest to all thoughtful men. The theory of society is continually undergoing changes, and it certainly seems to me that officers who wish their administrative efforts to be successful will find it profitable to keep in touch with the aspirations of the various classes of workers in this country and also abroad, and, further, to devote a little time to the study of the problems connected with the science of human society. I do not for one moment wish to suggest that you should seek inspiration from Plato and Aristotle, the fathers of the science of society, nor from the writings of Bentham and Mills, but I do feel that we can all with real advantage to ourselves devote some attention to the articles relating to sociology which so constantly appear in the columns of the current issues of our leading magazines and newspapers.

The foregoing considerations leave little doubt that the knowledge required by our engineers should cover a wide range of subjects, and it goes without saying that whatever there is of it should be built up on an absolutely sound foundation.

In conclusion, I wish most strongly to impress on the younger members of this institution that although an engineer's work must be based on theory, yet practical experience alone can make an individual an engineer in anything more than title, and he can no more disregard the commercial aspect of his work than can the manufacturer, and consequently his education must be directed to this end. I hope that I may have succeeded in showing how important it is for each of us to study our own characteristics, as well as those of our subordinates. How this is to be done is a question which I fear must be left to each individual to solve for himself; those who best succeed in doing this will reap the richest reward. And I have also endeavoured to give some indication of the direction in which this institution can help us all. I have mentioned certain subjects which are of immense importance to us, but which in the past have not been as generally recognised to form part of an engineer's education as should have been the case. It will be of very valuable assistance to us, I think, if our council were to induce some who are masters of these subjects to give us the advantage of their knowledge and experience by reading papers on their own special subject during the ensuing session. This institution is still very young, but it cannot fail to grow in usefulness, and I have visions of the many benefits which it will be able to confer upon us all. I can only trust that the ensuing session will be as great a success as was the past one.

SCOPE FOR THE USE OF LARGE GAS-ENGINES FOR GENERATING ELECTRIC POWER IN ENGLAND.

BY LEONARD ANDREWS, M.I.E.E.

A.—For the utilisation of waste blast-furnace gases for driving machinery in ironworks.

B.—The generation of electric power for public supply purposes by surplus waste gases from blast furnaces.

C.—The generation of power for public supply by recovery plant producers.

A. The output of pig iron in England for 1906 was 1,149,388 tons. Under average conditions the waste gases from the production of this quantity of iron would be capable of producing in modern gas engines over 2,000,000 b.h.p. continuously. About 50 per cent. of the waste gases would, however, be utilised in driving the blowing engines, heating the air blast, etc. There would, however, be about 1,000,000 b.h.p. available for other purposes. At those ironworks where finished steel is made as well as pig iron, the whole of the surplus power could be utilised for driving rolling mills, and for other purposes. These steelworks are at present using very large quantities of coal which could be almost entirely saved.

In a paper read by the gas-engine manager of the Differdinger Iron and Steel Works it was stated that prior to installing gas-engines the consumption of fuel for an output of 21,400 tons of iron per month, of which from 70 to 80 per cent. was converted into steel and rolled, amounted to 5,300 tons per month, costing 18s. per ton, equals £4,800, or 4·48s. per ton of iron. Since gas-engines have been installed the coal consumption has been reduced to 500 tons per month, costing £450, and the output has been increased to 30,000 tons per month, giving a cost of fuel of ·3s. per ton of iron, and showing a saving of 4s. 2d. per ton, equals £6,250 per month, or £75,000 per annum. It may be assumed that if a gas plant with electric generators had been installed in the first instance the capital outlay would not have been greatly in excess of steam-driven plant, and the cost of labour, repairs, etc., would probably not be any greater for the gas plant than for the steam plant. It is presumed, however, that the steam plant was already installed, and with the exception of the point of fuel consumption was working satisfactorily, and when the gas-engine plant was installed the steam plant was scrapped, and its value written off. It will be interesting, therefore, to see what relation the saving referred to above would bear to the capital cost of the gas-engine plant. The size of the plant can be roughly determined from the known output of iron—viz., 33,000 tons per month, or 41 tons per hour. A ton of pig iron usually yields from 150,000 to 180,000 cubic feet (say, 160,000 cubic feet); the total gas available would, therefore, be 6,560,000 cubic feet per hour. Of this total about 2,500,000ft. would be required for heating the air blast, etc, and about 800,000ft. would be required for driving the gas blowing engines for the blast furnaces, leaving 3,260,000ft. available for generating power for rolling mills and other purposes. This quantity of gas would develop in modern gas-engines approximately 32,000 brake horse-power hours. The estimated capital cost of engines and generators for the above output complete, with cleaning plant, buildings, switchgear, etc, is roughly £400,000. The estimated cost of the blowing engines erected complete, with foundations, gas and exhaust pipes, cleaning plant, buildings (no allowance is made for using old engine-room buildings), etc., is £81,620. Total, £481,620. A saving of £75,000 a year would, therefore, amount to 15·56 per cent. on the new capital. No allowance has been made for the 40 per cent. increase in output of iron, which is presumably due to the new plant.

In Germany the majority of ironmasters have realised the enormous saving to be effected, and have installed their

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own plants. The ironmasters in this country have, however, with few exceptions, not devoted attention to this matter. There would appear to be an excellent opening for consulting electrical engineers to advise them and prepare schemes for the utilisation of waste gases and the electric driving of rolling mills and electric winding gear.

B. In cases where pig iron only is manufactured the surplus gases might be purchased at a very low rate by an independent electric power supply company, converted into electric power by gas-driven generators, and transmitted and sold to other works in the neighbourhood.

C. The generation of electric power by gas-engines running on power producer gas is a field that will probably chiefly interest electrical engineers. A few figures showing the relative capital and running cost of a 10,000-h.p. steam-turbine and gas-engine plant may be of interest. The capital cost in each case is calculated upon the assumption that the normal output of the plant would be 10,000 b.h.p, and that 20 per cent. of spare plant would be provided in each case, in addition to the overload capacity of the generators.

Capital Outlay.	Steam-turbine.	Gas-engine.
Engine and generators	£49,800	£77,100
Boilers, with foundations, flues, and boiler-house, feed pumps, coal-handling plant, and all pipe work	41,740	—
By-product recovery producers and gas-cleaning plant, with all pipe work	—	37,650
Engine-room building, cranes, and engine foundations	9,085	20,000
Switchgear and wiring for ditto	2,550	2,550
	£103,175	£137,300
Allowance for contingencies, 5 per cent.	5,158	6,865
	£108,333	£144,165
Capital cost per brake horse-power installed, including 20 per cent. spare plant	£9. 1s.	£12
Running Cost on a 90 per cent. Load Factor. Horse-Power Hours per Annum, 86,400,000.		
Fuel, 72,000 tons at 10s	£36,000	—
Fuel, acid, stores, and repairs for producers, less by sale of by-products	—	£11,250
Labour	3,588	4,500
Repair of turbine plant, including boilers	4,700	—
Repairs of gas-engine plant, exclusive of producer plant	—	3,600
Oil, waste, and stores, exclusive of producer stores	720	1,800
Interest and depreciation, 10 per cent.	10,833	14,416
Total cost	£55,841	£35,566
Total cost per brake horse-power hour	·1550d.	·0987d.

The above figures, which are based upon a number of different actual conditions which confirm each other, show that for a 10,000-h.p. plant running on a 90 per cent. load factor the cost of generating by modern steam-turbines is more than 50 per cent. greater than for modern gas-engines run on by-product recovery plants.

Unfortunately, a 90 per cent. load factor does not fall to the lot of a public supply undertaking, and many engineers have to consider the problem of supplying power at as low a load factor as 15 per cent. It will be interesting, therefore, to see how the running cost compares under the latter conditions:

Running Cost of 10,000-h.p. Plant working on a 15 per cent. Load Factor. Horse-Power Hours per Annum, 14,400,000.

	Steam-turbine.	Gas-engine.
Fuel	£6,600	£3,804
Labour	2,390	3,000
Repairs	2,350	1,800
Oil, waste, and stores	240	600
Interest and depreciation (10 per cent.)	10,833	14,416
	£22,413	£23.620
Total cost per brake horse-power hour	·373d.	·393d.

It would appear from the above, therefore, that for so low a load factor as 15 per cent. nothing is to be gained by putting down a gas-engine installation instead of a steam-turbine plant. It will be noted, however, that the dominating item of the running charges on a low load factor is the item of interest and depreciation, whereas on the high load factor the dominating charge is the cost of fuel. It is obvious, therefore, that in the first case it may pay to sacrifice economy of fuel to low capital charges, whereas in the latter case economy of fuel is of the utmost importance. Whilst few, if any, power supply undertakings could hope to attain a 90 per cent. load factor for the whole of the plant, it is possible in some undertakings to run a portion of the plant on a very high load factor; and it is already a common practice in steam-driven generating stations to run the most economical plant practically throughout the 24 hours of each day, and to reserve the less economical portion of the plant for the peak load, and there appears to be no reason against this practice being extended to the combined use of steam and gas driven generators. If a composite load curve giving the average daily load of a power supply station throughout the year is examined, it will be found in most cases that it is possible to run 25 per cent. of the total plant required for maximum load at an average load factor of from 60 to 80 per cent., and it will also be found that this portion of the plant will generate from 60 to 75 per cent. of the total units generated. It would appear, therefore, that the most economical arrangement of plant would be to put down gas-engines with their low fuel economy for from 25 to 50 per cent. of the output to be dealt with, and to put down steam-turbines with their comparatively low capital cost to deal with the remainder of the load. Some combination of this description has been recommended on more than one occasion in the past, but, so far as the writer knows, no such combination has yet been put into practice. The practice sometimes advocated of installing gas engines for the peak load, thereby taking advantage of their extremely low stand-by losses, and installing steam plant for the high load factor portion of the demand, is obviously altogether wrong.

LEGAL INTELLIGENCE.

LEYTON TRAMWAYS ARBITRATION APPEAL.

Mr. Justice Phillimore and Mr. Justice Walton, sitting as a Divisional Court, on Tuesday heard an appeal by the North Metropolitan Tramways Co. from the decision of the arbitrator appointed to assess the compensation to be paid to them for that portion of their tramways which the Leyton Urban District Council had acquired under their compulsory powers.

It was stated that the company had erected a large factory at Leyton in which they repaired and constructed cars for the whole of their system, including those portions which had been acquired by the London County Council and the Councils of the boroughs of West and East Ham. The company contended that the Leyton Urban District Council were bound to take over the car factory, as it was part of the tramway undertaking within their district. The arbitrator in his award, it was said, gave the company compensation for the whole of their undertaking in the public streets and a spur line leading from the main line up to the gates of the factory, but declined to make any award with regard to the factory, on the ground that it was not suitable to or used for the purposes of the undertaking within the district.

At the conclusion of the arguments their Lordships dismissed the appeal, holding that the local authority were not compelled to take the car factory. The company, however, were entitled to be compensated for the easement of the land inside the gates of the factory on which the tramlines had been laid, and no doubt the arbitrator in making his award had taken that into account.

Leave to appeal was granted.

CLAIM AGAINST MANCHESTER CORPORATION.

Judge Parry heard an action in the Manchester County Court last week in which Messrs. Walker and Homfray, brewers, Salford, claimed £47. 6s. damages, sustained in a collision between a pony and float and a horse and dray with an electric tramcar belonging to the Corporation.

The whole question turned upon the speed at which the tramcar was running at the time of the collision. Plaintiffs' witnesses alleged that the car was running at a speed of about 10 to 12 miles per hour, and that if it had been running at a reasonable speed the vehicles crossing the road would not have been run into. On the other hand, the driver of the car contended that the speed as alleged by plaintiffs was exaggerated. When he noticed the vehicles about 80 yards in front of him, he concluded that the drivers were waiting for the car to pass. When they turned over the metals he immediately reversed his motors, but the rails were greasy. He could not have been going at full speed, because he was running down the decline without power.

His Honour decided that the evidence was conclusive as to the negligence of the servant of the Corporation. As to the speed, his own experience of the cars was that if driven at a reasonable speed, under proper control, a car ought not to run 20 or 30 yards beyond the point of a collision. He had very often seen drivers of cars, on finding other drivers about to cross the road, whistle and attempt to pass in front of them. He did not agree with the contention of counsel for the Corporation that other traffic ought to wait until the

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cars passed. Both had a right to the road, and there must be a certain amount of give and take. Generally speaking, the drivers of the Corporation cars drove with great skill and care, and when other drivers did what they ought not to do the Corporation had them dealt with in the police court. But some of the Corporation's own drivers did the same thing, and when they were found to be driving carelessly they ought also to be summoned with as much freedom as drivers of other vehicles. In this case the driver of the car seemed to have thought it the duty of the traffic of Manchester to wait until a tramcar went by. The public were entitled to expect that the tramcars were kept under such control that they could be slowed down and pulled up in time to prevent accidents of this kind. The plaintiffs were entitled to succeed, but as they had not made every item clear he would give judgment for £40, with costs on the C scale.

COMPANIES' MEETINGS AND REPORTS.

BRITISH THOMSON-HOUSTON.

The twelfth ordinary general meeting of the British Thomson-Houston Co. was held on the 10th inst., Mr. J. F. Nauheim presiding in the absence of Mr. W. A. McArthur, M.P.

In moving the adoption of the report, the CHAIRMAN said that when he addressed the shareholders a year ago he expressed the hope that the next report of the directors would be a more favourable one. He was sorry to say that this hope had not been fulfilled; on the contrary, the business during the past year had disappointed their expectations. The causes were well known to the shareholders. On the one hand, they had had an almost unprecedented rise in the price of raw material, while, on the other hand, competition had been so severe that it had been impossible to recoup themselves by raising selling prices. In addition to this, heavy traction business—which had always formed the most important branch of their output—had come almost to a standstill in Great Britain. As stated in the report, they had contracted during the year for 10 locomotives for the Metropolitan Railway Co. and for the electrical equipment of several trains. This was practically all of the heavy traction business done in Great Britain during the period under review, and he was sorry to say this condition continued. As shown in the balance-sheet, they had considered it right to make this year exceptionally heavy depreciations, and, in addition to the available profits, they had used for this purpose the amount standing to the credit of the premium reserve account. A satisfactory feature which he would like to mention was that their cash liabilities had been very largely reduced, and they were fortunate in the position of being able to show large cash assets.

Mr. E. A. CAROLAN seconded the motion, which was carried unanimously.

FERRANTI LIMITED.

The report of Ferranti Limited, to be presented at a meeting of the shareholders to-day, states that the profit on trading for the year was £26,282. 8s. 6d., and after crediting discounts and interests and transfer fees, and deducting general establishment charges, repairs and renewals, legal expenses, and directors' and trustees' fees, there remains a balance of £11,944. 0s. 6d., which has been applied as follows: interest on prior lien debentures, £19. 7s. 8d.; interest on first mortgage debenture stock, £5,000; interest on bank loan, £1,233. 1s. 11d.; amount charged in respect of depreciation, £3,600—total, £9,852. 9s. 7d.; leaving a balance of £2,091. 10s. 11d. This sum has been deducted from the balance standing at the debit of profit and loss account at June 30, 1906, reducing the net debit balance to £5,411. 16s. 7d. In view of the keen competition in the industry and the high price of raw materials, the results for the year may be regarded as fairly satisfactory. The progress made by the various departments during the year is encouraging. Further improvements have been made in the works, and the general efficiency of the plant has been increased. In order to cope with the increasing business, the directors considered that it was necessary to obtain further working capital, and in March, 1907, meetings of the first mortgage debenture stockholders of the Company were held, and their consent obtained to the creation of a prior lien charge to the amount of £20,000 on the property of the Company. This issue has now been dealt with, and the effect of the increased working capital should be felt in the results of the current year. In order to assist the development of the business, the first mortgage debenture stockholders also agreed that the sinking fund on their debentures should not be payable until after Dec. 31, 1908. The directors who retire by rotation are Mr. S. Z. de Ferranti and Mr. Arthur Whittaker, who, being eligible, offer themselves for re-election.

FORTHCOMING EVENTS.

FRIDAY, OCT. 18.

Institution of Mechanical Engineers.—At 7.30 p.m., at Storey's-gate, S.W., "The Indicated Power and Mechanical Efficiency of the Gas-Engine," Prof. Bernard Hopkinson.

Junior Institution of Engineers.—At 7 p.m., at the Westminster Palace Hotel, annual general meeting, and 8 p.m., paper by Prof. W. E. Lilly, D.Sc., on "The Economic Design of Hollow Shafts."

Chemical Society.—At 9 p.m., at 21, Albemarle-street, W., "Organic Syntheeis and its Relation to Biology," by Prof. Emil Fischer, F.R.S. (Faraday lecture).

APPOINTMENTS VACANT.

General Manager and Engineer, Rhondda Tramways. Commencing salary, £450 per annum. Applications to the General Manager, the National Electric Construction Co., Queen Anne's-chambers, Westminster, S.W.

Engineer to superintend the erection and running of electric and compressed-air plant for working drills in the North-West Frontier Province of India. Applications to the Director-General of Stores, India Office, Whitehall, London, by Nov. 4.

OPENINGS FOR CONTRACTORS.

ABERDEEN—Enlargement of abattoir for the Corporation at Hutcheon-street (£13,000).

ABERYSTWYTH—Alterations to the National School and the Penparke School. Architect, Mr. G. T. Bassett, 17, Terrace-road.

ACTON—Extensions to central fire station (£1,800).

AGHALEE—Erection of dwellings by Rural District Council (£10,500).

ALDBOROUGH—Erection of school for Norfolk Education Authority (£2,500).

ALDERSHOT—Elementary school for Urban District Council.

ALNWICK—Erection of a number of houses at Read Stead, in the hamlet of Christon Bank, on the Falloden Estate, for Mr. M. T. Wilson.

ALPINGTON—Extensions to school by Norfolk Education Committee.

ANAMOE—Erection of dispensary residence for the Guardians of the Rathdrum Union.

ANTINGHAM—Erection of school for Norfolk Education Committee.

ARDEE—Labourers' cottage scheme by Rural District Council (£37,500).

ARDWICK—Erection of school, alterations and additions to existing school for Manchester Education Committee.

ARLESFORD—Infirmary for Guardians (£3,250).

ASCOT—Alterations and improvements at Catholic Schools.

ASHTON—Erection of weaving shed for Makerfield Mill Co.

ATTLEBOROUGH — Additions to school for Norfolk Education Committee.

AYR—New premises for the Ayrshire Creamery Co. (£1,900).

BANDON—Erection of labourers' dwellings for Rural District Council. (£52,290).

BARNOLDSWICK—Erection of a shop in Gisburn-street for Mr. L. Robinson.

BARROW—Erection of baths by Corporation (£1,060).

BASFORD—Erection of houses in Wainfleet-road for Messrs. Holmes and Sons.

BEN RHYDDING—Wesleyan church.

BEVERLEY—Erection of a high school for girls in Norwood for the Governors.

BLAENCLYDACH (GLAM.)—Alterations to club premises for the Committee of the Liberal Club, 12, Maddox-street.

BLEAN—Additions to workhouse (£1,450).

BODLIAM—Extensions to school by Norfolk Education Committee.

BONHILL—Enlargement of Vale of Leven Academy (£5,000).

BOOTLE—Municipal secondary schools for girls for Town Council.

BOURNEMOUTH—Erection of church, Charminster-road (£12,000).

BRIERFIELD—Furnishing and fitting Council school (£15,730).

BURNLEY—Cash and parcel office for tramways. Borough engineer, Mr. G. H. Pickles.

BUSHEY—Elementary school for District Council (£13,000).

CALLAN—Repairs to courthouse (£25).

CAMBORNE VEAR—Erection of Council school. Architect, Mr. S. Hill, Redruth.

CANTERBURY—Alterations and extensions to the city police station in Pound-lane. Mr. A. C. Turley, Guildhall-street.

CARDIFF—Erecting schools in connection with Nazareth house (between £3,000 and £4,000). Architect, Mr. E. W. N. Corbett.

CARDIGAN—House at Gwybert-road. Architect, Mr. L. Lewis.

CHATHAM—Erection of public convenience by Council.

CHICHESTER—New pavilion at Priory Park (£500).

CHINLEY—New church. Architects, Messrs. Currie and Thompson, Derby.

CLOWNE—Two houses, Westfield-lane, Barlborough, Mr. G. Rodgers; two houses, Neal-street, Clowne, Mr. J. Day; bakehouse, Elmton-lane, Cresswell, Mr. S. Morgan; two houses, Doles-lane, Whitwell, Messrs. T. and N. Newton.

COALPIT HEATH—Renovation of parish church (£300).

COLBY—Extension to school for Norfolk Education Committee.

CROES-GOCH — Additions to Council school for the Pembrokeshire Education Committee. Architect, Mr. D. E. Thomas, 17, Victoria-place, Haverfordwest.

CRUMPSALL—Enlargement to workhouse for Manchester Guardians.

CWM—School for Ebbw Vale Education Committee.

DARLINGTON—Two houses at Cockerton for the trustees of the late Mr. J. Harrison; alterations to property on Harrogate-hill for Mr. W. Robinson.

DERBYSHIRE—Erection of infectious diseases hospital by County Council (£3,657).

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DILTON—Erection of eight houses at Dilton for Westbury Rural Council.

DISLEY—Elementary school for Chester Education Board.

DONEGAL—Labourers' cottage scheme by Rural District Council (£25,500).

DOUGLAS—Erection of house in Strathallen-park. Architect, Mr. W. Lolley, Leeds.

DOVER—Three houses and shop at Matthew's-place for Mr. E. F. W. Lewis.

DOWNDERRY—Erection of public convenience for Rural District Council.

DROGHEDA—Erection of 54 houses by Rural District Council.

DUBMIRE—Erection of Council school. Architects, Messrs. Potts and Son, Sunderland.

DUMBARTON—Erection of free library.

DUMFRIES—Joint hospital for infectious diseases for County Council (£9,350).

DUNDEE—Houses for Messrs. Mudie and Martin, Elgin-street; alteration to workshop for Messrs. J. Durham and Son.

DUNMARRY—Erection of Orange Lodge hall. Architect, Mr. P. M. Jury.

DURHAM—Erection of Council school at Cleadon. Architect, Mr. J. H. Morton, 50, King-street, South Shields.

EBBW VALE—New tabernacle, Congregational church, schoolroom, etc. Architect, Mr. T. Roderick, Ashbrook House, Clifton-road, Aberdare.

EBBW VALE—School for Education Committee.

EDINBURGH—Erection of 12 villas at Chaterhall-road for Mr. J. Watson; two villas in Kilmaurs-road for Mr. Andrew R. Swellie.

EGHAM—Erection of Liberal club.

FAIRFIELD—Four houses in Tongue-lane for Mr. J. Smith.

FARNBOROUGH House and shop in Lynchford-road for the executors of Mr. J. Frisby; two houses in Yeovil-road for Mr. J. W. Young; house and shop in Queen's-road for Mr. C. E. Morton; house in Salisbury-road for Mrs. Hope.

FARNWORTH—Public offices for the Urban District Council. Architect, Mr. W. W. J. Lomax, 11, Fold-street, Bolton.

FERMOY—Erection of dwellings for Rural District Council (£77,200).

FERRYHILL—Erection of engine shed for Caledonian Railway Co.

FOULSHAM—Extensions to schools for Norfolk Education Committee.

FRIZINGHALL—Pavilion at grammar school. Architects, Messrs. Adkin and Hill, Bradford.

FULMODESTON—Extensions to school for Norfolk Education Committee.

GILLINGHAM—Three houses. Architect, Mr. W. C. Stunt, Faversham.

GLENAFTON—Enlargement of the sanatorium (£6,000).

GOODWICK—Erection of two houses for the Pembrokeshire Estate Co. Architect, Mr. J. P. Thomas, 9, Victoria-place, Haverfordwest.

GORGIE—New cattle market for Public Works Office.

GORTON—Council school for Education Committee.

GREENHEYS—Alterations to Baptist church (£300).

GREENOCK—Consumption châlet at Smithson Poorhouse (£900).

GUISBOROUGH—Two houses in Belmangate for Mr. H. S. Wilson; two houses in Sunnyfield for Mr. R. Nellis; four houses in Allison-street for Mr. W. F. Richardson.

HADDON—Infectious diseases hospital for County Council (£3,657).

HALIFAX—Erection of a brassfoundry. Architect, Mr. T. Kershaw.

HALSTEAD—Proposed secondary school.

HANDSWORTH—Chapel and registrar's house by Corporation (£6,000).

HANLEY—Offices for the Society of Pottery Workers.

HARBORNE—New fire station for Corporation (£90,000).

HARROGATE—Alterations to Rossett Holt. Architect, Mr. T. E. Marshall.

HAWORTH—Alterations to Council school for County Education Committee.

HAYES—Sixteen houses, Clayton-road, Mr. C. J. Dusgate; seven houses, Hayes End-road, Mr. T. Hunt.

HEMPNALL—Elementary school for Norfolk Education Committee.

HEMSWORTH—Shops, houses, and offices. Architects, Messrs. Garside and Pennington.

HEVINGHAM—Elementary school for Norfolk Education Committee.

HIGHAM—Erection of two shops for Earl Fitzwilliam.

HUDDERSFIELD—House for Mr. Fred. Wood; three houses for Mr J. H. Berry; one house for Mr. W. W. Pybus.

HYTHE—Additions to the Ursuline Convent, Seabrook-road; dwelling-house for Mr. J. G. White.

ISLE ABBOTS—Alterations and additions to Council schools. Architects, Messrs. Cottam and Sampson, Bridgwater.

KEIGHLEY—Extensions to the workhouse infirmary for the Guardians.

KELLING—Erection of school for Norfolk Education Committee.

KILMARNOCK—Infectious diseases hospital (£14,748).

KING'S LYNN—Alterations to technical institute.

KING'S SUTTON—Erection of elementary school for Northamptonshire County Council. Architect, Mr. J. T. Blackwell, Kettering.

KINROSS—Savings bank premises for Kinross-shire Bank.

LANCHESTER—Erection and completion of bathrooms, lavatories, dining-room, etc., at Maiden Law Sanatorium for the Joint Hospital Board. Architect, Mr. T. Wilson, 22, Durham-road, Blackhill.

LARNE—National School house. Architect, Mr. E. C. Dummer.

LEEDS—Fittings in connection with police station, Meadow-lane, for the Watch Committee. Architect, Mr. W. H. Thorpe, Phœnix-chambers, South-parade.

LEICESTER—Pavilion for county cricket club (£2,500).

LEISTON—Erection of school for East Suffolk Education Committee.

LEVEN—Eight houses, Glebe-street, for Mr. Forrester.

LITTLE SNORING—Erection of school for Norfolk Education Committee (£710).

LLANDILO—Extensions to electric cable by Council.

LLANDOVERY—Erection of school for Carmarthenshire Education Committee.

LLANELLY—Erection of mortuary for Council.

LLANFAIRFECHAN—House for Governors of St. Andrew's Hospital Northampton.

LONDON, S.E.—Extension of electric cable to the workhouse at Lewisham.

LONDON, S.E—Erection of a new post office at Blackheath, for the Commissioners of H.M. Works and Public Buildings.

LONDON, S.E.—Enlargement of Grange Mission Hall, Bermondsey. Architect, Messrs. E. Cross and Co.

LONDON, S.W.—Erection of school to accommodate 1,116 scholars on the Southfield site, Merton-road, Wandsworth, S.W., for the London County Council.

LONDON, W.C.—Enlargement of Bloomsbury County Court for H.M. Office of Works.

LONGFLEET—Alterations at workhouse for Poole Guardians.

LORN—Building of sanatorium for Argyll County Council (£7,000).

LYNN—Erection of 80 houses, Walker-street, for Mr. S. Baker.

MAIDSTONE—Erection of theatre (£7,000).

MANSFIELD—Erection of post office for H.M. Commissioners of Works.

MARKYATE—Elementary school for Herts Education Committee.

MATLOCK—Erection of isolation hospital by the Urban District Council (£3,600).

MELTON MOWBRAY—Two new villas in Craven-street for Mr. W. H. Denman; additions to Hamilton Lodge for Lord Hamilton of Dalzell.

MERRYWOOD—Erection of Council school for Bristol Education Committee.

MILNROW—Additions to co-operators' building. Architects, Messrs. Butterworth and Duncan, Rochdale,

MILNSBRIDGE—County workmen's club and institute (£1,200).

MIRFIELD—Two houses in St. Paul's-road for Messrs. H. Anderton and Sons; alterations to Beech Grove for Dr. Anderson.

MONMOUTHSHIRE—Erection of school at Rhiw-syr-Dafydd for the Education Committee.

MOUNT BELLEW—Labourers' cottage scheme by Rural District Council (£21,459).

MUNDESLEY—Erection of school for Norfolk Education Committee (£3,300).

NEWCASTLE—New offices for the Northumberland County Council. County surveyor, Mr. J. A. Bean.

NORTON—Erection of house at Allerford Crossing. Mr. E. A. Vaughan, Ilminster.

OLDCASTLE—Erection of dwellings for Rural District Council (£18,435).

ORMESBY—Erection of school for Norfolk Education Committee (£780).

OTLEY—Training college for teachers for West Riding Education Authority.

PARKHEAD—Renovation of parish church and building of hall (£1,500).

PATELEY BRIDGE—Alterations to cemetery chapel and erection of hearse-house. Architects, Messrs. Bland and Bown, Harrogate.

PENGE—Erection of fire station for Urban District Council.

PENYGROES—Erection of houses. Architect, Mr. W. Jenkins, Llandilo, South Wales.

PENTRE—Business premises Architect, Mr. W. D. Morgan.

PERTH—Enlargement of hall in connection with St. Andrew's Church (£1,500).

PONTYPRIDD—Erection of 21 villas. Architect, Mr. A. L. Thomas.

PORTSMOUTH—Erection of church (£15,000).

PRESTWICK (N.B.)—Erection of new church (estimated cost, £5,000). Architect, Mr. P. Macgregor Chalmers, Glasgow

PYRFORD—Home for crippled children (£15,000). Architect, Mr. E. J. May.

RACKHEATH—Elementary school for Norfolk Education Committee (£1,400).

RAMSBOTTOM—Erection of flock shed in Stubbins-lane for Mr. E. Hill.

RAMSGATE—Erection of hospital for Corporation (£12,000).

RAWTENSTALL—New school for Education Committee.

REDFIELD—Erection of church (£2,040).

RHAYADER—Erection of school, schoolmaster's house, offices, workshops, etc., for the Birmingham Water Committee.

RHYL—Pavilion and improvements to promenade.

RICKMANSWORTH—Additions to Croxley Green Church, and new house, Copthorne-road, for Messrs. Davis Bros.

ROCKLAND—Elementary school for Norfolk Education Committee.

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ROSSENDALE—Secondary school and technical institute for Board of Education (£26,000).

ROTHERHAM—School at the Masborough Independent Chapel. Architect, Mr. Totley, Rotherham.

ROYTON—Church for St. Andrew's parish.

ST. GENNYS—Restoration of church of St. German (£350).

SALFORD—Wiring Broughton Town Hall for Salford Corporation.

SALISBURY—Erection of mortuary for Corporation.

SCONE—Block of buildings to be erected for Mr. David Reid, High-street, at a cost of between £7,000 and £8,000. Architect, Mr. John Walker Smart.

SCOTSWOOD—Erection of 12 houses for Blaydon Co-operative Society.

SEAHAM—Lifeboat house. Architect, Mr. W. T. Douglass.

SEAHAM HARBOUR—New houses at Warden Colliery. Particulars of the Buildings Committee, Urban Council.

SEVEN KINGS—Underground convenience for Council (£616).

SILCOATES—School in connection with Congregational Church.

SLOUGH—Additions to parish church (£7,500).

SOUTHAMPTON—Extension of post office.

SOUTHAMPTON—Enlargement of post office for H.M. Office of Works.

SOUTHERY—Extension to school for Norfolk Education Committee.

SOUTHPORT—Erection of public convenience for the Town Council.

STANDISH—New presbytery and club adjoining R.C. Chapel for the Rev. Father Walmsley; eight houses in Heaton-street for Mr. H. Baxter.

STEVENAGE—Erection of elementary school.

STOCKTON BROOK—Wesleyan school (£600).

STOKE NEWINGTON—Extension to electric cables (£1,000).

STOKE POGES—New vestry. Architects, Messrs. Bodley and Hare.

STONE—Isolation hospital for Joint Hospital Board.

SUNDERLAND—Extensions to the workhouse for Guardians (£10,968).

SWANSEA—Additions to technical college for Education Authority.

SWANTON NOVERS—Extensions to school for Norfolk Education Committee.

SWORDS—Erection of library by Council (£338).

TALLISTOWN—School and caretaker's house for Ebbw Vale Education Committee.

TERRINGTON—Erection of school by Norfolk Education Committee (£500).

THOMASTOWN—Repairs to courthouse (£25).

THRYBERGH—Erection of elementary school for West Riding Education Committee.

TWICKENHAM—Infectious diseases hospital.

TUNSTALL—Installation of electric light at town hall.

URLINGFORD—Repairs to courthouse (£50).

WAKEFIELD—Three shops for Mr. A. S. Nicholson; rebuilding of the Harewood Arms at Kirkgate for Messrs. Tetley and Sons; alterations and additions to house at Leeds-road for the Governors of the Wakefield Charities; additions to clubhouse at Holmfield-lane for the Thorne's Working-Men's Club.

WALSOKEN—Elementary school for Norfolk Education Committee.

WATFORD—Erection of elementary school for Herts Education Committee (£11,850).

WAVERTREE—New church (£7,000).

WENDLING—Erection of school for Norfolk Education Committee (£437).

WEST LYNN—Erection of school for Norfolk Education Committee (£7,350).

WHALEY BRIDGE—Sunday school in connection with Holy Trinity Church (£650).

WHITEABBEY—Electric lighting installation (£3,410).

WIGTON—Two houses on the Brackenlands estate for Mr. Fisher.

WOOD DALLING—School extensions for Norfolk Education Committee.

WOODFORD—Sunday school and parish hall in connection with parish church.

WORKSOP—Erection of baths by Corporation (£3,600).

YORK—Secondary school is to be erected for City Council.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Dunkirk.—The Harbour Authorities invite tenders for two electric cranes for the port. Tenders by Oct. 20.

Antwerp.—The Municipality invite tenders for one 30-ton electric crane. Deposit £280. Tenders by Nov. 12.

Aci Reale (Sicily).—The Municipality invite tenders for electric light and power supply. Tenders by Nov. 4.

Wrexham.—Tenders are invited for one 50-kw. steam set for the Electricity Department. Tenders by Oct. 22.

Brussels.—Tenders are invited for cable for the municipal electricity works. Deposit, £40. Tenders by Oct. 25.

Brussels.—The Municipality invite tenders for cables and electrical accessories. Tenders to the Hotel de Ville by Oct. 23.

Sydney.—Tenders are invited by the Water and Sewerage Board for centrifugal pumps and electric motors. Tenders by Nov. 4.

Pontevedra (Spain).—The Municipality invite tenders for the installation and supply of electric lighting and power for 20 years. Tenders by Oct. 29.

Western Australia.—The Albany Municipality invite tenders for the lighting of the town for 15 years. Particulars from the Town Clerk. Tenders by Nov. 18.

Warrington.—The Corporation invite tenders for paper-insulated cables. Particulars from the Borough Electrical and Tramway Manager. Tenders by Oct. 22.

Toro (Spain).—Electric lighting and power supply installation for 10 years for the Municipality. Particulars from the Ayuntamiento Constitucional. Tenders by Oct. 30.

Rochdale.—Tenders are invited for one steam dynamo for the Corporation electricity department. Particulars from the Borough Electrical Engineer. Tenders by Oct. 19.

Madrid.—The Public Works Department invite tenders for the construction of electric tramways in Barcelona. Particulars from Direccion de Obras Publicas. Tenders by Oct. 24.

Grimsby.—Tenders are invited by the Corporation Electricity Department for additional switchboard panels. Particulars from the Borough Electrical Engineer. Tenders by Oct. 21.

Melbourne.—The Postmaster-General's Department invite tenders for 11 sets and a common-battery switchboard, and 3,000 subscribers telephones, etc., for the Windsor exchange. Tenders by Jan. 7.

Napier (New Zealand).—The Town Council invite tenders for lighting and power plant and an electric tramway equipment. Particulars from Mr. F. Bowen, town clerk. Tenders by Dec. 31.

Sydney.—The Postmaster-General invites tenders for the supply of wire insulators, fittings, etc. Particulars from the Commonwealth Offices, 72, Victoria-street, Westminster, London, S.W. Tenders by Nov. 6.

Portrush (Ireland).—The Urban District Council invite tenders for a complete lighting installation by electricity or gas. Copies of specification can be seen at the Town Hall, Portrush. Tenders by Nov. 2.

London, S.W.—The Secretary of State for India in Council invites tenders for the supply of crossings and switches. Particulars from the Director-General of Stores, India Office, Whitehall, S.W. Tenders by Oct. 29.

Melbourne.—The Deputy Postmaster-General invites tenders for the supply of 50 wall sets for telephones. Particulars from the Commercial Intelligence Branch of the Board of Trade. Tenders by Dec. 10.

London.—The London General Omnibus Co., of 6, Finsbury-square, E.C., invite, among other things, tenders for electrical appliances and tools, and leather machine belting. Tenders by Nov. 18.

Paris.—Pumping plant and electric dynamos and motors for the Municipal Waterworks Department. Estimate, £36,000. Particulars from the Canals and Waterways Department, Hotel de Ville, Paris. Tenders by Oct. 24.

Sydney.—The Postmaster-General invites tenders for 1,000 common-battery wall telephones and 100 portable telephones. Particulars from the Commonwealth Offices, 72, Victoria-street, Westminster. Tenders by Dec. 11.

Buenos Ayres.—Tenders are invited for the construction of underground electric tramways. Particulars from the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London. Tenders by June 1, 1908.

Tunbridge Wells.—Tenders are invited by the Corporation for the supply, delivery, and erection of the work in connection with the installation of a 500-kw. turbo-alternator, condenser, and pipework in sections. Tenders by Nov. 1.

Llandilo (Wales).—The Urban District Council invite tenders for supplying and laying about 200 yards of electric light cable and for supplying and fixing four lamps. Specifications from Mr. R. Shipley Lewis, clerk, Llandilo. Tenders by Nov. 2.

London, W.—The Directors of the Great Western Railway Co. invite tenders for the supply of stores from Dec. 1 next to Nov. 30, 1908. Tenders for Group No. 1 by Oct. 22, and Group No. 2 by Nov. 12. See advertisement in issue of Oct. 4.

Willesden.—The Urban District Council invite tenders for the supply of carbons for the public arc lamps for 12 months. Particulars from Mr. J. G. Bruce, electrical engineer, Electricity Works, Salusbury-road, Kilburn, N.W. Tenders by Oct. 28.

London, S.W.—The Secretary of State for India in Council invites tenders for the supply of (1) rails and fishplates; (2) bearing plates; (3) coach screws. Particulars from the Director-General of Stores, India Office, Whitehall, S.W. Tenders by Oct. 22.

Bedminster (Bristol).—The Bristol Education Committee invite tenders for lighting and ventilating by means of electricity a Council school to be erected at Merrywood, Bedminster. Tenders to Mr. Wm. Avery Adams, secretary, Guildhall, Bristol, by Oct. 23.

Glasgow—Tenders are invited for the supply of uniform clothing for the employés of the Corporation tramways department. Particulars from Mr. James Dalrymple, general manger, 46, Bath-street Glasgow. Tenders to the Town Clerk by Oct. 21.

London.—Tenders are invited by the London County Council for the electric wiring of tramways sub-stations at Holloway, Hackney, and Clapton, and of a car-shed at Holloway. Tenders to the Clerk to the Council, County Hall, Spring-gardens, S.W., by Oct. 29.

Stepney.—The Electric Light Committee invite tenders for work in connection with the Council's projected new generating station at the riverside at Blyth's Wharf, Limehouse, and sub-station at Osborn-street, Whitechapel. Tenders by Nov. 11. See advertisement.

Adelaide.—The Deputy Postmaster-General for Queensland invites tenders for a common battery switchboard and 3,000 subscribers'

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telephones. Specification No. 166. Particulars may be obtained from the Commonwealth Offices, 72, Victoria-street, London, S.W. Tenders by Jan. 8, 1908.

Rangoon.—For pumping plant for Rangoon Municipality. Particulars, etc., of Messrs. Ogilvy, Gillanders, and Co., London agents to the Rangoon Municipality, Suncourt, 67, Cornhill, London, E.C., accompanied by a remittance of 10s., which will not be returned. Tenders to the Agents by Oct. 31.

Leyton (Essex).—The Urban District Council invite tenders for the supply of lathe and other machine tools. Specification, etc., £1. 1s., from Mr. F. Harman Lewis, electrical engineer to the Council, at the Electric Light and Power Works, Cathall-road, Leytonstone. Tenders by Oct. 29.

Leicester.—The Tramways Committee invite tenders for the supply of 450 suits and caps, to be delivered in April next, for inspectors, motormen, and conductors. Samples may be seen on application and tender forms obtained from the Tramways Manager, 20 and 22, Humberstone-gate, Leicester. Tenders by Nov. 9.

Victoria.—The Deputy Postmaster-General at Melbourne invites tenders for the supply and delivery at Melbourne of 11 sections of a common-battery switchboard and 3,000 subscribers' telephones and other apparatus for telephone exchange, Windsor, in accordance with Victorian specification No. 148. Tenders by Jan. 7.

Adelaide (Australia).—Tenders will be received up to noon on Nov. 9, addressed to the Chairman, Municipal Tramways Trust, Adelaide, for the supply and delivery c.i.f. Port Adelaide of steel rails and fishplates for tramways. Specification, etc., from the Agent-General for South Australia, Threadneedle House, 28, Bishopsgate-street Within, London, E.C.

North Shields.—The Guardians of Tynemouth Union invite tenders for the provision and fixing of a fuel economiser, suitable for two Lancashire boilers each 30ft. by 8½ft., in connection with a chimney 120ft. high by 5ft. internal diameter, to be erected at the workhouse. Particulars from the Master, Preston-road, North Shields. Tenders to Mr. Septimus Scott, clerk, by Oct. 31.

Alexandria.—Tenders are invited for the following electrical equipment for the port of Alexandria: five large and seven small trans-shipping engines, six cranes of four tons, 36 cranes of two tons, 25 windlasses, various small plant and necessary accessories, and the construction and installation of a central power station. Particulars from M. le Directeur des Ports et Phares, Alexandria. Tenders by Nov. 1.

Edinburgh.—Tenders are invited for (Contract No. 6) junctions and pits in connection with the tramways extensions. Specification, etc., from the consulting engineer, Sir Alexander B. W. Kennedy, 17, Victoria-street, Westminster, London S.W., on payment of a deposit of £2. 2s., which will be refunded on receipt of a bona fide tender. Tenders to the Town Clerk, City Chambers, Edinburgh, by Nov. 8.

Stockport.—The Tramways Committee invite tenders for the manual and team labour, and the supply of sand, broken ballast for concrete, drain-boxes and drains (only) in laying the permanent way, paving, kerbing, flagging, etc., required in the Stockport-road improvement, Gorton-road improvement, Chestergate interlacing lines, and the car-shed approaches. Particulars from Mr. John Atkinson, borough surveyor, Stockport. Tenders to the Town Clerk by Oct. 21.

London, S.E.—The Camberwell Guardians invite tenders for the supply of engineering goods, etc., including rubber and asbestos goods, belting, valves, engine parts, tubes, and fittings, bolts, etc., and miscellaneous items; also for electrical department, lamps, switches, etc., telephone and lift parts, and miscellaneous items, to their infirmary, Brunswick-square, Camberwell, for period expiring Oct. 3, 1908. Particulars from the Guardians' Offices, 29, Peckham-road, S.E. Tenders by Oct. 23.

Spezia.—The Commercial Intelligence Branch of the Board of Trade are informed by the British Vice-Consul at Spezia that a public competition will be held simultaneously at the Royal Arsenals (Contract Offices) of Spezia and Naples and at the Ministry of Marine at Rome, at 11 a.m. on Oct. 26, when tenders will be received for a contract for supply to the Italian navy of rubber fittings and rubber goods for the estimated value of 185,200 lire (about £7,408). Tenders may be for one or more of three lots, valued at 82,000 lire, 53,000 lire, and 50,200 lire respectively. Deposits equal to 10 per cent. of the value of each lot tendered for will be required to qualify tenders. The special conditions of contract may be seen at the Ministry of Marine, Rome; at the Directorates-General of the Royal Arsenals; at the Technical Offices of the Navy at Genoa; and at the principal Chambers of Commerce in Italy.

RESULTS OF TENDERS.

Limerick.—The Borough Council have accepted the tender of the Western Electric Co., at £904. 5s., for supplying cable feeders.

Southwark.—The Electric Light Committee have accepted the tender of Charrington, Sells, Dale, and Co. for the supply of coal.

Dundee.—The Council have accepted the offer of the British Insulated and Helsby Cables, at £10,000, for the supply of cables in connection with the new generating station.

Hammersmith.—The Electricity and Lighting Committee recommend the acceptance of the following tenders: Western Electric Co., at £3,463, for 8,000 yards ·25 feeder cable and 90 joint-boxes; Lahmeyer Electric Co., at £400, for 1,000 yards ·125 three-core cable and 12 joint-boxes.

Yarmouth.—The Town Council have accepted the following tenders: Crompton and Co., 10-h.p. motor, with slide rails, switches, and starters, £35. 13s. 6d.; Miller and Co., wheel press, £88; Hatch, forge and emery machines, £30. 5s.; Brown and Colby, shafting, 11s. per cwt., and the supply of pulleys for same.

Norfolk.—The County Council have accepted the tender of the Tudor Accumulator Co. for the provision of additional storage for electric batteries and carrying out the necessary works in connection therewith.

West Ham.—The Corporation have accepted the tenders of the following firms for the supply and delivery for six months ending March 31, 1908, of indiarubber-covered wires and cables: W. T. Garnett's Cable Co., Barkerend Mills, Bradford; Plutte, Scheele, and Co., 18, Queenhithe, E.C.; India Rubber, Gutta Percha, etc., Co., 106, Cannon-street, E.C.

Finchley.—The Electricity Committee of the Urban District Council have accepted the tender of the Callender's Cable and Construction Co., at £8,999. 10s. 6d., for the supply of feeders, distributing and other cables, etc. The committee have also accepted the tender of Charrington, Sells, Dale, and Co. for the supply of 2,400 tons of coal at 14s. 11d. per ton.

Erith.—The following tenders have been received for the supply and construction of the overhead main to Crossness outfall works:

Johnson and Phillips (accepted)	£227	0	0
National Electric Construction Co.	283	6	8
Lund Bros.	312	0	0
Brush Electrical Engineering Co.	315	0	0
Callender's Cable and Construction Co.	417	15	0
R. W. Blackwell and Co.	430	0	0

London.—The London County Council have received the following tenders for the renewal of the wiring and the electrical plant and the steam-engine of the Woolwich ferryboat "Hutton":

Electrical Co., Charing Cross-road, London*	£378	0	0
Pinchin and Walton, Cannon-street, London	401	1	0
Siemens Bros. and Co., Westminster, London	455	0	0
Ditto (alternative)	497	0	0
Ditto (alternative)	499	0	0
Foote and Milne, Westminster, London	517	0	0
Electric Construction Co., Wolverhampton	625	0	0
Smeeton and Page, Queen Victoria-street, London	695	14	3

* Recommended for acceptance.

London, S.E.—The London County Council have received the following tenders for the supply and erection of boiler-feed pumps, etc., required for the second portion of the Greenwich electricity generating station:—

J. Cochrane, Barrhead, N.B.*	£2,100	0	0
Pratchitt Bros., Carlisle	2,244	10	0
Thames Ironworks, Shipbuilding, and Engineering Co., Glasgow	2,298	5	6
A. and P. Stenny, Glasgow	2,389	15	0
E. Scott and Mountain, Gateshead-on-Tyne	2,508	5	0
Glenfield and Kennedy, Kilmarnock	2,564	0	0
Thwaites Bros., Bradford	2,597	16	7
Electric Construction Co., Wolverhampton	2,695	0	0
Johnson and Phillips, Charlton	3,326	2	6
Haste Pump Co., Manchester	3,662	7	6

* Recommended for acceptance.

Maidstone.—The following tenders have been received for the supply of electrically-driven pumps in connection with the sewage scheme:

Mather and Platt	£2,655	0	0
Greenwood and Batley	2,404	7	0
Gwynnes, Limited	2,381	10	0
W. H. Allen and Co.	2,310	0	0
Penrose and Co.	2,291	10	0
Lancashire Dynamo Co.	2,284	5	0
E. Scott and Mountain	2,224	0	0
Electrical Co.	2,157	2	0
Brush Electrical Plant	2,092	6	0
British Electrical Co.	1,988	10	0
Siemens Bros. (accepted)	1,963	9	0
Johnson and Phillips	1,955	12	8
F. W. Brackett and Co.	1,917	7	0

BUSINESS NOTES.

TRACTION.

York.—The City Council have decided to apply for a light railway order empowering them to electrify the tramways system.

Yarmouth.—The receipts on the Yarmouth and Gorleston sections in the past four weeks totalled £2,746, and on the Caister route £462.

District Railway Fares.—On and after Monday next workmen's fares on the District Railway will be reduced. In most cases a reduction of 1d. or ½d. will be made.

Lye and Wollescote.—The Council are protesting against the action of the tramway company in discontinuing the children's fares, and are asking the company to reinstate them.

Standish.—The clerk has been instructed by the District Council to write to the Tramways Committee asking them if they would grant concessions to assistant school teachers to allow them to travel half-fare.

Rutherglen.—The Town Council have appointed a deputation to wait upon the convener of the Glasgow Tramways Committee and ascertain when they intend extending the tramway system to Burnside Station.

Dublin.—Mr. Charles Walsh, solicitor, while driving opposite Trinity College, Dublin, on the 14th inst., was thrown under an electric tramcar. He received such terrible injuries that he died almost immediately.

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Newcastle.—At a meeting of the Tramways Committee of the Newcastle Corporation it was decided to recommend the City Council to make a grant of £25 towards the fund for forming a tramway employés' band.

Stirling.—The County Council have agreed to discuss at their next meeting a letter from the Falkirk and District Tramway Co. suggesting an agreement being come to with the Council as to the maintenance and repair of the tramway track.

Madras Electric Tramways.—The traffic receipts for the fortnight ending Oct. 15 amounted to Rs.17,358, against Rs.15,580 for the corresponding period of 1906. The gross receipts from Jan. 1 totalled Rs.326,762, against a total of Rs.271,603 for 1906.

Erith.—The tramway manager reported to the Council Committee at their meeting that the traffic receipts for the previous two weeks, as compared with the corresponding weeks of last year, were as follows: 1907, £352. 19s. 10d.; 1906, £448. 10s. 8½d.

Lowestoft.—At a meeting of the Tramways Committee the chief clerk reported that the traffic receipts to date showed total receipts of £10,432. 8s. 10d., against £9,427. 3s. 1d. for the corresponding period of last year, and passengers carried 2,622,937, against 2,192,712, an increase of 430,227.

Doncaster.—At the Council meeting the Tramway and Electricity Committee recommended the construction of three new passing places on the tramway at the Shakespeare Inn, Balby-road, Carr-hill, and Queen-street, Balby, and in Sunny Bar at an estimated cost of £1,020. The committee's recommendation was accepted.

Musselburgh.—Mr. Frank T. Cooper, K.C., whose opinion was asked on the question of the liability of Town Council for the damage done to the electric car property during the recent strike, has reported to the effect that the Council are not liable for the bill. The matter will come before the first ordinary meeting of the Town Council.

Brierley Hill.—At the last Council meeting the Tramways Committee recommended the Council to appoint a deputation to wait on the tram company to discuss with them the question of the reinstatement of half fares for children, and also that a letter be sent the company urging them to erect a waiting-room at Scott's Green, near Dudley.

Southend.—On Tuesday afternoon John Jarvis, 64, of Castle-lane, Hadleigh, met with a serious accident on the Leigh section of the Southend tramways. He was boarding a tram near the Cricketer's Inn, carrying a couple of parcels, one in each hand, when he fell backwards heavily into the roadway, striking the car in his fall. It is believed that one of his parcels struck the car as he mounted, causing him to overbalance.

Morley.—In connection with the construction of the proposed light railway the Town Council have resolved to raise no objections to the plans showing the construction of tramway lines on macadamised roads, and that the chairman and the borough engineer be instructed to visit neighbouring towns, and that they be empowered to decide where granite paving is necessary, and also the quality of stone to be used. The single and double lines were approved.

Rochester.—It having been stated that the Prudential Assurance Co. were only prepared to make an advance of £37,000 to the Town Council for the construction of tramways at 4 per cent. interest, the town clerk was instructed to wait upon the company and endeavour to arrange for better terms, failing which the rate of interest offered was to be accepted, the loan to be spread over a period of 30 years, and repayable by equal annual instalments of principal.

Leith.—At a meeting of Leith Tramways Committee it was agreed to recommend the Town Council to insert in the proposed provisional order a clause empowering the Council to extend the electric tramway tramway system from Bonnington to Newhaven *via* Granton. Other proposed extensions were discussed, but in the meantime it was agreed only to get a report from the manager regarding the cost of extending the line from Seafield to the burgh boundary on the east, instead of all the way to Portobello.

Harton.—At a fortnightly meeting of the Harton Parish Council a deputation attended from the Whitburn Parish Council for the purpose of discussing the desirability of establishing a system of tramways between South Shields and Sunderland. It was pointed out that the present facilities were inadequate and expensive, and it was thought that if the Parish Councils approached the local authorities on the question, some scheme might be undertaken. After some discussion it was decided to further consider the matter.

Darlington.—At a meeting of the Darlington Electricity and Light Railways Committee, the general manager (Mr. J. R. P. Lunn) reported that the receipts from the tramcars for the four weeks ending Sept. 28 amounted to £867. 7s. 9d., as compared with £866. 14s. 11½d. in the corresponding weeks of last year, and the revenue per car mile was 7·23d., as against 7·11d. last year. The number of units of electricity generated for power and lighting purposes were 83,384, as against 52,240 in September last year, an increase of 63·8 per cent.

Huddersfield.—At the meeting of the Town Council on the 16th the financial report of the Tramways Committee was presented. It showed that the capital outlay on the undertaking to date was £112,902, and that the income for the half-year ended Sept. 30 was £44,118, against £42,360 in the corresponding half of last year. The working expenditure was £20,676, against £20,853, leaving a gross surplus of £23,442, against £21,507. After allowing for various charges there remained a net surplus of £5,110, against £3,175.

Wrexham.—An accident took place on the Wrexham and District Electric Tramways on the 11th. A car was proceeding down Gutter-hill, a steep incline between Rhos and Johnstown, when, owing to the brakes failing to act when applied, it ran into the gates of the level crossing on the Ponkey branch line of the Great Western Railway. The car crashed through the gates and caught the end of a Great Western motor-train which was standing at the Ponkey Station. The impact was severe and smashed off a buffer of the train, while the car was also damaged.

Partick.—At the Town Council meeting it was reported that the Streets and Roads Committee had approached the manager of Glasgow tramways with a view to having Whiteinch tramway terminus shifted either further west or east, as several accidents had occurred there lately owing to the congested state of the traffic. Mr. Dalrymple had said there was not much hope of having the terminus shifted until the traffic warranted such a step. As an alternative it had been suggested that a vacant strip of land adjoining the roadway might be acquired to relieve the congestion.

Ashton.—The Works and Management Sub-Committee of the Council have considered a communication from the general secretary of the Tramwaymen's Union, and have resolved to recommend the General Committee that the motormen and conductors working cars in the Manchester district be paid at the same rate and work under the same conditions as the men of the Manchester Corporation tramways, and that probationary motormen and conductors, upon appointment to regular cars, commence at the rate of wages paid to those who have been engaged six months.

Stepney.—At the last meeting of the Borough Council the Works Committee reported the negotiations which had taken place in regard to the electrification of the London County Council tramways from Aldgate, *via* High-street, Whitechapel-road, Mile End-road, and Bow-road, to the county boundary at Bow Bridge. They had further considered the matter, and had instructed the town clerk to inform the London County Council and the Board of Trade that they had no objection to the G. B. surface-contact system (which costs £10,500 per mile of single track) being employed.

Brighton.—The Brighton Tramways Committee have had under consideration a report from the town clerk (Mr. Hugo Talbot) upon the letter from the General Post Office with reference to the proposal to erect a Post Office telegraph wire across the tramway trolley wire in Preston-drove, stating that the Postmaster-General agrees to the erection of covered wires instead of the provision of guard wires (as originally applied for) in the present case, as the circuit is unimportant and the route is not likely to develop, and have resolved that the Corporation bear half the difference in the cost of providing covered wire instead of bare wire.

Tooting.—The extensions of the London County Council tramways, which were inspected by a Board of Trade representative recently, were opened for the use of the public on the 15th inst. They consist of an extension of the existing line from Tooting-broadway to Merton-road railway bridge, where they join the London United Tramway cars, which run to Hampton Court *via* Wimbledon and Malden. The other is an extension of the line from the Defoe-road terminus to Tooting junction of the cars plying between Tooting and the Hop Exchange, where they will meet the South Metropolitan Tramway Co.'s cars which run to Croydon.

Reading.—On Oct. 13 the first church parade of the employés and staff of the Reading Corporation tramways took place, when upwards of 100 men mustered and marched in procession, headed by the Reading Temperance Prize Band, to St. Giles's Church. The Mayor of Reading, the chairman of the Tramways Committee (Mr. Alderman Field, J.P.), Mr. Walter Binns (general manager and engineer), and members of the Tramways Committee took part in the parade. The sermon was preached by the Lord Bishop of Oxford (Dr. Paget), and the music for the hymns was rendered by the band. A collection was made on behalf of the Royal Berkshire Hospital.

Matlock.—At the last meeting of the Tramway Committee Mr. Foster, the cable tramway foreman, reported for the past month that the income was £169. 1s. 6d. and the expenses £83. 10s. 9d., showing a profit of £85. 10s. 9d. on the month's working. The income from luggage for September was £8. 7s. 8d. He had not stopped the cars to clear the tube out for three years, and he proposed to have the cars stopped after Christmas for a few days if the weather was favourable. The cars had usually been run to only eight o'clock in the winter season. The total amount in the hands of the treasurer was £275. 5s. 6d., and, less the accounts and wages for October, the balance in hand is now £169. 16s. 11d.

Ashby.—At the Urban Council meeting attention was called to the intended sale by the Midland Railway Co. of the vacant sites in Bath-street and Derby-road acquired by the company on the building of the Burton and Ashby Light Railway, and it was pointed out that under the third section of the order of 1903 the Council were to be afforded the opportunity of purchasing the land. After some discussion, in which it appeared that the Council was debarred from purchasing land as a speculation, the Council agreed to abandon their option in the matter. It was agreed that the Highways Committee should approach the company with a view to the purchase of a small portion in Bath-street for street improvement.

Lancaster.—One of the Corporation's electric cars met with an accident in Bowerham-road on the 11th inst., about 100 yards from the junction of the Scotforth and Park routes. Three men were at work on the wagon scaffold, repairing the wires, when the car came down the steep gradient, which is equal to 1 in 10. The driver applied the brake, but thought he could get past. The front part of the car did so, but the middle collided with the axle of the wheeled scaffold. The side of the car was knocked in and the vehicles were locked together. There were only a few passengers in the car, and though naturally alarmed they sustained no injury. The traffic was blocked for an hour before the damaged car could be removed.

Perth.—Councillor Crystal, convener of the Tramway Committee of the Town Council, has prepared a report on the finances, etc., of the tramways with a view to seeing whether some arrangement cannot be made to improve the present condition of affairs. The gist of the

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report is that the tramways could be made a paying concern if a great part of the burden which the tramway undertaking has at present to bear were transferred to the shoulders of the electric lighting department. Mr. Crystal thinks the electricity department could make up the difference that is lost, shown on the tramway account, by rearranging their charges to the lighting department and private consumers. The report is likely to meet with a good deal of adverse criticism.

Shanghai.—There is some idea of supplementing the tramway in Shanghai by lines of motor omnibuses. One of the alternative schemes to the tramway was to have no tramways at all, but lines of motor vehicles. This scheme was negatived, mainly upon the hypothesis that the native could not be trusted to become a reliable chauffeur. Curiously enough, the reverse has proved to be the case, and no modern invention has developed more rapidly in Shanghai, or contributed more to the expansion of the town, than the motor industry. Garages and repair shops are springing up in all directions, and the large number of valuable motorcars and motor boats, all of which are most of the time solely in charge of the native chauffeur, would strike any newly-arrived Occidental as exceptional anywhere.

Cardiff.—At the Tramways Committee Alderman Jacobs said he had many complaints of the noise made by the tramcars, especially in Cowbridge-road. Mr. Ellis said it was largely the result of the state of the track. The corrugation of the lines meant continued rattling of the cars, and the vibration was such that bolts were always getting loose. He attributed the noise partly to the foundation of the roads, which were not on rock, but on made-up soil. To his mind the wood blocks acted as a sounding box. Nothing was done in the matter. As a result of intervention by Councillor Chappell, it was resolved to recommend that the fares for workmen on the workmen's tramcars between Splott and the docks be 1d. instead of 2d., as at present. In the event of workmen having to change at Custom House-street and Bute-street corner it is proposed that transfer tickets shall be issued.

Stockport.—Thomas Winckley, an electric tram driver, in the employ of the Stockport Corporation, and John Nolan, a driver for the Oldham, Ashton, and Hyde Electric Tramway Co., were charged at the Hyde Police Court with obstructing the main road at Gee Cross on Sept. 26. Both the Stockport Corporation and the company's cars run on the Gee Cross length, and the alleged obstruction arose through two cars, travelling in opposite directions, meeting on a single line between two loops, and both drivers refusing to turn back. There have been similar prosecutions previously, and the chief constable described the conduct of the defendants as idiotic. The town clerk of Stockport stated that troubles similar to this were likely to be put an end to, the company's manager having just introduced a new system of signalling from one loop to another. The defendants were ordered to pay the costs.

Halifax.—The petition of tradesmen and residents complaining of the noise created by tramcars running to King Cross has received the consideration of the Tramways Committee, and a report was presented to them by the manager at their last meeting. It was resolved that the drafting of a reply to the memorialists should be left over until the new committee is appointed. Meanwhile, however, steps are being taken with a view to decreasing the noise complained of. Within the next few days the cross-over at Akeds-road will be taken up, and one cause of the noise will thus be removed. The committee have also had an estimate presented to them of the cost of relaying the up line, which is found to be another source of the noise. This work cannot possibly be done until next spring but it is anticipated that it will be taken in hand then. The gearing of the cars is another matter, and the cars are being renewed from this point of view as fast as they can be. It is intended that when the cars are re-geared to put as many of them as possible on the King Cross route, though to renew them all together would mean an immediate outlay of £700.

Hackney.—The Borough Council have consented to the London County Council's proposals for the widening of Lea Bridge-road and the extension of the tramways to Lower Clapton-road, but have rejected the scheme for the running of single lines of tramways through Englefield-road, Stamford-road, Ridley-road, and the eastern end of Dalston-lane to connect with those in Kingsland High-street and Mare-street, Alderman Sheehan succeeding in carrying an amendment in favour of a conference with Islington with a view to the widening of Ball Pond's-road and the laying down of double lines of tramways there, in lieu of the proposed single ones along Englefield and Stamford roads. Great importance is attached to the projected extension at Lower Clapton, as the County Council propose shortly to arrange for the purchase and electrification of the portion of the Lea Bridge, Leyton, and Walthamstow tramways situated in Lea Bridge-road and within the London County. When the existing lines are linked up direct communication will be provided between the Mare-street and Upper Clapton-road tramways and those running through the populous districts outside the county to Epping Forest and other parts.

Hampstead.—At the fortnightly meeting of the Borough Council the General Purposes Committee reported that they had considered a letter from the clerk of the London County Council referring to suggested widenings of Southampton-road, between Lismore-road and Dunboyne-street, the total cost of which is estimated at £7,500—£3,100 in Hampstead and £4,000 in St. Pancras—and inquiring whether, in the event of the County Council resolving to undertake the improvement, the Hampstead Council would consent to the doubling of the tramway in that thoroughfare, to reductions (if, and where necessary) of the width of footways and to contribute one-third of the net cost of the street widenings in Hampstead, amounting to about £1,033; also enclosing a plan showing the improvement proposed, and adding that a similar letter had been addressed to St. Pancras. The committee recommended that the London County Council be informed that the Borough Council were still of opinion that the widening of the roadway was required solely for the purposes of the tramways as intimated to that authority in January, 1902, and that, therefore, the Council were not prepared to contribute any portion of the expense of such widening. After a long discussion the debate was adjourned.

Glasgow.—The Tramways Committee of the Corporation at their last meeting considered a request by the Amalgamated Society of Engineers that their members at present employed at Pinkston power station should be paid at the rate of double time for Sunday work and for meal hours. Mr. James Dalrymple, the general manager, stated that the repair squad at Pinkston power station had been working for several months on a regular night shift. This might continue for six or nine months yet. The men worked six nights per week, with a working shift of 8½ hours, or a working week of 51 hours. The rate of pay was 1d. per hour over day rates. The Saturday night shift extended into Sunday morning, and the men stated that the time from 12 midnight on Saturday to 9 a.m. on Sunday should be paid for at double rate, according to the rules of their society. Mr. Dalrymple's contention was that those rules were not framed for such conditions. At the workshop such conditions could not arise, and, of course, if the staff were asked to work at Coplawhill on Sunday they would be paid double time. Double time would, of course, also be paid at Pinkston if the men were asked to work beyond the ordinary hours required to make up their 51-hour week. It was decided by the committee by nine votes to three that the men be paid at the rate of double time for Sunday work.

Shoreditch.—Numerous complaints having been received by the Borough Council as to the speed of the new electric cars, the attention of the County Council and the Board of Trade has been drawn to the matter. The Board of Trade has now replied, transmitting a copy of a communication received from the County Council and stating that they saw no sufficient reason to vary the speeds and stops imposed by the draft regulations and by-laws. The speeds fixed by the regulations of the Board of Trade, it was pointed out, were maximum speeds only; the actual speed of the cars must be governed by the condition of the traffic. In fixing the maximum speed to be allowed the Board had regard not only to the conditions existing in the busy times of the day, but also to those existing on Sundays and in the early hours of the morning and at late hours of the night, at which times there was little vehicular traffic on the road. The town clerk also read a letter from the County Council on the subject, pointing out that the electric cars in service on the whole of the Council's northern tramways are fitted with electromagnetic track brakes. In the circumstances they opined that there was no need for any reduction in the maximum speeds sanctioned by the Board of Trade, and that such reduction would not be to the advantage of the public using the tramways.

Kirkcaldy.—In connection with the running of the Wemyss tramways over the Kirkcaldy line difficulties have arisen. The present arrangement is that Wemyss cars running over the Kirkcaldy line are allowed 3½d. per car mile, while Kirkcaldy Corporation receive the whole of the takings. There has been trouble, however, owing to cars for both systems frequently traversing the route at the same time. Mr. J. B. Hamilton, manager of the Leeds tramways, after inspecting the route, was asked to report on the question. The first part of Mr. Hamilton's report has arrived. He states that such an arrangement as had been come to for through communication between town and country areas was absolutely necessary for the convenience and development of the districts. He considered that the proposal that the service should be 20 minutes and 10 minutes, varied according to traffic requirements at times which could be arranged, was a reasonable one to ask the town authorities to provide within their area. He suggested that they should transpose the termini of the upper and lower routes of the Kirkcaldy system, which would mean the making of one route from Gallatown to Whytescauseway and the lower route from Junction-road to the Links terminus. He advocated the installation of a 20 minutes' foundation through service to be augmented at busier periods by a 10 minutes' service.

Edinburgh.—A conference has taken place between the Tramways Committee of the Edinburgh Town Council and representatives from Leith Corporation in reference to proposed extensions of tramways on the borders of the city and burgh in which both might be jointly interested. The schemes were explained in some detail in a report by the Leith Tramway Committee. They were three in number: (1) an extension of Leith by Seafield to Portobello; (2) an extension by Ferry-road to Davidson's mains; and (3) an extension by Ferry-road and Granton-road to Granton, with a return to Newhaven along the sea-front. Councillor M'Michael, chairman of the Edinburgh Tramway Committee presided. After hearing the Leith representatives, it appears that the Edinburgh Committee expressed the view that the city had not sufficient interest in the first two schemes mentioned to go on to their consideration. In regard to the scheme for Granton, it was thought to be of a practicable nature and worthy of consideration. The line would be about three miles in length, and would be worked on the overhead electric system. The cost was estimated to be about £11,000 per mile, in all about £33,000, and of that sum Edinburgh's interest, according to territory, would be represented by a third, or say £12,000. The Edinburgh Tramway Committee did not commit themselves to any finding on the subject. They promised to seek for further information and give the scheme their careful consideration.

Oldham.—The manager of the Oldham tramways (Mr. L. Slattery) has issued his half-yearly balance-sheet, which gives some very interesting information on the working of the trams during the past six months. From figures it appears the gross income was £52,737. 3s. 3d. The gross profit, excluding loss of interest for the half-year, amounts to £7,128. 4s. 2d. The latter is subject to stock-taking and income tax. From the details it appears that 1,893,090 units at 1½d. per unit amounted to £11,831. 16s. 3d.; £740. 16s. was paid for rates, £30 for car licences, and £72. 0s. 9d. for the quarter's forage account (Cleansing and Carrying Committee). The details of the

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income show that the total traffic receipts for the six months ended Sept. 23, 1907, were £51,454. 12s. 1d.; contract tickets, £10; parcel receipts, £134. 3s. 5d.; rent and advertising on cars, £402. 8s. 3d; sale of scrap metal, £18. 5s. 10d. Uniforms cost £179. 15s. 1d.; ticket punches, £37. 10s.; poor rate to Royton, £105. 17s. 6d.; poor rate to Crompton, £38. 2s. 6d.; poor rate to Lees, £8. 16s 4d.; and district rate for Lees, £9. 5s. Interest paid on loans is put down at £6,666. 6s. 3d.; contributed to sinking fund, £5,039. 6s.; interest to sinking funds, £814. 2s. 4d.; and rent of leased lines, £2,835. 1s. 9d. The balance on the credit side of the net revenue account for the half-year ending Sept. 23, 1907, shows that £22,046. 18s. 1d. was received on the revenue account; £148. 15s. interest on sinking fund.

Clayton West and Darton Light Railway. — The light railway from Clayton West to Darton, the construction of which has been authorised by the Light Railway Commissioners under confirmation of the Board of Trade, will be 3 miles 6 furlongs and 8 chains long. It will commence in the parish of Clayton West by a junction with the Clayton West branch of the Lancashire and Yorkshire Railway near its termination at Clayton West Station, proceeding thence generally in an easterly direction through the parish of High Hoyland, in the rural district of Penistone, by way of Deep Haigh Wood and Park Hill into and terminating in the parish of Darton, by a junction with the Barnsley branch of the Lancashire and Yorkshire Railway near Darton Station. The speed at which trains may travel is limited to 25 miles an hour, and both goods and passengers will be carried. The authorised capital of the company is £43,500 in 4,350 shares of £10 each, and of this capital the Lancashire and Yorkshire Railway Co. may contribute a sum not exceeding £21,750. Power is given to lease the line, when it has been constructed, to the Lancashire and Yorkshire Co. Mr. Henry Kaye and Mr. Charles Wray, and one other person to be nominated by them, are to be the first directors, the Lancashire and Yorkshire Co. also having power to appoint one director for every £7,250 capital subscribed by them. The period within which the line is to be constructed is five years.

Belfast.—The Tramways Committee at their last meeting discussed the question whether, in going for a Bill in the next session of Parliament for the acquisition of the Cavehill and Whitewell tramways, they should seek powers for borrowing £100,000 or £60,000. The town clerk stated that in his opinion the latter sum would be ample for the acquisition of the undertaking, and, so far as he understood, the line would not need to be doubled for several years to come, as it had just been relaid in an up-to-date style. After several of the members had spoken, some for and some against the larger amount being applied for, the manager explained that the purchase of the system would exhaust the £60,000, and would leave nothing at all for the equipment of the line, as he required all the cars at present in existence for the main line. As the line was at present constructed—a single line with 13 cross-overs—the cars would not be able to travel so fast as if it were a double line. He was hoping that when the system passed into the possession of the Corporation he would be able to run the cars from Chichester Park to Glengormley at the rate of 16 miles an hour instead of 12 miles, and if that were done he believed that in a shorter time than perhaps many of the members anticipated he would be able to make the line a paying concern. Under the existing conditions, however, he was afraid it would remain a non-paying one. A member of the committee asked the town clerk would it be possible, if the Bill they secured only mentioned £60,000, to obtain further money in order to double the line in future when required. The town clerk replied that the money could certainly be obtained through a Local Government Board order. On the question of the cars, the manager explained that he had permission to build 25 cars every year, and up to the present only 10 cars had been constructed this year. It was decided that the sum of £60,000 should be included in the Bill instead of the larger sum.

LIGHTING AND GENERAL

Buxton.—The District Council have resolved to apply for a loan of £1,700 for extensions to electricity works.

Colchester.—The Corporation have decided to install six mechanical stokers at the electricity works at a cost of £1,017

Surbiton.—An inquiry will be held on Oct. 29 into the application of the Council for sanction to a loan of £20,000 for electric lighting.

Cromer.—An inquiry will be held on Oct. 23 into the Council's application for sanction to borrow £8,000 for electric lighting purposes.

Crewe.—The Local Government Board will hold an inquiry on Oct. 23 into the application of the Council for sanction to borrow £3,000 for electric lighting purposes.

Brighton. — The Electricity Committee are about to consider the desirability of obtaining powers to supply outside districts from the Southwick generating station.

Indo-European Telegraph Co.—The directors have declared an interim dividend for the half-year ended June 30 last at the rate of 5 per cent. per annum, free of income tax, payable on and after Nov. 1 next.

Release of Trustee.—According to the *London Gazette*, A. C. Procter, 23, King Edward-street, Macclesfield, has been released from trusteeship in the estate of S. Hargreaves, electrical engineer, 2, Victoria-arcade, Buxton.

Bangor.—The Gas and Electricity Committee reported at the City Council meeting that a decrease had taken place in the output of gas, whilst there were 14,023 electric lamps connected at the end of August, and 140 added during September.

Notice of Intended Dividend.—The *London Gazette* announces that the last day for receiving proofs in the estate of R. S. Blackburn, electrical engineer and contractor, Osborne-street, and Ribstone Works, in Hebden Bridge, Yorkshire, is Oct. 31.

Tunbridge Wells.—A Local Government Board inquiry has been held for the purpose of obtaining sanction to borrow £9.600 for electric lighting purposes. It was stated that the undertaking had been a success. The application was unopposed.

Portsoy.—The public telephone is to be introduced to the town of Portsoy at an early date. Property in South High-street recently purchased is to be used as the telephone exchange, and probably a connection will be made with the village of Fordyce.

Heywood.—At the last Town Council meeting the chairman of the Electricity Committee reported that the electricity department had had a successful year's working, and there was no reason to think that the department would require any help from the rates this year.

Norden.—The National Telephone Co. having offered to provide a telephone call office in the district on condition that the Council guarantee they shall receive £10 a year, the Council have decided to do this provided the call office is put in a place which they approve.

Perth.—From a minute of the Watch and Lighting Committee of the Town Council it appears that the cost for electric current consumed in public lamps for the period from May 17 to Sept. 1 amounted to £269. 3s. 7d., as against £269. 4s. 9d. for the same period last year.

Woking.—A petition is to be presented to the Postmaster-General for the improvement of the local telephone service. Woking is within the 3d. area, but 6d. is charged for trunk calls to London, owing to the fact of the messages going through Guildford, which is outside that area.

India.—In connection with the scheme for the extended electrical working of their collieries, the East Indian Railway have not decided definitely whether direct-coupled three-phase induction motors would not, all things considered, be preferable to continuous current motors. The question is receiving attention.

Hetton.—At the Urban Council meeting it was reported that seven out of ten special public electric lights in the district were lit, and in the course of a few weeks, upon increased power, the whole 10 would be lit. It was agreed to write to the tramways company about the dust nuisance created by the passing cars.

Partick.—The Secretary for Scotland has consented to the borrowing of £10,555 by the Council to meet the cost of engine-room extension, building for stores, etc., and for capital expenditure up to May last. The total sum authorised to be borrowed for works under the Partick electric lighting order is now £122,477.

Islington.—The Electricity Committee of the Borough Council are proposing to extend the distributing mains to supply various properties at an estimated outlay of £285. The total revenue derived from the electric undertaking in the quarter ending June 30 last was £9,586, against £8,088 in the corresponding period of 1906.

Rangoon.—The electrical inspector to the Burma Government is drawing up a comprehensive scheme for the lighting of the many Government buildings in Rangoon, the power being obtained from the city installation. The existing separate power stations in some of the larger buildings will, it is believed, be done away with.

Wolverhampton.—The Electricity Committee of the Corporation have decided to lay down new mains for the purpose of supplying electricity for lighting and motive power to the works of Messrs. J. Perks and Sons. edge-tool makers, Commercial-road, and to the Chillington Tool Works, Willenhall-road, at a cost of £2,560.

Stretford.—The Council have decided to make application to the Local Government Board for sanction to the borrowing of £36,445 for extensions to the electricity plant; also £2,723, being the expenditure incurred on the electricity undertaking in excess of the amount sanctioned, and £3,000 for the purchase of motors to be let on hire.

Eastbourne.—Extensions of the municipal electricity undertaking, involving an expenditure of £10,000, have just been completed. The Council have agreed to make application to the Local Government Board for sanction to borrow the sum of £7,000, the estimated cost of the extensions of electricity mains, etc., during the next three years.

Caerphilly.—At a meeting of Caerphilly District Council a letter was read from the Board of Trade stating that the conditions of their order for electric lighting in the Caerphilly area had not been complied with, and asking for the Council's reasons why the order should not be revoked. It was resolved that the clerk furnish the Board with full details.

Oriental Telephone and Electric Co.—The directors have declared the following interim dividends: 3 per cent. on the 6 per cent. cumulative preference shares for the current year, less income tax, and 3 per cent. on the ordinary shares, free of income tax, payable to those shareholders whose names were on the share registers of the company at Oct. 16.

Coalisland (co. Tyrone).—A movement is on foot in this town, which is a mining and weaving centre, for the introduction of an electrical lighting scheme for the town and district. At a preliminary meeting last week Messrs. Stewart submitted a plan which was favourably received. The power is to hand in the River Torrent, which connects the local canal with Lough Neagh.

Ramsbottom.—The General Purposes Committee of the Council have given their consent to the Lancashire Electric Power Co. to supply current for a term of five years to the Woodhey Laundry, on condition that during such time as the agreement for transfer is not in operation the Council receive 2½ per cent. of the gross receipts of the company in respect of such supply.

Morley.—The Electric Lighting Committee of the Corporation have reported that the output from the works for the month ending Aug. 31 was 9,729 units, as compared with 7,908 the same month last year, being an increase of 1,821 units. There had been sold to consumers

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by meter 7,732 units, as against 5,525 units the corresponding month of last year, being an increase of 2,207 units.

Northfleet.—The Gravesend Town Council at a special meeting rescinded the resolution which they passed last June breaking the sealed contract to supply Northfleet with electric current. Northfleet demanded specific performance, and threatened Gravesend with a writ. The opposition to Northfleet collapsed in quite a startling manner, only four members holding out against the recission.

Dunfermline.—Ten members of the Town Council favourable to the erection of a generating station have had a meeting, and have resolved to suggest a scheme for the supplying with electricity of the compulsory area, which is restricted to High-street, Bridge-street, and East Port-street. This latest scheme falls far short of the magnitude of those discussed during the past two years, and latterly departed from altogether.

Portsmouth.—A very satisfactory statement was made at the meeting of the Town Council with reference to the state of the borough's finance. It was reported that on the urban account there was a favourable balance of £46,000, and that with the assistance from the Electric Light Committee the Council will be enabled to make a reduction of 2d. in the £ on the urban district rate, which will then be 2s. 4d. for the year.

Birkenhead.—On Friday last the Tramways and Electricity Committee of the Corporation made their annual inspection of the installation. Visits were paid to the South-end generating station, the New Ferry depôt, the Bentinck-street, and Craven-street power stations. After the inspection the party were entertained to tea at the Laird-street depôt, the chair being occupied by Mr. W. G. Wall, chairman of the Tramways Committee.

Glasgow.—The Secretary for Scotland has authorised the Glasgow Corporation electricity department to borrow £150,000 for the execution of works, raising the total sum authorised to be borrowed to £1,850,000. The Secretary for Scotland trusts that the suggestion conveyed in his letter of Jan. 13, 1906, as to increasing the provision made annually by way of sinking fund for redemption of the £885,000 borrowed prior to 1900, will be kept in view.

Truro.—The General Purposes Committee of the City Council having considered letters from the general superintendent and the provincial superintendent of the National Telephone Co., received in reply to the protest of the Council against the change which the company had made in their rates, the town clerk was instructed to endeavour to arrange for the provincial superintendent to interview the committee for the purpose of discussing the matter.

Kilmarnock.—The Town Council considered the affairs of the electric department at their last meeting. Charges of mismanagement were levelled at the committee, which the provost characterised as a travesty of the truth, and held that the undertaking had been as well handled as any of a similar kind in the country. Mr. Whittington, Norwich, was appointed assistant electrical engineer, and it was agreed to conjoin the posts of traffic manager and chief inspector, and make a rearrangement among subordinate employés so as to effect a saving in working expenses.

Willington.—Upon the recommendation of the Works Committee, the Urban District Council have decided to ask the County of Durham Electrical Power Distribution Co. to state a price per unit for the supply of electricity for lighting purposes within the area of the Willington urban district, provided the Council agree to allow the company to erect overhead cables on steel lattice poles in the main street between North-lane End and the rectory, the remainder of the district to have overhead wires on wooden poles.

Whitehaven.—At the last Council meeting the electrical engineer's report showed that four new consumers had been connected since the previous meeting, and extensions had taken place at the Grand Hotel and Tangier-street, the equivalent in 8-c.p. lamps added to the mains being 129, and in motors one 1-b.h.p. and one 7-b.h.p. motor. Applications were in hand for a 2-b.h.p. and a 10-b.h.p. motor. The electrical engineer also reported on the progress that was being made with the surface condensing plant.

Stepney.—At the last meeting of the Borough Council the Finance Committee reported having considered the question of the provision for the future supply of electricity. They had considered the plans submitted by the Electricity Committee showing the general outline of the scheme, and the intimation from that committee that it was necessary to obtain sanction for a loan at the earliest possible moment. They recommended that the town clerk be instructed to apply to the London County Council for sanction to borrow £57,000 to cover the cost of such scheme, to which the Council agreed.

Barrow.—In reply to a letter from the Barrow-in-Furness Traders' Association with regard to charges for electricity in shops, the Council Electricity Committee have informed the association that they were unable to agree to the request for a reduction in the present charges for the supply of electricity, and have pointed out the fact that the shop load only extends over about two hours daily, whereas the dwelling-house load is practically steady for four or five hours, thus enabling the same amount of machinery to turn out from two to three times as many units in the one case as in the other.

Ainsworth.—A special meeting of the Tramway Committee of the Bury Town Council has been held for the purpose of considering the question of lighting the Bury New-road, Ainsworth, along which the trams run. It was reported that the chairman and the manager had gone into the subject, and they informed the committee that the road could be lighted by means of cables being run from pole to pole, and electric lamps suspended from the span wires. There is some little difficulty in the way of carrying out this scheme, but hopes are entertained that the difficulties will be overcome. The Ainsworth Parish Council, it is understood, will bear the cost of erecting the lamps.

Cleckheaton.—At the last meeting of the chamber of commerce a letter was read from the Board of Trade saying that sanction had been refused to the proposed transfer of the incompleted works under the Spen Valley light railway orders to a new company. This was interpreted as meaning that the new company has declined to assume certain of the responsibilities under the orders which the Board of Trade think should be carried out, but it was not thought that the chamber could usefully take any further step until it is seen what the original promoters now propose to do with regard to the section of line which remains to be laid in the Cleckheaton and Liversedge districts.

Frome.—At the monthly meeting of the Urban District Council the Lighting Committee reported having considered a letter from the Frome Electricity Supply stating that they proposed suspending an incandescent lamp below the Nernst burners, so that the former would become lighted if the Nernst should fail; also that they were improving the mechanism of the lamps generally, and requesting the Council to dispense with the fines, except when total extinctions occurred. The committee ordered that the arrangement of the supply company be approved, and that for three months no fines be enforced in cases where the secondary burners were alight. The Council adopted the report.

Hull.—At a meeting of the Telephones Committee the chairman called attention to the fact that the Postmaster-General, in a letter to the Hull and District Chamber of Trades, had stated that in connection with the establishing of the exchange a considerable portion of the wages had been charged to capital account, and, having stated that such a statement was inaccurate, it was moved by Councillor Dawson, seconded by Councillor Robins, "That the attention of the Postmaster-General be called to the statement purported to be made in a letter addressed by him to the Hull Chamber of Trades, and that he be asked to specify in detail the items which he states are incorrectly debited to capital account." The motion was carried.

Stock Exchange.—The Stock Exchange Committee have appointed Oct. 23 as a special settling day in Aluminium Corporation's 250,007 7 per cent. participating preference shares of £1 each, 15s. paid, Nos. 1 to 250,007; Mount Lyell Comstock Copper Co.'s 525,332 shares of 4s. each, 2s. 6d. paid, Nos. 1 to 486,318 and 505,987 to 545,000; and United Serdang (Sumatra) Rubber Plantation's 69,000 shares of £1 each, 15s. paid, Nos. 1 to 69,000; and Oct. 29 in Perak Rubber Plantation's 25,000 vendors' shares of £1 each, fully paid, Nos. 50,001 to 75,000. The committee have ordered to be quoted in the official list the Aluminium Corporation's 250,007 7 per cent. participating preference shares of £1 each, 15s. paid, Nos. 1 to 250,007.

Swansea.—At the meeting of the Electric Light Committee of the Corporation the engineer reported on the system of charging for light. He believed, he said, in the retention of the maximum demand system, but it should be optional, and to those who required a fixed rate he recommended a flat rate of not less than 4½d. per unit, providing that the price continued at least 12 months. The chairman favoured the maximum demand system, but times changed so rapidly that he had reason to alter his views. He agreed with the engineer's recommendation that whilst the maximum demand system should be retained, consumers requiring a fixed rate should have it. The engineer's recommendation was agreed to, the optional rate not to come into force before March next.

Interesting Scientific Exhibition.—A novel and interesting exhibition is to be held at the Royal Horticultural Hall, Vincent-square, Westminster, London, S.W., from Oct. 22 to 26 inclusive. The event is being organised in connection with the *Model Engineer*, and will include a splendid collection of engineering models of all kinds, electrical, optical, and scientific instruments, technical education apparatus, and lathes, tools, and workshop appliances. Many of the models will be shown at work. Scientific lectures and demonstrations will be given each day, the subjects including colour photography, sound waves, wireless telegraphy, gyroscopes, X-rays, radium, electric welding, and other interesting items. High-class music and refreshments will be provided. The price of admission will be 1s.

Sutton Coldfield.—The accounts of the electric lighting department for the year ending March last have been presented. The authorised capital of the undertaking is £38,980, but the amount actually spent in capital outlay has been £40,104. 6s. 7d., of which £949. 12s. was spent during the past 12 months. The revenue account shows that while the actual working cost, generation, distribution, management, etc., only amounted to £2,640. 3s., the undertaking was to an extent crippled by having to find an additional £2,593. 3s. 11d. for the repayment of loans and interest, this bringing the total expenditure up to £5,233. 6s. 11d. Sale of current produced £4,477. 7s. 11d., including £807 for public lighting, and the total number of units sold was 322,901, as against 292,427 the previous year.

Erith.—At the meeting of the Electricity Committee the electrical engineer reported that the transformer kiosk to supersede the pit at Lower Abbey-road, Abbey Wood, had been erected on the site approved by the Works Committee. He also reported the receipt of an application for one 5-h.p. and one 25-h.p. motors under the hiring scheme, and the committee resolved that the application be granted. The committee are recommending the Council to resolve that the wiring and fitting of premises under the assisted wiring scheme be not in future undertaken where the value of the installation is less than £5, and where the applicant is only a weekly, monthly, or quarterly tenant; also that the instalments be spread over a period not exceeding three years, instead of three or five years at the option of the applicant, as at present.

Gravesend.—The Council electrical engineer's quarterly report to the Electricity Committee was as follows: units supplied to tramway company 97,734, corresponding quarter 1906 101,572; units supplied

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to private consumers 60,518, corresponding quarter 1906 41,036; units supplied to public lighting 27,863, corresponding quarter 1906 23,700; units supplied to works 30,003, corresponding quarter 1906 21,934; units generated 243,326, corresponding quarter 1906 212,498. It being necessary that a complete set of plans should be prepared showing all mains laid, it was resolved that the borough surveyor carry out the work by his staff at the expense of the electricity department. Application having been received for a supply to the new mission hall in Singlewell-road, it was resolved that the application be acceded to. The cost of this extension will be £85. The engineer was directed to bring up a further report as to any further extensions.

King's Lynn.—At the last meeting of the Council Electricity Committee the engineer reported that since the last meeting seven additional applications had been received for 149 lamps, making a total of 28,628 of 8 c.p., or equivalent. He also reported upon the capacity of the boilers at the works, and said the plant was estimated to carry 28,744 lamps connected to the mains. The total number of lamps now connected was about 30,700. They were gradually rising to the full capacity of the boilers, and an extra one would be very useful during the winter. The consideration of the report was deferred until the next meeting of the committee. The lessee of the theatre asked for a reduction of ½d. per unit, as was granted to consumers who used the electric light after eight o'clock at night for six nights a week. He had no claim to the privilege, but he was a large consumer. The committee stated they were unable to make an exception in this case.

Ayr.—The annual report of the electrical engineer of the burgh of Ayr was submitted to the October meeting of the Town Council. This showed that for last year the total number of consumers of current for lighting had been 1,098, as compared with 1,009 in the previous year; the number of 8-c.p. lamps being 47,487, as against 43,710; and the number of motors connected 61 of 209·5 h.p., as compared with 52 of 171 h.p. The number of units of electricity generated had been 1,482,131, an increase of 107,554 units. The prices of the current had been for private lighting 4½d., as against 5d. per unit; for private power, 2d. to 1½d. sliding scale; tramway traction, 1½d. for 200 000, 1d. for remainder; public lighting, 2d. The total capital expenditure amounted to £96 220. 18s. 7d., as against £94,609. 14s. 8d. The total income had been £13,139. 18s. 1d., an increase of £230. 19s. 1d.; and the expenditure £12,212. 19s. 4d., an increase of £403. 18s. 3d., leaving a surplus of £926. 18s. 9d., as compared with £1,099. 17s. 11d. The reports points out that, notwithstanding the reduction of ½d. per unit to private consumers, the revenue from the same consumers had increased by £117. 7s. 1d.

Record Cranes for the Admiralty.—We understand that Messrs. Cowans, Sheldon, and Co., of Carlisle, have been commissioned to supply the crane equipment required by the Admiralty at their new dock at the Devonport dockyard. The installation will consist of one 20-ton and two 30-ton steam travelling cranes, two 75-ton electric Fairbairn cranes, and a 160-ton electric revolving cantilever crane. This last-mentioned crane is of an interesting type, and when in working order it is claimed that it will take rank as the largest crane erected in any private or Government shipyard in the world. The concrete foundations for the crane are now being prepared on behalf of the Admiralty by Sir John Jackson, Limited. The crane is designed to lift 160 tons at a maximum radius of 95ft. and 80 tons at 105ft., the extreme radius for light loads of 30 tons being 128ft. The height from the quay level to the top of the girders will be 143ft. 6in., and the over-all length of revolving girders, which are 28ft. deep, will be no less than 220ft. The machinery for the light and heavy lifting and traversing the crab will be situated in a house at the back end of the girders. The revolving girders are carried on a braced tower 46ft. square and about 110ft. high. The crane will have main lifting, light lifting, traversing and revolving motions, each worked by a separate electric motor of the Westinghouse enclosed type. The crane will be tested with the unusually heavy load of 240 tons, and, although only nominally designed for lifts of 160 tons, it will be to all intents and purposes a 200-ton crane.

Dundee.—The members of the Chamber of Commerce and other business men have had an interview with the general superintendent for Scotland of the National Telephone Co. on the subject of the new telephone tariff. The superintendent declared that the new rates did not apply to present subscribers, and that the company had no intention of applying them. He pointed out that the new management was for the purpose of making as much money out of the business as they could, and to enable them to develop the system as it ought to be developed. Statements were made on behalf of two firms, that when adding a new line to their existing system they had been compelled to adopt the new tariff, and it was to work out at double the previous cost. Reference was made to the agreement between the Telephone Co. and Dundee Town Council, and the town clerk stated emphatically that under it the company had no power to interfere with the present rate to subscribers in Dundee. The president of the Chamber of Commerce said the assurances given them did not take them to a satisfying point. It was impossible to conceive that there was any intention on the part of the Postmaster-General to have two schedules of rates and two different systems in force after 1911, when the Government assumed control, and he felt sure that the only thing to be expected was that when 1911 came, if not before, they would all be required to go on the new system. The business of the Government ought not to be to get an increased profit out of the telephones, but to give a service as cheap as possible to the public—cheaper rather than dearer than that charged by the company.

Handsworth.—The Electricity Supply Committee report that by the Handsworth Urban District Council Act, 1901, the District Council are authorised to borrow certain amounts for tramway purposes and other amounts for electric supply purposes. The amount authorised to be borrowed includes the cost of a generating station. During the progress of the Bill the cost of the station was divided, and part of the amount allocated to tramways and part to electric supply. One station only has been built, from which energy is supplied for lighting and power and for traction, and a considerable part of the plant is so arranged that it can be used either for lighting or power or for traction. The committee are advised that under these circumstances it will be more convenient to consider the whole of the generating station, land, buildings, and plant as being part of the electric undertaking. A statement has been prepared from which it appears that the total capital expenditure in connection with the electrical undertaking, together with the payments which it is estimated will have to be made to the end of the current financial year, amounts to £70,060. 4s. 4d., including £2,896. 6s. 7d., the cost of the tramway feeder cables already laid. The Council have already borrowed £47,294 for electric supply purposes under the Act of 1901, and have under that Act authority to borrow for the same purposes a further sum of £1,756. If the cost of the tramway feeders, the amount of the loans already taken up, and the loans authorised for electric supply purposes but not taken up, be deducted from £70,060. 4s. 4d. (the estimated expenditure to March 31, 1907), a sum of £18,113. 17s. 9d. remains. The committee are recommending that the whole of the generating station and the plant therein be treated as belonging to the electric supply undertaking, current for tramway purposes to be supplied from such station at a price to be determined from time to time. The committee also recommend application to the Local Government Board for sanction to the borrowing of £18,200 It is also proposed to borrow £1,756 for electric supply purposes, and £2,896. 6s. 7d. for tramway purposes. The number of consumers connected on Sept. 30 last was 167; equivalent in 8-c.p. lamps, 20,503.

Yarmouth.—At a meeting of the Council General Purposes Committee the borough surveyor reported that the arc lamps of 1,500 c.p. had been removed and a group of incandescent electric lamps substituted with an aggregate of 300 c.p. each, which was, in his opinion, neither effective nor economical, and that the recent extensions in the district necessitated a considerable increase in the lighting. Following upon that statement the surveyor was requested to submit a report at the next meeting of the committee. This he did, and it read as follows: "By instructions in the minutes of your committees of Sept. 1 and Oct. 2, 1905, the Gorleston parade and cliffs have been lighted during July, August, and September at an expense of £67. 10s. per annum, and by your minute of Oct. 20, 1906, you agree to pay a further sum of £19 per annum for continuing two arcs on the cliff for the whole year, making a total annual expenditure of £86. 10s. The number of houses recently erected in this neighbourhood demands that the lighting of the public roads should be considerably extended, and I herewith submit a plan showing the lamps which I consider necessary. I recommend that the 10 arc lamps should be continued during the summer three months, if it can possibly be arranged by the Electricity Committee to provide anything approaching the nominal 2,000 c.p. which should be given by these lamps. The cost of this will be as agreed in 1905—£67. 10s. Eleven additional lamps are necessary to adequately light the public roads, which I recommend shall be of the same type as those fixed on the North Denes estate, at a cost of £3. 3s. per lamp, £34. 13s.—total, £102. 3s. In the summer further lighting along the parade is necessary, and I recommend that seven lamps should be provided and lighted by the Electricity Committee at 30s., a sum which provides a fair allowance for the capital expended (£10. 10s.). Provided that in this district the Electricity Committee cannot supply a satisfactory arc lamp, I advise that, in place of the 10 arc lamps now lighted at a cost of £67. 10s., 18 electric lamps at 30s. be provided, thus effecting a saving of £40. 10s. on the season's lighting, and giving a better result than the lighting carried out this year." The Council have decided that the chairman of the Electricity Committee be requested, in conjunction with the borough surveyor and the electrical engineer, to bring up a report with regard to the foregoing statement, and also generally upon the street-lighting of the whole borough.

Birmingham.—The business of the electric supply department of the Corporation of Birmingham is rapidly increasing, and to an extent which exceeds the most sanguine anticipations. The public demand this year up to date is at least 50 per cent. higher than it was in the same period of last year. The progress is likely to continue, and the committee are seriously considering the advisability of applying to the City Council for permission to complete the full equipment of the Summer-lane station. If the development proceeds as rapidly in the near future as it has done of late, the time will soon come when it will be necessary for the committee to ask the Council for power to considerably enlarge their resources. The large increase referred to is exclusive of the extended supply of electricity demanded by the tramway service, and is mainly due to the hire of motors and the increased demand for electric power by manufacturers. Hitherto the committee have placed their profits on the undertaking to a reserve fund to meet contingencies, but the probabilities are that, now the consumers have reaped the benefit of a reduction of charges, the profit will soon be sufficient to enable the committee to hand over an annual contribution to the relief of the rates of the city.—Mr. M. K. North, one of the inspectors of the Local Government Board, has held an inquiry relative to the application of the City Corporation for sanction to borrow £81,900 for the purposes of their electrical supply undertaking. Mr. Pritchard, deputy town clerk, informed the inspector that the Birmingham electric supply undertaking was taken over by the Corporation under their Act of 1899. The Corporation found it necessary from time to time to improve the undertaking, and to borrow capital to enable them to develop it. He did not think it necessary to go back further than the application made to the Board in 1904 for sanction to borrow £373,568. That sanction was exhausted, and in April, 1906, sanction was obtained to borrow £16,000 for additional mains. That sanction had also been exhausted. The Corporation had found it necessary for some time to make large extensions, and to meet anticipated requirements for the

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next two or three years they now asked for £81,000. Part of the sanction they had been compelled to anticipate, owing to the requirements of certain districts; and up to Sept. 31 last £2,307 had been spent. Since then a considerable further amount had been spent. Dealing with the growth of the department since 1904, Mr. Pritchard said the number of units sold in 1904 for lighting purposes was 4,367,164. In 1905 the number was 4,645,027, or an increase of 277,863. In 1906 it was 5,383,904, or an increase of 738,000; whilst in 1907 it was 7,009,602, an increase of over a million and a half. The number of consumers increased in those years by 139 in 1904, 172 in 1905. 227 in 1906, and 339 in 1907. In answer to the inspector, Mr. Pritchard produced the financial statement presented on June 4 last bringing the accounts up to the previous March 31, showing a balance carried to the profit and loss account of £54,411. But that did not represent the amount of profit. The surplus carried to the reserve fund, allowing for interest on loans, etc., was £7,713. The undertaking was not a charge upon the rates, and at present all the surplus was carried to reserve fund. Councillor Ellaway (chairman of the Electric Supply Committee) told Mr. North that the loan was absolutely necessitated by the great increase which had been experienced. He added that every main extension brought before the committee was carefully considered, particularly in regard to the relation of cost to probable income. Unless a fair proportion were shown it was not dealt with.

PROVISIONAL PATENTS, 1907.

Oct. 7.

22054. Protecting or shrouding devices for use on metallic standards or uprights of electric tramway schemes. John Collier, 5, John Dalton-street, Manchester.

22057. Improvements in and relating to flexible connecting cords for telephone and telegraph switchboards. Leslie Robinson, 86, Newcombe-street, Annfield, Liverpool.

22082. Improvements in or relating to ignition systems comprising multiple induction coils with separate trembler or tremblers. Stanley James Watson and George Herbert Smith, 306, High Holborn, London.

22083. Reversible commutator cam. Albert Paul Louis Boulanger and George Herbert Smith, 306, High Holborn, London.

22085. Improvements in and relating to electric batteries. Karl Schwarzwälder, Thanet House, Temple Bar, London. (Complete specification.)

22117. Improvements in and relating to secondary batteries. J. Stone and Co., Limited, and Edwin Mumford Preston, 77, Chancery-lane, London.

22131. Improvements in and relating to the control of electric motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Allgemeine Elektricitäts-Ges., Germany.)

Oct. 8.

3060A. Improvements in or relating to electrolytic apparatus. Alfred Julius Boult, 111, Hatton-garden, London. (Elektrizitäts Akt.-Ges. vormals Schuckert und Co., Germany.) (Date applied for under Rule 5 of the Patents Rules, 1905, Feb. 6, 1907.) (Complete specification.)

22140. Spring electrical appliances. Harold Ashton, "Freshfield," Egerton-road, Davenport, Cheshire.

22151. Improvements in electric signalling on railways. Woolf Cohen, 54, Cheetham Hill-road, Manchester.

22168. Improvements in and relating to electric measurements on alternating-current circuits. Charles Cornfield Garrard, and Ferranti, Limited, 18, Southampton-buildings, London.

22194. Improvements relating to electric switches. John Kiell and Albert Archie Stow, 165, Queen Victoria-street, London.

22202. Improvements in insulating material. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

22203. Improvements in and relating to the control of electric motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Allgemeine Elektricitäts-Ges., Germany.)

22204. Improvements in valves. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

22211. Improvements in and relating to secondary batteries. Emil Laurence Oppermann, 60, Queen Victoria-street, London.

Oct. 9.

22248. Improvements in or connected with thermoelectric alarm apparatus. John Propert, Lloyd's Bank-buildings, Canute-road, Southampton.

22259. Improvements in electric locks. John Charles Etchells, 6, Bank-street, Manchester. (Complete specification.)

22283. Electric furnace for the continuous extraction of zinc from its ores. Eugène François Côte and Paul Rambert Pierron, 23, Southampton-buildings, London.

22285. Improvements in the construction of dynamo-electric machinery, and in the method of suspending same. Hugh Christopher Cole Cornish Silver, 173, Fleet-street, London.

22301. Improvements in current-collecting devices for dynamo-electric machines. Jakob Emil Noeggerath, 83 Cannon-street, London. (Date applied for under Patents Act, 1901, Oct. 10, 1905, being date of application in United States. (Complete specification.)

22302. Improvements in methods of neutralising induction from alternating electric current systems. The British Thomson-Houston Company, Limited. 83, Cannon-street, London. (General Electric Company, United States.)

22311. Improvements in the electrodeposition of iron. Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London.

22312. Improvements in the manufacture of iron articles by electrodeposition. Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London.

Oct. 10.

22317. Electric and aseptic mouth-gag and dental searchlight. Donald George Gordon Macdonald, 24, Royal Exchange, Manchester.

22349. Improvements in electric switches or controllers. John Charles Etchells, 6, Bank-street, Manchester. (Complete specification.)

22404. Improvements in and relating to dynamo-electric machines. Allgemeine Elektricitäts-Gesellschaft, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Oct. 22, 1906, being date of application in Germany.) (Complete specification.)

22405. Improvements in systems of electric motor control. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

Oct. 11.

22911A/06. Method and means for sealing electric conductors in or through glass or like vitreous material. Charles Orme Bastian and George Calvert, Birkbeck Bank-chambers, Chancery-lane, London. (Date applied for under Rule 5 of the Patents Rules, 1905, Oct. 16, 1906.)

26212A/06. Improvements in or connected with anodes for electrodeposition. Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London. (Date applied for under Rule 5 of the Patents Rules, 1905, Nov. 19, 1906.)

26212B/06. Improvements in or connected with anodes for electrodeposition. Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London. (Date applied for under Rule 5 of the Patents Rules, 1905, Nov. 19, 1806.)

26212C/06. Improvements in or connected with anodes for electrodeposition. Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London. (Date applied for under Rule 5 of the Patents Rules, 1905, Nov. 19, 1906.)

22446. Improvement in telephonic apparatus or in connection therewith. Samuel Marsh, 7, Ivy-terrace, Grove-road, Eastbourne.

22457. Improved means of electrically connecting dynamo-electric machines with their supply or distributing circuits. Edward Macgregor Duncan, Birkbeck Bank-chambers, Southampton-buildings, London.

22467. Improvements in and relating to transformers for electric current. François Michel Edouard Pinot, 7, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Nov. 9, 1906, being date of application in France.) (Complete specification.)

22473. Improvements in or relating to electric ships' logs. Egbert Vincent Hector Rizzo, 9, Warwick-court, Gray's-inn, London.

22475. Improvements in insulating rollers for cables, wires, or the like. Williams Phillips Thompson, 6, Lord-street, Liverpool. (G. Schanzenbach und Co., Kommandit-Gesellschaft, Germany.)

22478. Improvements in or relating to electrical resistance devices for the control of electrical energy telephone transmitters, coherers, and the like, and mechanical dampers for vibration. Harold Sheen Martin, 6, Lord-street, Liverpool.

22481. Improvements in and relating to the control of electric motors. Allgemeine Electricitäts-Gesellschaft, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Oct. 15, 1906, being date of application in Germany. (Complete specification.)

Oct. 12.

22503. Improved electric radiant heat bath. Walter Noël Probert and Herbert Henry Jackson, Gough-chambers, Savile-street, Hull.

22526. Improvements in alternating-current electric motors. Henry Charles Edward Jacoby, 21, Finsbury-pavement, London.

22527. Improvements in alternating-current electric motors. Henry Charles Edward Jacoby, 21, Finsbury-pavement, London.

22543. Improvements in and relating to anodes for electrodeposition. Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London. (Complete specification.)

22547. Improvements in or relating to electrical heating of metals and other substances, and to apparatus therefor. Augustin Emilio Bourcoud, 46, Lincoln's-inn-fields, London.

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22549. Improvements in bases for electrical switches or appliances. Harry William Cox, 111, Hatton-garden, London.

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Oct. 31.)

1906.

19709. Method of and means for sealing electric conductors into or through glass or like vitreous material. Bastian and Calvert.

20856. Apparatus for electrically measuring the height or the pressure of fluids at a distance. Perret. (Date applied for under International Convention, Sept. 9, 1905.)

22002. Deposition of white metallic alloys by electrolysis. Wheatley and Lark.

22107. Space telegraphy. Cabot. (Date applied for under International Convention, Nov. 18, 1905.)

22218. Controllers for electric currents of high tension. Krizik.

22489. Electric arc lamps. Johnson and Phillips, Limited, and Tubbs.

23389. Electric switch operating apparatus. Van Buskirk.

24234. Purification of tantalum. British Thomson-Houston Company. (General Electric Company.)

24985. Electrolytic deposition of metals. Cowper-Coles.

25988. Electromechanical transmission devices. Johannet. (Date applied for under International Convention, Dec. 4, 1905.)

26290. Methods of and means for insulating the supports of electric conductors. Egnér.

26523. Lamps for magnetic compasses. Lake. (Hadlock and Glover.)

23926. Electrical connection devices. Strode and White.

26989. Protective devices for electric installations. Allgemeine Electricitäts-Ges. (Date applied for under International Convention, Nov. 28, 1905.)

26995. Brush rocking gear for dynamo-electric machines. Leitner.

28321. Trolley wire clip for overhead electric tramways and the like. Imeson, Finch, and Imeson.

29657. Arc lamps. Créteaux. (Date applied for under International Convention, Dec. 30, 1905.)

1907.

817. Apparatus for illustrating mechanically the laws governing the oscillation and deflection of magnetic needles, and for certain mechanical experiments. Bennett.

887. Receivers for wireless telegraphy. Marconi, and Marconi's Wireless Telegraph Company.

3381. High-tension magneto-electric ignition apparatus. Unterberg and Helmle.

4515. Apparatus for suspending arc lamps and other articles Spencer.

4715. Method of amplifying the feeble energy effects of electric waves, and apparatus therefor. Fessenden.

5209. Combined portable telephone and telegraph instrument. Medhurst.

5354. Method of producing electrical oscillations. Eisenstein.

5866. Dynamo-electric machines provided with commutating field coils. Erben. (Date applied for under International Convention, Jan. 16, 1907.)

6390. Means for indicating when conductors of electrical energy are charged or in live condition. Gridley.

7320. Arc furnaces for the electrical treatment of gases. Salpetersaure-Industrie-Ges. (Date applied for under International Convention, July 6, 1906.)

7443. Electric telegraphs. Siemens Bros. and Co. and Grimston.

8359. Electric resistance element. Boult. (Hoskins.)

9637. Process for increasing the durability of carbon and graphite electrodes in aqueous solutions. Chemische Fabrik Buckau. (Date applied for under International Convention, May 8, 1906.)

10694. Systems of insulation for high-potential electric conductors. Locke.

11754. Telephone transmitters. Heys. (General Acoustic Company.)

12135. Magneto-electric ignition apparatus. Roos.

12150. Electric typewriters. Lemblé. (Date applied for under International Convention, May 25, 1906.)

12643. Inverted incandescent vapour lamps. Kothe.

13319. Electrical signalling installations constantly fed with current. Siemens Bros. and Co. (Siemens und Halske Akt.-Ges.)

13986. Manufacture of metallic filaments for electric glow lamps. Haddan. Bergmann Elektricitätswerke Akt.-Ges.)

14426. Testing apparatus for electric fusible cut-outs. Henning.

15857. Electric arc lamps. Girdlestone and Thorkelin.

17855 Mountings or fittings for tubular incandescent electric lamps. Assersohn.

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £		Last price. £
Alliance Electrical Co., 5 per cent. Cum Pref., Nos. 1-70,000	1	..	½ ⅝
—— Ord., 1,125 000	1	..	⅛-¼
Aron Electricity Meter, 6 p.c Cum. Pref. Shares, 1-125,000	1	..	5/32-9/32
British Aluminium Co., Ordinary, 2 001-40 000	5	..	4-5
—— 7 per cent. Cum. Pref., 1-40 000	5	..	4⅞ 5⅛
—— "A" 6 per cent. Cum. Pref., 1-20 000	5	..	4½-5
—— 4 per cent. Funding Certificates, 1-20 000	5	..	3¾ 4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	100 103
—— 5 per cent Loch Leven Deb. (Reg.) Red., 1-3 000	100	..	96 99
British Insulated and Helsby Cables Ord., 1-100 000	5	..	6½-7
—— 6 per cent. Cum. Pref., 1-100 000	5	..	5⅞ 6⅛
—— 4½ per cent. Mortgage Debentures	100	..	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	85-89
British Westinghouse Elec. and Manuf. 6 per cent Pref., 275,001-375 000	3	..	1-1¼
—— 4 per cent. Mortgage Debenture Stock	100	..	62 67
Brush Electrical Engineering, Ordinary, Nos. 1 105 751	2	..	¼-½
—— Non. Cum., 6 per cent., Pref.	2	..	⅜-1⅛
—— 4½ per cent 1st Debenture Stock	100	..	85-86
—— 4½ per cent. 2nd Debenture Stock	100	..	67-70
Callender's Cable, Debentures	100	..	105¼-107½
—— Ordinary	5	..	9½ 10½
—— 5 per cent. Pref.	5	..	5¼ 5⅝
Consolidated Electrical Co., Ordinary, 1 110,000	1	..	7/16-9/16
Crompton and Co.	3	..	1⅜-2
—— 5 per cent. Debentures	100	..	96-99
Dick, Kerr and Co., Ordinary, 1 260 000	1	..	1¼-1½
—— 6 per cent. Cum. Pref., 1-305,000	1	..	1-1¼
—— 4½ per cent. Debenture Stock, Red.	100	..	101-104
Edison and Swan United, "A" Shares, 1-79 261	3	..	1 1/16-1 5/16
—— "A" Shares, 01-017,139	5	..	2½-2⅝
—— 5 per cent. Debentures	100	..	87-90
—— 4 per cent. Deb. Stock, Red.	100	..	83-85
Electric Construction, Nos. 1 to 112 100	2	..	⅛-¼
—— 7 per cent. Cumulative Pref.	2	..	¼-½
—— 4 per cent. Perp. 1st Mort. Deb	100	..	77-81
Electrolytic Alkali Co., Ordinary, 1-202,218	1	..	3/16-5/16
Ferranti, Limited, 5 per cent 1st Mort. Deb. Stock. Red	100	..	—
General Electric Company (1900) 5 per cent. Cum. Pref.	10	..	8-8½
—— 4 per cent. 1st Mort. Deb. Stock	100	..	90-95
W. T Henley's Telegraph Works, Ordinary	5	..	11-12
—— 4½ per cent. Preference	5	..	5- ½
—— 4½ per cent. Debentures	100	..	105½-107½
India Rubber, Gutta Percha, and Telegraph Works	10	..	14½-15½
—— 4 per cent. Debentures	100	..	6-8
National Electric Construction Co., 1-170,000	1	..	13/16-15/16
Parker, Thos., Limited, Ordinary	10	..	10-10½
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-30,000	5	..	—
Telegraph Construction and Maintenance	12	..	30-32
—— 5 per cent Bonds	100	..	99½-102½
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	..	8⅝-9¼

Electric Lighting and Supply.—

Name.	Amount paid. £		Last price. £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5	..	⅛-5
Bournemouth and Poole, Ordinary	10	..	9½-1 ⅛
—— 4½ per cent. Cum. Pref., 7 501-15 000	10	..	8⅛-10⅛
—— 6 per cent. Cum Second Pref., 15 001-22,500	10	..	9⅜-10⅛
—— 4½ per cent. Debenture Stock, Red	100	..	99-102
Bromley (Kent) Electric Light and Power Co	5	..	4⅜-5⅛
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	108-110
Brompton and Kensington, Ordinary	5	..	7⅛-8
—— 7 per cent. Preference	5	..	7⅛-7⅛
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	..	6½-7⅜
—— Nos. 80,001-100.000	4	..	6¼-7¼
Cambridge Electric Supply Company, £10 Ord.	8	..	12½-13½
Canadian General Electric Co., Common Shares	$100	..	10 -110
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	..	99-102
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	..	3⅝ 4⅛
—— 4½ per cent. Cum Pref., 1-80 000	5	..	3½-4
—— 4 per cent. Debenture Stock, Red.	100	..	9 -99
—— "City Undertaking," 4½ p.c Cum. Pref., 1-40,000	5	..	3⅜-3⅝
—— ditto (1903) 40,001-80 000	5	..	3¼-3½
Chelsea Electricity Supply	5	..	3¼ 3½
—— 4½ per cent Debentures	100	..	102-106
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000	..	96-99
City of London, Ordinary	10	..	8½-9⅜
—— 6 per cent Cumulative Pref	10	..	1 ⅛-11⅛
—— 5 per cent. Debenture Stock	100	..	122-125
—— 4½ per cent. 2nd Deb Stk. Prov. Certs (all pd.)	100	..	97-100
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1 630	£0	..	52-53
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100	..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10 001-50,000	5	..	3⅜-4⅛
—— 5 per cent Preference, 1-50,000	5	..	4⅜-4⅝ xd
County of London Elec. Supply, Ordinary	10	..	6⅜-7⅛
—— 6 per cent. Cum Pref.	10	..	10-11
—— 4½ per cent. Debentures Prov. Certs. All pd., Red.	100	..	107-110
—— 4½ per cent. 2nd Debentures Prov Certs	100	..	86-89
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5	..	¼-½
—— 6 per cent. Cum Pref.	5	..	¼-½
—— 4½ per cent First Mort. Deb	100	..	76-81
Electrical Development Co. of Ontario 5 per cent. 1st Mort. 30-year Gold Bonds, 10 751-15 750	—	..	75½77½ p.c.
Electric Lt & Traction Co. of Aust., 6 p.c. Cm Pf., 1-30,000	5	..	2⅛-2⅜
—— 5 per cent Debenture Stock, Red	100	..	85½-89
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red	100	..	94-96
Folkestone Electric Supply, Ord., Nos 1-10 000	5	..	4⅜-5⅛
—— 4½ per cent. First Deb Stock, Red.	100	..	96-99
Hove Electric Lighting, Ord., 1-15 000	5	..	6¼-7 xd
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red	100	..	101-104
Isle of Wight Elec. Lt and Pr., 4½ p.c. Db. Stk., Red	100	..	94-97
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref. 1-150 000	1	..	—
Kensington and Knightsbridge Elec. Lt., Ord, 1-21,000	5	..	8⅛-9¼
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red	100	..	97-101 xd
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9⅜-10½
London Electric, Ordinary	3	..	1⅛-1⅜
—— 6 per cent. Pref.	5	..	3⅛-4⅜
—— 4 per cent 1st Mortgage Debenture Stock, Red.	100	..	89-93

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Name.	Amount paid. £	Last price. £
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red (Prov. Certs.), all paid	100	92-95 xd
Metropolitan Ordinary, 100,001-100,000	5	5¼-5¾
—— 4½ per cent. First Mortgage Debenture Stock	100	105 107
—— 4½ per cent. Cum. Pref.	5	4⅞-5⅛
—— 3½ per cent. Mortgage Debenture, Red.	100	87-92
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds. 1935, C 1-1,000 ($100), D 1-3,000 ($500), M 1-4,400 ($1,000)	—	72-74 p.c.
Mexican Light and Power Co., Capital Stock	$100	44-46
—— 5 per cent 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14 000 ($1,000)	—	82-84
Midland Electric Power Dis., 4½ p.c 1st Mort. Deb	—	95 98
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009	5	6¼-6¾
—— do., 57 010-75 000	5	6¼-6¾
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid	5	6¼-6¾
—— 5 per cent., Pref., 1-57,003	5	5-5½
—— do., 75,001-87,500 (issued at 10s. prem., 4s paid)	5	5-5½
Notting Hill Electric Lighting	10	11-12
—— 4 per cent. First Mort. Debs. Nos. 1 500 (Reg.)	100	95-97
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	5½ 6
—— 4 per cent. Debenture Stock	100	96-97
River Plate Electricity Co., Ord., 1-119 687 & 120,501-120 507	1	⅞-1
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	⅞-1
—— 5 per cent. Debenture Stock, Red.	100	95 98
Rosario Electric Co., 6 per cent. Cum Pref. 1-20 000	5	4⅞ 5⅛
—— 6 per cent. Cum 2nd Pref., 1-15,000	5	4⅞ 5⅛
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	96 98
Shawinigan Water and Power Co., 5 p.c. Cons 1st Mt. Bds.	—	99-101 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5	¼ ⅛
—— 4 per cent. Debenture Stock	100	71-75
South London Ordinary	5	1⅛-2⅛
South Metropolitan Electric Light and Power, Ord.	1	⅛-¼
—— 7 per cent Cum Pref.	1	1-1⅛
—— 4½ per cent. 1st Mort. Deb.	100	99 102
St. James's and Pall Mall, Ordinary, 101-20,020	5	7¼ 8¼
—— 7 per cent. Pref.	5	6⅞-7⅛
—— 3½ per cent. Deb.	100	86-91
Urban Electric Supply Co., Ordinary, 8-30,007	5	1⅛-2⅛
—— 5 per cent. Cumulative Preference, 50 001 80,000	5	1⅞-2⅛
Westminster, Ordinary	5	8¼-9¼
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	4⅞-5⅛

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine, 5½ per cent. Cum. Pref., 1-260,007	5	5 15/16-6 3/16
—— Ord.	5	7⅞-8
—— Permanent 6 per cent. Debenture Stock, 1888	100	131-134
Auckland Elec Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	102-105
Barcelona Tramways, Ord., 1-20 000	10	—
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	—
—— 5 per cent Deb., Red., 1-600	100	—
—— 4½ per cent. Red. Deb Stock	100	—
Bath Elec. Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1	11/16 13/16
—— 5 per cent. Cum. Pref. Shares, 1-59 394	1	⅛-1
Birmingham and Midland Trams., 4½ p. c. 1st Db. Stk., Red.	100	94-97
Blackpool and Fleetwood Tramroad	10	13⅞-14⅝
Bombay Elec. Supply and Trams. Co., 6 per cent. Cum. Pref.	8	7¼-8
—— 4½ per cent. Deb. Stock, Red.	100	94-96
Brisbane Tramway Invest., Ord., 1-75,000	5	2½ 3½
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4⅞ 5¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	96-100
British Columbia Electric Railway Co., Ord Def.	100	131-136
—— Ord. Pref.	100	112-116
—— 5 per cent. Cum. Perpetual Pref. Stock	100	104-107
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	98-101 xd
—— 4½ per cent. Vancouver Power Deb.	100	102-104
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	1⅜-2¼
—— 6 per cent. Cm Pf., 30,0001-60 000	10	5¼ 6
—— 5 per cent. Perpetual Debenture Stock	100	86-99
—— 4½ per cent 2nd Deb. Stock	100	78-81
Bueno Ayres and Belgrano Trams	5	4 7/16 4 11/16
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	4⅛-5¼
—— "B" 6 per cent Cm. Pf., 1-27,500	5	4⅜ 5¼
—— 5 per cent. Deb. Stock, Red.	100	105 115
—— Prov. Cert.. all paid	100	104-105
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100	92-97
Buenos Ayres Gd Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100	99-103
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	98-103
Buenos Ayres Lacrcze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	91-94
Calcutta Tramways, 1-105,000	5	7-7½ xd
—— 105,001-137,610	5	5 5¼
—— 4½ per cent. 1st Deb. Stock, Red.	100	102-105
Cape Electric Tramways, Nos. 1-480,000	1	⅛-¼
City of Birmingham Tramways, 5 per cent. Cum Pref.	5	4¼-4¾
—— 4 per cent 1st Mortgage Deb., 1-3 000 (1917)	100	95-99 xd
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	5⅛-5⅜
—— 4 per cent. Deb. Stock, Red. 1985	100	98-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	94-98
Cork Electric Tramway and Lighting Co., Ordinary	10	13-14
—— 6 per cent. Cum. Pref.	10	12½-13¾
—— 4 per cent. Debentures	100	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	13-14
—— 6 per cent. Pref., Nos. within 1-60 000	10	12¾-13¾
—— 3½ per cent. Mort. Debs., 1-3,000 Red	100	90-95
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100	97-100
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1,000	82 87
Imperial Tramways, Ordinary	all	18-19
—— 6 per cent. Cum. Pref.	all	14-14½
—— 4½ per cent. Deb. Stock	100	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30 001-60,000	5	¾-1⅛
—— 4 per cent. 1st. Mt. Db Stock, Red.	100	66-71
Kalgoorlie Electric Tramways, 1-250,000	1	3/32-5 32
—— 5 per cent "A" Deb. Stock	100	89-93
—— 6 per cent "B" Deb. Stock	100	77-81
Kidderminster and District Lighting and Traction, Pref.	5	10- 0½
Lancashire United Tramways, Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	94-97
—— £296 500 2nd Mort. Deb. Stock	—	—
—— £83, 30 Deferred Deb. Stock (all fully paid)	—	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1	1-1¼
—— 6 per cent. Cum. Pref., Nos. 1-425,553	1	1-1¼
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100	92-97
London United Trys. (1901), 5 per cent. Cum. Pref.	10	7¼-8¼
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100	82-86
Madras Elec. Trams. (1904) 5 per cent. Deb. Stk., Red.	100	96-99
Manila Elec. R.R. and Lightg. Corp., 5 p.c 1st Lien and Coll. Tr Stkg Fund Gold Bonds of 1953, Red. 1-...,635	$1 000	80-92
Manx Elec. Railway Co., 5½ p.c. Cum Pref., 201-21 635 and 23,436 25 000	—	4¼ 5
—— 4½ per cent 1st Mort. Deb Stock, Red.	100	98-99
Metropolitan Elec Trams., Defd., 1 000 001-1 314 016	1	1/16 3/16
—— 5 per cent. Cum Pref. 500,001 1 000 000	1	27/32-3 /32
—— 4½ per cent. Deb. Stock, Red.	100	94-97
Mexico Trams. Co., Gen. Cons 1st Mort 50-year 5 per cent. Gold Bonds	—	80-82 p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con. Mort Bonds, 1926 1-5,500 and 7,001-8,000	$1 000	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 601-2,000 1922	100	101-103
New General Traction, 6 per cent. Cum Pref., 1-10 000 and 34 001-74 000	5	¾-1⅜
Oldham, Ashton, and Hyde Tramway, Ordinary	10	2
—— 5 per cent. Cum. Pref.	10	8¾-9
Perth Elec. Tramways (W.A.) 5 per cent 1 Mrt. Deb. Stk.	100	101-105
Potteries Electric Traction, Ordinary, 1-245,000	1	⅛-¼
—— 5 per cent Cum Pref., 300,001-545 000	1	⅛-¼
—— 4½ per cent Debenture Stock	100	95 98
Provincial Tramways Co., Ordinary, 1-24,912	10	4⅜-5¼
—— 6 per cent. Cum. Pref., 1-10,000	10	10¼-11¼
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-20,000	5	5⅛-5⅝
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100	97-99
Sao Paulo Tramway, Light, and Power Co.	$100	108-113 xd
—— 5 per cent. 1st Mort Deb., Red. 1929, 1-11,000	$500	93-95 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent Cum. Pref., 19,571-169,570, Prov. Certs.	1	⅛-1
—— 4 per cent. Deb St ck, Red. 1-40	100	83-84
Sunderland District Electric Tramways, 5 p.c 1st Mort. Debs., Red., 1-1 600	100	84-88
Yorkshire (West Riding) Elec Tram. Co., Ord., 70,001-110,000	5	1-1½
—— 6 per cent. Cum. Pref., 1-46,261	5	3¼-3⅝
—— 4½ per cent. 1st Deb. Stock, Red.	100	87-90

Electric Railways.—

Name.	Amount paid £	Last price. £
Central London, Ordinary	100	62-64
—— 4 per cent. Pref.	100	88-90
—— " " deferred	100	43-46
—— 4 p c Deb. Stock (Prov. Script Certs., fully paid)	100	102-105
City and South London, Consolidated Ordinary	100	46-48
—— 4 per cent Debenture Stock	100	102-105
—— 5 per cent. Pref. Stock '91	100	116-119
—— " " " '96	100	113-116
—— " " " '01	100	113 116
—— " " " '05	100	108-111
Liverpool Overhead, 5 per cent. Pref	10	10-10½
—— Ordinary, 1-50 000	10	3¾-4⅛
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	94-96
Underground Electric Railways of London, 5 per cent. Profit-sharing Secured Notes	—	48-53

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price. £
Amazon Telegraph Co., 1-25,000	10	3-3½
—— 5 per cent. Debs., Red., within 1-1,069	100	85-88
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78 000	$1 000	89-91
Anglo-American Telegraph Co., Ordinary	100	52-55 xd
—— 6 per cent. Preferred Ordinary	100	93-96 xd
—— Deferred Ordinary	100	14¼-14¾
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100	99-102
Chili Telephone Co., 1-44,000	5	6¾ 7¼
Commercial Cable Co., Stg., 500-year 4 p.c. Deb. Stk., Red.	100	90-94
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	6¼ 7¼
—— 10 per cent Preference, 1-6,000	10	15¾ 16¾
Direct Spanish Telegraph Co., Ordinary	5	3¼ 3½
—— 10 per cent Cum. Preference	5	9-9½
—— 4½ per cent Debs., 1-600	50	98-101
Direct United States Cable Co.	20	12-13 xd
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100	100-102
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100	97½-100½
—— 4 per cent. Reg. Mort. Debs. (Mauritius subsidy), 1-8 000, 1913	25	100-102
Eastern Extension, Australasia and China, 1-300,000	10	11½-11¾ xd
—— 4 per cent. Mort. Deb. Stock, Perp.	100	97-102
Eastern Telegraph Co., Ordinary Stock	100	128-133 xd
—— 3½ per cent. Preference Stock	100	83½-86¼ xd
—— 4 per cent. Mortgage Debenture Stock	100	101-104
Great Northern Telegraph Co. (of Copenhagen)	10	34-36
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1,200, Red.	100	100-102
Indo-European Telegraph Co.	25	54-56
Marconi's Wireless Telegraph Co., 1-256,127	1	¾-1⅛
—— 255,128-284,190	1	¾-1
Monte Video Telephone Co., Ordinary, 1-72,680	1	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492	—	⅛-¼
National Telephone, Preferred	100	106-108
—— Deferred Stock	100	106-108
—— 6 per cent. Cum. First Pref.	10	10½-12¼
—— 6 per cent Cum. Second Pref.	10	10-12
—— 5 per cent. Non Cum. Third Pref.	5	5¼-5½
—— 3½ per cent. Deb. Stock, Red.	100	9 -98
—— 4 per cent Deb. Stock, Red.	100	100-102
Oriental Telephone and Electric Company	1	1 7/32-1 11/32
—— 6 per cent. Cum. Pref	1	1 3 16-1 5/16
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100	97-100
United River Plate Tele. Co., Ordinary, 1-100,000	5	7-8 xd
—— 5 per cent. Cum. Pref., 1-40,000	5	5-5½
—— 5 per cent. Debenture Stock, Red.	100	—
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	99-102
West African Telegraph Co.	10	10-10¼
West Coast of America, 1-30 000 and 53 001-53,008	2½	1¼-1⅜
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100	97 100
West India and Panama Telegraph Co., Ordinary	10	7/16-9/16
—— 6 per cent. Cum. 1st Preference	10	7-8
—— 6 per cent. Cum. 2nd Preference	10	6¼-7½
—— 5 per cent. Debs., Red., 1-800	100	98-102
Western Telegraph Co., 1-207,930	10	12½-13½
—— 4 per cent. Debenture Stock, Red.	100	100-103

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1907.	1906.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of t ack.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Oct 9	1,395	1,362	+ 31	− 1,634h	25½	25	May 31	64,071	15,630,351	1,379,723	0 98	11·14	2,512	6·45
Ayr Corporation	,, 12	206	223	− 17	—	8	8	,, 15	14,328	3,316,380	353,945	1	9·71	1 830	5·16
Baker Street and Waterloo Ry.	,, 12	2 610	1,705	+ 905	+13,400	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 13	1,064	1,082	− 18	− 453	23·53	23·53	March 31	55,025	11,145,531	1,309,903	1·18	10·08	2,338b	6·03
Birmingham Corporation	,, 12	5 371	—	—	—	56½	—	,, 31	17,133	4,709,798	266,526	·86	14·5	8 866	—
Blackburn Corporation	,, 9	1,112	1,035	+ 76	+ 1,927	24	24	,, 25	48,875	8,661,720	986,953	1·35	11·19	2,036	7·44
Blackpool Corporation	,, 10	982	850	+ 132	− 1,551	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	,, 12	509	423	+ 86	− 1,057	16½	16½	Dec. 31	31,846	2,325,677	579,264	3·28	13 19	—	7·27
Bolton Corporation	,, 13	2 275	2,169	+ 106	+ 3,789	42	40	March 31	95 766	20,205.196	2,161,130	1·13	10 63	2.394	6·14
Bournemouth Corporation	,, 9	1,594	1,481	+ 113	+ 1,032	17·41	16·82	,, 31	55,276	10,058,288	1,121,623	1·32	11 83	3 226	7·19
Bradford Corporation	,, 12	4,714	4 410	+ 304	+ 1,918	95	95	,, 31	230,085	47,108,000	5,053,392	1·172	10 927	2,396	—
Brighton Corporation	,, 13	909	935	− 24	− 2,771	9½	9½	,, 31	50,339	11,321,160	1,152,828	1·06	10·48	,914·8	8·0·4
Bristol Tramway Company	,, 11	5,074	5,078	− 4	—	51½	51½	Dec. 31	259.799	45,312,373	6.127,135	—	—	—	—
Burnley Corporation	,, 12	1,244	1,199	+ 45	—	40	40	March 31	57,992	11,082,704	1,197,772	1·31	11 61	5,288	8 17
Burton Corporation	,, 13	238	—	− 13	− 411	8½	8½	,, 31	17 960	3,878,269	454,082	1·07	9·21	2,0·8	6 76
Cardiff Corporation	—	—	—	—	—	32 62	†32·26	,, 31	112,209	24,134,363	2,770,049	1·12	9 72	3,782	9·44
Carlisle Tramways Company	Sept. 7	193	229	− 36	− 503	8·5	8·5	Dec. 31	10 713	2,935 002	359,756	—	7·14	—	5 18
Central London Railway	Oct 12	5,721	6,503	− 982	−11,579	6	6	,, 31	347,588	4,875,547	1,281,214	1·86	65·10	57,931	35·60
Charing X, Euston, & Hamp. Ry.	,, 12	2,620	—	—	—	8	—	—	—	—	—	—	—	—	—
City and South London Railway.	,, 13	3,185	2 884	+ 302	+ 7,378	6½	6½	,, 31	—	—	—	—	—	—	—
Colchester Corporation	,, 2	240	233	+ 7	--	8	8	March 31	10,588	2 457,653	320,788	·97	7·47	1,401	6 12
Cork E. T. and L. Company	,, 10	466	502	− 64	− 767	15½	15½	Dec 31	24,895	5,814.376	882,256	1·01	6·64	—	4 69
Croydon Corporation	,, 11	1,393	—	—	—	12 c	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 11	257	270	− 13	− 29	7 23	7·23	March 3	—	—	—	—	—	—	—
Dover Corporation	,, 12	216	254	− 38	− 971	4½	4½	,, 31	11 250	2 853,200	284,343	·94	9·49	2,500	—
Dublin and Lucan Electric Ry.	,, 11	123	114	+ 9	+ 188h	6⅔	6⅔	Dec 31	6,358	402,611	110,738	3·79	13·78	942	7 33
Dublin U.T.	,, 11	6 500	5,373	+1,127	+ 25,402	48½	48½	,, 31	267,489	50,050,949	7,077,372	1·18	9·07	691	5 55
Dundee City Tramways	,, 9	1,186	—	− 75	+ 408	22	22	May 15	59,154	13 086 396	1,005 911	·906	1·96	2,180	7 42
East Ham Corporation	,, 12	839	903	− 14	− 282	14	14	March 31	36,652	3,689,658	863,816	·64	10 18	2 9·4	6 79
Glasgow Corporation	,, 12	18,130	17,283	+ 847	+ 7,720h	79½	79½	May 31	756,490	195,767,519	17,946,595	—	0 12	—	—
Gloucester Corporation	July 10	278	304	− 26	—	15	15	March 31	15,465	3,902,077	563,595	·60	6·68	959	5·32
G.N., Piccadilly, and Brompton	Oct. 12	4,515	—	—	—	9	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	37	37	,, 31	74,019	17,849,642	1,540,707	—	1 53	2,085	8·56
Huddersfield Corporation	,, 12	1 605	1,500	+ 105	+ 2,091	35	35	,, 31	69,938	12 838,150	1 665,262	1·24	9 71	1,923	—
Hull Corporation	,, 12	3,220	3,310	− 90	+ 3,217	26	26	,, 31	112,651	27,104,921	2,910,698	1	29	—	—
Ilford Corporation	—	—	—	—	—	10½	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 10	143	135	+ 8	+ 219	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	11,586	3,626,656	419,800	·7 7	6 62	1 480	5·22
Lancashire United Tramways	,, 9	1,301	1,217	+ 84	+ 12,767	38½	28	—	—	—	—	—	—	—	—
Leeds Corporation	,, 12	6,778	6 350	+ 428	+ 7,835	89½	89½	March 25	298,233	64,223 666	7,121,038	1 10	0 02	351	—
Leicester Corporation	,, 12	2,537	2 415	+ 122	—	42	42	Dec. 31	26,011	12 039,252	1,229 507	1	9·79	—	4 82
Liverpool Corporation	,, 5	11,586	11,534	+ 52	+ 7,540	104	104	,, 31	547.625	116,642 663	12,166 419	—	—	—	—
Liverpool Overhead Railway	,, 13	1,437	1,427	+ 10	+ 1,371h	6·65	6 65	June 30	81,302	11,171,865	1,024,275	—	—	—	—
London County Council	Sept 28	32,958	25,904	+7,054	+134,738	98	98	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 28	262	242	+ 20	—	6	6	Sept. 30	14,511	3,128,867	359,435	1 08	9 68	2 630	6 48
Maidstone Corporation	—	—	—	—	—	2	2	March 31	4,740	850,121	112,227	1 3·	10 13	2,370	—
Manchester Corporation	Oct 12	15,099	14,409	+ 690	+30,948	149	149	,, 31	631,956	126,900,875	14,123,124	1 19	10 73	4,299	6·89
Metropolitan District Railway	,, 6	8,006	8,179	− 173	− 918	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 13	15,620	15,429	+ 191	+ 5,467	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 12	148	148	—	− 9	2⅔	2⅔	,, 31	6.159	1,992.647	206.358	82	7 14	2.239	—
Newcastle-on-Tyne Corporation	,, 12	4,208	4,147	+ 61	+ 368	50	50	,, 31	197,849	43,067,934	4,326,152	1 07	0 98	3,967	7·0
Newport (Mon.) Corporation	June 29	639	628	+ 11	+ 1,397	15½	15½	,, 31	30,356	7,252,535	783 435	—	9 29	—	6·4
Oldham Corporation	—	—	—	—	—	34	34	,, 25	65 553	13,466,245	1,504,740	1 16	10 45	1,886	—
Portsmouth Corporation	May 25	2,330	1 578	+ 752	+ 632	28½	28½	,, 31	95,702	19,625,329	197,499	1· 7	11 63	—	—
Reading Corporation	Oct. 3	644	666	− 20	− 707	33½	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	11·23	21·29	,, 31	14,881	2,837,110	386,547	·24	9·24	1,102	7 92
Rotherham Corporation	--	—	—	—	—	9½	9½	,, 31	23.569	5,251,472	593,054	1 07	9 53	2,612	7·49
Salford Corporation	,, 14	4,633	4,593	+ 40	+ 3 521	70⅔	70⅔	,, 31	214,111	39,213,660	4,894,580	1 28	10 29	—	—
Scarborough Tramways Co.	—	—	—	—	—	4½	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 13	5,701	5,430	+ 271	+ 7,254	35⅔	35⅔	,, 25	210,565	63 952,283	,049,899	903	9 543	3,653	5 54
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,365	9 294,771	1,108,369	1 27	11·02	—	7 83
Southend-on-Sea Corporation	,, 9	360	359	− 1	− 169	9	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	,, 31	39,550	6,766,031	1,027,730	—	9 23	—	4 75
Sunderland Corporation	,, 13	1,350	1,359	− 9	− 559	20	20	,, 31	64,858	15 364 463	1,495,685	1·004	10·36	—	6·37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	4,937	1,315,757	102,751	0·87	1 53	1,371	—
Torquay Tramways	Oct 10	193	—	—	—	5 16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 12	803	761	+ 42	+ 607	12 68	12·43	,, 31	43,607	7,995,451	862,12	9·7	12·14	3,132	7·30
Warrington Corporation	—	—	—	—	—	9	9	,, 31	17,057	4,418,225	403,363	—	9 8·	—	6·33
West Ham Corporation	,, 10	2,235	2,374	− 139	+ 1,265	14·7	14 7	,, 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	,, 9	326	839	− 13	+ 304	20	20	,, 31	41,905	8,847,066	950,338	—	10 583	2,062	6·15

† And 98 miles of interlacing track. a Train mile. b Per mile of single track. c Miles of route. h Half-year's figure k Double track.

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NOTES

P. and O. Batti-Wallahs.—This society, whose members are drawn from past and present electricians in the employ of the Peninsular and Oriental Steam Navigation Company, opens its usual season of social functions to-night (Friday) with a smoking concert at the Holborn Restaurant.

Ventilation in Coal Mines.—The Government have appointed an expert mining engineer to investigate and report on the conditions of ventilation prevailing in coal mines in the United Kingdom. Inspectors complain that the language of the Act puts them at a disadvantage when prosecuting the owners of ill-ventilated mines, owing to the vagueness of the legal definition of "adequate ventilation." It is hoped the forthcoming investigations will result in measures being taken to rectify admitted shortcomings in the ventilation systems of coal mines.

Life-Saving Apparatus.—The council of the Society of Arts are prepared to award, under the Fothergill Trust, a gold medal, or a prize of £20, for the best portable apparatus or appliance for enabling men to undertake rescue work in mines or other places where the air is noxious. In the award of the medal regard will be had, firstly, to excellence of design and contrivance, and, secondly, to excellence of manufacture. Credit will be given to such parts of the apparatus as are the invention of the exhibitor, the object being to distinguish the apparatus which gives the best promise of being practically useful. Inventors intending to compete should send in a notice of their intention, together with a full description of their inventions, not later than March 31, 1908, to the secretary of the Society of Arts, John-street, Adelphi, London, W.C.

A Question of Name.—A recommendation which appears in the agenda for this week's meeting of the Stepney Borough Council, is significant of a change which has brought with it increased functions within the sphere of municipal electricity undertakings. The General Purposes Committee of the Stepney Borough Council, after consultation with the Electric Lighting Committee, have come to the conclusion that the title of the latter committee is inadequate, and that in future the committee should be designated the "Electricity Supply Committee." The reason for such a change is at once obvious, seeing that the function of such committees comprise not only the duty of supplying energy for public and private lighting, but also for power purposes. There is much diversity in the nomenclature of municipal electricity committees, and some day, perhaps, may see greater uniformity.

Telegraph Finance.—During the discussion in the House of Commons last session upon the Telegraph (Money) Bill a good deal of criticism was levelled against the financial management of the telegraph services, and the Postmaster-General (Mr. Sydney Buxton) promised, on behalf of the Government, that a committee of inquiry would be appointed to consider means for the working of the telegraph and telephone services on a more commercial basis. The composition of this committee is now announced as follows: Mr. C. A. King, C.B., Comptroller and Accountant-General of the Post Office, chairman; Mr. W. Blain, C.B., a Principal Clerk in the Treasury; Mr. John Bromley, C.B., Accountant-General of the Board of Education; and Mr. W. B. Peat, president of the Institute of Chartered Accountants in England and Wales. The functions of the committee are to consider the various accounts and returns presented to Parliament in connection with the telegraph and telephone services, and to report in what manner those accounts can be modified or supplemented so as to show more clearly the financial result of those services.

Transatlantic Wireless Telegraphy.—The papers have been giving full accounts during the past few days of the inauguration by the Marconi Company of their service of wireless telegraphy between this country and Canada. So far the service has worked satisfactorily, and gives promise of continued success. Press messages are now being transmitted, and the first message to the *Daily Telegraph* from the New York correspondent by wireless telegraphy occupied less than 10 minutes in transmission from Port Morica, Cape Breton Island, to Clifden in Galway. The *Times* correspondent, in sending greetings from Mr. Marconi, hopes soon to be able to send at least part of his regular dispatches by wireless telegraphy. No one will withhold from Mr. Marconi and the Marconi Company the hearty congratulations which are due to them on the successful inauguration of what is intended to be a regular Transatlantic wireless service.

Northern Scientific Club.—The sixth annual report shows this club to be in a very flourishing condition in respect of membership and finance. At the annual meeting last week the officers were elected, and, as will be seen from the following list, they are representative of various branches of applied science. The president is Sir W. H. White, and the committee consists of Sir I. Owen, Colonel Saxton White, Prof. H. Louis, Dr. J. T. Dunn, Messrs. T. M. Clague, A. L. Drummond, J. H. Holmes, H. Rowell, H. Smith, A. Spiller, and W. A. Woodeson; hon. secretaries, Mr. T. Hanning and Dr. W. H. Sodeau; hon. auditors, Messrs. G. Ralph and J. Thompson. The president delivered an address upon the application of the gyroscope for steadying ships and claimed that it had reached beyond the toy stage, which was proved by the fact that the firm who had built the "Mauretania" were to develop Dr. Schlick's apparatus in this country.

National Telephone Company's Employes.—Considerable dissatisfaction is expressed at an order which has just been issued and which affects the whole of the central battery fitters of the National Telephone Company, making it necessary for them, after a preparatory course of 12 weekly lectures, to pass a written examination. The *Westminster Gazette*, in stating the employés' case, says the work is of a highly technical character, involving long practical familiarity with many different branches of the subject, and is only paid at the lowest rates of unskilled labour, the majority of the hands receiving only 6d. per hour. The examination, it is urged, will not add to their efficiency, and while success will bring no increase of pay, failure will be punished by dismissal, though many of the men have been employed by the company for upwards of 20 years. Nor, it is complained, will it be a test of competence, for new hands, often with the highest theoretical qualifications, are absolutely useless until they have served an apprenticeship with old-service men. The men are organising opposition to the new order, and intend to appoint a deputation to lay the case before Mr. G. F. Greenham and Mr. Ridd, chief and assistant electricians.

Coal-Cutting Machinery.—Part 2 of the general report and statistics relating to persons employed and accidents at mines in the United Kingdom contains some statistics with reference to the use of coal-cutting machines in mines. It appears that in 1906 there were 333 collieries where coal-cutting machines were at work as against 295 in the preceding year. The total number of machines employed was

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1,136 as against 946 in 1905, of which 451 were worked by electricity and 685 by compressed air as against 446 electricity and 500 compressed air in the preceding year. The following table shows the number of machines used in the various districts and motive power employed:

District.	Number of machines.	Electricity.	Compressed air.
East Scotland	176	112	64
West Scotland	129	59	70
Newcastle	87	24	63
Durham	132	55	77
York and Lincoln	252	94	158
Manchester and Ireland	53	8	45
Liverpool and North Wales	107	6	101
Midland	140	70	70
Stafford	30	17	13
Cardiff	14	1	13
Swansea	6	3	3
Southern	10	2	8

Last year there were only two fatal electrical accidents underground, both in connection with coal-cutting machines in the East Scotland district. These were fully explained in a recent issue of this journal. A peculiar fatal accident in an underground motor-room in the Stafford district, as to the cause of which expert witnesses differed, is now classed as an explosion of fire-damp. The Midland district inspector gives particulars of a case of lightning passing into a mine during a thunderstorm, by way of braided overhead wires on the surface. He advises the use of lightning arresters for overhead wires whether they are insulated or not.

Electric Contact-Makers. — Messrs. Brecknell, Munro, and Rogers have obtained patent rights for an electric contact-maker which is designed for closing circuits to signalling and time-recording apparatus and for its operating mechanism on electric railways and tramways.

FIG.2.

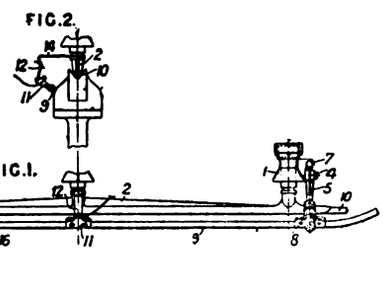

FIG.1.

Contact is made through a switch, 12, 14, and also through the trolley, as shown in the illustration. An auxiliary conductor, 9, is held in insulating clamps, 8, on arms, 5, pivoted to the hangers, 1, of the trolley wire, 10, and carries a clamp, 11, with one part, 12, of the switch. The other part, 14, of this switch is connected to the ear, 2. The arms, 5, are held by an adjustable stop, 7, so as to keep the conductor, 9, clear of the wire, 10, and the switch, 12, 14, open. The trolley, 16, engages the conductor, 9, and swings it on its pivots, 4, so closing the switch, 12, 14, and also connecting the conductors, 9, 10. The switch, 12, 14, may have rubbing contacts, as shown, or the contact 12 may simply bear on the contact 14.

The Local Sections.—The programme for the session of the Glasgow Local Section has now been issued, but the arrangements are apparently not yet completed. At least, this much might be gathered from the programme, which gives the dates of the monthly meetings, but not the subjects of the papers. The session opens on Nov. 12 with a presidential address, which will be delivered by Prof. Francis G. Baily. The meetings of the section will be held, as before, in the Lecture Hall, 207, Bath-street, Glasgow; but the meetings of the students' section (which commenced on the 18th inst.) are fixed to take place at the Glasgow Technical College. The annual dinner will be held on Wednesday, Nov. 20, and the annual smoking concert on Saturday, Feb. 1.—The syllabus for the Manchester Students' Section of the Institution of Electrical Engineers has come to hand, and, as will be seen from the following list, an extremely interesting programme of papers has been arranged. The session will open with a supper and smoking concert on Tuesday, Nov. 5. The real work of the session commences on Nov. 19, when Mr. L. F. Lepine will read a paper on "Power for Works and Factories, with Costs." Among the papers to be read are the following: "The Evolution of the Modern Switchboard," E. P. Hill, B.Sc.; "Electricity and Matter," L. H. A. Carr; "Starters and Control Gear," P. C. Jones; "The Design of Polyphase Induction Motors," W. D. Redfern, B.Sc.; "Electrical Driving of Textile Mills," W. Hanna; "Electrical Testing," A. E. Jepson; "Some Notes on Power Station Equipment and Design," C. W. Crosbie. Among the visits arranged are the works of Messrs. Ferranti Limited; the General Electric Company, Limited; Mather and Platt, etc.

Generating Electricity by Small Gas Plants.—The following are figures on the cost of energy from a 100-h.p. gas-producer plant which our contemporary, the New York *Electrical World*, states appeared in the 1907 "Question Box" of the Canadian Electrical Association. In one case from Alberta, anthracite coal with a calorific value of 12 B.Th.U. was assumed, costing £1 per ton in pea size. The producer efficiency was 78 per cent. The first cost of a 100-h.p. suction gas-producer engine and compressed-air starter, together with erection and foundations, was taken at £1,400. The attendance for a plant of this size is small if the plant is properly equipped, an allowance of four hours per day being ample, according to the example we are now citing. The following figures were given by the contributor. A 100-b.h.p. consumes 1lb. of coal per horse-power hour, or 1,000lb. per 10 hours, and the stand-by losses of the other 14 hours will not amount to more than 30lb., hence the fuel was taken at 1,030lb. The following are the operating costs: engineer, 300 days (four hours each), £60; coal, 154·5 tons at £1 per ton, £155; oil and waste, £46; interest on investment at 8 per cent., £112; depreciation, £112; insurance, repairs, taxes, £50—total, £535; per horse-power year, £5. 7s.; load factor, 100 per cent. To this must be added the cost of water used to cool the engine and that used in the scrubber, 4·5 gallons per horse-power hour; the water used in cooling the cylinder can be used over again if cooling tanks are employed; the allowance for the scrubber and vaporiser is three gallons. However, it is inadvisable to use again the water that has passed through the scrubber and been purified, because if there is a large percentage of sulphur in the coal, the sulphurous acid generated in the producer acts on the wrought iron of the scrubber. Repairs to the producer consist of removing the firebrick lining, once a year as a minimum, and sometimes once in three years. The coke in the scrubber requires removal about twice a year.

Junior Institution of Engineers. — The annual general meeting of this institution was held at the Westminster Palace Hotel on Friday, Oct. 18. Mr. Lewis H. Rugg, A.M.I.C.E., the retiring chairman, presided at the commencement, and was succeeded by Mr. Frank R. Durham, A.M.I.C.E., elected at the meeting. The Council's annual report, which was presented, recorded a very satisfactory year of work. Eight meetings for the reading and discussion of papers had been held and 36 visits had taken place,

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the average attendance at the former being 118 and at the latter 81. Reference was made to the successful summer visit to Glasgow and Edinburgh; to the institution's monthly journal, the annual volume recently completed consisting of 616 pages; to the development of the library, and to the institution's benevolent fund was stated that the membership was now 967, as compared with 908 a year ago, and the accounts indicated that the institution was in a sound financial condition. The annual meeting of the contributors to the benevolent fund then took place, after which a paper on "The Economic Design of Hollow Shafts" was read by Prof. W. E. Lilly, D.Sc., of Dublin University, the institution's member of council representing Ireland. It described a number of original experiments on secondary flexure carried out by the author at Trinity College. General considerations of the existing methods of the design of shafts were first dealt with, and the influence of secondary flexure on design was dwelt upon. The author then passed on to the experimental study of the various forms developed by such flexure, derived formulæ from theoretical considerations were given and applied to particular cases, and reference was made to analogous cases of beams and columns. It was announced that M. Gustave Canet, of Paris, the newly-elected president, will deliver his inaugural address on Nov. 18, taking for his subject "The Latest Improvements in English and French Modern Artillery," and that the meeting for its delivery would be held at the Institution of Civil Engineers, Great George-street, Westminster, by kind permission of the council.

Edison Storage Battery.—It is not often that Mr. Edison is heard in public, but whenever he does make one of his rare public appearances his words are anxiously awaited by the reporters, ever on the look-out for information which may lend itself to sensational paraphrasing. Thus for a number of years the public have been led to expect the invention of an accumulator which will solve the problem of the generation and storage of electrical energy on vehicles, and have had held out to them hopes of electric traction without the necessity of a central station and its networks of conduits, connections, etc. According to the latest reports, this long-expected consummation is not far off. Mr. Edison is reported to have told the members of the American Electro-Chemical Society, at a meeting on the 18th inst., "that he had perfected an electric storage battery, and that horses, except those kept for pleasure, would soon disappear from the streets." Electrically-driven motorcars have been in use for some years, but the small storage capacity of the batteries, as well as their exceedingly heavy weight, have limited their use on cars for town work or for short runs. The attention of inventors has been centred upon the solution of these problems, but, so far, no material development has taken place. It is known that Mr. Edison has devoted many years and much thought to the discovery of a medium for combining in a battery light weight and the capability of storing electricity in bulk, and if the reported new Edison accumulator proves practicable, it will have an important effect. But bearing in mind previous announcements, it is well not to place too much reliance upon the report until there have been opportunities for submitting the finished article to thorough and practical tests. But the storage battery is not alone in claiming the attention of Mr. Edison. For instance, he is said to have invented an improved cement which can be poured into iron moulds, and it is claimed that within 24 hours a three-storey house, which shall be absolutely fireproof and practically permanent, can be built at a cost of less than £200.

Regulating Iron Reduction in an Electric Furnace.—A patent has been taken out by Dr. P. L. T. Héroult, to be worked by a French company. In smelting iron ore in a furnace with one vertical electrode, while the crucible below forms the other terminal, it is possible by adjusting the quantity of lime added to the charge to produce a thinner or thicker scale or lining upon the side walls of the furnace in the fusing zone. If more lime is added than is necessary to maintain the composition of the slag, the excess lime forms a scale or lining. On the other hand, to diminish the thickness of this scale it is only necessary to supply less lime than the slag requires, whereupon the slag will dissolve the scale until its equilibrium is restored. By adjusting the thickness of this scale it is possible to diminish or enlarge the cross-section of the zone of fusion, thus concentrating more or less the energy density in the fusion zone. If the cross-section is reduced and the energy density increased, the electrode is lifted by the usual automatic mechanism which maintains the voltage and current constant. The increase in the length of the zone of fusion then increases the rate of reduction in this zone, and produces á pig of higher silicon content. The reason given by Dr. Héroult is that when the electrode is raised the incandescent carbon column becomes longer, and this added resistance enables the arc (which extends from the lower end of the electrode to the top of the carbon column) to become a little shorter. Consequently, there is less heat for the melting of the oxide of the charge, and the operation of the furnace is less rapid, but the oxides which are melted pass through a long column of carbon and are more completely reduced. Since it is at least approximately true that the iron is first reduced and then the silicon, it follows that the elongation of the zone of fusion produces an increased silicon content in the product. Therefore, by increasing the thickness of the scale, the silicon content of the product is increased, or by decreasing the thickness of the scale the opposite effect is obtained. A description of this patent appears in the current month's issue of our contemporary, *Electrochemical and Metallurgical Industry.*

Publications Received.—There have come to hand parts 3 and 4 of vol. 27 of the *Proceedings* of the Royal Society of Edinburgh. Chief among the communications of interest are the following: "The Physical Properties of Mixed Solutions of Independent Optically-Active Substances," by Clerk Ranken and W. W. Taylor; "Vibrating Systems which are not subject to the Boltzmann-Maxwell Law," by Dr. W. Peddie; "The Partition of Heat Energy in the Molecules of Gases," by Dr. Paul Ehrenfest; "The Electric Conductivity and Refracting Power of Sea-Water," by Dr. E. G. Hill; "The Variations of Young's Modulus under an Electric Current," by Henry Walker. — The *Calendar* for the session 1907-8 for the Armstrong College, Newcastle-on-Tyne, has come to hand (price 1s., post free 1s. 4d.). This college forms an important part of the Durham University, the degrees of which in science and letters and its diplomas in engineering, naval architecture, and mining are open to students of the college. The course of electrical engineering is under the professorship of Dr. Wm. Thornton, and students who have followed the prescribed course extending over three years and have passed the several examinations may proceed to the degree of B.Sc.—We have received from the publishers, Sir Isaac Pitman and Sons, Limited, 1, Amen-corner, London, E.C., an advance copy of an important new work of reference, entitled "Where to Look" (price 1s. net). The book is published in the hope that it may prove useful to those who are uncertain as to where to look for information on subjects which are treated in the numerous reference annuals.—The *Bulletin* of the Société Belge d'Electriciens for October contains an article by R. Goldschmidt on wireless telegraphy and telephony, while M. Orban deals with

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the application of electricity to agriculture.—The *Journal* of the Western Society of Engineers (vol. xii, No. 4), published at Chicago, contains the following among other contributions: "Some Problems in Wood Utilisation in the United States," R. S. Kellog, U.S. Forest Service; "How to Prevent Failure in Concrete Construction," Dr. W. Michaelis; "The Application of the Storage Battery to Lighting Power and Railway Service," J. M. S. Waring.

Australia.—The supply of telegraph and telephone insulators forms a large portion of the export trade in electrical goods from this country to Australia. But the desire of the colonists to satisfy their requirements by home manufacture instead of by import threatens some future diminution of exports from this country, especially in regard to porcelain insulators. It is held, for instance, that these insulators can very well be made in Australia, for there is said to be no lack of suitable material. In Victoria, for instance, within 100 miles of the G.P.O., there is a large deposit of fine porcelain-making kaolin. An analysis made in the Government laboratory of two samples proves the clay to be the purest kaolin, absolutely free from lime, but high in alumina and silica. Mr. P. G. Bayley, the Government analyst, in reporting on these samples, said: "Both of these clays form good, sound briquettes. As was to be expected from the analysis, the shrinkage is large, but there was no fusion. The yellow colour obtained with each on heating at a muffle temperature is completely removed at the higher temperature of the wind furnace. These clays should be of some economic value, and are worth further investigation on an industrial scale. The analysis reads: silica, 53·83 per cent.; titanium, nil; alumina, 30·45; ferric oxide, 1·45; ferrous oxide, 0·04; lime, nil; magnesia, 0 83; soda, 0·26; potash, 1·70; water, 3·23; ignition, 7·95; chlorine, 0·25; phosphoric acid, trace; sulphuric acid, trace. The colour test was: air dried, white; muffle test for hours at 1,110deg. C., yellowish; furnace after, white; heating 1,450deg. C., flinty; furnace dried, 145deg. C., white."—So successful has been the working of the Melbourne city electricity undertaking, which during the first six months of the present year increased its revenue to the extent of £5,985 and its net profits by the sum of £1,453, that the Corporation, in order to make provision for additional demands, have decided to have two additional boilers erected at the station at a cost of £3,030. With the increased plant, it is hoped that the extension of the electric lighting scheme to Hopetoun will be possible. The local papers state that efforts are to be made to develop the deposits of brown coal at Altona Bay and to utilise it for generating electricity on the spot and transmitting the power to Melbourne for driving the suburban railways and other purposes. The Premier states that when Mr. Merz, the expert engaged to report upon the electrification of the suburban railways, arrives from England he will go into the question of obtaining the power from the coal deposits at Altona Bay.

The Training of Insurance Surveyors.—The insurance surveyor is often called upon to inspect and report upon electrical installations or materials when he possesses little or no practical or theoretical knowledge of his subject. This looseness on the part of insurance companies has in the past resulted in the passing of installations in which defective materials have been used, and led to the inevitable fire, which has in no few cases been conveniently ascribed to the employment of electricity instead of to the real and removable cause—defective work or materials. It is not supposed that an insurance surveyor is gifted with the power of boundless knowledge, or that he possesses the infinite wisdom to enable him to authoritatively advise upon matters of which he has had no previous experience, but it is at least expected that he should be sufficiently competent in the various branches of his work, and that in the case of electric light and power installations he should know the difference between good and bad work. If such a knowledge had been more general, the number of fires due to electrical causes, few as it is, would have been still less, and we would have been spared many of the gratuitous criticisms upon the suitability of electricity for lighting and power made by those who who have interests in rival means. Fortunately, the surveyors connected with the various insurance companies who are not insensible to the great and increasing use of electricity realise the limitations of their knowledge, and are taking steps to make themselves proficient in electrical knowledge, which they recognise as an important branch of their work. An example of this is afforded by the Insurance Institute of Newcastle-on-Tyne. Last winter a short preliminary course of instruction for insurance surveyors was undertaken under the auspices of the institute, and the course is being continued this season. A series of weekly lectures, which commenced on Oct. 17, is arranged to be held every Thursday evening (till Dec. 19) at the Armstrong College. Mr. F. O. Hunt, A.M.I E E., is the lecturer, and his series of lectures comprise: The heating of conductors. $C^2 R$. Institution of Electrical Engineers' standard of density. Voltage drop in conductors—Resistance materials and their properties. Temperature coefficient and its effect on safety under various conditions—Flexibles. Some recently published investigations—Alternating currents, production and transmission—Choking coils and transformers—Hysteresis and eddy currents in iron—Design of continuous-current motors, heating and sparking, limits of output, and necessity for ventilation—Practical points in construction of commutators and brush gear. We hope that similar work will be undertaken in other centres.

Power in Manufactures.—The American Bureau of Census has just issued a *Bulletin* which contains statistics on the power employed in manufactures during the year 1905. The total power thus employed, according to this report, was 14,641,544 h.p. To this amount steam-engines contributed 10,828,111 h.p., or 73·9 per cent.; waterwheels, 1,647,969 h.p., or 11·3 per cent.; electric power, owned or rented, 1,592,483 h.p., or 10·9 per cent.; gas or gasoline engines, 289,514 h.p., or 2 per cent.; and other kinds of power, 283,467 h.p., or 1·9 per cent. The New York *Electrical World*, comparing these figures with those of 1900, shows that in five years the total horse-power increased more than 40 per cent. The largest relative increase for any of the kinds of power was one of 270·5 per cent. reported for owned electric motors. Rented electric power increased 141·9 per cent., and the power of gas and gasoline engines 114·9 per cent. Although steam-engines are by far the most important source of power, electric power and the power of gas and gasoline engines are becoming of increased relative importance in manufacturing. Water power, while increasing absolutely, is diminishing in comparison with other kinds of power. At the census of 1905 power derived from electricity was reported as 1,592,483 h.p., which represents an increase over the amount reported at the census of 1900 of 1,099,260 h.p., or 222·9 per cent. The development was extraordinary in the States distinguished chiefly for heavy manufacturing on a large scale. The horse-power reported rose in Pennsylvania from 107,746 to 346,797, or 221·9 per cent.: in New York, from 77,598 to 222,111, or 186·2 per cent.; in Illinois, from 49,235 to 165,265, or 235·7 per cent.: in Ohio, from 42,157 to 144,467, or 242·7 per cent.; and in Massachusetts, from 32,828 to

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91,017, or 1777·2 per cent. The increase in the number, size, and total capacity of gas and gasoline engines has been another marked feature of industrial development. The number of gas and gasoline engines reported increased from 14,334 in 1900 to 21,525 in 1905, their horse-power from 134,742 to 289,514, and their percentage of the total horse-power employed in manufacturing establishments from 1·3 to 2. When it is recalled that at the census of 1890 the capacity of gas-engines in manufacturing establishments was only 8,930 h.p. and is now over 30 times as great, it will be seen that a really remarkable change has taken place. The effect of the introduction of electricity has been to retard the increase of other kinds of rented power. The various electric lighting companies throughout the country have found renting power a large and profitable source of income, giving them a load for their generating apparatus in the daytime. Thus they are able to run their plants at nearly the full capacity at all hours of the day and night.

Corrosion of Iron.—Two papers on this subject which appear in the September issue of *Electrochemical and Metallurgical Industry* establish some important hypothesis on the causes of the corrosion of iron as an electrochemical phenomenon. It is shown, for instance, that the carbon-dioxide theory cannot be satisfactory, since the presence of carbon dioxide is not necessary for the corrosion of iron. In support of this conclusion some experiments are described by Dr. Walker, the author of one of the papers. Thus in a crucial experiment on the electrochemical theory the fact is established that iron dissolves in water which contains not more than a trace of electrolyte, no oxygen, and no carbon dioxide. The dissolving of iron in the moisture is the first step, while the second step is the oxidation of the ferrous ions to ferric by oxygen of the air. The loose colloidal ferric hydroxide thus produced moves towards the cathode under the influence of the current and piles up there in the form of rust. The function of oxygen in the corrosion is double; the secondary function being, as just explained, the oxidation of the ferrous ions. According to Dr. Walker, however, oxygen must also fulfil a primary function—namely, to depolarise those cathodic portions of the iron upon which hydrogen tends to precipitate. In conjunction with Dr. A. S. Cushman, Dr. Walker has devised a special indicator which shows directly where the cathode and the anode zones are on an iron surface. This may be described as follows: A piece of iron is immersed in ordinary water to which has been added a little phenolphthalein and a trace of potassium ferro-cyanide. Within a very few minutes the iron is seen to divide itself into zones or surfaces which exhibit opposite polarity. Those portions where the iron is anodic become coated with a precipitate of Turnbull's blue, owing to the escape of the iron ions at those points. Those portions on which hydrogen is being liberated, acting as cathodes, become bright red, owing to the formation of hydroxyl ions. This action may be more easily studied if this reagent (for which Dr. Cushman has proposed the name "ferroxyl") be thickened by the addition of natural gelatin or agar-agar. There are two possibilities to limit rusting. The first is to make the iron so pure and to guard against unhomogeneity and bad segregation to such an extent that galvanic couples are not likely to be formed. The second method is to use the present commercial kinds of iron and steel and protect them by a coating such as a dilute solution containing bichromate. It is quite possible, as our contemporary points out, that the cheapest way to make a better iron and steel might be so to treat open-hearth or Bessemer steel subsequently in the electric furnace. If the corrosion of iron is an electrolytic process, and electro chemistry is at the bottom of the corrosion trouble, it would be only proper that another branch of electro-chemistry—the electric furnace—should solve the problem.

Electro-Metallurgy.—Some results of an experimental investigation carried out by Messrs. A. E. Greene and F. S. Macgregor at the Massachusetts Institute of Technology on the electrothermic reduction of iron ores containing titanium appear in a recent issue of *Electrochemical and Metallurgical Industry*. Investigations up to the present time have demonstrated that iron ore can be economically smelted in the electric furnace where power is cheap. There are many phases of the problem, however, regarding which data are entirely lacking at the present time, but upon which Messrs. Greene and Macgregor's investigations shed some additional light. Particular attention was directed to the following points: (1) the design and construction of an experimental electric furnace of about 30 kw. capacity; (2) the measurement of the temperature of the molten charge; (3) the factors affecting the temperature, and the methods of regulating it; (4) the effect of temperature and of composition of charge on the quality of iron produced; the calculation of the amount of electrical energy required per ton of pig iron. The apparatus employed in these experiments is somewhat interesting. Alternating current was used, which was generated by a special 1,100-volt, 133-cycle, 30-kw. generator, belt driven by a 50-h.p. direct-current motor, supplied with power from the power plant of the institute. The energy was transmitted at 1,100 volts to the transformer in the furnace laboratory, from which it could be taken at voltages varying from 10 to 160 volts, and applied directly to the furnace. The electrical instruments used for measuring current, volts, etc., were an ammeter, alternating current, 5 amperes; a voltmeter, alternating current, 65 volts; a wattmeter, alternating current, 6 amperes and 65 volts; a current transformer; a voltmeter, direct current, 15 volts, and a galvanometer for the thermo-electric pyrometer. The temperature of the molten bath was measured by means of a Wanner optical pyrometer reading from 0deg. to 4,000deg. C. The standard six-volt lamp was supplied with current from a storage battery. This voltage was maintained constant by means of a slide wire resistance in series with the lamp between the mains of the battery, and was read on the 15-volt Weston voltmeter. A thermoelectric couple was used for getting the temperature of the gases. The dimensions of the furnace and crucible as finally used are as follows: height of furnace, 24in.; length of side, 23in.; depth of crucible, 8in.; size of upper portions of crucible, 9 square inches; size of base, 5 square inches; distance from bottom of crucible to top of furnace, 15¼in. Various methods were tried of determining the temperature of the molten zone. It was found that the most suitable method was that of the horizontal plugged tube entering near the base of the crucible. It was found that the temperature may be regulated by the energy input, by the current or voltage, and to a certain extent by the height of the electrode, and that the temperature responds very quickly to these charges. To maintain constant temperature with a constant rate of input of change, the energy input must also be constant. The observations on electrical input were not primarily taken with the idea of obtaining data on the efficiency of the electric furnace, but rather to show the relations between power input and the resulting temperature; nevertheless, the results are very good when the small size and relatively large radiating surface of the furnace are considered. The lowest amount of energy required in any run per ton of metal reduced was found to be 0·75 electric horse-power year.

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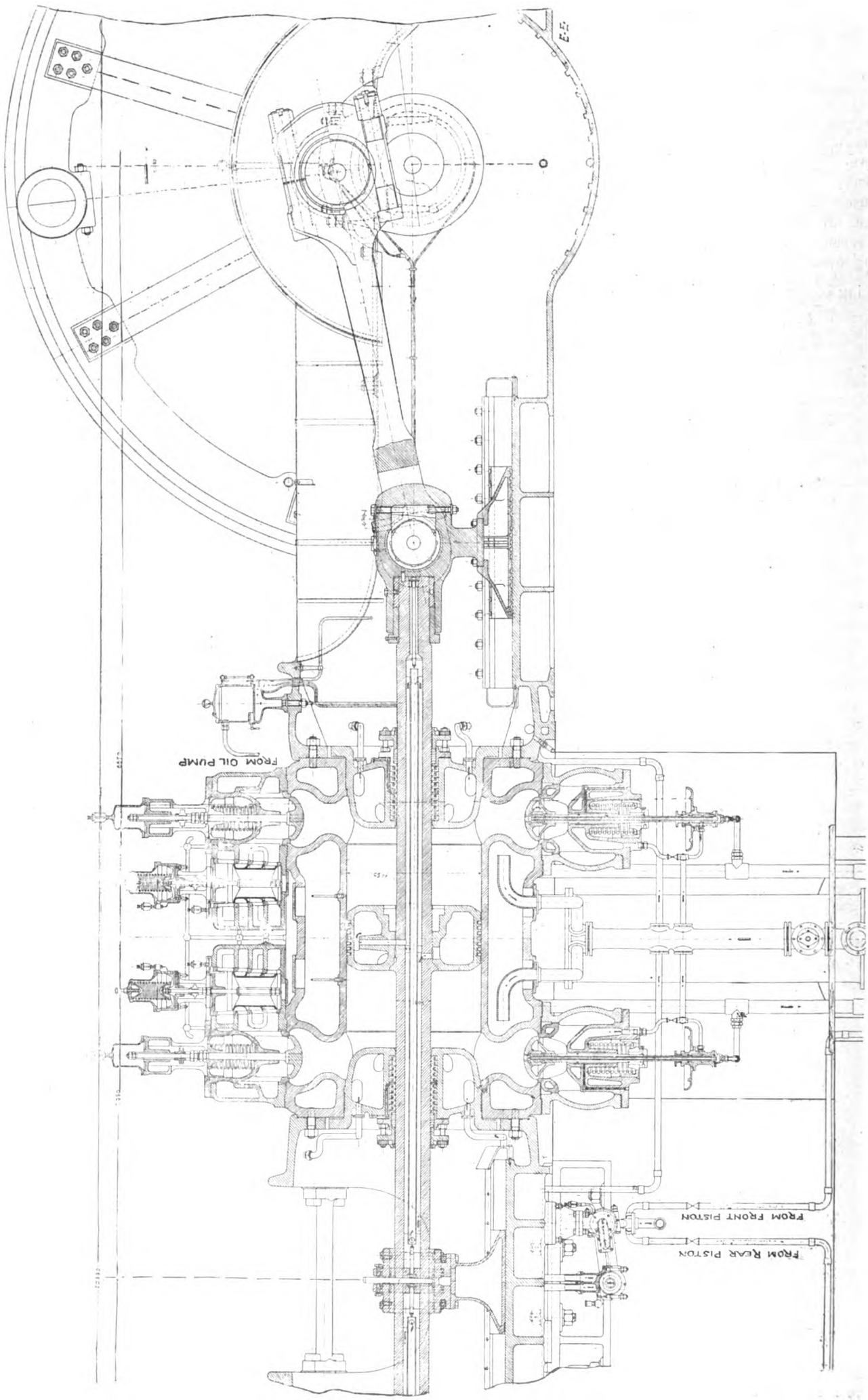

FIG. 5.—Section of One-Half of one of the 2 200-h.p. Ehrhardt and Sehmer Gas-Engines running at the Hoerde Iron and Steel Works

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LARGE GAS-ENGINES IN GERMANY.

The Key Engineering Company's Tour.

(Continued from page 556.)

Our readers will be interested in the details of the gas-engines referred to in the previous articles, and which from the number of repeat orders secured must give satisfaction to the users. About four years ago Ehrhardt and Sehmer took up the manufacture of large gas-engines, and since then have succeeded in producing one of the most economical and reliable engines on the market. In designing this engine the following requirements have been kept in view the whole time, and a great amount of time was given to studying the conditions which are met in gas-engine practice but absent from steam engines, where experience in these latter was of no assistance. The Ehrhardt and Sehmer gas-engines work on the double-acting four-cycle principle, and in order to obtain the greatest output for weight are built in tandem or twin-tandem arrangement. The four-cycle principle gives the greatest adaptability and synoptical character, and with proper designing is scarcely affected by dust in the gas. It has also exceptional advantages over some other types for driving alternators in parallel, which was done regularly at two of the plants inspected.

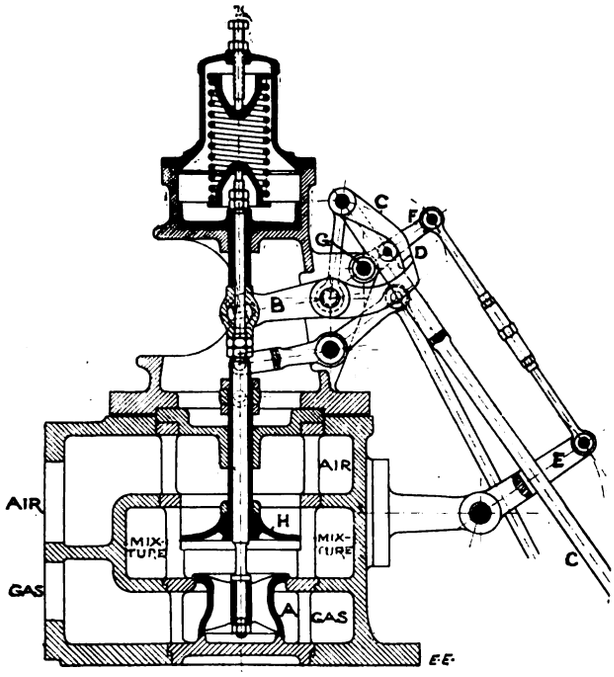

FIG. 6.—Section of the Ehrhardt and Sehmer Patent Mixing Valve Gear.

Reliability of working is the determining factor in estimating the value of gas-engines. For reliable working the engine must start up with certainty, be able to take up the full load quickly, as well as carry same continuously even under the most unfavourable circumstances, particularly when variations in the quality of the gas take place. It is also necessary for a gas-engine to accommodate itself to rapid fluctuations of load between no load and full load as easily as a well-designed modern steam-engine without either racing or pulling up. An engine, again, must not be susceptible to dust in the gas. It cannot sometimes be helped that the dust percentage rises above normal, and on this account the parts must be so designed that dust deposits thus caused shall not materially affect the working until they can be removed; and, further, for this purpose the valves must be so constructed that they can easily be dismounted and cleaned in a very short space of time. The valve gear must on no account allow an excess of gas in the explosive mixture, which would, of course, be pure waste, and raise the temperature of the cylinder walls. It must be possible to clean the pistons and cylinders without dismounting such parts as the slipper guides, which require great skill and considerable time in re-erecting, and the amount of work in periodic overhauls must be as little as possible. Care must be taken that all parts are so proportioned that the stresses which come about in working do not exceed those which have been proved safe in steam-engine practice. Castings must be from a high-quality iron, and free from all shrinkage strains. Lubrication must be sufficient, economical, and easily looked after.

The special points of interest about the Ehrhardt and Sehmer engines are found in the valve gear, piston and cylinder design, and high-class workmanship. A section of a typical engine is given in Fig. 5. The drawing (Fig. 6) shows the patent mixing valve gear. From this it will be seen that the gas-valve, A, is actuated by the lever B, which is moved by the lever C. This obtains its motion from an eccentric on the half speed shaft through the trip, D. The trip gear is timed by the governor through the levers E and F and the connecting link between them, the position of the pin, G, determining the time of closing of the gas-valve. There is no air-valve on the mixing valve gear to introduce complications. The gas-valve, it will be seen, is a simple double-seated valve, and entirely uninfluenced by the pressure of the gas. There are no guiding surfaces in the gas passage, and consequently a large amount of dirt in the gas cannot cause sticking through tar deposits. It will further be seen that a round plate, H, fixed to a sleeve outside the gas-valve spindle is brought into the mixture chamber, and is adjusted by hand from the lever L. This is set, in the first instance, when an engine is started up to suit the particular conditions under which it will work, and does not require altering when running. Its object is to prevent the gas and air from impinging upon one another as they enter the mixture chamber, and at the same time allow both to flow freely into the cylinder. This arrangement of the mixing valve gear gives good governing, suiting itself to not only variations in the load but also to alterations in the gas quality or pressure. It is so set that the gas-valve *always* closes before the end of the suction stroke, so that after having drawn in its gas charge the piston sucks air into the cylinder at the end of the stroke. This ensures that there is no explosive mixture in the mixing chamber, and does away with the danger of back fires. As there is always an excess of air in the gas and air charge, the greatest economy is obtained and the gas is entirely consumed.

The cylinder and water jacket are cast in one piece. The cooling space is very deep, and numerous large inspection holes are provided, which enable cleaning to be done with the greatest ease and least loss of time. In constructing the outer jacket and cylinder in this manner part of the stresses occurring in the latter are taken up by the former, and, further, all difficulties of making joints between the various parts are avoided. These joints in engines with a separate liner do, as a matter of fact, cause a lot of trouble, and the packings usually need to be renewed at intervals varying from four to ten weeks. The cylinders are supported entirely from their ends by the frame, distance piece, and back slipper guide, and do not rest on any intermediate supports. This construction enables a large amount of space to be left in the foundations under the cylinders, thus leaving the exhaust valve and gear easily accessible.

Owing to the size of the engine, we have in Fig. 5 reproduced one cylinder only in section. The position of the second cylinder is indicated on the left of the illustration. This also shows clearly the method of water-cooling the piston and piston rod. The hollow link motion for feeding this system at the centre is shown, and is very neat. The design is such that there is little angular motion on the joints of the links carrying the circulating water. In the illustration both the exhaust ports and valves are water cooled, but the valves are no longer jacketed in the latest engines we inspected in the shops.

(To be continued.)

ASCOT AND DISTRICT GAS AND ELECTRICITY COMPANY.

Opening of the Electricity Works.

These works were opened on Tuesday last by Sir Walter Palmer, Bart., and the occasion is unique in that it marks

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the first attempt to carry on a combined gas and electricity undertaking. We believe that Ascot stands alone in this country in possessing combined gas and electricity stations, so that the equipment of the electricity station should prove of particular interest. But before describing the plant installed it will not be amiss to give a brief historical account of the undertaking, and of the difficulties which the enterprising company had to encounter before receiving sanction to carry out their plans.

The Ascot District Gas Company were incorporated by the Ascot District Gas Act, 1882, with a capital of £60,000 and borrowing powers of £15,000. The company's area of

FIG. 1.—Exterior of Buildings.

supply comprised the parishes of Sunninghill, Sunningdale, Easthampstead, Warfield, Binfield, Winkfield, and Waltham St. Lawrence in the county of Berks, and the parishes of Windlesham and Bagshot and Bisley in the county of Surrey. In the year 1905 it became apparent that there was a demand for electricity springing up in parts of the company's area, particularly in the parishes of Sunningdale and Sunninghill. After consideration the company decided to endeavour to obtain powers to supply electricity themselves and to utilise the land adjoining the gasworks as a site for a generating station, and Messrs. Lees and Butterworth, of Westminster, were instructed as solicitors and

MR. H. W. HANDCOCK, A.M.I.C.E., M.I.E.E.

parliamentary agents in the matter. In the session of 1906 the company promoted a Bill in which they sought power to extend their gas limits, and to supply electricity throughout the whole of their area of gas supply as proposed to be extended by the Bill, and to raise additional share capital to the extent of £30,000 with the usual borrowing powers. However, an application was made at the same time to the Board of Trade by independent promoters for a provisional order to authorise a supply of electricity throughout an area including, *inter alia*, the parishes of Sunningdale and Sunninghill and Windlesham, which were within the Ascot District Gas Company's existing limits of gas supply, and the parish of Chobham, which the Ascot Company were proposing to include within their limits, and throughout all of which parishes they were seeking power to supply electricity. The promoters of the provisional order petitioned against the gas company's Bill, and objected to powers for the supply of electricity being conferred on the gas company in competition with the provisional order which they were promoting. The gas company objected to the *locus standi* of the promoters of the provisional order to be heard against their Bill, but the Court of Referees allowed the promoters

MR. W. A. SCHULTZ, J.P., SECRETARY TO THE COMPANY.

of the provisional order a *locus* against the Bill. The Select Committee on the Bill were appointed to meet on March 14, 1906, but the gas company succeeded in getting the consideration of the Bill postponed to enable the Board of Trade to give their decision on the provisional order, so that if the order was made the Bill confirming it and the Ascot District Gas Bill might be considered by the same committee as competing Bills, and if the provisional order was refused the gas company might be saved the expense of a parliamentary contest. The gas company opposed the

MR. ALFRED H. DYKES, A.M.I.C.E., M.I.E.E.

grant of the provisional order, and on April 4, 1906, the Board of Trade held an inquiry to consider the application. At this inquiry, though the promoters of the provisional order were not prepared with any estimate of expenditure or other engineering evidence, the gas company were prepared to put forward a complete scheme upon which they had then been advised by Messrs. Handcock and Dykes, the consulting engineers. The Board of Trade, however, decided that they could not go into the details of a competing scheme, and the gas company were, therefore, somewhat handicapped in their opposition. The decision of the Board of Trade on the provisional order had not been given on April 24, when the Select Committee to

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consider the gas company's Bill was appointed to meet on May 1. The advisers of the gas company communicated this fact to the Board of Trade requesting the Board of Trade to come to a decision either to grant or refuse the order, so that if the order were granted the Bill to confirm it and the gas company's Bill could still be taken as competing Bills by the same committee, while if the order were refused the effect of the refusal would be to deprive the promoters of the provisional order of any right to be heard against the Bill of the gas company, who would then get an unopposed Bill, as they had then succeeded in getting rid of all the other opposition. As a result, the Board of Trade on April 26 decided not to proceed with the application for the provisional order, and the promoters of the provisional order immediately withdrew their opposition to the gas company's Bill, which passed through both Houses of Parliament as an unopposed measure.

The Ascot District Gas Company are to be congratulated on having been the first gas company to obtain powers for the supply of electricity in the face of a competing application from independent promoters of a provisional order. In 1899 the Walker and Wallsend Union Gas Company obtained powers to supply electricity throughout a portion of their gas limits, and in the same year the Andover Gas Company obtained power by agreement with the Corporation to take a transfer of a provisional order for the supply of electricity which had been granted to the Corporation. The Ascot case was, however, and still is, the only case where a gas company has succeeded in obtaining powers to supply electricity and at the same time secured the rejection of a competing application for the supply of electricity by independent promoters. Steps were immediately taken to put the powers into operation, and the engineers were instructed to prepare the necessary plans and specifications. Tenders were then taken, and the contracts were finally placed early in May, 1907. Current

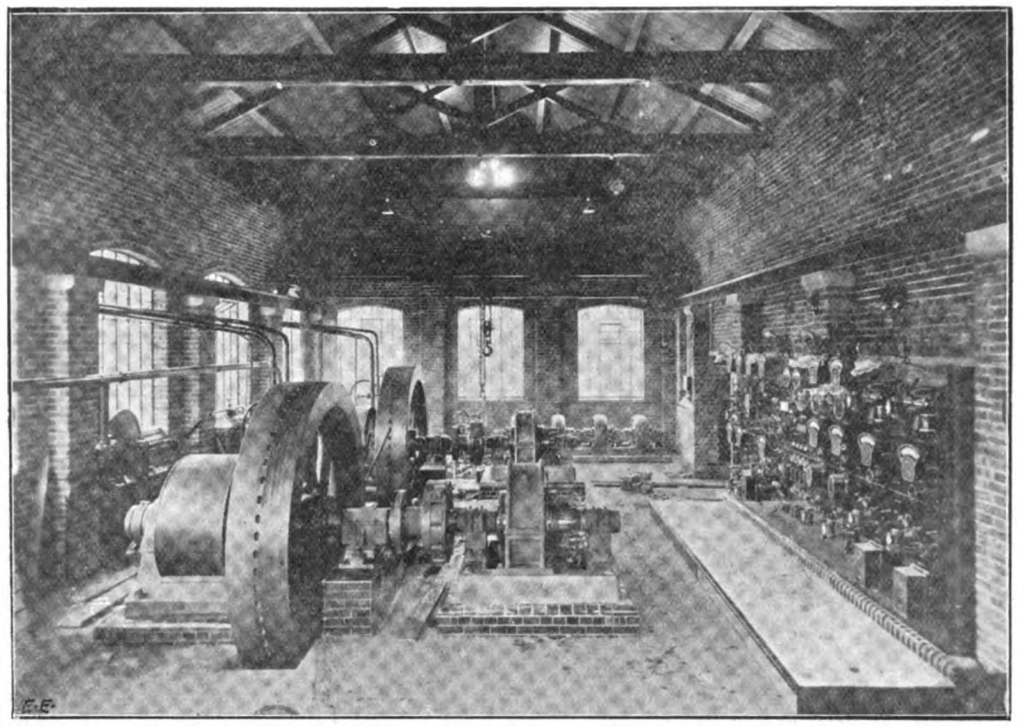

FIG 2 View of Engine Room, showing Gas-Driven Generating Sets, Boosters, and Switchboard.

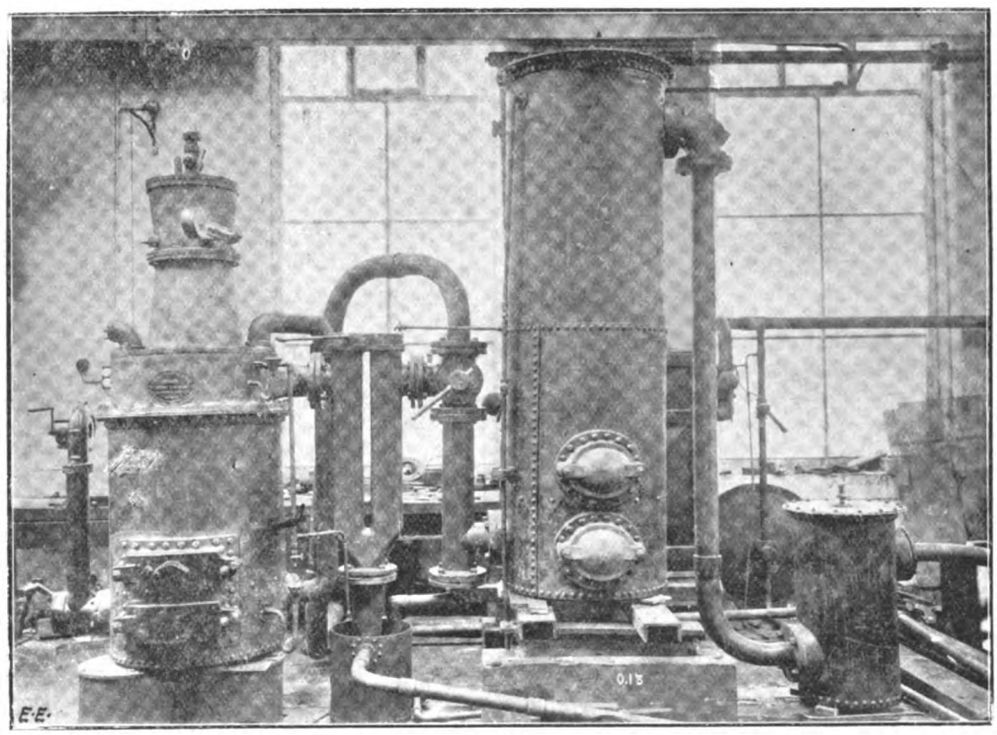

FIG. 3.—Hornsby-Stockport Suction Gas Plant.

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was first turned on to the mains on Oct. 5, just five months later.

The engine-room has been built on the site of the old oxide-house, the roof of which was raised some 6ft. to obtain the necessary height for the crane. The purifier-room has been remodelled so as to accommodate the accumulators. The buildings (a view of which is seen in Fig. 1) are substantially built of red brick with slate roofs, the floor of engine-room being tiled, and the raised bed of the gas-engines and dynamos are built in brown glazed bricks. The general plant (Fig. 2) consists at present of two Hornsby-Stockport horizontal engines, each capable of working continuously at 90 b.h.p. Each engine is coupled through a flexible coupling to a Johnson and Phillips direct-current dynamo capable of giving normally 460 volts 110 amperes at 210 r.p.m. The engines have electric ignition and are started by means of compressed air provided by a motor-driven air compressor. A petrol starter, with hand pump, is also provided as a stand-by to the compressed air system.

Outside the engine-room there is mounted on iron columns and girders a cast-iron tank, 18ft. by 12ft. by 6ft. deep, which supplies the water for the gas plant and also for the water circulation of the engines. A small centrifugal pump is driven off each engine to assist the circulation. This tank is supplied from a well in the works by means of a motor-driven pump, and a stand-by supply to come into action in the event of the well failing is provided from the water company's mains.

Gas is supplied from a Hornsby suction producer provided with the usual cleaning and scrubbing plant (Fig. 3). In addition to the ordinary hand fan for blowing up the producer, a small electrically-driven blower is provided, the hand blower being merely used as a stand-by. The fuel used is the coke produced on the works. There is only one producer, a branch from the lighting gas-main being run through a meter into the engine-room, with the necessary gas-bags and fittings, so that either engine can, when desired, be run with lighting gas. The engine-room is spanned by a hand-power overhead traveller capable of lifting up to 10 tons. To the left of the main switchboard is a semi-automatic balance booster, consisting of two balancer motors and two booster dynamos coupled in level. Each booster gives 100 amperes at any voltage from 10 to 90. The shunts of the balancers are cross connected and the boosters are reversing, with diverter coils and rheostats, so that they automatically regulate the voltage, and thus reduce very considerably the attendance on the switchboard.

The main switchboard is situated in the wall between engine and accumulator rooms, a brick chamber being formed behind giving ample access to the back of the board. The accumulator regulating switches are mounted in the wall of this chamber looking into the cell-room, and are actuated by means of spindles and hand wheels on the main board, thus keeping all the battery connections in the cell-room. The switchboard consists of the usual dynamo, battery feeder, and middle-wire panels, the instruments being of the moving-coil type supplied by Messrs. Everett-Edgcumbe, except the feeder voltmeters. These were made by Messrs. Nalder Bros. and Thompson to the engineers' designs, and, in addition to being compound wound to show the voltage at the ends of the feeders, have an atttachment by means of which an electric bell rings when the voltage rises or falls below a predetermined amount. This plan, which the engineers have adopted in several of these stations, is exceedingly convenient in the smaller stations, as it obviates, with the assistance of the automatic booster, the necessity of constant attention to the switch-board. The cell-room is remarkably roomy, and contains 240 type No. 614 L.Q. 11 Tudor cells capable of discharging at 54 amperes for 10 hours with a maximum discharge of 140 amperes for three hours, all the cells being arranged on one tier only.

At the present time some seven miles run of mains have been laid, consisting of three-core, paper-insulated, lead-covered cable by Messrs. Siemens Bros. laid on the solid system in wooden troughing. All services and straight-through joints are lead wiped joints, and wiped joints are made on to all three and four way disconnecting boxes, the earthing of the lead sheathing being thus continuous throughout. Two sizes of distributor cables only are used—·1 by ·1 by ·1 square inch and ·05 by ·05 by ·05 square inch. The meters used are Siemens's new pattern ampere-hour meters with cyclometer dials.

The price of current has been fixed for the present at 7d. per unit for lighting and 4d. per unit for power, the voltage of supply being 220 on either side of the three-wire system. From the applications already received it is clear that the undertaking is meeting a long-felt want in the district, and that before very long the station will, under the able supervision of Mr. A. E. Brooks, the present manager, justify the step that the directors have taken.

The plans and specifications were prepared by Messrs. Handcock and Dykes, 1, Victoria-street, Westminster (to whom we are indebted for facilities for viewing the works), the company's consulting engineers. Mr. E. J. H. Bluett has acted as clerk of works during the carrying out of the work. The contractors were: buildings and foundations, Mr. Pizzey, Ascot; gas plant, gas dynamos, water-tank piping, etc., Messrs. Bilbie, Hobson and Co. (Messrs. Hornsby and Sons, Limited); accumulators, Tudor Accumulator Company; switchboard, boosters, and connections, Electric Construction Company; overhead crane, Messrs. Herbert Morris and Bastert; underground mains, meters, and services, Messrs. Siemens Bros. and Co.; station wiring, Messrs. Tyler and Freeman.

The successful issue of the scheme was largely due to Mr. W. A. Schultz, J.P., the secretary of the gas company, who has devoted a large amount of time and attention to the work throughout, and on him a great part of the work in connection with the obtaining of the parliamentary powers and other preliminary work naturally fell.

The opening ceremony was well attended, and the visitors, many of whom were residents in the neighbourhood, evinced much interest in the works. Later a dinner was held in the Berestede Hotel. This was presided over by Sir Walter Palmer, who was supported by Sir Joseph Savory, the directors of the company, Mr. A. H. Dykes, and many residents of Ascot and district.

THE ECONOMIC DISTRIBUTION OF ELECTRIC POWER FROM BLAST FURNACES.*

BY B. H. THWAITE, A.M.I.C.E. (LONDON).

(Concluded from page 491.)

Another and important argument in favour of the pooling policy is the fact that some 4,000 kw. to 5,000 kw. of energy is the minimum demand of many of the most desirable of the electro-chemical and other operations, so that in a single works, without a drastic reorganisation of the plant, it would be impossible to secure this output of electric energy; whereas, by the pooling of the available power from several works, this power would be obtained with little change from existing conditions. Of course, the power available entirely depends upon the extent the gas-engine displaces the steam-engine to satisfy the internal power demands of the works. The following table gives an impression of the power available from several works in a district, without any change of plant and operations, to secure the fullest possible economy of the waste gases. The works, although in one district, are scattered:

	Kilowatts available for external services.
District A, one furnace always available	1,490
District B, two furnaces	2,700
District C, one furnace	1,700
Total available	5,890

By the pooling system a minimum total power potential of 5,890 kw. is available, and this would justify the setting up of electro-chemical and electro-metallurgical apparatus. One of the advantages of this policy of pooling is obvious: it would not only permit such an association of power production as to justify the cost of mains to central stations, but it would provide an irresistible

* Paper read at the Vienna meeting of the Iron and Steel Institute.

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incentive to the thorough electrification of all the iron and steel power machinery, and justify the expenditure in securing the maximum possible efficiency of the blast-furnace gas.

The axiom that unity is power could not be more appropriately demonstrated than by the pooling of the power from the furnaces of several works, which, individually, would be too small to justify the establishment of a central distributing station and its associated transmission mains. The policy of pooling furnace gases is the basis of an Act of Parliament which received the Royal assent last year, and applies in an area some 400 square miles in extent, including in the area many furnaces belonging to separate firms. The full description of this pooling scheme may constitute the object of a future paper by the author, who is one of the engineers of the parliamentary Bill. It is very likely that there are iron-making districts where it would not be necessary to incur the expense of securing parliamentary powers for rights to lay down the electrical transmission mains, or where it would be possible to sell the whole of the pooled and available power to satisfy the demands of one electrical industry: for instance, that of producing calcium carbide (the basis of acetylene gas production), which, as the author has frequently pointed out in 1898 and since, is an ideal associate for an ironworks, because the agents of production are coke, limestone, and electric energy. Again, the production of aluminium, the operating process of which is now common property, involves the production of many thousands of kilowatts of energy. In the promotion of the Act of Parliament above referred to, the one objection met with was, that supposing the market for iron does not justify the manufacture of pig, and it became financially imperative to blow out the furnaces, what about the supply to the pooling station under these circumstances? Of course, it was admitted that the profit secured from the furnace gas would reduce the risk in making the stock, but supposing it did not, what then? The author has solved this difficulty by designing a generator that, harnessed to the furnace gas cleaning plant, produces gas of more or less exactly the composition of furnace gas. The combustible portion of a typical example of this gas is chemically constituted as follows:

	Per cent.
Carbon monoxide	32·4
Marsh gas	0·4
Hydrogen	1·6

The cost of this apparatus is small, because the cleaning plant and associated gas-mains are those installed for the furnace gas. Such a generator, of the generating capacity of the pooled gas proportion from a given furnace, would be available within three hours' notice, and the simplicity of the apparatus makes the question of depreciation during stand-by periods of little or no economic importance. The fluid slag from this generator can be readily converted into slag wool. This furnace type of gas generator, designed by the author, is being adopted by one of the most important of Continental iron firms to compensate for the vagaries of furnace output, and is also to be used in the above-mentioned parliamentary proposition. It was illustrated on p. 262 of the *Journal* of the Iron and Steel Institute, 1906, No. III. The advantages of the pooling policy will, of course, depend upon the individual circumstances of different works. The mills are probably standing some 23 per cent. of the total hours of a week, and the power waste associated with this idle week-end period will be available. Besides, the displacement of the steam rolling and other machinery by gas and electric motors will provide power all the week, and the auxiliary gas generators can be drawn upon to balance the power required for the mills.

The great change in the attitude of the Board of Trade in relation to electrical transmission schemes makes the pooling policy more economically desirable in England than it would have been when the Government department insisted that the electric mains should be placed underground, involving a heavy expenditure in wayleaves and in construction and maintenance. The permission, under reasonable restrictions, to transmit by aerial cables means a reduction in cost of no less than one-fifth that of an underground transmission line. This means for the same expenditure on underground mains an increase of length of aerial transmission line of five times, and as with the modern experience of high-pressure transmission systems the loss of energy in transmission is comparatively of little consequence, it is obvious that the area of the field of demand for the pooled power is increased, say, directly as the square of the diameter. To understand the progress in the efficiency and unit proportion of electrical power generation and transmission systems, the following comparison may be quoted, in which the author's original proposition of 1892, prepared in collaboration with Mr. James Swinburne, F.R.S., supported by estimates, etc., from the leading Continental experts, is compared with the state of affairs to-day:

Year.	Unit power of gas-engines.	Thermal efficiency.	Electric generators.	Pressure of transmission line.	Economic distance.
	B.H.P.	Per cent.	Kilowatts.	Volts.	Miles.
1892	300	20	1,500	20,000	100
1907	3,000	30	10,000	88,000	250

The harnessing of the gas-engine to the blast furnace resulted in the almost immediate increase of its unit power capacity proportions. The author was prepared to design a 2,000-i.h.p. single-unit multiple-cylinder blast-furnace gas-engine in 1899. The flywheel type of electric alternating-current generators of immense capacity assisted in the gas-engine increased power unit evolution. The foregoing tabulated improvements all point in the direction of the policy of pooling or concentration of the power output. The irresistible incidence of this pooling policy in even a modest way will be to ultimately displace steam by gas electric power for blowing and other furnace power requirements, for driving the rolls in the mills, and for satisfying the general power requirements, because the capital expenditure of the ironmaster will be mostly confined to the provision of the electric motor This pooling policy should eventually lead to the suppression of all preventable wastes in the use of the furnace gases.

Recapitulating the advantages of pooling, it may be said that besides facilitating the electrification of the rolling mills by the reduction in capital cost of plant, it will secure, in addition to the advantages of electrical driving, a substantial increase in the proportion of the furnace power gas, available by the suppression of the mill steam boilers. The pooling proposition will constitute an ideal combine, securing an all-round benefit to the ironmaster and the power consumer, and tend to promote the establishment of new electric industries, and thus enlarge the field of demand for power. It will financially justify expenditure in apparatus and on technical changes to secure the fullest possible economy in the use of furnace gas in the works. Of course, any available gas from associated coke-oven plant subject to certain mixing operations as will reduce the proportion of hydrocarbon in the combined gases will be available for the pooling station. The economy resulting from the direct production of power, with a rationally-designed plant, has been abundantly proved. A well designed and built gas-engine, using pure and waterless furnace gas, and associated with a high-class electrical generating machine, is claimed to be able to develop the hours of a kilowatt-year for 66s. 8d., assuming, of course, that no charge is made for furnace gas. This economic figure of cost to an ironmaster is unapproachable by any other system of power generation, barring water power, which is often located in such awkward if not almost inaccessible positions as to destroy the economic advantages of such power, *per se*.

As the author pointed out in 1897, few iron-making countries can benefit to the extent available to British ironmasters, because of the geographic advantages possessed by Great Britain, and because of the fact that British manufacturing industries are so well concentrated geographically as to permit electric energy to be distributed under the most advantageous conditions, assuming always that the policy of the British Government is as beneficent in its attitude to the iron and steel industry as other Governments are.

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THE ENGINEERING OF SHOW-WINDOW ILLUMINATION.

Although our readers are possibly not acquainted with some of the reflectors mentioned in the following article by J. R. Cravath and V. R. Lansingh, which we reprint from the *Electrical World* of New York, this fa t will detract little from its interest and usefulness to engineers on this side of the Atlantic:

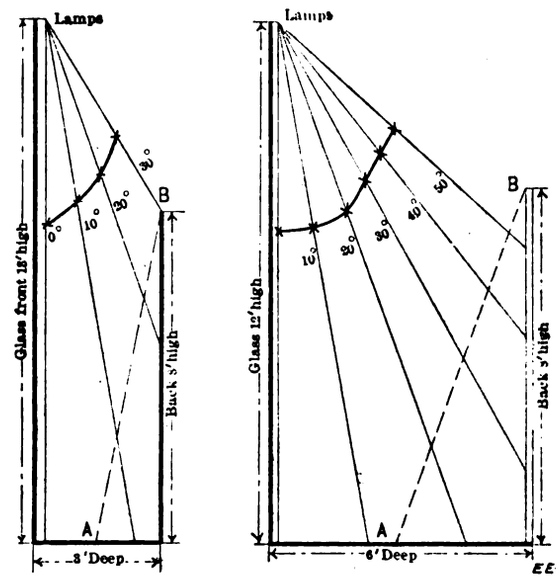
The central-station contract agent or solicitor should be in a position to give customers sound advice on the lighting of their show windows, as this is now a most desirable class of business. It is the purpose of this article to take up only show windows which are to be lighted for the purpose of displaying the goods in them to the best advantage. Decorative lighting has its place in certain kinds of show windows, especially those in which the display of the goods is of secondary importance. Light is of itself attractive both to moths and men, and a window in which there are a lot of exposed lamps may attract attention and invite people to pass along the street where it is located rather than along a darker street. It does not, however, show up the goods to the best advantage, and that is the main object of a strictly "show" window. The merchant is not advertising the electric light company; he is trying to show his goods in such a striking and pleasing manner by night as to be able to sell them. In such windows the display of goods is the first consideration. A display of light, if brought into too great prominence, may even go so far as to detract from the display of the goods and give them a place of secondary importance, either by blinding the observer so that he cannot see the goods, or by making the decorative lighting features so prominent that the goods are forgotten.

It is now too generally established to permit of controversy that for the best illumination of goods in a show window, most of the sources of light must be concealed. Whatever light is exposed should be for secondary decorative purposes. When dealing with the illumination of goods from concealed lamps, we have a purely engineering problem rather than one of decorative or artistic effect.

The position of the lamps in the window is the first thing to consider. The common form of show window necessitates placing the lamps at the front and top of the window. This accomplishes the double object of making it easy to conceal the lamps from the casual observer and of throwing light on those portions of the goods which are seen from the street. The plan of studding a lot of lamps over the ceiling of the show window is not to be recommended except for decorative purposes, as the lamps in the back of the window cast so much of their light behind the goods in the front part of the window instead of illuminating the portions of the goods facing the street. It is, however, important to have all sides of the goods which can be seen from the street well illuminated—that is, there should be no dark shadows at the sides of the goods. If the window is wide—that is, has a wide pane—and there is a row of lamps at the top next to the glass, this matter of lighting the sides of the goods takes care of itself. If the window has a very narrow pane and is very deep—that is, if it extends far back from the street—it may be necessary to provide for more lamps than those along the front window pane. Lighting from above has sometimes been supplemented by concealed lighting from below. At present writing, such lighting from below has hardly passed the experimental stage, and, therefore, cannot be taken up here. If lighting from below is used at all, the lamps must be well concealed from passers, and the great preponderance of light must still be from above in order to prevent unnatural shadows.

Taking, therefore, the top of the window next to the glass as the proper location for the lamps, the next step is the selection of the proper lamps and reflectors to produce the best results in the different sizes of windows. Right here it may be said that while the average run of window lighting of to-day is very much in advance of that of 10 years ago from an illuminating engineering standpoint, there is room for an equally great improvement in the next 10 years. To-day we see concealed lamps in most show windows instead of the exposed lamps of 10 years ago, and we see the lamps equipped with reflectors where reflectors were not used formerly; but the selection of the reflectors in most cases has been made without any regard to the shape of the window to be lighted. As a result, we see high, narrow windows, which call for reflectors which concentrate the light over a small area, equipped with reflectors with a wide distribution adapted to low, deep windows, thus sending much light where it is not needed entirely outside the window area. On the other hand, we see low, deep windows in which very concentrating reflectors are used.

In many windows the reflectors are so pointed as to deliver a large percentage of their light on the sidewalk rather than in the show window. There are some who maintain that ample illumination of the sidewalk in front of the store is a part of the game of attracting people to the place at night. With the numerous electric signs and ample street-lighting on most down-town streets, however, such lighting of the sidewalk is not necessary, and, in fact, detracts from showing up goods to the best advantage. If a show window is thoroughly lighted, there will be enough reflected light from the back of the window and the goods for all practical purposes of sidewalk illumination. Taken altogether, the business streets of our cities are full of absurdities in show window lighting



FIGS. 1 AND 2.—SHOW WINDOW ILLUMINATION.

The question of the proper selection and installation of lamps and reflectors for show-window lighting depends mainly on the shape of the window to be lighted. As show windows are made in such a great variety of relative dimensions, it is difficult in an article of this kind to even approximate the numerous problems that come up in practice. The problem will be solved for a number of the more common proportions of show windows, and the same methods can be followed with other dimensions than than those given.

The two principal things to be accomplished by the reflector that we use for a given window are, first, the confinement of most of the light flux or rays to the space within the window, so that there will be as little as possible going in useless directions; and, second, the even or uniform illumination of the goods, so that there will not be too much of a contrast between the lighting of different parts of the window.

In selecting reflectors we must, of course, have before us information on the light distribution of the reflectors that are likely to be useful. Photometric tests showing the light distribution given by various common reflectors are now easily available. With such information before us to work with, the first thing is to find out what shape of photometric curve, or, in other words, what kind of light distribution is the ideal one for the window under consideration.

We will take up first a very high, shallow window, such as shown in cross-section in Fig. 1. In this the lamps are

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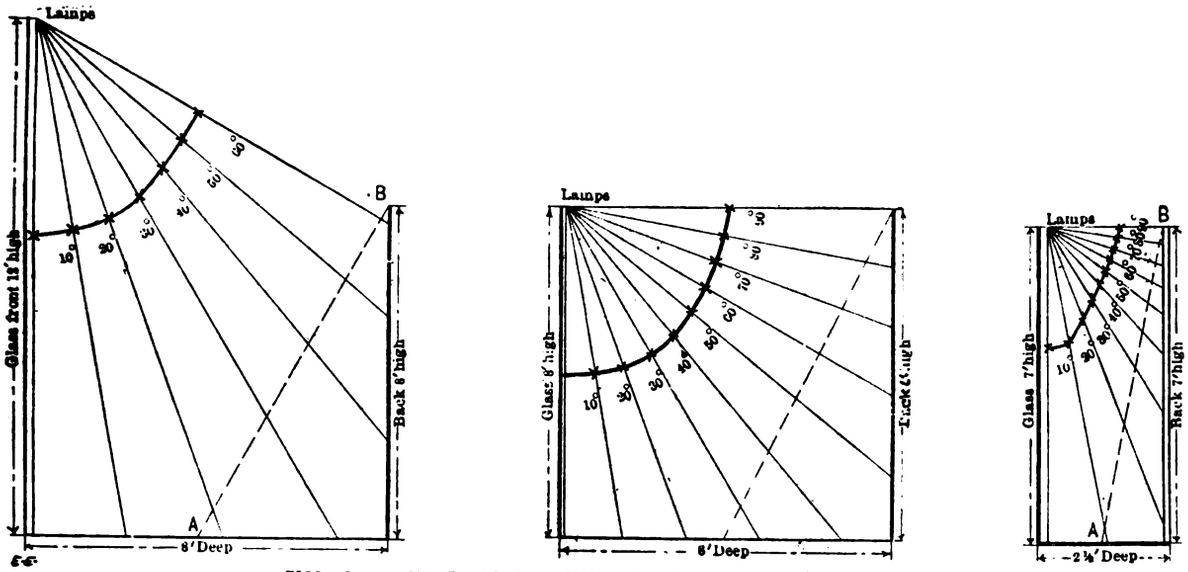
13ft. above the bottom of the window, the window is 3ft. deep, and has a back 8ft. high. In case the window has no back, as frequently is the case in small stores, the method of treatment will be similar. The first step in the problem is to draw a cross-section of the window to scale, as in Fig. 1. We wish now to learn the most desirable distribution of light from the lamps, in order to illuminate equally the show window in all parts where goods are displayed. form of the photometric curve which we should seek, a perpendicular line from the lamps to the bottom of the window should be drawn. Then with the lamps as a centre, draw radial lines every 10deg. to the bottom and back of the window, as in Fig. 1. It is now evident that we want a reflector that gives most of its light within an angle of 30deg. We must next learn what distribution is best within that limit. We will now assume that the position



FIGS. 3, 4 AND 5.—DISTRIBUTION OF LIGHT IN SHOW WINDOWS

As the contents of show windows change from week to week, one cannot always predict exactly what distribution of light is desirable One way is to figure on securing an equal illumination at the points most remote from the lamps—namely, along the floor and back of the window. If the goods stand some height in the window, they will, of course, receive greater illumination than the bottom and back, so that usually a point less distant than the bottom and back of the window must be figured on. There is of the goods in this window will usually be about that of the dotted reference line, A B, which is drawn from the top of the back to the middle of the bottom of the window. If the goods are all to be in the bottom of the window, our reference line, A B, should be at the bottom of the window. Measure the distance on each radial 10deg. line from the lamps to the reference line, A B. Extract the square root of the number (best done with a slide rule) and then measure and mark with a cross on the radial line a point

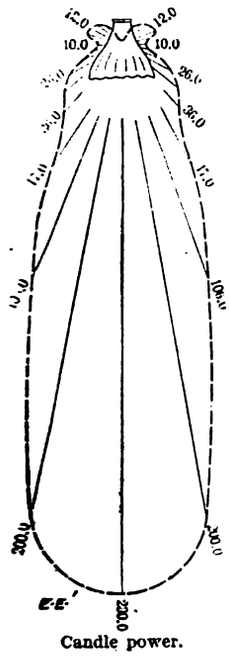


FIG. 6.—LIGHT ABOUT A CONCENTRATING PRISMATIC REFLECTOR

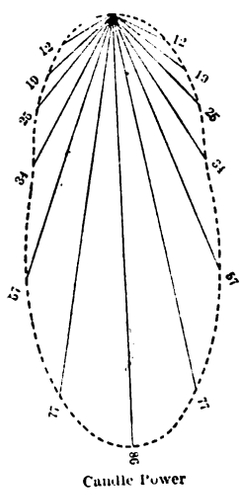


FIG. 7.—DISTRIBUTION OF LIGHT ABOUT A CONE-PARABOLIC REFLECTOR.

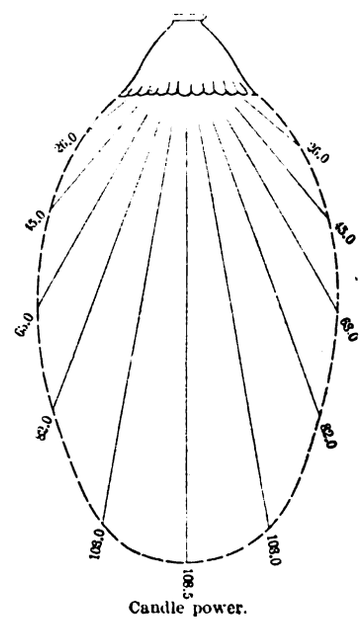


FIG. 8.—LIGHT ABOUT A CONICAL MIRROR REFLECTOR.

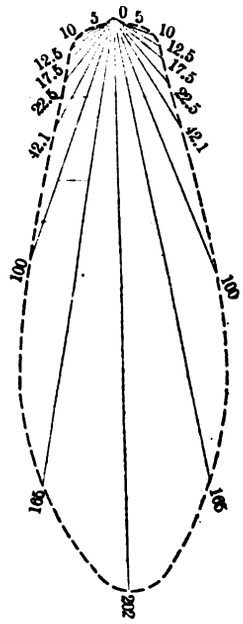


FIG. 9.—LIGHT ABOUT A CONICAL PLATE MIRROR REFLECTOR.

undoubtedly also some room for argument as to whether we should figure on normal illumination—that is, the illumination on goods placed at right angles to the rays from the lamps—or whether we should figure on horizontal or vertical illumination received on horizonal and vertical surfaces in the show window. Normal illumination has the advantage of being simpler to calculate, and is probably nearest a correct basis, everything considered.

To determine what kind of light distribution will best illuminate our window, or, in other words, to find out the corresponding to the square root so obtained. Repeat this operation for each radial line. Draw a curve through the points thus obtained, and this curve is the ideal distribution curve for that window. We now have to select from the reflectors commercially available the ones coming nearest to these conditions None conform to them exactly. The authors have selected from the reflector tests they have at hand the reflectors which seem to be best suited to the various windows considered. Some of these tests have already appeared in the book entitled "Practical Illumina-

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tion" by the authors, but they are reproduced here for convenience in studying the problems brought up by this article.

To meet the conditions in such a window as shown in Fig. 1 the authors have selected several reflectors, the light distribution of which is shown in Figs. 6 to 11. Fig. 6 is that of a holophane concentrating prismatic reflector with a 32-c.p. lamp. This reflector delivers a large percentage of its light within an angle of 30deg., or 15deg. each way from the vertical. If used in such a window as Fig. 1, the lamp axis should be tipped so as to come between 19deg. and 20deg. lines in Fig. 1, preferably a little to the right of the 10deg. line.

In Fig. 7 is shown the light distribution of a concentrating D'Olier aluminium reflector with a 16-c.p. lamp. The lower part of this reflector is conical in form, curving off to a parabola near the neck. This reflector, if used in such a window as Fig. 1, should be pointed between the 10deg. and 20deg. lines. Fig. 8 shows the light distribution about an "X-ray" deep conical mirror reflector with a 16-c.p. lamp. This should also be pointed slightly in toward the back of the window. Fig. 9 shows the light distribution about a common form of conical reflector consisting of sections of mirror mounted in a metal cone case.

The reflector has an opening of about 90deg., and is 10in. in diameter. Fig. 9 shows the distribution with a 16 c.p. lamp and Fig. 10 with a 32-c.p. lamp. It is seen that it is extremely concentrating with both the lamps, giving most of its light within the confines of such a window as Fig. 1. Another reflector suited to this kind of window is one recently brought out under the name of the "X-Ray Helmet." This is designed for 125-watt Gem lamps or 105-watt tungsten lamps. It is not symmetrical, but has a flat side which is intended to be placed toward the window pane to catch and reflect light which would otherwise be wasted outside the window. The distribution of light from it is, therefore, not symmetrical. Fig. 10 shows the distribution of light in a plane at right angles to the flat side of the reflector. If hung as in Fig. 10, the window pane would be at the right and the goods at the left. Fig. 11 shows the distribution of light from this reflector in a plane parallel with the flat side of the reflector—that is, the distribution as it would be sideways in the window.

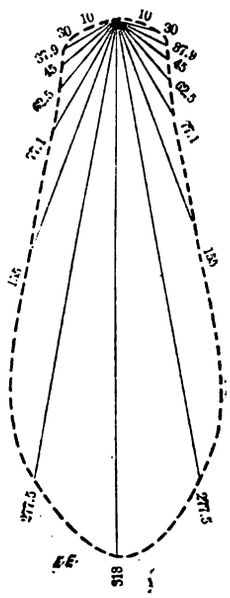
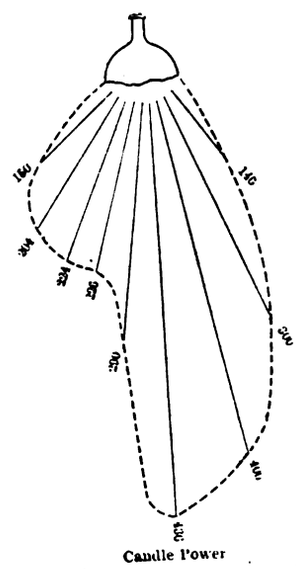


FIG. 10.—LIGHT ABOUT A CONICAL MIRROR REFLECTOR.



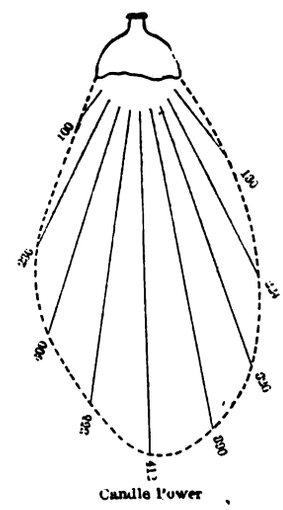


FIG. 11.—DISTRIBUTION OF LIGHT IN TWO PLANES ABOUT AN X-RAY HELMET REFLECTOR.

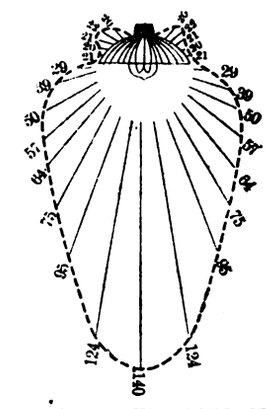


FIG. 12.—LIGHT ABOUT GEM LAMP AND CONCENTRATING REFLECTOR.

As to the number of lamps and reflectors that must be installed to satisfactorily light a window—or, in other words, the distance apart of the lamps—local conditions must always be considered. In cities where very high window illumination is necessary in order that the show windows may not seem dark by contrast with those of other merchants, the lamps should be placed close together; while in country towns and on suburban streets, fewer lamps will answer the purpose. The position of the lamps, the angle at which they are placed, and the reflector should, however, be the same for all windows of the same dimensions, the only variation being in the number per yard of window front.

We will next take up the window indicated in Fig. 2, where the lamps are placed 12ft. above the floor. The window is 6ft. deep and the back 8ft. high. Here we evidently need a reflector which will cover 50deg. and give a curve like that plotted in Fig. 2. For such a window

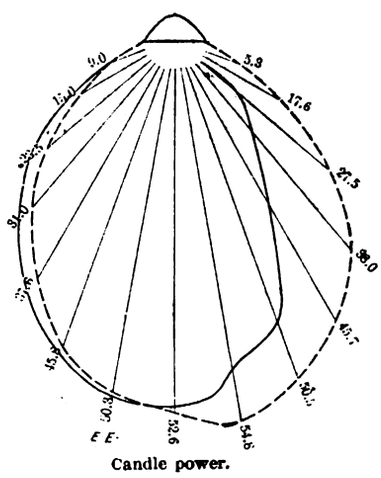


FIG. 13.—LIGHT ABOUT A PARABOLIC ALUMINUM REFLECTOR.

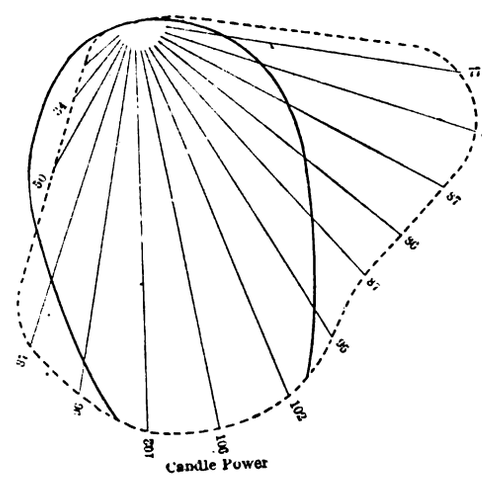


FIG. 14.—LIGHT ABOUT AN X-RAY POKE-BONNET IN TWO PLANES

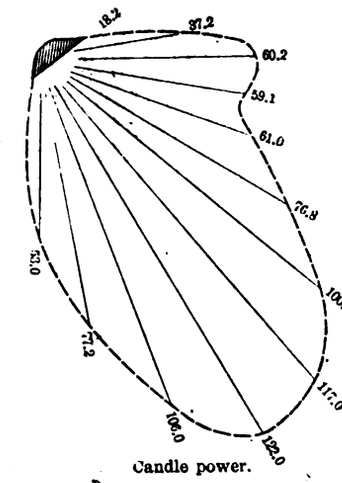


FIG. 15.—LIGHT ABOUT COMMON WINDOW TROUGH.

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the reflector mentioned in Fig. 11 would evidently give good results, as would also that in Fig. 8 if it were inclined at an angle of about 25deg. from the vertical. The regular concentrating prismatic reflector used on 125-watt Gem lamps, the distribution of which is shown in Fig. 12, would also be fairly good for this purpose, although evidently allowing much more light to escape above in the window and into the street than would be consistent with the maximum economy.

In Fig. 3 we have a window with lamps placed 12ft. high, with a window 8ft. deep and 8ft. high at the back. Here an angle of 60deg. must be covered. For such a window the distribution of light shown by Fig 16, which is that of an "X-ray" reflector with a 32-c.p. lamp, is excellent. The reflector used in Fig. 12, as well as that used in Fig. 11, could also be used in this window if properly pointed at an angle to cover enough area. If the reflector shown in Fig. 11 were used at an angle, it would be advisable to place a supporting strip along the top of the window against which the flat side of the reflector could rest, so as to take the strain of the very heavy reflector from the shade holders and lamp sockets. In fact, such a supporting strip is advisable with all concealed window reflectors when placed at an angle, although it is more necessary with the extremely heavy reflectors. Such a support can easily be installed by putting a piece of wood or pipe across the window at the proper place.

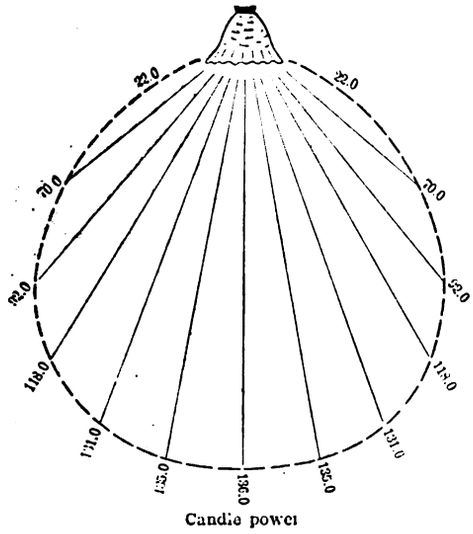

FIG. 16.—LIGHT ABOUT X-RAY CONICAL REFLECTOR.

In Fig. 4 is shown the proportions of an extremely deep, low window, where the lamps are only 8ft. above the window floor and the window is 8ft. deep and 8ft. high at the back. In such a window it is usually desirable to light it well clear to the top of the back as well as in the extreme front, which means that the reflector must cover an angle of 90deg. Usually with such low windows there is not much room for the lamps; hence it is sometimes impracticable to put a lot of conical reflectors along the top of the window because of their size.

Were it not for this, the reflector which gave the light distribution shown in Fig. 16 would be good for this window.

A reflector specially adapted to this work is the "poke bonnet," the light distribution of which is shown in Fig. 14. This reflector gives nearly the same amount of light high in the window as straight down, which in the case of a window of this kind is exactly the thing desirable. Another reflector which could be used in such a window is the common parabolic aluminium half reflector, which gives a distribution of light like that shown in Fig. 14, with a 16 c.p. lamp.

A peculiar form of window which is found frequently in stores which are slightly below street level is that shown in section in Fig. 5. The window is only 2½ft. deep and 7ft. high both at front and back. There is usually but little available space for the lamps because they come such a short distance above the heads of passers. In such windows goods are frequently placed in the extreme top. In fact, the best part of the display is usually in the top because the window is very small, and goods in the bottom do not receive as close inspection from passers as those in the top For such windows the common form of window trough with sectional plate mirrors is well adapted in its light distribution. The distribution of light from such a trough with two 16 c.p. lamps is shown in Fig. 15. The light distribution shown in Fig. 14 could also be used in such a window, and would produce higher illumination of the top of the window than the common window trough, though there would be more contrast between the top and bottom of the window if a reflector like that shown in Fig 14 were used.

The reflectors have so far been considered mainly on their reflecting qualities when new, without regard to their probable depreciation or their relative first cost. The first cost is such a small item on any reflector that is used every night in a shop window, that it need hardly be considered. The probable depreciation is a serious question, however, because it may result in a great loss of light. As to depreciation, the common plate mirror type is the worst offender. It starts in with an efficiency which is very high, but under the heat that is developed by the large number of lamps in the top of the show window, it may easily be depreciated in a few years, so as to be passed by some of its less pretentious rivals. Some specially-patented processes of silvering give better results in durability than common plate mirrors. Prismatic reflectors, of course, consisting as they do of nothing but glass, need simply be taken down and washed to make them as good as new. All reflectors suffer equally from dust on the inside and on the lamps. None of those considered in this article is affected by dust on the outside. All of those considered are subject to more or less breakage, except the aluminium. While the plate mirrors held in tin cases never completely fall apart, the breaking and dropping out of sections could be considered the equivalent of breakage on the other glass types.

Another thing to be considered is the question of concealing the lamps entirely from view as seen from the street. As a rule, there is not sufficient space between the top of the glass and the ceiling to place any form of conical reflector without making it visible. In order to overcome this objection it is customary either to use a shade which, when the lamps are lighted, is lowered to conceal them, or to paint a black, red, or other coloured strip across the top of the window. This strip can also be used to good advantage for advertising purposes to display the company's name or goods sold by making the letters transparent, or, in other words, leave the letters clear, painting in the balance of the strip. This, of course, requires the window to be lighted by reflectors which will allow some light to fall on the strip. In this case prismatic reflectors, such as that shown in Fig. 6, are best adapted, although such a reflector as that shown in Fig. 13, if placed near the top of the band, will often admirably answer the purpose. In the case of trough reflectors of either the standard or "poke bonnet" type, it is often unnecessary to paint such a strip in the window on account of their relative shallowness, as the lamps are generally placed horizontally. Whether a window should be lighted so as to take advantage of the illuminating sign at the top of the window or not must be left to each individual case.

FITTINGS FOR ELECTRIC LIGHTING.

Some Season's Specialities.—I.

The cycle of time has once more brought round to us the period of the year when manufacturers and factors of electric light fittings and accessories give prominence to their winter season specialities, and when, on the other hand, contractors are on the look-out for novelties which combine artistic finish with economy in price, suitable to the satisfaction of the most fastidious tastes. If a glance round the showrooms of the leading and most representative manufacturers reveals nothing exceptionally striking in the way of fancy fittings, there are at least to be seen sufficient examples in evidence of the steady progressive tendencies in this line, and proof of the fact that the

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advance has not been stayed. Below we illustrate several types of new fittings that are being introduced during the current season, and the improvements that are noticeable in the design of these types, together with their relative inexpensiveness, show, we venture to think, that the leading

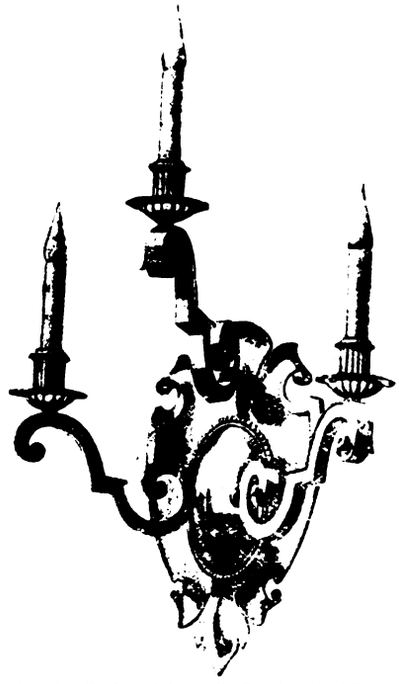

FIG. 1.—Design of Armorite Bracket (G.E.Co.).

manufacturers strain every effort to meet the ever-changing requirements of those interested in the electrical installation trades.

FIG. 3.—Dutch Style Electrolier (G.E.Co.).

The General Electric Company, Limited, 71, Queen Victoria-street, London, E.C., are introducing a new metallic medium to which has been given the distinctive trade mark of "Armorite," and which can be worked up into almost any design of electric fitting, as our illustration (Fig. 1) shows. The technical qualities of "Armorite" are a blend of toughness with rigidity, strength, and great ductility. After exhaustive and practical tests, the General Electric Company claim this metal to be incorrodible, and to retain its soft, silver-like lustre even though exposed to sea air, fog, or dampness, and not affected by humid foreign climates. The appearance of the metal is not unlike

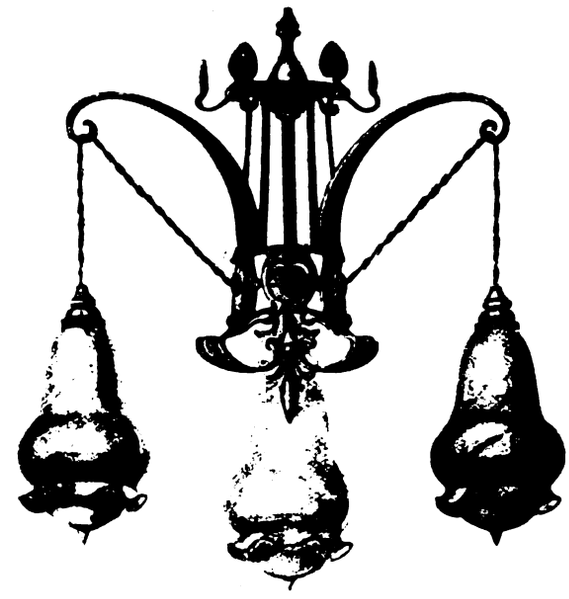

FIG. 2.—Pendant for Osram Lamp (G.E Co.).

oxidised silver or armoured steel, having the advantage of the beautiful colour of the former and the texture of the latter, which gives the finished article an artistic quality that

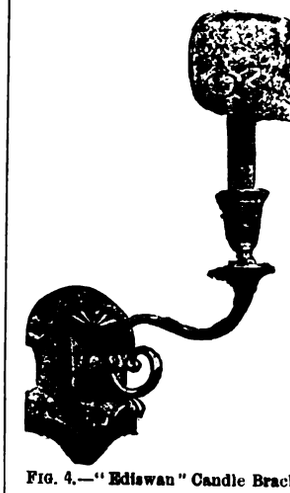

FIG. 4.—"Ediswan" Candle Bracket.

FIG. 5.—"Ediswan" Ceiling Fitting.

is often hard to find in these days of machine-made goods. In their usual enterprising way the General Electric Company are losing no time in bringing "Armorite" before electrical engineers, contractors, and architects, and at their showrooms are showing a large selections of fittings, etc., made from this metal. Their works are now busily engaged upon several large contracts for "Armorite"

FIG. 6.—"Ediswan" Fancy Bracket.

fittings made to their own special designs, among them being some large fittings for a Northern cathedral, each fitting having a diameter of 9ft. and having a massive appearance. This is not the only speciality which the

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General Electric Company are bringing out this season. They are also supplying fittings specially adapted to the

FIG. 7.—Simplex Three-Light Electrolier.

requirements of Osram lamps (Fig. 2). These fittings are arranged so that the lamps hang vertically. By means of a simple nipple and cord arrangement, any ordinary fittings may be converted for use with Osram lamps. Owing to the voltage limit of these lamps being 130, in cases over this voltage the lamps must necessarily be used in series, and for this purpose various adaptors can be had, whether for private houses, shops, or street-lighting. The showrooms of the General Electric Company reveal a fine varied display of ordinary electroliers, pendants, brackets, etc., from which selections are difficult to make. But the specimens of candelabra, Dutch

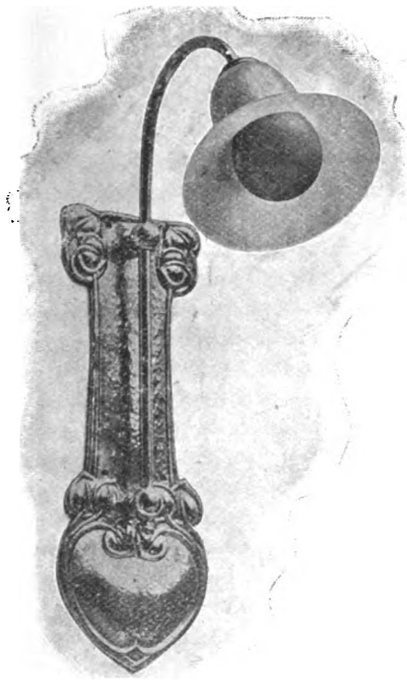

FIG. 9.—Simplex Bracket.

and Flemish types, are specially noticeable The persistency with which the candelabra of these types have appeared in each successive period under the changing form of illuminant since their original creation have made them of established worth, while for greater adaptability those models that appeal most in their design have been produced by the company in various sizes. Electroliers of these types are also to be obtained, and Fig. 3 shows a reduced specimen of the "Rembrant," the actual length of which is 48in. over all, and the spread to nipple 18in.

The new productions of the Edison and Swan Company, Limited, Ediswan-buildings, Queen-street, London, E.C.,

FIG. 8.—Simplex Dining-room Pendant.

include a number of fittings of highly ornamental and well-finished types. Figs. 4, 5, and 6 represent the very latest specialities that have been introduced in this line, and one can hardly fail to notice the elegant appearance which these neat specimens give. Fig. 4 is a new Ediswan candle bracket, and Fig. 6 represents a fancy bracket of different type. A new type of ceiling fitting, richly decorated in gilt and fitted with cut glass, is shown in Fig. 5.

Simplex Conduits, Limited, in answer to repeated inquiries, have opened a new department for the supply of electric lighting fixtures. Although patterns ranging from a cheap plain brass bracket to an expensive electrolier are supplied, a speciality is being made of hand-wrought metal fittings in numerous artistic designs. These are listed in the current catalogue, and the illustrations show four typical patterns. Fig. 7 is a three-light electrolier, which, although hand made in either brass, copper, bronze, or gilt finishes, is sold at an extremely low price. Fig. 8 is a dining-room or hall pendant made in two sizes, 10in. or

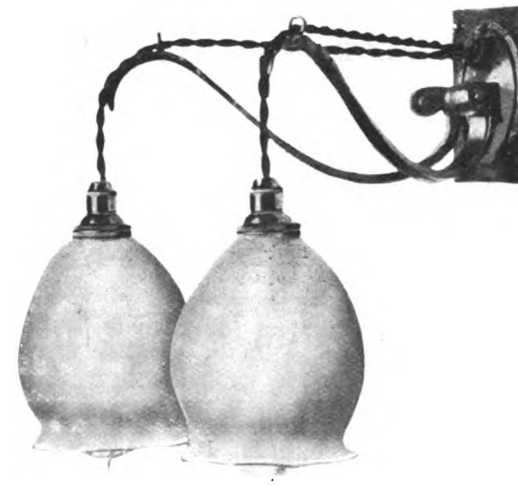

FIG. 10.—Simplex Bracket.

20in. diameter respectively, and Figs. 9 and 10 show types of brackets. It is anticipated that there will be a large demand for low-priced yet pleasing, well-finished fittings of this description.

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AN APPEAL.

For more than forty years the writer has in one guise or another been connected with and watched closely the Press of England. It has without doubt deteriorated, and is deteriorating. In years gone by its aim was to educate and to elicit the truth. Its aim now is to be sensational and to make money—make it honestly if not found out, but to make it at all hazards. If the technical Press attempted the task of correcting the daily Press, it would find nothing else to do and never complete its task. For pure, unadulterated carelessness of statement and ignorance of subject the daily Press stands supreme. One great advantage of the technical Press is that in each case it deals more or less with one subject only, whereas the daily Press deals with everything, and the more improbable and sensational the topic the more it likes it. For years past the sensational electrically has been the big gooseberry of the daily paper. Edison has been a godsend to the correspondent from the other side. If other subjects are lacking, trot out Edison, and the editors or sub-editors on this side gravely put the telegraphic information in big type with the necessary startling headlines. We all admit Edison to be a clever man. He has made money—plenty of it; hence his genius goes without saying. But coolly contemplating the realities of his work, one is bound to confess a certain amount of scepticism as to what he really has done. Take this last dose of eulogy. According to the *Observer* of Sunday last, Edison has at length completely conquered the accumulator difficulties (similar statements have been made under startling headlines about every three months for years past, so it is nearly time something was done), and hence the problem of electric traction is solved. He has also solved the problem of erecting cheap houses for the working classes. Leaving the electrical problem—about which anyone can talk for a twelvemonth and get no forrader—take the other question. Brodie, the city engineer of Liverpool, one of the most modest and yet one of the ablest engineers that civilisation knows, years ago did what Edison is now said to have done—that is, run a mixture of cement and clinker in a framework to make one wall of a house in a block. No doubt Edison may have altered and perhaps improved a few details, but to be credited with having devised the scheme of building houses by framing their walls in concrete in one piece shows the utter ignorance of the correspondent about matters of the kind. Houses, stables, etc., have been built long since in Liverpool on this plan, which Brodie successfully introduced. Further, while repudiating Edison's initiative in this, let us give other credit to Mr. Brodie. There is not in the world a more consistent experimentalist in certain practical directions. Prof. Forbes, if we remember rightly, first directed attention to "refuse" as a source of heat, while Mr. Bennett, then engineer to Southampton, conclusively proved that the waste heat of refuse destruction could be utilised for the driving of dynamos. But Mr. Brodie has done more than all others combined to prove the value of refuse, not only in one but various directions. He destroys his refuse sanitarily—with the waste heat he drives a large electrical installation, the clinker he uses with cement to form the walls of his cheap houses, and so utilises to the last ounce. This is an achievement of considerable importance, especially when it is said the waste heat obtained is so constant in quantity that not an ounce of other fuel was for some years, if it has ever been, used to keep up steam in this installation. Why trouble to discuss the technical ignorance of these papers? There is just one reason which makes us do it occasionally. These misleading paragraphs get distributed

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through the world, as is easily seen if a little trouble is taken to trace the reproduction in paper after paper, and among the hundreds or thousands who see the statement are some potential buyers and users The custom of these buyers swell the orders of the wrong parties. Thus orders for things which can be had better and more cheaply in this country go elsewhere. The concrete example we mention to-day is but one of hundreds. One which appeals very strongly to some of our manufacturers is in the direction of apparatus for telephonic work. Here, again, much credit due to this country was recklessly thrown away by the emotional Press, and gradually the mass of the community came to accept the doctrine there is nothing good manufactured here—a conclusion absolutely incorrect. Another false move is the constant railing against all things that be here, and the appreciation of all things that be elsewhere. This one thing has lost millions of pounds' worth of orders to this country and sent them to competitors, for buyers in the uttermost parts of the earth are influenced by all these adverse statements, and hesitate to place orders where the system and productions are condemned by the very papers that ought to support. We have been told again and again of orders given from Australasia to America instead of Great Britain because of the damaging remarks in the English papers, and the trouble gets worse instead of better since the advent of the hustling, emotional style. A newspaper should state facts as clearly, truthfully, and succinctly as possible, leaving the conclusion to the wisdom of its readers, instead of which we get the conclusions of ignorant people, and the facts are wanting. A conclusion stated by an expert is another matter. Is there any possibility of change in this state of things?

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TECHNICAL PROBLEM No. 1,008.

SIR,—I should like to send an answer to Question No. 1,008, but it is rather vague, and I cannot see what the 500-volt direct-current supply has to do with the conversion of single-phase at 2,000 volts to direct current at 250 volts. The question states that the company supply at 500 volts direct current, but the diagram shows the company's mains as single-phase. I do not, of course, want you to explain my difficulties away, excepting so far as to inform me whether an error has crept in.—Yours, etc.,

S. E. T.

We communicated with the sender of this question, and he replied as follows:

Sir,—Received your communication of the 18th inst., and thank you for the enclosed 1s. and for answering my query in so practicable a manner. The question was rather badly worded; it should have read: ". . the company *also* supply 500 volts direct current." I did not show the 500-volt mains on my rough sketch because the distance between the generating station and proposed position of motor-generator is several miles, and the cost of copper for transmitting energy by 500-volt direct current to charge the 100 accumulator cells would be prohibitive. Still, as a small 500-volt cable it might be preferable to start up off the 500-volt direct current instead of off the battery I wish to charge.—Yours, etc., W. J. R.

[There is still time to send in answers to this question or to send any amendments which may be considered necessary to solutions already sent in.—ED., *E. E.*]

THE FINANCIAL CRISIS IN AMERICA.

The latest developments of the American financial crisis as cabled over just before we went to press yesterday show that receivers have been appointed by the United States Circuit Court for the Westinghouse Electric and Westinghouse Machine Companies and the Security Investment Company, and that petitions for the appointment of receivers for the Nernst Lamp Company were being prepared for presentation. We think that these reports are apt to cause some misunderstanding, and that the exact position should be stated for the benefit of those who are interested in the electrical companies involved. The receivership of the Westinghouse Company is only temporary, and is due to the fact that the Westinghouse Company needed a great deal of money to conduct an extending business. Indeed, the *Times* correspondent cables that "the Westinghouse Company and the Nernst Lamp Company, manufacturing companies, are in an absolutely solvent condition," and that "the condition of the Security Investment Company in no way affects the Union Switch and Signal Company or the Westinghouse Air-Brake Company." The fact that a receiver has been appointed on the application of Mr. Chas. Westinghouse may be taken as a proof that the appointment is only of a temporary nature, and that the step was necessary in order to protect the companies. We are informed by the London representative of the Westinghouse Company that the works are full of orders, and that the execution of these orders will be in no way interfered with.

INTERNATIONAL EXHIBITIONS: THEIR VALUE TO MANUFACTURERS.

The report of a committee appointed on Oct. 22, 1906, by the Board of Trade to make inquiries with reference to the participation of Great Britain in international exhibitions was published at the end of last week. The committee consisted of Sir Alfred Bateman (chairman), Sir Isidore Spielmann, Mr. A. Wilson Fox, C.B., Mr. Charles A. Harris, C.B., C.M.G., Sir James Kitson, M.P. (now Lord Airedale), Mr. Algernon Law, Mr. Malcolm Ramsay, C.B., Sir Swire Smith, and Mr. Samuel J. Waring. Mr. U. F. Wintour was appointed secretary.

The terms of reference included the question whether the results in the past had been such as to warrant the Government in giving financial support to similar exhibitions in the future; and if so, what steps are desirable in order to secure the maximum advantage from any public money expended. While acknowledging that, generally speaking, from a financial point of view great international exhibitions are not regarded with favour by manufacturers in this country, the committee hold that the indirect advantages obtained outweigh any comparative lack of direct commercial results. In the case of the machinery and engineering trades, the direct results obtained by exhibiting have occasionally been of considerable importance; but this remark, it should be observed, does not apply to specialities for which there is a very limited demand, or to very heavy goods, such as large marine engines, locomotive engines, or certain classes of machine tools. As to the direct benefit to be derived from exhibiting by any particular firm, this is to a large extent dependent on whether that firm is represented at the exhibition by an efficient agent.

Although the evidence goes to show that firms do not, as a rule, gain much in the way of increased orders from taking part in exhibitions, the committee are in favour of the continued participation of this country in all really important exhibitions, owing to the indirect advantages resulting from them. Even trades which are unwilling to take part in exhibitions themselves think that the manufactures and arts of this country should be represented at them, and the committee consider that they are to be looked at in the light of advertisements. The report says: "In our opinion, the same causes which render it necessary for individual firms to spend large sums of money on advertisements in order to maintain their position in a particular trade, also render it imperative that every effort should be made at the present day to maintain and improve the reputation of British manufactures as a whole. Experience has shown that even in the case of firms with an established reputation and world-wide connections,

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attempts to discontinue advertising have usually been followed by a diminution in the sales effected, and we cannot but think that the neglect by Great Britain of one of the most important forms of national advertisement would be equally detrimental to her interests as a manufacturing country."

The committee refer at length to the unsatisfactory manner in which the United Kingdom has participated in exhibitions in the past, and to the wavering support, pecuniary and other, that has been given to exhibitors by the Government. The report condemns the lack of definite policy with regard to exhibitions, which has led to the country's being inadequately represented, especially on more recent occasions. It is pointed out that in other countries the whole business is carefully organised either directly by the Government, or under its benevolent supervision.

The committee, in stating their recommendations, express their opinion that it is of the first importance that an improved machinery should be set up which will secure, first, a more prompt consideration of invitations to participate in exhibitions; and, second, a more effective representation of this country at any exhibition in which his Majesty's Government may decide to take part. In order to obtain these objects they suggest that, before everything else, the Government should provide in future for continuity of organisation from exhibition to exhibition. This, they consider, would be effected by the appointment of a permanent official whose duty it would be to collect full information respecting past exhibitions and to evolve a proper system for application in the future. They do not consider that the proper performance of this work necessitates the creation of a separate department. On the other hand, they think that his Majesty's Government will be invited to take part in exhibitions of considerable importance with sufficient frequency to provide practically continuous employment for, at any rate, one official of standing.

In these circumstances they recommend that a special officer—of approximately the rank known as principal clerk—should be attached to one of the departments of the Board of Trade as the officer specially concerned with exhibition work, and that he should be primarily responsible for the proper organisation, conduct, and winding up of all exhibitions. He would draw for clerical assistance upon the general staff of the department, or on such other sources as the Board of Trade might arrange.

A number of broad rules are laid down as to the general principles of management, and, in conclusion, the committee express the belief that if effect be given to their recommendations, much of the difficulty which has been experienced hitherto in obtaining creditable exhibits will be removed, and a considerable saving of public money effected.

COMMENTS ON THE I.E.E. MODEL GENERAL CONDITIONS.

The model set of general conditions concerning contracts drawn up by the committee of the Institution of Electrical Engineers mark a distinct step towards the establishment of uniformity in this department, and it is interesting to note the effect which such proposals have upon wiring contractors and similar people. Owing to the fact that the conditions apply principally to larger works than that undertaken by the majority of wiring contractors, their opinion has not yet been made definite, but an opportunity of ascertaining their attitude was afforded by a paper read by Mr. W. Cross, A.M.I.E.E., at a meeting of the northern branch of the Electrical Contractors' Association on the 9th inst.

The first point raised is that of responsibility for payment. This arises in connection with the work ordered through an architect, and Mr Cross places under consideration a clause which his firm has recently drafted for incorporation in all estimates, and which reads: "Unless otherwise agreed upon before acceptance of order, it is understood that the person or persons to whom this tender is addressed will hold themselves responsible for payment." Some architects when letting a sub-contract insert a clause providing for certification by the architect for direct payment by the purchaser if the chief contractor does not pay promptly, and such a clause would be very useful in certain cases. In modern conditions, applying to large contracts, a clause specifies that the purchaser will provide a crane for the contractor's use in erecting plant, and it would appear that this clause might be extended to the use of customers' apparatus, in some instances, on the smaller work of electric wiring.

In wiring work a very serious question is that of alteration, addition, or omission of work specified in the original contract. It nearly always occurs, and frequently leads to serious disputes. Clause 20 of the model general conditions is designed to avoid such differences, and reads: "The contractor shall not alter in any way whatsoever any of the work except as directed in writing by the engineer; but the engineer shall have full power from time to time during the execution of the contract to alter, amend, omit, or otherwise vary any of the work, without in any way affecting or vitiating the contract, and the contractor shall carry out such alterations, amendments, omissions, variations, or directions, and be bound by the same conditions, as far as applicable, as though the said alterations, amendments, omissions, variations, or directions occurred in contract. The difference of cost, if any, occasioned by such alterations, omissions, variations, or directions, shall be added to or deducted from the contract price as the case may require. The amount of such difference, if any, shall be ascertained and determined in accordance with the rates specified in the schedule of prices, so far as the case may be applicable, and where the rates are not contained in the said schedules, or are not applicable, they shall be settled by the engineer and contractor jointly But the purchaser shall not become liable for the payment of any charge in respect of any such alterations, amendments, variations, or directions unless the instruction for the performance of the same shall state that the matter thereof is to be the subject of an extra or varied charge, or unless the particulars of his claim shall be set forth in writing by the contractor, and furnished to the purchasers within 30 days after the execution of the same; but, subject to these conditions being duly complied with, the purchasers shall be subject by such particulars unless they or the engineer object thereto in writing within 30 days after delivery thereof."

The gist of the above lengthy statement, as applied to wiring contracting work, is that where schedule rates for work are stated in the original contract, these rates shall be taken as the basis of any alterations made during the course of the work. This, although at first sight equitable, not infrequently would lead the contractors into grave difficulties. As Mr. Cross pointed out, the great cost of a job if anything is changed after the men have started is a matter of common knowledge, even if the alteration is only apparently very slight. The writer of the paper has himself proved that in such cases it is often wise to stop work entirely until the purchaser finally decides what is to be done, as workmen will not work well under such conditions, and money is lost on labour alone, quite apart from possible waste of material. Mr. Cross suggests a clause reading somewhat as follows: "Alterations may be made to any position of apparatus without charge, provided that notice is given before work is commenced, and that such alterations do not increase the cost of the work specified, but alterations ordered after work has been started will be charged extra." It is quite easily seen that the clause—"In the event of the engineer requiring to dispense with or add to any part of the plant or work to be done under this contract, such reasonable and proper notice shall be given to the contractors as will enable them to make their arrangements accordingly"—is wholly inadequate to meet the loss and damage sustained by alterations of work after operations have started, all the more because it is stated that, "unless the contractor shall otherwise agree in writing, the total sum of money set out in the contract shall not be affected by such alterations, amendments, omissions, variations, or directions to the extent of more than 10 per cent. of the amount of the contract." The value of altered work and material often far exceeds this limit, and the stipulation, "provided always that in cases

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where goods or materials are already prepared, or any matter or patterns made or work done that requires to be altered in respect thereof, a reasonable sum shall be allowed by the engineer," is not sufficient to meet the case.

The terms of payment is a matter of prime importance, and it is suggested by the writer of the paper that wiring contractors when quoting architects should make the price subject to 10 per cent. if payment is made within one month of completion, this being defined as "the first day the installation has been used by purchaser or had a satisfactory test," so as to allow the builder, if the order comes through him, the commission he expects.

The penalty clauses for non-completion of work are very disagreeable to wiring contractors, and are distinctly one-sided unless a clause is also inserted giving the contractor an extra if he cannot carry out the work from causes beyond his control in the time specified. Cases have been known where, under penalty, the work had to be carried out in, say, 18 months, but as the building was not ready for three years extra expense was caused to the wiring contractor, who had prepared and was quite in a position, so far as himself was concerned, to complete in the time specified.

The whole question of tendering is an important one to the wiring trade, and the following are a few suggestions by Mr. Cross for inclusion in conditions attached to wiring contracts. As regards guarantee, the following is a clause which has worked well, inasmuch as the material specified by the purchaser is omitted from the guarantee: "The work under the specification is guaranteed for a period of 12 months after completion against faulty material or workmanship, the date of completion being taken to be the first day on which the installation has received a satisfactory test, or which has been used by the purchaser. This guarantee does not include accident, fair wear and tear, special material specified by purchaser, or faults occurring after another contractor or person has carried out any work on the installation." This reservation is made because it has happened more than once that the purchaser has specified material, such as tumbler switches, which the contracting firm has tested and discarded as unsatisfactory.

Clauses should be inserted regarding insurance ("All workmen employed by us to be insured under the Workmen's Compensation Act, and all work executed and material delivered on the site to be insured by us against damage by fire until completion"); overtime work—some people expect that overtime will be worked without extra charge to suit their convenience; quality and type of cable, stating either length required, or exactly what points are to be connected and size of cable required; method of support (casing and cover, close joint steel tube sunk in plaster, welded or screwed with drawn-in wire, gas-pipe or insulators) and accessories, specifying clearly what switches, fuses, and fittings are included. Avoid such terms as "best material," "complete installation," or "everything included" in tender. In the case R. Cost and Son *v.* Holford, tried February, 1907, the rule was laid down that "even if a specification be clearly prepared setting down every item and the contract has been given to supply a *complete installation* no charge can be made for omissions from the specification." Specify, in the case of material supplied by the purchaser, whether the contractor includes fixing or not. Let the purchaser attend to all details regarding the material he orders, as he then finds that the contractor is not making so much on fittings as was supposed.

A few opinions culled by Mr. Cross from practical experience are worth noting. It is a mistake to reduce a price after a tender has been sent in, as it is certain that competitors will also be asked to do so. The number of tenders asked for any job should be limited to four or five, distributed among firms known to be capable of doing the work. The preparation of schemes and tenders for quantities should in equity be charged for, but a contractor naturally cannot afford to offend an architect or other gentlemen from whom he expects work. Nevertheless, free preparation is a little unfair, and should not be expected. Consulting engineers have a bias towards specifying special makers for all material, and as most contractors buy in quantities, and not for particular jobs, it is impossible to quote a fair price for the work. In one case about the only material on a job that could be ordered from any firm the contractor preferred was the solder! The situation was aggravated by the fact that some of the specified goods were unsatisfactory. Insufficient information is often given in inquiries, and the purchaser oftentimes has not enough sense to accept the best schemes. Take, for example, a hall that would be most efficiently lit by 50 single-light pendants, costing, say, £50. It would be possible to install 16 five-light fittings, giving 80 lights at a cost of, say, £32, with larger profit to the contractor. The purchaser would not see that he would have to use 60 per cent. more current, and would accept the lowest tender. Mr. Cross has evidently had wide experience in this branch of work, and his remarks, based on practice, carry a good deal of weight. It would be interesting to receive in our correspondence columns the opinions of others interested in this subject.

THE SUSPENSION OF MOTORS ON TRAMCARS.

BY C. H. R. T.

It has long been recognised by electric tramway engineers that the methods of suspending car motors in general use are not satisfactory, owing to only a portion of the weight of the motors being carried on springs. With the ordinary "nose suspension," which is in almost universal use with geared motors, the gears are subjected to much greater wear than would be the case if the spur wheels were not fixed rigidly to the car axles, whilst the axles themselves are subjected to severe shocks when the wheels encounter obstacles, owing to about half the dead weight of the motors resting on them.

The problem has been satisfactorily tackled on the Continent in connection with motors having a direct drive—*i e*, in which no speed-reducing gear is used between the armatures and the car axles, two well-known cases being in the later type of locomotives used on the Valtellina line in Italy and those built by the A.E.G. for the Berlin-Zossen high-speed trials; but a satisfactory arrangement does not appear to have been designed for use with geared motors. In the case of the Valtellina locomotives, the motor rotors have hollow shafts through which the car axles pass, the rotor shafts running in bearings forming part of the motor framework. There is normally a clearance of about 2in. between the car axles and the hollow rotor shafts all round. The rotation of the rotor is transmitted to the car wheels through a parallel link arrangement, so that, although the rotors and wheels revolve together, the car axles, with their axle-boxes, are free to rise or fall when the wheels encounter inequalities or obstacles on the line, without this vertical motion and shocks being transmitted to any part of the motor or other equipment. The result is, of course, that depreciation of the electrical equipment, and also of the track, is reduced to a minimum. In the case of the A.E.G. cars for the Zossen high-speed trials, a similar arrangement of hollow rotor shaft was used, the car wheels in this case, however, being driven through radial spring arms, fixed on the hollow shafts, instead of through link gearing as in the Valtellina case, whilst the clearance is about ½in. only, instead of 2in.

With geared motors as used in tramway work, it is necessary for the bearings of the pinion and spur-wheel shafts to be rigidly connected together, so that the distance between the two cannot alter, as otherwise, of course, the wheels could not be kept in gear. As the pinion is necessarily on the armature shaft, which runs in bearings forming part of the main motor casting, it follows that the axle on which the spur wheel is fixed must also have bearings forming part of the motor framework, or which are rigidly connected thereto, and the spur wheels being commonly fixed direct on the car-wheel axles, the general practice is to form bearings as projections to the motor castings and by means of these to support one end of the motors, the other ends being supported by springs on the truck frames. With this "nose-suspension" arrangement—which is shown diagrammatically in Fig. 1 for comparison with the

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arrangement shown in Fig. 2, which is to be described later—although the spur-wheel and pinion centres are kept at a fixed distance from one another, it is obvious that the teeth are not only subjected to the legitimate steady strain due to the driving torque, but they also experience severe strains and shocks, owing to the relative vertical motions of the spur-wheel and pinion axles, caused by the oscillation of the motors about the car axles (owing to their other ends being spring-suspended), and by the car wheels encountering inequalities and obstacles on the rails. Other objections to the arrangement which have already been mentioned are that the motors themselves are subjected to severe shocks, and that the wear and tear of the rails must be greater than if the motors were entirely spring-borne.

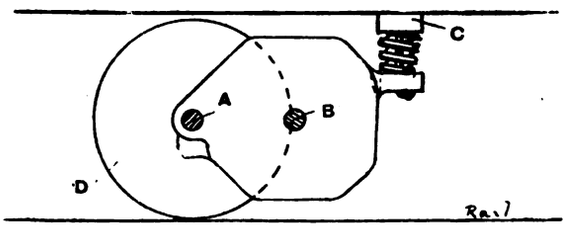

FIG. 1.—A, Car Axle; B, Armature Spindle; C, Truck Framework; D, Car Wheel

The obvious remedy for all these troubles appears to be the adoption of a somewhat similar arrangement to those described in connection with motors not provided with speed-reducing gear, the only difference being that the spur wheels, instead of the rotors or armatures, must be mounted on hollow shafts, through which the car axles must pass, and which must run in bearings rigidly fixed to the motor framework. With this arrangement, which is shown diagrammatically in Fig. 2, the motors may be either fixed rigidly to the trucks or spring-suspended from them, the connection between the hollow spur-wheel shaft and the car wheels being made by suitable spring arms or links. In Fig. 2 these arms are not shown, and in both figures the spur wheels and pinions are omitted for clearness.

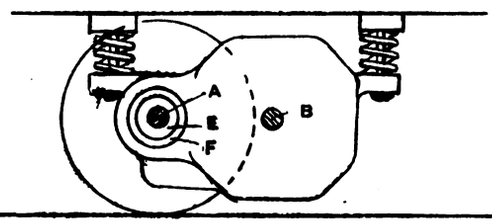

FIG. 2.—A, Car Axle; B, Armature Shaft carrying Pinion; E, Clearance between Axle and Hollow Shaft; F, Hollow Shaft carrying Spur Wheel. Note.—The spring drive prevents shaft A ever coming into contact with hollow shaft F. The amount of clearance, E, depends on the strength of the car suspending springs and the amount of sway allowed for.

The chief difficulty in the arrangement suggested appears to be the comparatively large bearings which would be required for the hollow shafts, but as this difficulty has been overcome in connection with high-speed railway work, there seems to be no reason why any special difficulty should be expected from this cause in tramway work. Another point which may be urged against the arrangement is that the distance between the car-wheel axles and the armature spindles would have to be an inch or two greater than at present, with a consequent increase in the size of the gear wheels for the same speed ratio; but whilst in the case of most existing trucks every inch of room is occupied, there should be no great difficulty in slightly altering the usual dimensions when designing new trucks.

FACTORY AND WORKSHOPS ACT, 1901.

Through the courtesy of Mr. H. Faraday Proctor, the honorary secretary of the Incorporated Municipal Electrical Association, we are able to reproduce in full the objections of the association to the draft regulations issued from the Home Office, 1907, relating to the generation, transformation, distribution, and use of electrical energy in premises under the Factory and Workshops Act, 1901. These take the form of a letter addressed to the Secretary of State at the Home Office, Whitehall:

The objectors are the Incorporated Municipal Electrical Association, an association representing by its members practically the whole of the municipal electrical undertakings of the United Kingdom, and formed primarily for promoting the interests of such undertakings. The association through its members represents a capital expenditure of over £30,000,000, incurred by local authorities in respect of electrical works in the United Kingdom, and also of many millions of pounds sterling expended by the consumers supplied from the numerous systems, whose interests both as consumers and ratepayers they desire to protect. The objectors are of opinion, and respectfully submit, that "undertakers," with statutory powers and obligations, authorised under the Electric Lighting Acts should be under the control and regulations of one Government department only as regards technical matters. Since, by the Electric Lighting Acts, undertakers are already and always have been subject to the control and regulations of the Board of Trade as made and amended from time to time, and since such regulations provide ample protection to workmen, different regulations issued by another department are undesirable. If further or more detailed regulations are necessary, the association would welcome an amplification of the existing regulations rather than the issue of new rules by any other department.

The association, therefore, asks that nothing contained in the regulations as drafted, or as they may be amended, shall apply to undertakers or their works authorised under the Electric Lighting Acts. The association submits that the regulations generally would unfairly and seriously handicap the use of electricity as compared with other forms of energy not subject to such regulations. The association submits that the regulations should not be made retrospective, except in cases where it is shown that existing works have in practice proved dangerous. The association submits that the regulations as a whole are too vague and general to be instructive or useful; whilst even in the hands of an expert they are open to so many constructions as to be a source of perpetual misunderstanding and expense. All inspectors employed in connection with the enforcing of the regulations should be specially appointed electric inspectors fully qualified and experienced in the description of works under inspection. Occupiers of premises should in all cases be given a right of appeal against the decision of any inspector.

PRELIMINARY.

If the regulations are in any instances made retrospective, an alteration of the dates by which the regulations shall be complied with is necessary, as compliance with the dates mentioned would be impracticable.

DEFINITIONS.

Cables.—The association respectfully submits that this definition is improperly applied to the expression "cable" and would lead to great confusion.

Switchboard.—The association submits that this definition is too wide. If taken literally, a single switch, a single fuse, or the coils of an arc lamp with the requisite conductors would constitute a switchboard.

Switchboard Passageway.—This definition is too general. As it stands it would embrace even a telephone box containing a switch for controlling the light, etc.

REGULATIONS.

No. 1.—The association submit that the word "are" should be substituted for the word "may" in the second line. The association is of opinion that this, in common with most other of the regulations, is too vague and general to be of any real use. Regulations drawn up on such general lines are deemed very undesirable, since they give to inspectors the power of deciding what shall or shall not be considered necessary. It is not proposed to repeat these remarks in respect of each rule to which they apply. It will be understood that they apply generally to nearly every one of the regulations as drafted.

Nos. 2, 3, etc.—See objection to No. 1.

No. 4.—This regulation should be deleted. The use of switch fuses and disconnecting links should most certainly be allowed. Note.—Under regulation 9 a link would appear to be a switch.

No. 5.—The last sentence, commencing with the words "Every fuse shall be," should be deleted or amended. The association is of opinion that there are certain fuses which must of necessity receive attention whilst there is, to a certain extent, a risk of shock, but such would be attended to by competent persons only, and, therefore, the danger would be reduced to a minimum, and would be trivial in character.

No. 11.—This regulation should be deleted, because (*a*) it is preferable and far safer that under certain conditions there should be one switch only for the control of two or more motors, etc. Conditions often exist under which switches if more than one be installed are liable to be mistaken one for another with dangerous results, as, for instance, on a crane or other machine driven by more than one motor. (*b*) The use of switch fuses

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instead of switches should be allowed, as the addition of innumerable switches would greatly add to the risks as well as expense.

No. 12.—The association is of opinion that paragraphs 2 and 3 should be deleted, because they would involve great expense without corresponding benefits.

No. 13.—Paragraph 2 should be deleted, because (*a*) the grouping of portable apparatus on one control should be allowed; (*b*) the provision of a plug connector is sufficient in most cases and is often preferable to a switch.

No. 15.—This regulation should be made to apply to high-pressure and extra high-pressure switchboards only.

No. 17.—As previously stated, it is imperative that these regulations should not be made retrospective; this observation applies especially to this regulation. This regulation cannot be enforced even as regards new work unless the definitions are amended.

No. 18.—Sub-Section (*b*): this sub-section should not apply to low-pressure instruments (where one pole is at earth potential) used on switchboards for the control of high-pressure or extra high-pressure circuits. Sub-Section (*d*): This sub-section should be deleted as compliance is impracticable, or so nearly so, as to be most undesirable.

Nos. 21 to 33 (inclusive).—These regulations should only apply to high-pressure and extra high-pressure working.

No. 30.—Although referred to in the above paragraph, special attention is directed to this regulation, which, it is contended, would needlessly alarm the great majority of users of electricity who use low-pressure currents, and would result in a serious set back to the electrical industry generally. The association submit that this regulation should only apply where high pressure or extra high pressure is employed.

No. 33.—Line 3: the words "switchboard or" to be deleted, as, owing to the wording of the definition of a "switchboard," a switch for controlling the lighting of the sub-station could not be placed within reach, and such arrangement is necessary. Line 4: the word "accidental" to be inserted between the words "within" and "reach."

FORTHCOMING EVENTS.

FRIDAY, OCT. 25.

P. and O. Batti-Wallahs' Society.—At 7.45 p.m., smoking concert at Holborn Restaurant.

Physical Society.—At 5 p.m., in the Physics Laboratory, Royal College of Science, Imperial Institute-road, South Kensington, "On the use of Variable Mutual Inductances," by Mr. A. Campbell; "On Magnetic Oscillators as Radiators in Wireless Telegraphy," by Dr. J. A. Fleming.

Junior Institution of Engineers.—At 7 p.m., visit to the "Model Engineer" Exhibition at the Royal Horticultural Hall, Vincent-square, Westminster.

SATURDAY, OCT. 26.

Junior Institution of Engineers.—At 2.30 p.m., visit to Blackfriars Bridge widening works.

TUESDAY, OCT. 29.

Faraday Society.—At 8 p.m., at Institution of Electrical Engineers, 92, Victoria-street, S.W., "On the Electrolysis of Salt Solutions in Liquefied Sulphur Dioxide at Low Temperatures," by Bertram D. Steele, D.Sc.; "Note on the Action of Aluminium Powder on Silica and Boric Anhydride," by Frank E. Weston, B.Sc., and H. Russell Ellis, B.Sc.; "Reduction of Metallic Oxides by means of Calcium Hydride," by F. Mollwo Perkin, Ph.D., and Lionel Pratt. Mr. N. T M. Wilsmore, M.Sc., will exhibit a series-parallel lamp resistance useful for electro-chemical work.

FRIDAY, NOV. 1.

Institution of Mechanical Engineers.—At 8 p.m., adjourned discussion on Prof. Hopkinson's paper.

PERSONAL.

Mr. Charles Archer, who has been in the charge of the National Telephone Co.'s business at Wigan, has been transferred to the Manchester district.

The Huddersfield Corporation have approved of the appointment of Mr. J. W. Button, A.R.C.S., A.M.I.E.E., of Battersea, as head of the engineering department at the technical college at a commencing salary of £250 per annum.

The Limerick Borough Council have appointed Mr. P. T. McNamara as borough electrical engineer in place of Mr. J. P. Gallinagh, who has accepted an important position in Singapore.

Mr. Golie, at present in the employ of the South Lancashire Tramway Co. at the generating station at Atherton, has been appointed as engineer at the Brownlow-hill Workhouse, Liverpool.

The Wolverhampton Town Council have increased the salary of their electrical engineer, Mr. C. E. C. Shawfield, by £75 this year, and a like amount a year hence, making it £600 per annum.

At the Railway Telegraph Superintendents' and Electrical Engineers' conference held last week, Mr. C. H. Ellison, telegraph superintendent of the North-Eastern Railway, was elected president for the year 1908.

Mr. J. Cathcart Christie, A.M.I.E.E., at present one of the senior electrical engineers of the Corporation of Glasgow, has been appointed chief engineer for the electrical works about to be constructed at Arbroath.

Mr. John Bell, the newly-appointed assistant lecturer and demonstrator in the mechanical engineering department of the Northampton Polytechnic Institute, Clerkenwell, has already been for some time engaged in technical instruction, having for the past three years acted as assistant lecturer and instructor in a similar department at the City of Bradford Technical College. Before this, Mr. Bell was engaged in practical engineering work, comprising work in the drawing office and fitting and erecting. He was a "Salt" scholar of the Salt Schools, Shipley, Yorks, and is a graduate of the Institution of Mechanical Engineers.

At the ninth annual competition for the London Private Fire Brigades' Championship, the Robertson Electric Lamps Fire Brigade were again successful in carrying off the Marshall championship cup. There were 21 brigades in the competition, and this is the third time the Robertson brigade have been successful in securing first place. Out of the events entered for they secured a first prize, three seconds, and a fourth prize, and, in addition to carrying off the championship cup, the Robertson brigade also won the Hitchcock shield, a new trophy for the brigade showing the best general improvement during the year. They also made a tie in the competition for the Nestle cup, which carries with it the championship of the United Kingdom.

LEGAL INTELLIGENCE.

BOURNEMOUTH CORPORATION v. POOLE AND DISTRICT ELECTRIC TRACTION CO.

Last week the case of the Corporation of Bournemouth *v.* the Poole and District Electric Traction Co. was heard before Mr. Justice Joyce in the Chancery Division.

Mr. TOMLIN (who appeared with Mr. Danckwerts, K.C., for the Poole Co.), said the sale of the tramways was made subject to all liabilities and engagements of the company incurred or entered into in the ordinary course of business in connection with the Poole undertaking, outstanding or undischarged on the appointed day, which was Dec. 31, 1903, being indemnified by the Corporation. The two items unsettled were £7,000 in respect of a loan from the London and South-Western Bank, utilised for discharging liabilities to creditors in the ordinary course of business, and £4,558. 3s. 8d. in respect of liabilities to sundry other creditors. When the matter came before the present Court, his Lordship referred it to Mr. Sneath, a chartered accountant, to report whether all or any part of the two sums were liabilities or engagements of the company incurred or entered into in the ordinary course of business, and counsel contended that Mr. Sneath's answers were in effect that a large part of the two items was a liability incurred in the ordinary course of business.

Mr. HUGHES, K.C., for the Corporation, submitted that Mr. Sneath's report was not binding on the Court. With respect to the item of £4,558, which the report had reduced to £2,330, he urged that the Corporation could not be asked to pay the company anything in respect of capital outlay, as they had already received it in the award. With regard to the item of £7,000, which had been reduced to £6,476, he contended that it was impossible for the company to show that it was borrowed in respect of the undertaking at all.

After further argument, his LORDSHIP held that the company was entitled to £6,476 odd out of the £7,000 bank loan and £2,570 (part of the £4,558) on the ground that they were liabilities and engagements of the company incurred in the ordinary course of business in connection with the Poole undertaking, outstanding or undischarged on the appointed day, as defined in the agreement of purchase. His Lordship also directed that each side should pay its own costs.

LLOYD'S v. THE MARCONI CO.

In the Court of Appeal on Tuesday, before the Master of the Rolls and Lords Justices Fletcher Moulton and Farwell, the case of Lloyd's *v.* the Marconi International Marine Communication Co. was heard on the appeal of the defendants from a judgment of Mr. Justice Kekewich in the Chancery Division. The action was brought by the plaintiffs, the well-known firm of underwriters, for specific performance of an agreement by the defendants to provide and install apparatus for working the Marconi system of telegraphy at Lloyd's signal station at the North Foreland. It appears that on Sept. 26, 1901, an agreement was come to between the plaintiffs and the defendants by which the defendant company granted to Lloyd's the right to use the Marconi system for the sole purpose of maritime signalling, as thereby defined, at Lloyd's signalling stations during the currency of the agreement in any part of the world, with certain exceptions not material to be stated. The defendant company had to provide and install apparatus for working the system at such of the plaintiffs' stations as plaintiffs might during the agreement require, and plaintiffs were to pay for such installations and also a royalty for each station at which the apparatus was installed. It was also agreed that plaintiffs should before Oct. 1, 1906, give to the defendant company an order for the installation of the system in at least 10 of plaintiffs' signal stations, and should keep the system installed and available for working. It was also provided that the plaintiffs should not use any system of wireless telegraphy except the Marconi system, and the term of the agreement was for 14 years from its date.

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Clause 13 also provided that during the term of the agreement the wireless telegraphy stations already established in the United Kingdom by the company should be worked by the plaintiffs, but all revenue derived from such stations in respect of sea telegraphy should be acccounted for, less Post Office charges, by the plaintiffs to the defendant company. Clause 17 provided that during the term the plaintiffs should not apply to the Post Office for any licence which would prevent the working of sea telegraphy by the company in accordance with the agreement. It appeared that some delay took place in naming the 10 Lloyd's signal stations at which the apparatus was to be installed, but in November, 1905, the plaintiffs alleged that it was completed and furnished to the defendant company, the list including the North Foreland. The plaintiffs alleged that the defendants then became bound to install the system at the signal station at the North Foreland. The apparatus was installed by the defendants, but in April, 1906, the defendants removed it from that station and re-erected it at a new station of the defendant company in the neighbourhood, and this, plaintiffs said, rendered it impossible for the defendants to perform their obligations under the agreement. Defendants contended that there could not be two stations at the North Foreland, and that as they had at the date of the agreement one there already established they had the right to retain it. Mr. Justice Kekewich held that the defendants were bound to provide at Lloyd's signal station at the North Foreland apparatus for working the Marconi system at such station. Hence the present appeal of the defendants.

Without calling upon counsel for the respondents, their Lordships affirmed the decision of Mr. Justice Kekewich, the MASTER OF THE ROLLS saying that he shared with Mr. Justice Kekewich the difficulty in appreciating the position taken up by the defendant company. It appeared to his Lordship that the construction of the agreement was reasonably clear, and he had, therefore, to adopt the judgment of Mr. Justice Kekewich. The appeal was dismissed, with costs.

TANNER v. THE UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON.

At the Wandsworth County Court on Monday Charles Frederick Tanner, Wandsworth, applied to his Honour Judge Russell for a review of a compensation award made by that Court on July 6, 1906.

Counsel for the applicant said that prior to the award, which was for 12s. 4d. a week, an agreement had been filed under the Act whereby the applicant was paid 18s. 2d. a week, half his average earnings. He now asked for an increase to the full amount, which had been reduced on account of the man being taken back into the service of the company. The applicant was employed as mate to an electrical fitter, his wages being 36s. 4d. a week, and on Jan. 16, 1906, he met with a serious accident, and was taken to St. George's Hospital. He was at the time fixing upper cables to the roof of the engine-room at Lots-road, Chelsea, when he slipped, and, falling, clutched hold of some live wires. It was fortunate that he was not electrocuted on the spot, but he fractured his hip, broke his thigh, and sustained concussion of the brain, as well as severe burns on both his hands. After a while he was taken back, and the compensation was reduced to 12s. 4d. a week. In January last his wages were increased to 28s. for doing other and lighter work, and his Honour was now asked to find that the object of the increase was to upset the compensation. On March 16 application was made to reduce the compensation to 8s. 4d. a week, on the ground that he was earning 28s. a week wages. At any rate, immediately afterwards he was discharged, and the company gave as a reason that the applicant insisted upon full compensation. After his dismissal he was paid 12s. 4d. a week, and he gave a receipt without prejudice, considering himself entitled to 18s. 4d.

Counsel for the company said his clients contended that the applicant was able to do work, and there was medical evidence on either side.

His Honour directed that the case should be decided by a medical referee, and he referred it to Dr. Felix Kempster.

CANNON v. METROPOLITAN ELECTRIC TRAMWAYS.

At Clerkenwell County Court the action was called of Mrs. Cannon, of Wood Green, who sued the Metropolitan Electric Tramways, Limited, for £1,500 as damages for injuries sustained whilst a passenger by one of defendants' cars. A jury had been empanelled, but before evidence was called counsel held a consultation, and as a result it was announced that a settlement had been arrived at, and that the case would be withdrawn from the jury.

Judgment was, therefore, entered in the plaintiff's favour for the amount agreed upon.

ARTHUR v. DUNDEE CORPORATION.

In Dundee Sheriff Court last week, Sheriff Campbell Smith closed the record in an action for damages raised by George Arthur against the Town Council of Dundee. The sum sued for is £250 in respect of the death of pursuer's three-year-old child, who was knocked down and killed by a tramway car in Strathmartine-road on April 8. Pursuer avers in his condescendence that his daughter, while crossing the road, was knocked down by the car and dragged for about five yards, part of the car passing over her body. The car had to be levered backwards before the child could be released. Arthur alleges that the death of his child was due to the negligence of defenders. The car, he stated, was travelling at excessive speed, and was not under the control of the driver, who, pursuer believed, was only learning to drive, and was incompetent. Had the brakes been applied in time the accident might have been prevented. Defenders deny liability. They aver that the child stepped off the pavement when the car was within 6ft. of her, and, heedless of the driver's shouts, ran in front of the vehicle, and was knocked down. The driver, on seeing the danger, applied his brakes and stopped the car in about half its length. The vehicle was travelling at a speed of six or eight miles an hour—a normal speed—and was under the control of an experienced driver, who had been in the service of the tramway company and the Corporation since 1895. Defenders deny an allegation that the guard in front of the car was defective, as also a statement by pursuer that drivers of cars cannot comply with Board of Trade regulations and also run up to their scheduled times.

COMPANIES' MEETINGS AND REPORTS.

EDISON AND SWAN UNITED.

The twenty-fourth ordinary general meeting of the Edison and Swan United Electric Light Co. was held on the 17th inst., Mr. Hy. Wolfenden, chairman of the Company, presiding.

In moving the adoption of the report (*Electrical Engineer*, Oct. 11), the CHAIRMAN said that they might congratulate themselves on the results of the past year's trading. The increase of profit was only about £500 over the preceding year, but that had been earned in the face of very high prices for raw materials and very keen competition in the selling prices of their manufactured articles. The net result was that they had maintained their dividend, written off liberally for depreciation, added to reserves, and strengthened the Company's position generally. He did not propose to deal with the question of metallic-filament lamps, beyond assuring them that the matter had not been lost sight of. The net revenue account showed a balance brought forward from profit and loss of £54,236, an increase over the preceding year of £526. On the other hand, debenture interest absorbed £16,390, being £340 less than last year. Depreciation on freehold and leasehold property, plant, tools and stock, and reserves for bad and doubtful debts, amounting altogether to £13,831, was practically the same total as before. The rate of depreciation on plant is 8 per cent.; £7,500 had been allocated to the general reserve fund which was started last year, thus increasing that fund to £12,500. The net balance available for distribution was £16,514, to which had to be added the sum brought forward, making a total of £25,521, out of which the Board recommended the payment of a dividend on the "A" shares of 4½ per cent., the same as last year, being 2s. 6d. per share on the partly-paid shares and 4s. 2d. per share on the fully-paid shares. These payments would absorb £15,978, leaving £9,543 to be carried forward. The share capital remained as before, but there was a reduction of £6,100 in the debenture stock owing to the purchase and cancelment during the year of £1,600 4 per cent. stock and £4,500 5 per cent. stock. The average prices paid were £86. 8s. for the 4 per cent. stock and £90. 16s. 5d. for the 5 per cent. stock. The profit resulting from these purchases had been applied as a further reserve against stocks. The Altrincham Electric Supply Co. was going steadily forward. After making full provision for depreciation, the ordinary shares had received a dividend of 5 per cent for 1906, and the probabilities were that this rate might be exceeded for 1907. The item of plant, £61,900, was more by £1,162, notwithstanding that £6,000 had been allowed for depreciation. During the year they had added a certain amount of new and additional machinery, but the larger part of the expenditure had been incurred in connection with the electrification of the works at Ponder's End.

Mr. E. B. ELLICE-CLARK, M.I.C.E., seconded the resolution, which was adopted after a brief discussion.

CAMPBELLTOWN AND MACHRIHANISH LIGHT RAILWAYS.

At the annual meeting of this Company it was stated that on the whole the directors were satisfied that the prospects of the Company were excellent, and the results already obtained justified the belief that the line would become a valuable property. At the credit of revenue account there was a balance of £780. 16s. 1d. The directors decided to recommend payment of a dividend of 2½ per cent. on the ordinary shares.

MONTE VIDEO TELEPHONE.

The annual general meeting was held on Tuesday under the presidency of Mr. F. W. Jones.

In moving the adoption of the report the CHAIRMAN remarked that steady progress had been maintained, and there was ample reason for congratulation. With the increase of the dividend on the ordinary shares from 5 per cent. to 6 per cent., and the placing to reserves and carrying forward of larger sums than ever before, the Company showed a still further improved condition in its affairs. The reserves had also been increased. The large capital expenditure on renewal and extension of plant which the Board had for a number of years been anticipating had not been called for, owing to the Company's not having obtained permission to lay down an underground system. Their efforts to obtain such a permission had been continuous, and he hoped they would shortly prove successful. In anticipation of an underground plant, the Board obtained in February last from the United River Plate Telephone Co. the services of Mr. H. Planchon in making an examination and report on the Company's existing plant and the changes that would be necessary and advisable. Sir John Gavey, late engineer-in-chief to the Post Office, who is now visiting the River Plate, had undertaken to report on the Company's plant and business. This would also be of valuable assistance in deter-

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mining the character and details of the projected new capital expenditure.

Mr. C. Lock seconded the motion, which was adopted.

STIRLING AND BRIDGE OF ALLAN TRAMWAYS.

The report of this Company shows that the total earnings for the year have amounted to £5,475. 2s. 11d., being an increase of £222. 18s. 5d. compared with last year. The expenditure under revenue has been £4,472. 1s. 1d., being an increase of £159. 8s. 1d. The balance at credit revenue is £1,003. 1s. 10d., and of this sum the directors recommend that £761. 16s. be applied to payment of a dividend of 4 per cent. (less income tax) on the preference and second preference shares, and a dividend of 4 per cent. (free of income tax) on the ordinary shares, leaving £241. 5s. 10d. to be carried forward to renewal account.

WESTERN TELEGRAPH.

The directors of the Western Telegraph Co., after transferring £85,000 to general reserve fund, £5,000 to maintenance ships' reserve fund, £10 000 to marine insurance fund, and £10,000 to land and buildings depreciation fund, recommend a final dividend of 3s. per share, making with previous distributions a total dividend of 6 per cent. for the year ended June 30, 1907, and also the payment of a bonus of 2s. per share, both free of income tax. The balance of the account is carried forward.

ROSARIO ELECTRIC.

The report of the Rosario Electric Co. for the year ended June 30 last, to be presented to the meeting on the 29th inst., states that the balance at credit of profit and loss account, after making provision for depreciation of buildings, plant, etc., and for expenses of issuing new capital, is £20,305, to which must be added the amount brought forward from the last account (£2.767), making a total of £23.072. The directors now propose to pay a dividend of 5s. each on the ordinary shares (making a total of 8 per cent. for the year), adding to the reserve fund £5,000, and leaving to be carried forward £4.600. To meet the increasing demand the directors have ordered a seventh steam dynamo of 1,000 kw. A new arrangement has been made with the municipality for the supply of electric current for street-lighting. The directors have been informed that the municipality have already ordered the necessary lamps, and the Company is providing additional cables to supply these lamps and for general use.

CUBA SUBMARINE TELEGRAPH.

The report of the Cuba Submarine Telegraph Co. for the half-year ended June 30 last, to be presented at the meeting on the 30th inst., states that the total receipts of the six months were £24,756, while the expenses amounted to £6,571, leaving a balance of £18,184, to which has to be added £6,791 brought forward, giving a total of £24,975 to be dealt with. The sum of £5,675 has been placed to the reserve against loss on investments and £5,000 added to the reserve fund, which now stands at £103,000. The dividend on the preference shares will absorb £3,000, and leave £11,299, out of which the directors recommend a dividend at the rate of 6 per cent. per annum on the ordinary shares, free of income tax, the balance—£6,499—being carried forward to the current half-year.

PARSONS MARINE STEAM-TURBINE.

The report of Parsons Marine Steam-Turbine Co. states that the profits for the year ended June 30 last amounted to £56,021, enabling the directors to pay a dividend of 10 per cent. and a bonus of 2½ per cent., carrying forward over £11,000. The production of turbine engines during the year was 79,600 h.p., and the orders in hand amount to 27,800 h.p. The total output of engines since the commencement, including the work of numerous licensees, amounts to 1,485,000 h.p.

METALLIC SEAMLESS TUBE.

The report of the Metallic Seamless Tube Co. for the year ended June 30, 1907, states that the net profit, after providing for depreciation on plant and machinery, directors' and auditors' fees, etc., amounts to £2,309, to which must be added the balance brought forward of £2.603, giving an available sum of £4,913. The directors recommend a dividend of 5 per cent. on the ordinary shares, free of income tax, leaving a balance of £3,683 to carry forward.

NEW COMPANIES REGISTERED.

Bude Electric Supply Co.—Registered Oct. 7. Capital, £7,000 in £1 shares. Objects: as title. Agreement with Christy Bros. and Co. Minimum cash subscription, 3,000 shares. Registered office: The Strand, Bude.

I. T. E. Electric Co. (1907)—Registered Oct. 12. Capital, £1,000 in £1 shares. Objects: as title. Agreement with the Cutter Electrical and Manufacturing Co., A. E. Newton, and W. M. Scott. No initial public issue. Registered offices: 72, Finsbury-pavement, E.C.

Brook, Hirst, and Co.—Registered Oct. 16. Capital, £20,000 in £1 shares. Objects: to take over the business of electrical and mechanical engineers, manufacturers of electrical switches, etc., carried on by P. S. Brook and J. A. Hirst as Brook, Hirst, and Co., at the Northgate Electrical Works, Victoria-road, and at George-street, Chester. No initial public issue.

Bickerton Copper Mines Syndicate, Limited.—Registered Oct. 9. Capital, £750 in £1 shares. Objects: to acquire the benefits and obligations of certain agreements granting options for leases of the Bickerton Copper Mines, Cheshire; to adopt an agreement with M. J. Regan, and to carry on the business of copper and general miners, prospectors, explorers, metallurgists, financiers, etc. No initial public issue.

Acme Patent Fire-Alarm Co, Limited.—Registered Oct 9. Capital, £2 000 in £1 shares. Objects: to acquire the business of patent fire-alarm manufacturers carried on by A. Goldsmith, G. Francombe, and F. E. Ryall at 30 and 32 Albany-street, Kingswood, Bristol, as the Acme Patent Fire-Alarm Co., and to carry on the same and the business of electrical, mechanical, and general engineers, electricians, instrument makers, suppliers of electricity, etc. No initial public issue. Registered office: Two Mile-hill, Kingswood, Bristol.

Simms Manufacturing Co., Limited.—Registered Oct. 3. Capital, £60,000 in £1 shares. Objects: to acquire the business of the Simms Manufacturing Co. in connection with motors, motor vehicles and accessories, magnetos and the like, and to carry on the business of manufacturers of and dealers in magnetos, magneto parts and accessories, motors, carriages, vans, wagons, boats, launches, flying machines, cycles and vehicles, electricians, suppliers of electricity for power or other purposes, rubber manufacturers and merchants, dealers in mineral oils, etc. No initial public issue.

Liens Registered.

Tasmanian Copper Co, Limited.—A debenture, dated Oct. 14, 1907, to secure £12,000, charged on all the company's property, present and future, in the Australian Commonwealth, has been registered.

P. P Motor Co., Bournemouth, Limited.—£700 5 per cent. debentures, created and dated Oct. 3, 1907, charged on the company's undertaking and property, present and future, have been registered. No trustees.

Horsfall Destructor Co., Limited (Leeds).—A debenture, dated Sept. 27, 1907, to secure £4,000, charged on the company's undertaking and property, present and future, including uncalled capital, has been registered.

Selby Motor and General Engineering Co., Limited.—A 5 per cent. debenture dated Sept. 18, 1907, to secure £3,000, charged on the company's undertaking and property, present and future, including uncalled capital, has been registered.

Saxon Engineering Co., Limited (Stoke-on-Trent).—Issue on Sept. 25 of a £1,000 6 per cent. debenture, part of series created Nov. 7, 1906 to secure £5,000. Charged on the company's property, present and future, including uncalled capital.

Whirling Switch Car Syndicate, Limited (London).—£700 6 per cent. debentures, created and dated Sept. 4, 1907, charged on the company's undertaking and property, present and future, including uncalled capital, have been registered. No trustees.

Fleetwood and District Electric Light and Power Syndicate, Limited, London, E.C.—Charge registered Oct. 4 for a sum not to exceed £1,850, pursuant to an order of the High Court of Justice, dated July 26, 1907. Secured on the property, assets, and undertaking.

Sturmey Motors, Limited, Coventry.—Particulars of £5,000 debentures, created by resolution of Sept. 6, 1907, have been filed pursuant to Section 14 (4) of the Companies Act, 1900. Property charged: the company's undertaking and property, present and future, including uncalled capital. No trustees.

New Motor and General Rubber Co, Limited (London).—Issue on Sept. 30 of £600 5 per cent. debentures, part of series created May 20, 1997, to secure £10,000. Charged on the company's undertaking and property, present and future, including uncalled capital. Total amount previously issued of same series, £7,450.

New Motor and General Rubber Co., Limited (London).—Issue on Sept. 28 of £3,000 5 per cent debentures, part of series created May 20, 1907, to secure £10,000. Charged on the company's undertaking and property, present and future, including uncalled capital. Total amount previously issued of same series, £4,450.

Gloucester Railway Carriage and Wagon Co., Limited.—Issue on Oct. 9 of £300 4 per cent. debentures, part of series created May 23, 1900, to secure not more than the nominal amount of the capital Charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £380,434.

Electrolytic Alkali Co., Limited, Middlewich.—Issue on Sept. 23 of £1,600 4½ per cent. first mortgage debentures, part of series created July 9, 1904, to secure £50,000, charged on the company's undertaking and property, present and future, including uncalled capital. Trustees: Liverpool Mortgage Insurance Co., 6, Castle-street, Liverpool. Total amount previously issued of same series, £31,100.

Tambopata Rubber Syndicate, Limited.—A trust deed, dated Sept. 5, 1907, to secure £15,000 debentures, has been registered. Property charged: two rubber estates on the Tambopata River, Bolivia, known as El Porvenir and La Union, the company's farms or cultivated patches, various works, buildings, offices, storehouses, distillery plant, machinery and rolling stock, the benefits of a concession from the Bolivian Government, under which the company is entitled to two square leagues of rubber ground for every league of road built, and the company's undertaking and property, present and future, including uncalled capital.

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OPENINGS FOR CONTRACTORS.

ABER—Military camp for War Department.

ABERAMAN—Two houses at Ynyslwyd-road.

ABERCWMBOI—Alterations and additions to Park Gate Lodge.

ABERDEEN—Reconstruction and enlargement of slaughter-house on the north side of Hutcheon-street for the Aberdeen Flesher Incorporation (architect, Mr. John Rust); alterations in connection with premises at Lime-street and Clarence-street for the Northern Agricultural Co. (architect, Mr. George Coutts); mission church, etc., for the Diocesan Home Mission Board (architect, Mr. Arthur Clyne); alterations in connection with music hall, Exchange-street, for Mr. J. Sinclair, Viewbank Cottage, Cults; additions to premises at Provost Blaikie's Quay for the Aberdeen Commercial Co. (architects, Messrs. Jenkins and Marr).

ABERPORTH—Alterations and additions to Council Schools.

ALDERSHOT—Six houses, Lower Farnham-road, for Mr. G. Greenwood.

AYLESBURY—Additions to Royal Bucks Hospital.

BALLINROBE—Workmen's dwellings for Rural District Council (£31,469).

BANBRIDGE—Dwellings for the Rural District Council (£4,600).

BANGOR—Government offices for H.M. Office of Works.

BANNOCKBURN—House for Mr. D. Miller at Quakerfield.

BARNET—Isolation hospital for Urban District Council.

BARROWFORD—New mill for Holmfield Mill and Power Co.

BARRY—New school, Gladstone-road, for Barry Education Committee.

BATLEY—Steam laundry for Co-operative Society.

BEDFORD—Public convenience for Corporation. Mr. N. Greenshields, borough engineer.

BEDMINSTER—Council school at Merrywood. Architect, Mr. H. Bryan, Bristol.

BERKHAMSTED—New stores and five shops, Lower King's-road, for Mr. Pike.

BESCOT—Additions to house, Slaney-road, for Mr. A. Slater.

BEVERLEY—Alterations to Norwood House and secondary school for girls for East Riding Education Authority; seven houses and two shops in Holme Church-lane, and 17 houses in the new street off Holme Church-lane for Mr. H. Vokes.

BEXHILL—Enlargement of municipal buildings (£2,750).

BIRMINGHAM—Extension to Corporation electricity works (£81,900).

BISHOP'S STORTFORD—Two villas by Mr. A. Frankland in Manor-road; two villas in Thornfields-road by Mr. J. Day.

BLACKBURN—Primitive Methodist school (£1,800).

BLOXWICH—Six houses, Little Bloxwich-road, for Messrs. J. and F. Wootton; bakehouse for Mr. Atkins, Samuel-street.

BOSCOMBE—New parish church (£8,550).

BOURNEMOUTH—Elementary schools. Architect, Mr. F. W. Lacey.

BOWBURN—House for Mr. T. Burns.

BRADELEY—Addition to Council schools (£4,291).

BRAWBY—New school, North Riding Education Committee.

BRIDGWATER—Court house for Corporation (£5,000).

BRIGHTLINGSEA—Police station for Essex Joint Committee. Architect, Mr. H. W. Gibson, Chelmsford.

BROMLEY—Alterations to Roe House, Southborough-road, for Mr. J. Staples; 15 houses, Nichol-lane, for Mr. L. Evans; three houses, Plaistow-grove, for Mr. T. Crossley; adaptations of buildings for shops, London-road, for Mr. T. N. Marks; four houses, Bickley-crescent; two houses for Messrs. Jones and Andrews, Sandhill-road and Cromwell-avenue; four houses, Clarence-avenue, for Mr. A. Parnacott; eight houses, Sandhill-road, for Mr. J. Elliman.

BROUGHTY FERRY—Additions to Grove Academy for Education Department.

BURY—Alterations and additions to baths superintendent's house.

BUSHEY—House, Grange-road, for Mr. G. Jaggard; additions to Old Heathbourne, Bushey Heath, for Mr. Stanley Goddard.

BUXTON—Extensions to Council electricity works (£1,700).

CAMBORNE—School for Cornwall Education Committee.

CANNOCK—Nurses' home for Guardians.

CARDIFF—Welsh Congregational church, Eyre-street.

CATHCART—Stable and coach-house at Strathmore for Dr. Murray Lyon.

CHESTERFIELD—Extensions to Corporation electricity works (£5,000).

CHISELDON—Alteration of hall for school. Architect, Mr. R. J. Beswick, Swindon.

CLARKSTON—Villa in Clarkston-road for Messrs. J. and A. W. Money, 131, West Regent-street, Glasgow.

CLITHEROE—Technical school for Education Authority (£10,000).

COLCHESTER—Mechanical stokers at electricity works (£1,017).

CORSHAM—Fire station for Parish Council.

COXHOE—Thirty-nine houses for Messrs. Todd and Son at Clarenceville.

CREWE—Extension to electric lighting (£3,000).

CROMER—Extension to electric lighting (£8,000).

CUBBINGTON—Clubhouse for Oddfellows. Architect, Mr. F. P. Trepess, Warwick.

CWMAMAN—Twenty houses at Glynnafod-street for colliery officers, Glanaman-road.

CWMBACH—New schoolrooms, etc, at Ebenezer Chapel, Bridge-road.

DARWEN—Alterations to Wesleyan School.

DROGHEDA—Additions to municipal technical school.

DUDLEY—Park-keeper's residence for Corporation.

DUNDEE—School for Dundee School Board (£15,500).

DUMFERMLINE—School of textile industries (£11,000). Architects, Messrs. H. and D. Barclay, of Glasgow.

DUNSTABLE—Elementary school for Beds Education Committee.

DURHAM—Ninety-six houses for Bell Bros., Limited, at Bowburn.

DURRINGTON—Council school for West Sussex Education Committee.

EASTBOURNE—Extension to Council electricity works (£7,000).

EDINBURGH—Double villa, Portobello-road, for Mr. A. Harper; railway mission hall at Wheatfield-terrace.

EGHAM—New Liberal club in High-street for the trustees, Messrs. Buckeridge, Searle, and Harding; shop and house, Thorpe-road, for Mr. W. Reynolds; four houses, Park-avenue, for Mr. H. C. Rogers; house, Park-avene, for Mr. W. Worby.

ELDERSLIE—Three houses in Main-street for Messrs. D. Houston and Currie, 13, St. James's-place, Paisley.

ESH—Enlargement of Waterhouses Workmen's Club.

EXBURY—Additions to parish church.

FLEETWOOD—New Sunday schools for the Primitive Methodists (£3,000). Messrs. Smith Bros.

FOLKESTONE—Grammar school for County Education Committee (£2,000).

FORDYCE—Additions to academy for School Board.

FOWEY—Offices for Mr. C. E. Treffry.

FRESSINGFIELD—Alterations to Voluntary School. Architect, Mr. J. Fisher.

GLASGOW—New fire station on the west side of Craigie-street for the Corporation; reconstruction of premises in Brown-street and Broomielaw for the Seaman's Friend Society; alterations and additions to buildings in George-square and West George-street for the Merchants' House; extensions to electricity undertaking (£150,000).

GLOUCESTER—Petty sessional court for County Council. Architect, Mr. M. H. Medland.

GOLCAR—Stables, etc., for Co-operative Society.

GORLESTON—Pavilion at recreation ground for Town Council (£450).

GOUROCK—New school for School Board (£9,925).

GRANGEMOUTH—Engine shed for the Caledonian Railway Co.

GRAVESEND—Six houses in Raphael-road for Mr. T. W. Hooker; houses in Brandon-street for Mr. R. Saunders; houses in Essex-road for Messrs. Archer and Son.

GREAT HARWOOD—House for Mrs. Brennand, Blackburn-road.

HADDENHAM—Villa for Mr. F. Merrick; outbuildings for Mr. H. W. Ricketts.

HANWELL—Isolation hospital for District Council.

HARLINGTON—Two houses in Harlington-road. Mr. A. Winch.

HARLOW—Police station for Essex County Council. Architect, Mr. F. Whitmore, Chelmsford.

HARPENDEN—Fittings at County Council school (£170).

HARROGATE—Two houses, Skipton-road, for Mr. C. A. Nettleton; three houses, Western-terrace, for Mr. Wm. Walker; 12 houses, Poplar-grove, for Messrs. Brown and Staples; alterations to property at Princes-street for Mr. R. Peach; motor-house, bath-room, etc., at Knowle Brow, Brunswick-drive, for Mr. Wilson; alterations to house in Rutland-road for Mrs. Roberts.

HASTINGS—Pavilion for Town Council.

HEBBURN—Alterations to property, Lyon-street, for Mr. A. Shanley.

HERTFORD—Extensions to engine house (£500).

HEYWOOD—Spinning mill for Ring Spinning Co.

HORNSEA—Public convenience for Urban District Council.

HORTON—Additions to school. Architect, Mr. S. E. Barrow.

HUCKNALL—Alterations at Seven Stars Hotel for Home Brewery Co.; six houses for Mr. James Whyatt.

JOHNSHAVEN—United Free Church.

KEIGHLEY—House at Woodville-road. Architect, Mr. D. W. Weatherhead. House in King Edward-street, Sutton Mill, for Mr. Fred Wilson.

KELLY BRAY—Wesleyan chapel and school. Architect, Mr. L. Scantlebury.

KILWINNING—Additions to public school for Town Council (£2,000).

KIVETON—Houses at Dinnington for Mr. Wade Kay; houses at Wales for Mr. M. E. Cartlidge; two houses at Kiveton-park for Mr. Wigmore; six houses at Anston for Messrs. Newberry and Clerk.

LANCASTER—Children's home for Guardians (£4,200).

LARGS—Corporation abattoir (£1,400).

LEEDS—Extension of works for Messrs. Harding, Richardson, and Rhodes. Architect, Mr. W. Bakewell.

LIVERPOOL—Workshop and store building in Kinsley-road for Messrs. Bullen Bros. and Son; fire and police station for Corporation (£4,000).

LLANDRINDOD—Additions and alterations to Bath Cottage, Tremont-road.

LLANELLY—Refrigerator at Council market (£1,200).

LONDON, E.—Extension to Stepney electricity works (£57,000).

LONDON, N.—Extension of Islington electricity works (£285).

LONDON, N.W.—Enlargement of Willesden public library (£1,630).

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LONDON, S.E.—Renovation of church and chapel for Deptford Cemetery Committee.
LONDON, S.E.—Re-erection of the Waterman's Arms, Deptford, for Messrs. Mann, Crossman, and Paulin, Limited.
LONDON, S.W.—Additions to Albert Bridge Flourmills, Anhalt-road, Battersea. Henry Lovatt, Limited.
LONDON, S.W.—Public library for Fulham Borough Council (£15,000).
LONDON, W.—Disinfecting station for Paddington Borough Council (£5,350).
LONDON, W.C.—Blocks of dwelling-houses, Gray's-inn-road. Messrs. Joseph and Smithem.
LONDONDERRY—Workmen's dwellings for Rural District Council, No. 1 (£17,788); ditto, No. 2 (£31,960).
LUDLOW—Alterations to grammar school. Architect, Mr. H. Brakspear.
LUTON—Entertainments enclosure at Wardown Park for Town Council (£580).
LYDNEY—Cottage hospital (£1,200).
MAGHERAFELT—Workmen's dwellings for Rural District Council (£35,790).
MAIDSTONE—Two houses for Messrs. Clarke and Epps; additions to Bow Hotel for Messrs. Isherwood and Co.; new theatre for the Maidstone Theatre and Palace of Varieties Co.; mortuary for Urban District Council (£300).
MATLOCK BATH—Pavilion, pump-room, and baths for Corporation (£20,000).
MEDOMSLEY—Fourteen houses and refuse destructor for Annfield Plain Co-operative Society. Architect, Mr. T. Wilson, Blackhill.
MERTHYR—Enlargement of isolation hospital (£5,000).
MIDDLESBROUGH—Public convenience for Corporation (£700).
MIDSOMER NORTON—House (£8,500). Messrs. J. Long and Sons, Bath.
MINERA—Elementary school for Denbighshire County Council.
MORRISTON—Six sheet mills (£100,000). Mr. W. H. Edwards.
MOSTON—Mission church and school (£400).
NEWBURY—Two shops for trustees of municipal charities.
NEWCASTLE—Extension of Corporation cattle market.
NEWPORT—School for Education Committee (£7,000).
NITSHILL—New hall for the trustees of the R.C. arch-diocese of Glasgow.
NORTHALLERTON—Secondary school for North Riding Education Committee (£6,300).
NORTHAMPTON—Extensions to Corporation baths (£2,930).
NORWICH—Elementary school at Heigham (£10,690).
NOTTINGHAM—Pupil teachers' centre for Board of Education (£8,000).
OBAN—Police buildings for Argyllshire County Council (£900).
OGMORE VALE—Renovation of Bethania Chapel. Architect, Mr. W. B. Rees, Cardiff.
OLDLAND—New church for All Saints' parish (£3,400).
ORFORD—Church for the parish of St. Margaret's (£1,000).
OVING—Additions to house for Mr. H. Foster.
PAISLEY—Villa at Corsebar for Messrs. White and Galloway, Glasgow.
PARTICK—Extension to Council electricity works (£10,555).
PEMBROKE—Isolation hospital for Guardians (£250).
PERTH—Town hall (£25,000).
POOLE—Municipal offices (£2,600).
PORTH—Two houses for trustees of Welsh Wesleyan Church.
PORTHCAWL—Five houses on the New-road for Mr. H. Evans, of Maesteg.
PORTSMOUTH—Additions to Church of England Soldiers' and Sailors' Institute (£2,500).
PURLEY—Mortuary by Urban District Council.
READING—Free library for Corporation (£4,000).
REDFIELD—Mission church in Blackswarth-road, St. George (£2,000). Messrs. Cowlen and Sons.
ROWLANDS GILL—Renovation of educational premises, Hookergate Store.
RUGBY—Extensions of Council school buildings (£4,800).
RUGELEY—Erection of Roman Catholic school.
RUNCORN—Conversion of market hall into public baths.
ST. AUSTELL.—New house, stable, and coach-house, Hendra-lane, for Mr. J. Kent.
ST. CLEER—House at Jaysland. Brooks, Liskeard.
SCARBOROUGH—Council elementary school (£2,350).
SEA HOUSES—Primitive Methodist manse. Architect, Mr. G. Reavell, Alnwick.
SHEFFIELD—Corporation baths (£12,000).
SLOUGH—Thirteen houses in White Hart-road; six houses in Montague-road for Mr. H. D. Bowyer; house in Stoke-lane for Mr. C. J. Jackaman; house in Montem-lane for Mr. T. Turner.
SOUTHAMPTON—Central fire station (£5,200).
SOUTH BANK—Municipal buildings for Urban District Council (£1,500).
SOUTHEND—House, Sandleigh-drive, for Mr. F. J. Gregory; police quarters for Essex Standing Joint Committee, Claremont-road; motor-house, rear of The Leas, for Mr. L. G. Boor; additions and alterations to two houses in Milton-road for Mr. J. E. Knight; four houses, Plas Newydd, for Mr. J. Sumner; three houses, Hainault-avenue, for Mr. W. Jones, jun.
SOUTHEND—Pavilion at Southchurch Parade (£215).
STAPLEFORD—Police station for Notts Joint Committee (£1,600).
STIRLING—Double villa for Messrs. Ronald at Causewayhead.
STOCKPORT—Spinning mill. Architects, Messrs. Scott and Sons, Manchester.
STOKE MANDEVILLE—Additional school accommodation.
STONEY STRATFORD—Extensions to Baptist chapel (£450).
STRATFORD, E.—Mission hall in connection with St. Thomas's Church.
STRETFORD—Extension to Council electricity works (£30,445).
SURBITON—Electric lighting (£20,000); erection of conveniences (£230)
SWANAGE—Additions to Vernow for Mr. G. Pond; houses in Queen's-road for Mr. J. Parsons; additions to house in Cowlease for Mr. G. Burt; house near King's-road and house at Sunnydale for Sir J. M. Burt.
TEDDINGTON—Fire station and residential quarters for Urban District Council.
TREDEGAR—Offices for Tredegar Coal Co.
TRILLICK—Workmen's dwellings for Rural District Council (£5,075).
TUNBRIDGE WELLS—Extension of Council electricity department (£9,600).
TWYDALE COLLIERY—Eighty houses for Messrs. Bell Bros.
TYWARDREATH—Villas, Par Green, for Mr. J. H. Rosevear.
WALNEY—Parish church at Walney Island.
WALSALL—Additions to house, 102, Lichfield-street, for Mr. W. Parks; machine shop and engine-room for Messrs. Alfred Russell and Co.; additions to St. John's School, Pleck; additions to Sandwell-villas for Mr. H. H. M'Connal; three houses, Bentley-lane, for Mr. T. H. Jones; additions to the Manor Works, Sandwell-street, for the Birmingham Dental Supply Co.; conversion of library to art school (£1,520).
WANSTEAD—Parish hall and Sunday school. Architects, Messrs. Church, Deacon, and Cameron.
WARKWORTH—House at Heather Leazes for Mr. J. W. Bell; house (architect, Mr. G. Reavell, jun., Alnwick); alterations to "Paradise," Embleton, for Mr. M. Appleby.
WATERFOOT—Secondary school for Board of Education (£26,000).
WATFORD—Extensions to free library (£200).
WAVERTREE—Church for parish of St. Thomas.
WELLS—New court-house for Joint Committee (£8,000).
WESTCLIFF-ON-SEA—Police quarters. Mr. H. W. Gibson, Chelmsford.
WEST PELTON—Hall for Spiritualists' Society.
WEXFORD—Workmen's dwellings for Rural District Council (£29,380).
WEYBRIDGE—Police station for Surrey Joint Committee.
WEYMOUTH—Pavilion for Council.
WHITEHEAD—New parish church (£3,000).
WHITLEY—Secondary school North Riding Education Committee (£950).
WOLVERHAMPTON—Extension to Council electricity works (£2,560).
WOODHALL—Engine-house for Spa Water Co.
WORCESTER—Buildings for Town Council at Foregate (£2,000).
YARNFIELD—Isolation hospital. Mr. W. Wynne, clerk to the Board.
YEOVIL—Almshouses for Town Council.

APPOINTMENTS VACANT.

Electrical Engineer, Haslingden Corporation. Applications to Mr. W. Musgrove, town clerk, by Oct. 29. See advertisement in last issue.

Engineer to superintend the erection and running of electric and compressed-air plant for working drills in the North-West Frontier Province of India. Applications to the Director-General of Stores, India Office, Whitehall, London, by Nov. 4.

Assistant to Borough Electrical Engineer, Eccles Corporation Electricity Department. Salary, £120 per annum. Applications to Mr. Edwin Parkes, town clerk, by Nov. 11. See advertisement.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Antwerp.—The Municipality invite tenders for one 30-ton electric crane. Deposit £280. Tenders by Nov. 12.

Aci Reale (Sicily).—The Municipality invite tenders for electric light and power supply. Tenders by Nov. 4.

St. Annes-on-Sea.—The Urban District Council invite tenders for cable for the electricity department. Particulars from the Engineer and Manager.

Toro (Spain).—Electric lighting and power supply installation for 10 years for the Municipality. Particulars from the Ayuntamiento Constitucional. Tenders by Oct. 30.

Paisley.—The Corporation Electricity Department invite tenders for coal supply for three or six months. Tenders to Mr. C. F. Parkinson, engineer and manager, by Nov. 2.

Glasgow.—The Corporation invite tenders for supply of uniform caps for the tramways employés. Particulars from the Tramways Manager, 46, Bath-street, Glasgow. Tenders by Nov. 6.

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Melbourne.—The Postmaster-General's Department invite tenders for 11 sets and a common-battery switchboard, and 3,000 subscribers telephones, etc., for the Windsor exchange. Tenders by Jan. 7.

Napier (New Zealand).—The Town Council invite tenders for lighting and power plant and an electric tramway equipment. Particulars from Mr. F. Bowen, town clerk. Tenders by Dec. 31.

Madrid.—The Provincial Government invite tenders for a five years' supply of electric current to three hospitals. Particulars from the Deputacion provincial, Plaza de Santiago 2. Tenders by Nov. 11.

Portrush (Ireland).—The Urban District Council invite tenders for a complete lighting installation by electricity or gas. Copies of specification can be seen at the Town Hall, Portrush. Tenders by Nov. 2.

London, S.W. – The Secretary of State for India in Council invites tenders for the supply of crossings and switches. Particulars from the Director-General of Stores, India Office, Whitehall, S.W. Tenders by Oct. 29.

Melbourne.—The Deputy Postmaster-General invites tenders for the supply of 50 wall sets for telephones. Particulars from the Commercial Intelligence Branch of the Board of Trade. Tenders by Dec. 10.

London.—The London General Omnibus Co., of 6, Finsbury-square, E.C., invite, among other things, tenders for electrical appliances and tools, and leather machine belting. Tenders by Nov. 18.

Dublin.—The Dublin United Tramways Co. invite tenders for stores, including electric supplies, for the year ending Dec. 31, 1908. Tenders to Chairman, 9, Upper Sackville-street, Dublin, by Nov. 11. See advertisement.

Dublin.—Tenders are invited for the supply and erection of one low-pressure switchboard of three-phase type. Tenders to the Chairman of the Cleansing Committee, 3, Cork-hill, Dublin, by Nov. 4. See advertisement.

Sydney.—The Postmaster-General invites tenders for 1,000 common-battery wall telephones and 100 portable telephones. Particulars from the Commonwealth Offices, 72, Victoria-street, Westminster. Tenders by Dec. 11.

Buenos Ayres.—Tenders are invited for the construction of underground electric tramways. Particulars from the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London. Tenders by June 1, 1908.

Tunbridge Wells.—Tenders are invited by the Corporation for the supply, delivery, and erection of the work in connection with the installation of a 500-kw. turbo-alternator, condenser, and pipework in sections. Tenders by Nov. 1.

Edinburgh.—Tenders are invited for an electric light installation at Towerbank School, Portobello, for the Edinburgh School Board. Tenders to Mr. G. W. Alexander, clerk, School Board Offices, Castle-terrace, Edinburgh, by Oct. 26.

London.—The London County Council invites tenders for the installation of electric lighting at the Lawn-lane School, Kennington, S.E. Tenders to the Clerk, County Hall, Spring-gardens, S.W., by Nov. 5. See advertisement in last issue.

Llandilo (Wales).—The Urban District Council invite tenders for supplying and laying about 200 yards of electric light cable and for supplying and fixing four lamps. Specifications from Mr. R. Shipley Lewis, clerk, Llandilo. Tenders by Nov. 2.

Pamplona (Spain).—The Madrid Public Works Department invite tenders for the construction and maintenance of an electric tramway in Pamplona. Particulars from the Dirección de Obras Públicas, Ministerio de Fomento. Tenders by Nov. 5.

London, W.—The Directors of the Great Western Railway Co. invite tenders for the supply of stores from Dec. 1 next to Nov. 30, 1908. Tenders for Group No. 1 by Oct. 22, and Group No. 2 by Nov. 12. See advertisement in issue of Oct. 4.

Willesden.—The Urban District Council invite tenders for the supply of carbons for the public arc lamps for 12 months. Particulars from Mr. J. G. Bruce, electrical engineer, Electricity Works, Salusbury-road, Kilburn, N.W. Tenders by Oct. 28.

Buenos Ayres.—Tenders are invited for (1) the construction of and (2) the concession to work the two principal sections of the underground electric railway. Particulars from the Argentine Legation, 12, Rue van Moer, Brussels. Tenders by May 1, 1908.

London.—Tenders are invited by the London County Council for the electric wiring of tramways sub-stations at Holloway, Hackney, and Clapton, and of a car-shed at Holloway. Tenders to the Clerk to the Council, County Hall, Spring-gardens, S.W., by Oct. 29.

Stepney.—The Electric Light Committee invite tenders for work in connection with the Council's projected new generating station at the riverside at Blyth's Wharf, Limehouse, and sub-station at Osborn-street, Whitechapel. Tenders by Nov. 11. See advertisement in last issue.

Adelaide.—The Deputy Postmaster-General for Queensland invites tenders for a common battery switchboard and 3,000 subscribers' telephones. Specification No. 166. Particulars may be obtained from the Commonwealth Offices, 72, Victoria-street, London, S.W. Tenders by Jan. 8, 1908.

Rangoon.—For pumping plant for Rangoon Municipality. Particulars, etc., of Messrs. Ogilvy, Gillanders, and Co., London agents to the Rangoon Municipality, Suncourt, 67, Cornhill, London, E.C., accompanied by a remittance of 10s., which will not be returned. Tenders to the Agents by Oct. 31.

Leyton (Essex).—The Urban District Council invite tenders for the supply of lathe and other machine tools. Specification, etc., £1. 1s., from Mr. F. Harman Lewis, electrical engineer to the Council, at the Electric Light and Power Works, Cathall-road, Leytonstone. Tenders by Oct. 29.

Leicester.—The Tramways Committee invite tenders for the supply of 450 suits and caps, to be delivered in April next, for inspectors, motormen, and conductors. Samples may be seen on application and tender forms obtained from the Tramways Manager, 20 and 22, Humberstone-gate, Leicester. Tenders by Nov. 9.

Victoria.—The Deputy Postmaster-General at Melbourne invites tenders for the supply and delivery at Melbourne of 11 sections of a common-battery switchboard and 3,000 subscribers' telephones and other apparatus for telephone exchange, Windsor, in accordance with Victorian specification No. 148. Tenders by Jan. 7.

Glasgow.—The Caledonian Railway Co. invite tenders for the supply of stores for 12 months from Jan. 1, 1908, including telegraph appliances, telephones, etc., electric lighting material and fittings, galvanised wire, asbestos and guttapercha goods, etc. Tenders to the Secretary, 302, Buchanan-street, Glasgow, by Nov. 4.

Adelaide (Australia).—Tenders will be received up to noon on Nov. 26, addressed to the Chairman, Municipal Tramways Trust, Adelaide, for the supply and delivery c.i.f. Port Adelaide of steel rails and fishplates for tramways. Specification, etc., from the Agent-General for South Australia, Threadneedle House, 28, Bishopsgate-street Within, London, E.C.

North Shields.—The Guardians of Tynemouth Union invite tenders for the provision and fixing of a fuel economiser, suitable for two Lancashire boilers each 30ft. by 8½ft., in connection with a chimney 120ft. high by 5ft. internal diameter, to be erected at the workhouse. Particulars from the Master, Preston-road, North Shields. Tenders to Mr. Septimus Scott, clerk, by Oct. 31.

Edinburgh.—Tenders are invited for (Contract No. 6) junctions and pits in connection with the tramways extensions. Specification, etc., from the consulting engineer, Sir Alexander B. W. Kennedy, 17, Victoria-street, Westminster, London S.W.; on payment of a deposit of £2. 2s., which will be refunded on receipt of a bona fide tender. Tenders to the Town Clerk, City Chambers, Edinburgh, by Nov. 8.

RESULTS OF TENDERS.

Witney.—The Electric Supply Co. have placed an order with Johnson and Phillips for the supply of a dynamo.

Newcastle.—The Lambton Collieries Co. have placed an order with Johnson and Phillips for stranded aluminium cables.

London.—The British Patent Perforated Paper Co. have placed an order for the supply and erection of a direct-current dynamo with Johnson and Phillips.

Lewisham.—The Guardians of the Lewisham Workhouse have placed the order for the supplying and laying of a new feeder cable with Johnson and Phillips.

Staines.—The Linoleum Manufacturing Co. have placed an order with Johnson and Phillips for complete telephone equipment, including overhead wiring, etc.

Glasgow.—The Clyde Navigation have placed an order with Johnson and Phillips for the supply and erection of power and lighting cables for their Renfrew workshops.

London, S.E.—The tender of Messrs. Leslie and Co., Kensington, at £3,820, for the erection of the Lewisham tramways sub-station, has been recommended to the London County Council for acceptance.

London, N.W.—The Willesden District Council have accepted the tender of the British Electric Transformer Co., Hayes, Middlesex, for supply of seven 50-kw. static transformers for the electricity department, at £71 each.

Bradford.—The Guardians have accepted the tender of the Bradford Electrical Engineering Co., 3, Royal-arcade, for the general maintenance of the electric wiring installation, telephones, bells, etc., at the union hospital, Horton-lane, Bradford.

Dundee.—The Electricity Committee have accepted the following tenders for plant for the new generating station at Carolina Port: Willans and Robinson, for two turbo-alternators, each of 2,000 kw., £18,676 (Dick, Kerr, and Co., Kilmarnock, sub-contractors for generating part of the plant); Babcock and Wilcox, Glasgow, boilers, £14,735; British Insulated and Helsby Cables, Prescot, Lancs., cables for stock, £2,000; Siemens Bros. and Co., low-pressure cables, £1,575. The Committee also recommend the acceptance of the offer of Smith, Hood, and Co. for 1,000 tons of Cowdenbeath "duff" coal for the electric station.

BUSINESS NOTES.

TRACTION.

Geneva Tramways Co. (1906).—Traffic receipts for the month of September, 1907, 298,011fr.; increase on 1906, 8,467fr.

Blackburn.—The Great Harwood and Rishton Urban Councils have consented to an extension of time for the construction of the proposed light railway for Blackburn, Whalley, and Padiham on certain conditions relating to the roadways, etc.

Llandudno.—The opening of the electric tramway service on Saturday last was a very popular event, and the cars were crowded with passengers throughout the day. The service will undoubtedly improve Llandudno as a place of winter residence.

Buenos Ayres and Belgrano Electric Tramways Co.—The traffic receipts for the week ended Oct. 21 amounted to £4,006, corresponding week last year £3,876—increase, £130. Aggregates from

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Jan. 1, 1907, £161,014; from Jan. 1, 1906, £152,027—increase, £8,987.

Holmfield and Southowram.—The Board of Trade have confirmed the following order made by the Light Railway Commissioners: Holmfield and Southowram Light Railway (Extension of Time) Order, 1907, amending the Holmfield and Southowram Light Railway Orders of 1902 and of 1905.

Wakefield.—When the Wakefield and District Light Railway Co. desired to abandon the branches from Wakefield to Ardsley and Alverthorpe they met with strong opposition from the Wakefield Corporation and other local bodies. Recently the Board of Trade held an inquiry with regard to the company's proposal, and they have granted an extension of time of two years to enable the company to complete the undertaking.

Hurst.—At the meeting of the Highways and Tramways Committee of the District Council, the clerk reported that the Ashton Corporation had paid the tramways account for the half-year ending Aug. 16 last, amounting to £212. 12s. 5d. The surveyor was directed to write to the Ashton tramways department calling their attention to the bad state of some portions of the tramway pavement, and requesting them to repair same.

Loose.—The tramline to Loose is an accomplished fact, and the cars are now running. The Board of Trade inspectors went over the route on Wednesday of last week, and having declared their satisfaction, the cars were started in the afternoon. The first to run was a decorated car. The season-ticket rates are as follows: High-street, Maidstone, to Loose, £2. 10s. a year, £1. 7s. 6d. a half-year, 17s. 6d. a quarter; High-street to Wheatsheaf, £1. 15s. a year, £1 a half-year.

Haslingden.—A decision has now been arrived at by the Haslingden Council regarding what course to pursue in the electrification of its tramways. The Corporation has decided to generate its own electricity, for which purpose a power station will be established and electrical machinery installed. An electrical engineer will also be appointed. The conversion of the system from steam to electricity will be commenced on April 1 of next year. It is expected that before long one will be able to ride from Accrington to Haslingden.

Newcastle.—The annual report of the Corporation tramways of Newcastle has been issued for the year ended March 31, 1907. The total lengths of tramways worked by the Corporation at March 31 were as follows: 53 miles in Newcastle, owned by the Corporation; and 2⅝ miles in Wallsend and 3½ miles in Gosforth, owned by the Tyneside Tramways and Tramroads Co.; the total length being 59⅛ miles of single track. The Corporation operate over 6⅛ miles of the Tyneside Co.'s lines, and the company operate over 8¼ miles of the city tramways.

Southend.—At the Council meeting the borough surveyor reported that some of the rails on the Southchurch-road section east of Lancaster-gardens required renewing, and he was directed to carry out the necessary work towards the end of October. The electrical engineer also reported the result of his examination of that portion of the track between Leigh-road Schools and the Plough, and informed the committee of the steps about to be taken to remove corrugation from the rail on the south side of the track at this point, and his action was approved.

Keighley.—The Corporation Tramways Committee propose that return tickets (available on day of issue only) be issued on the following sections of the Ingrow and Utley tramway route at a charge of 1d.—viz: between Ingrow terminus and King-street, King-street and Mechanics' Institute, Mechanics' Institute and East-avenue, East-avenue and Utley terminus; also that tickets be issued for a continuous journey over the whole of the tramway system, commencing at any stopping place and returning to the same point, at the following fares—viz.: adults, 3d.; children under 13 years of age, 1½d.

Pontypridd.—The gratifying increase in revenue from the Pontypridd tramways was maintained during the past month. The report of the engineer (Mr. Teasdel), which was presented to a meeting of the Electrical Committee, showed receipts from the Treforest and Cilfynydd route £777. 6s. 4½d., as compared with £676. 11s. 1d. for the corresponding period, equivalent to an increase of 25,000 passengers carried. The new Trehavod section brought in £335 revenue, the majority of the passengers being workmen who travel at reduced fares. A shelter for the workmen at Cilfynyddd was in course of erection.

Hastings.—At a recent meeting of the Council a question was asked as to what amount was paid annually by the tramways company in rates and wayleaves, and what rate in the £ did that sum represent, and what amount was paid by the tramways company in water rate and charges, to which the borough accountant replied: "The wayleaves payable by the tramways company for the current year amount to £1,069. 15s. 7½d.; rent of cable, £5; the general district and special rates for the current year amounted to £426. 10s. 5½d.; the poor rate, based upon last year's figures, is estimated at £460. 7s. 2d.—total, £1,961. 13s. 3d. This sum is equivalent to a rate of 1·16d. in the £. The amount paid by the company for water supplied during the year ended March 31 last was £533. 14s. 9d."

Bradford.—The report of the Tramways Committee of the Bradford Corporation for the half-year ended Sept. 30, 1907, shows that the total revenue for this period, including bank interest, is £129,326, as against £126,534 for the corresponding period last year. The total amount of the operating expenses is £82,967, leaving a gross profit of £44,976. From this has to be deducted for interest, sinking fund, and income tax, after making allowance for £1,383 for bank interest, a sum of £28,669. This gives a net profit of £16,307, as against £10,732 for the corresponding period of last year. This profit is a record one in the history of the tramways, and as an indication of the steady growth of the undertaking it may be said that, except for 1902, when the net surplus for the 12 months was £19,849, it is larger than has been recorded for any full year.

Huddersfield.—The borough treasurer's financial statement in connection with the tramways for the six months ended September last shows that the capital outlay to date was £112,902. The income had been £44,118, or 10·84d. per car mile (including £42 682 for passengers, £582 parcels, and £418 coal haulage), as compared with £42,360, or 11·03d. per car mile last year. The expenditure had amounted for traffic expenses, general repairs and maintenance, power expenses and general expenses to £20 676, or 5·08d. per car mile as compared with £20 853, or 5·43d. per car mile last year, leaving a gross surplus of £23,342, equal to 5·76d. per car mile run, as compared with £21,507, or 5·60d. per car mile, last year. After payment of rent of leased lines, interest on capital and redemption of debt, and allowing £6,194, being 3 per cent. for depreciation, a net surplus was left of £5,110, being a profit of 1·26d per car mile.

Dowlais.—The monthly general meeting of the Dowlais Chamber of Trade was held on Tuesday last in the Oddfellows' Hall. On behalf of the deputation that conferred with Mr. G. H. Dixon (managing engineer of the Merthyr Electric Traction Co.) respecting the proposed extension of the existing tramway service from the High-street terminus to Caeracca and Pant, the president and Mr. J. G. Rees both reported, and spoke of the friendly greeting they received. They set forth arguments, facts, and figures with a view of showing that whilst the suggestion, if carried into effect, would be of great convenience to those residing at and going to and from the populous and still increasing areas alluded to, the town would also benefit thereby very materially. Mr. Dixon appeared to be favourably impressed by their representations, and promised that after surveying the ground and getting all the necessary statistics and details to submit the proposal to his board of directors at their earliest meeting.

Walsall.—The following are the particulars respecting the working of the Corporation tramways during the past four weeks and the corresponding weeks in last year—viz.: Four weeks ending Sept. 29, 1906—number of passengers, 367,357; receipts £2,020. 10s. 7d.; car miles run, 46,921; receipts per car mile run, 10·33d. Four weeks ending Sept. 28, 1907—number of passengers, 405,858; receipts, £2,246. 18s. 3d.; car miles run, 48,342; receipts per car mile run, 11·16d. Wages paid (including repair of permanent way): four weeks ending Sept. 27, 1906, £605. 10s. 11d.; four weeks ending Sept. 26, 1907, £626. 3s. 10d. The town clerk has been instructed to apply to the Board of Trade to inspect the reconstructed lines on the Bloxwich section with a view to their being certified as fit for public traffic. The town clerk has been instructed to ascertain from the insurance companies their rate for insuring the Corporation tramway undertaking against third-party claims, having regard to the decreased risk owing to the conversion into double lines.

South Shields.—The story of a cruel hoax at the expense of 30 local tramway employés has been made known. Some time ago a driver working on the South Shields tramways system made an announcement to the effect that he had secured the position of chief inspector on a new tramway system in Warwick, and it is alleged that he persuaded a number of his fellow workmen to go to that place, promising them employment for higher wages. Fifteen of the men were or had been employed on the South Shields tramways, and a similar number belonged to other neighbouring systems. They received a hearty send-off at a social gathering at South Shields, the company including the alleged chief inspector. They took their departure from South Shields on Friday night last, and on reaching Warwick were astounded to learn that there was no new system of trams and no vacant berths, and that no Shields man had been appointed chief inspector. Some of the men, who were married, with families, were absolutely stranded, while others, who were better situated financially, were able to return to Shields. The so-called inspector's whereabouts are unknown.

Nottingham.—At the last Council meeting the chairman of the Tramways Committee was questioned as to why the trams that used to run between Colwick-road and Market-place *via* Station-street had been discontinued. The Chairman said the question was merely one of money. Originally there was a six minutes' service from the Market-place to Colwick-road and back. In response to a deputation the committee, with that anxiety to try and please everybody for which they were noted, diverted half of that service in the opposite direction and made a circular route. The experiment was continued for three months, and after a report had been made it was unanimously decided to revert to the original manner of running. The people of Sneinton did not make use of the route as they were expected to do. Personally he was very much disappointed with the result, as he hoped the circular route would have been kept on, but since they had reverted to the original method the receipts had very much increased. In conclusion, he said he might mention that on Saturday last the takings on the trams were the largest they had ever had, amounting to £1,126, the number of people carried being 246,000.

Ipswich.—A revision in the tramway fares has been decided upon, and the following notice has been posted in the cars: "On and after Thursday, 24th inst., double return tickets, price 2d., will be issued to all passengers who ask for them on cars running before 8 a.m. on weekdays. The double return ticket will enable the holder to ride an ordinary 1d. fare stage before 8 a.m., two separate 1d. fare stage journeys between the hours of 12.30 and 2.30 p.m. (going to and from dinner), and a 1d. fare stage journey at any time between five o'clock and the running of the last car. These tickets are available on the day of issue only, and on one car only for each journey. The tickets are divided into three sections; the first (the largest section) is to be given to the conductor in lieu of coin for the second journey, the second section for the third journey, the third section for the fourth journey, and in exchange the passenger will receive ordinary ½d. workmen's tickets. These tickets will not be issued on Christmas Day or Bank Holidays. On and after the same date workmen's tickets will only be issued on special Felixstowe-road workmen's dinner-hour cars

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to those holding return tickets. No ½d. tickets will be issued in these cars in exchange for coin."

Dundee.—In connection with the Downfield extension of tramways soon to be operative the Corporation Tramways Committee have resolved to inaugurate a 10 minutes' service from Commercial-street to Baldovan-road, Downfield, cars to run alternatively *via* Main-street and Moncur-crescent; the Constitution-road cars to run to the top of Moncur-crescent, making a frequent service along Strathmartine-road by running alternately with the half service to Downfield, which will traverse this route. A service to the top of Main-street *via* Victoria-road and Dens-road will make practically a 10 minutes' service to the top of Hilltown *via* the Eastern route. The fares for the new tramways have been fixed as follows: the fares between High-street and Fairmuir to remain as at present; the through fare between High-street and Baldovan-road, outside and inside, will be 2d.; from Baldovan-road to or from the top of Moncur-crescent, outside and inside, will be 1d.; Baldovan-road to and from Main-street, outside or inside, 1½d.; Fairmuir to or from Gelly Burn, outside or inside, ½d.; and Gelly Burn to or from Baldovan-road, outside or inside, ½d. Transfer tickets are to be issued and accepted on the Constitution-road cars to complete the journey to or from Fairmuir or beyond at the above rates.

Manchester.—Some time ago the Manchester and Salford Trades' Council appointed a committee to consider the question of extending the facilities for workmen on the tramway system. This committee reported to the meeting of the council held in the Caxton Hall on Thursday week that they had come to the conclusion that the reform urgently needed was an extension of the time in which workmen are allowed to travel at reduced rates. At present workmen's tickets are issued on the Manchester tramways up to seven o'clock in the morning. The committee suggested that this should be altered so as to allow of workmen travelling at the lower rate on any tram which reaches its destination before half-past eight. Candidates at the November elections will be urged to support this change in the City Council.—At the last meeting of the Corporation Tramways Committee the chairman pointed out that the returns showed the receipts from the tramways undertaking during the past seven months to be £32,000 in advance of those of the corresponding period of last year. It was decided that for the future all promotions from the ranks—of guards, drivers, timekeepers, inspectors, and road inspectors—should be made by the committee, and not as hitherto by the management.

Edinburgh.—At a meeting of the Tramway Committee of the Town Council there was considered the proposal as to the construction of a new tramway line by Ferry-road, round by Newhaven to Granton. The town clerk submitted a report which stated that the distance of the proposed line was 2·9370 miles. There were three ways of carrying out the proposal—namely: (1) the two Corporations contributing the cost of construction proportionately and being joint owners, while the tramway would be worked by Leith; (2) the tramway to be constructed wholly by the Leith Corporation at their own expense and worked by them on terms arranged, including option to Edinburgh to acquire joint ownership; (3) by arranging with an outside company to construct and work the line. Leith Corporation proposed that the cost should be borne equally in proportion to the length within the respective burghs. The working terms suggested were to charge the average rate of working expenses per car mile upon the Leith system as a whole—excluding any payment for sinking fund and interest, or any charge in respect of purchase price. There would be credited the average amount of revenue per car mile earned by the Leith system as a whole, any surplus to be paid over to the Corporations in the proportions of capital held by them. It is proposed to make the line single throughout, with passing places and double lines at the termini. The total cost would be £33,000, of which Edinburgh's share would be over £11,000. Assuming the amount was £12,000, the expenditure falling on the city would involve an annual charge for sinking fund and interest commencing at £820. With regard to the second alternative, it was stated that this would be practically the same as that under which the line in Pilrig-street along the boundary was constructed, and was now worked by the Corporation of Leith. The third alternative, if adopted, would be similar to those upon which consent was some time ago given to the proposed line from Queensferry. After discussion, the town clerk was instructed to write the Leith authorities and say that the committee were considering favourably the proposal, and that Edinburgh should find on terms the proportion of the capital expenditure. Before, however, they could come to a final decision they would require information on certain points of the financial aspect. The committee has also conferred with the tramway company, together with the exhibition executive, with respect to a proposed extension of the Gorgie line in order to cope with the approaching exhibition traffic. This exhibition will depend on the tramway company largely and the committee have decided to recommend the construction of the line at an estimated cost of £6,000.

LIGHTING AND GENERAL

Eton.—The Board of Guardians have decided to establish electric communication between the new infirmary and the workhouse.

Hackney.—The London County Council have sanctioned the borrowing of £17,815 for extensions to the electric light undertaking.

Monmouth.—A Local Government Board inquiry will be held on Nov. 5 into the Council's application for sanction to a loan for the electricity undertaking.

Victoria (British Columbia).—A petition is being circulated at Main Island asking that a cable be laid to the island and telephone communication established.

Worksop.—The Local Government Board have sanctioned the borrowing of £700 by the Urban District Council for extensions to the electricity undertaking.

Aldershot.—The Council are extending the mains along Church-lane with the purpose of replacing the existing gas lamps at the top of Edgar's-hill with electric arcs.

Elyria (U.S.A.).—Owing to the rapid increase in their business the Dean Electric Co. have found it necessary to double their plant, and with this end in view extensive additions are now under way.

Linthwaite.—The Council have appointed a committee to make inquiries as to a probable demand for electric light with a view to approaching the Huddersfield Corporation for the necessary supply.

Calcutta Electric Supply Corporation.—The number of units delivered to consumers during the four weeks ended Sept. 27, 1907, were 592,464, compared with 458,373 in the corresponding four weeks of 1906.

York.—The City Council have agreed to the construction of new tramway routes under a light railways order. A poll of the ratepayers is to decide whether the Corporation or a company shall construct and work the tramways.

Oban.—At a meeting of the Council Lighting Committee held on 9th inst., it was agreed that the pay of pupils in the electric light department be: for first year, nil; for second year, £10 per annum; and for third year, £20.

Release of Trustee.—According to the *London Gazette*, Mr. F. S. Salaman, 1, Oxford-court, Cannon-street, E.C., has been released from trusteeship in the estate of Messrs. Watson and Huntingdon, electricians, 83, Battersea-rise, and Dering-street, Bond-street, London.

Huddersfield.—At the last meeting of the Electricity Committee the engineer reported that the number of consumers on Sept. 30 was 2,569, an increase of 18 on the previous month, and that the lamps connected at the same date numbered 187,978, an increase of 1,463.

Lowestoft.—The Local Government Board have sanctioned the borrowing of £16,950 by the Corporation for the purchase of the following items: feeders, £6,250; services and distributors, £5,000; meters, £1,500; public lighting, £1,200; motors for hiring, £3,000.

Belfast.—A deputation has waited upon the Tramways Committee respecting the extension of tramways at Ligoniel. It was pointed out that the cost would be £6,600, and the committee stated their approval of the scheme and that the extension should be made as soon as possible.

Pontypridd.—At a meeting of the Pontypridd Electricity Committee, Mr. J. E. Teasdel, the manager, reported that during the preceding month the value of electricity generated amounted to £543. 10s. 5d., as compared with £429. 8s. 6d. in the corresponding month of last year.

Manitoba (Canada).—The City Council of Winnipeg are considering the question of applying to the Legislature at its next session for power to sell current for domestic lighting in Winnipeg and outside municipalities. The city has already applied for this power twice, and it has been refused on both occasions.

Liverpool.—At the meeting of the Tramways Committee it was reported that during the fortnight ended Oct. 12 the receipts amounted to £22,746. 11s. 8d., an increase of £66. 11s. 8d. on the corresponding period of last year; the passengers carried numbered 4,937,311, an increase of 32,637; and the mileage 446,793, an increase of 5,350 miles.

Brighton.—The Electricity Committee have resolved to seek power to supply electricity to outside districts, and have authorised the engineer to pay the fees, not exceeding £6 in the whole, of such of the junior members of the electricity works staff as desire to attend the engineering classes at the municipal technical college.

St. Marylebone.—The electrical engineer of the Borough Council has reported that if the bonus scheme sanctioned up to the end of December, 1906, were applied for the six months ending June, 1907, there would be a bonus earned of 87·5 per cent. of the average weekly wage of each man included in the scheme. The Electric Supply Committee have ordered that the bonus scheme be continued.

Melbourne (Australia).—Owing to the continuous increase in the demand for electricity within the metropolitan area, the Electric Supply Committee of the City Council has found it necessary to make provision for additional boiler power in time for next winter's demand. The Council has decided to invite tenders for the supply of two additional boilers at the station at an estimated cost of £3,030.

Brockie-Pell Arc Lamp, Limited.—The receivers appointed by the debenture holders and the liquidators are offering for sale by tender the goodwill of the business; the benefit of contracts and orders on hand; the plant, machinery, tools, fittings, furniture, and other similar effects of the value of over £6,700; the entire stock-in-trade of the company. For particulars see our advertisement columns.

Lahore.—The representatives in the Punjab of the Hydro-Electric Power Syndicate in London, which is to supply Lahore with electricity, have made a survey of the area of probable consumption in Lahore and in planning lines for the mains. The endeavour of the syndicate will be to supply light at such rate that should not be greater per candle-power produced than kerosene oil illumination.

Dartmouth.—At the last meeting of the Council a long explanatory letter regarding certain complaints made by the Council as to the electric lighting was received from the local manager of the Urban Electric Supply Co. It was decided that the company be paid their account in full on this occasion, but that an intimation be sent to them that in future care must be taken to prevent a recurrence of the cause of complaint.

Margam.—At the monthly meeting of Margam District Council a committee was appointed to open up negotiations with the Aberavon Corporation with a view to drafting a mutual agreement for carrying into operation electrical provisional orders in their possession, and with a view to drafting a scheme for lighting the district with elec-

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tricity, for working a tramway service, and supplying motive power from one generating station.

Clayton.—The Light Railway Commissioners have approved of a light railway from Clayton West to Darton. When the line is completed it is likely to be leased to the Lancashire and Yorkshire Railway Co. Five years have been fixed as the period for construction, and the line will be more than three miles long, to meet the cost of which capital is to be raised by the company amounting to £43,000.

Birmingham.—A Local Government Board inquiry has been held by Mr. M. K. North into an application by the Corporation to borrow £81,900 for the purpose of the electric supply undertaking. It was stated that the number of units sold in 1904 for lighting purposes was 4,367 164, whilst in 1907 the figures were 7,009,602. The number of consumers increased in those years by 139 in 1904, 172 in 1905, 227 in 1906, and 339 in 1907.

Detroit (U.S.A.).—The Northern Engineering Works, crane and hoist builders, of Detroit, Mich., are adding a new power station to their plant. The boiler and coal storage station will be built at once, and will be approximately 30ft. by 60ft. in size, one storey, fireproof construction throughout, with reinforced cement roof, iron doors, etc. It will be equipped with Wickes boiler, Murphy stoker, and Webster heater. Contracts have been let.

The New Magnetic Observatory.—The new magnetic observatory which is being erected for the Government at Eskdalemuir will be completed in a few weeks' time. Begun last year, in March, it is now receiving the finishing touches, the estimated cost of the undertaking being something like £20,000. The buildings are situated on part of the farm of Nether Cassock, 10 acres of which were acquired for the purpose from the Duke of Buccleuch.

Oldham.—At the usual meeting of the Corporation Electricity Committee the engineer's report showed that during the fortnight the number of lamps connected was: arc, 638; incandescent, 23,152; motors, 341; equivalent to 102,359 lamps of 8 c.p., showing an increase during the fortnight of: incandescent, 204; motors, 5; equivalent lamps of 8 c.p., 570; making a total of: arc, 638; incandescent, 23,356; motors, 346; equivalent to 102,929 lamps of 8 c.p.

Arbroath.—The scheme for the introduction of an electric supply into the burgh is soon to be an accomplished fact. Mr. George Balfour, of London, who recently obtained an electric lighting order, has indicated that he intends to begin the work of constructing his electric station about the end of December, and expects to be in a position to give a supply of light and power within six months. The introduction of the light is being looked forward to with interest by the residents.

Clitheroe.—A letter from the Board of Trade has been received by the Town Council with respect to the electric lighting order. The letter states that as nothing has been done with respect to the order, it devolves upon the Board to determine whether the order should be allowed to remain in force any longer. The Board are prepared to consider any representation which the undertakers wish to make in the matter. The Council have instructed the clerk to write asking for a 12 months' extension.

Mansfield.—At the last Town Council meeting the engineer reported 26,995 units passing through station meters during September, an increase of 153, and 46,602 traction units generated, an increase of 11,182. The committee decided that the price of electricity for radiators and electrical irons should be at the rate of 2½d. per unit. A resolution was received from the Highways Committee asking the committee to reduce the charge for the arc lamps for public lighting, and consideration was adjourned to the next meeting.

Derby.—Strong complaints have been made by the Town Council as to the delay in completing the extension of the electric tramways on the Ashbourne-road and the Uttoxeter-road, and at a specially convened meeting of the Council, at which the discussion lasted two hours, the Tramways Committee were requested to see that the contractor pushed on with the work with all possible speed. A resolution was also passed to the effect that the full amount of damages payable by Messrs. Blackwell under the contract should be enforced up to the day of completion.

Stoke-on-Trent.—At the last Lighting Committee the electrical engineer presented his monthly report, in which he stated that during the month of September 30,146 units had been supplied, an increase on the corresponding period of last year of 97 per cent.; and that the number of consumers now on the books was 315, representing a total of 25,498 8-c.p. lamps. The committee have adopted a scheme for laying mains in Fenton, and are recommending the Council to make application to the Local Government Board for sanction to the borrowing of £9,400 to meet the estimated cost.

Chorleywood.—The Parish Council have written the Watford Council with reference to the proposal of the Northwood Electric Light Co. to apply for a provisional order authorising the supply of electricity at Chorleywood among other places, stating that at a special meeting called for the purpose of considering the matter the following resolution was unanimously passed: "That as electric light would be a convenience to the inhabitants of Chorleywood, the Parish Council are of opinion that no opposition should be offered to the application of the company." The Watford Council decided not to oppose the application.

Chesterfield.—A Local Government Board inquiry at the municipal hall on the 17th inst. considered an application by the Chesterfield Town Council for a loan of £5 000 for the electrical undertaking. Mr. A. G. Drury was the inspector appointed by the Local Government Board. The Town Clerk, in making the application, said the population of the borough was between 30,000 and 31,000, and its assessable value was £99,605. There were no sanctioned loans outstanding. [The Electrical Engineer said the loan now asked would be apportioned as follows: £2,500 for mains, £1,500 for motors, and £500 each for meters and indicators. At the close of the inquiry Mr. Drury inspected the electricity works.

Merthyr.—At a meeting of the Town Council the borough engineer reported upon the lighting of the main road from Merthyr to Dowlais. On the advice of the engineer, the Works Committee decided to recommend the adoption of the system of overhead wires for the lighting of the road by electricity. This system was denounced as ugly and dangerous, but the engineer said that the system was in use in various towns, an advantage being that a large number of lamps could be switched on and off simultaneously. His report further showed that by placing the electricity company and the gas company into competition the former offered better lighting at less money than the gas company. It was decided to adopt electric lighting.

Stock Exchange.—The Stock Exchange Committee have appointed Nov. 6 a special settling day in Consolidated African Copper Trust's 50,000 preference shares of £1 each, 5s. paid, Nos. 1 to 50,000, and New Mysore Manganese Co.'s 100,000 shares of £1 each, fully paid, Nos. 1 to 100 000, and 50,000 shares of £1 each, fully paid, Nos. 100,001 to 150,000. The committee have also ordered Sumatra Para Rubber Plantation's 50,000 shares of £1 each, fully paid, Nos. 1 to 50,000, to be quoted in the official list. The committee have further been asked to allow South Metropolitan Electric Tramways and Lighting Co.'s 19,570 6 per cent. cumulative preference shares of £1 each, fully paid, Nos. 1 to 19,570, to be quoted in the official list.

Epsom.—In reply to the Board of Trade's circular asking for a return relating to the supply of electricity for the information of the House of Commons, the clerk gave to the Urban District Council at their last meeting the following particulars respecting the Council's undertaking: power and heating, 6 647 units delivered, 2¾d. price per unit; private lighting, 88,597 delivered, 5½d. and 4d.; public lighting, 94,524 delivered, 4·3d. price—total units delivered, 189,768; average price, 4·5d. The electrical engineer's quarterly statement showed that during the three months ending June the income from public lighting was £473, as compared with £380 in the corresponding period of last year, and from private lighting £534, as compared with £407.

Liquidations.—The *London Gazette* announces that the Northern Electric Supply Stores has been wound up voluntarily, and Mr. A. Dunbar appointed liquidator. A general meeting of the members of the Electrical Coal-Cutting Contract Corporation will be held at the York-buildings, Adelphi, Westminster, on Nov. 20, at 3 p.m., for the purpose of receiving the liquidator's account. Creditors of the Medical Electro-Thermic Generator Co. are required to send all particulars of their claims to Mr. H. W. Freshwater, 7 and 8, Railway-approach, London Bridge, S.E., the liquidator, by Nov. 11. Creditors of the I.T.E. Electric Co. are required to send all particulars of their claims to the liquidator, Mr. P. F. Huddleston, 72, Finsbury-pavement, London, E.C., by Nov. 30.

Ontario (Canada).—The City Council of Hamilton are at a standstill regarding the new pumps for the Beach pumping station. It is impossible to decide on the kind of pumps to purchase until the source of electric power has been decided upon. The inability to decide has been caused by the Hydro-Electric Commission not being in a position to give definite figures. The Ontario Railway and Municipal Board has approved of the application of the by-law of the town of Sudbury providing for the extension of the waterworks and electric lighting system. Debentures to the amount of 10,000dol. will be issued. The Council of Listowel will probably install a municipal electric lighting plant. The present electric lighting contract expires about the end of the present year, and a municipal plant is considered with favour.

Kirkcaldy.—At a meeting of the committee of the Town Council the question of telegraph facilities was under consideration. The town clerk had received a letter from the Postmaster-General stating that he was anxious to meet the views of the Town Council, but, as the telegraph business of the town generally had declined, he would not be justified in affording increased facilities at more than one other post office in the town. He considered that on the whole telegraph accommodation at the harbour office would probably be the most useful, but he was willing to extend the system either to that office or the Linkstown office, whichever the Corporation might prefer. The committee decided to recommend that telegraph facilities should be provided at the harbour sub-office in preference to the Links-street office.

Plymouth.—According to the return presented to the Electricity Committee the sale of current in August amounted to 166,232 units, producing an estimated revenue of £1,642. 3s. In the corresponding period of last year 131,880 units were sold, and the receipts totalled £1,385. 11s. During last month the Corporation trams consumed 104,047 units, for which, at the reduced price at which current is supplied for power purposes, they have to pay £758. 13s. 6d. The trams owned by the Corporation consequently took nearly two-thirds the output of current, and contributed little short of one-half the revenue of the electricity undertaking. Last year the month's consumption of current by the trams was 76,913 units, and the amount paid £560. 16s. 5d.

Dundee.—In one department of municipal trading Dundee Corporation has received something like a check. It was proposed that the electricity department should be furnished with powers to let out on hire and to sell motors, fittings, and the like. In furtherance of this policy it was under contemplation to apply for powers under a provisional order by the Board of Trade. At the last meeting of the Electricity Committee correspondence between the town clerk and the Secretary of the Board of Trade on the subject was submitted. It appeared that the Board of Trade have never granted powers of this nature under a provisional order, and that any movement of the kind must be carried out by order obtained in accordance with the customary parliamentary procedure. In view of this situation the committee has decided that no further action in the matter should be taken.

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Ebbw Vale.—Owing to the great demand for electric current purchased by the Council from the Ebbw Vale Steel, Iron, and Coal Co., representations have been made to the vendors for a supplementary supply. This has been refused on some technical grounds, and the company have asked the Board of Trade to intervene in inducing the Council to furnish particulars of their scheme for the disposal of the additional supply, together with plans and results up to date. The Board of Trade replied to the effect that the matter in dispute between the company and the Council did not appear to be one in which the Board of Trade had any authority to intervene. In face of this reply the Council considered they had scored a distinct success, and the clerk was instructed to write the company asking what their intentions were relative to carrying out the agreement. It was stated that the electric lighting scheme of the Council had been a complete success, apart from the refusal of the Ebbw Vale Co. to supply sufficient current to meet the demand.

Bradford.—The annual report of the Bradford Corporation electricity department, which has just been issued, shows that steady progress is being made. The number of consumers has grown from 2,206 to 2,259, an increase of 2·4 per cent. The output of units both for private lighting and for motive power is also increasing, the figures up to the end of December, 1906, being 2,621,149 and 2,660 348 respectively, whilst for the half-year ending June 30 last, 1,444,133 units for private lighting and 1,372,349 for motive power had been sold. The use of incandescent lamps is also extending, these at the end of June numbering 147,653. There were 24,801 arc lamps in use at the same date, whilst the number of motors connected with the main was 176,912, as against 91,575 in December, 1901. It is hoped during the current year to complete the dividing up of the tramways distribution system by the addition of another five feeders, and the work at the sub-stations at Odsal and Thornbury in connection with the extra high-tension scheme is being proceeded with.

Burslem.—Owing to the large increase in the demand for electrical energy at Burslem, it has been necessary to install a 350-kw. dynamo. This new set consists of a Howden three-crank enclosed high-speed engine coupled to a standard Dick-Kerr generator, fitted with all the latest improvements. As indicating the increase of business at these works, it is only necessary to mention a few of the latest additions to the electric light mains—viz., the new Wedgwood Art School, which is entirely lighted by electricity, and the Manchester and Liverpool District Bank. The lighting of the Tunstall markets has been so entirely unsatisfactory owing to the failure of the gas-engine driving the pressure pump, that it has been necessary to install an electric motor to do this work, and now the lighting is as satisfactory as gas lighting can be, though many people seem to be disgusted that up-to-date electric lighting was not adopted, as was done by the Burslem Town Council in the St. John's Market. Electric motors are being installed, amongst others, at the works of Messrs. Billington and Newton, Wm. Boulton, Limited, Doulton and Co., and Alfred Meakin, Limited.

Bridgend.—At the last Town Council meeting the Electric Light Committee reported that they had discussed the question of free wiring, and the consideration of the subject had been adjourned. The electrician reported that he had, as requested, fitted two Osram lamps, which he considered highly satisfactory. If these lamps should be adopted in place of the arc lamps, he estimated a saving of £50 per annum. The subject was referred to committee. The electrician reported that he had received an application to supply energy equivalent to 160 8-c.p. lamps at the new county court offices. He further reported that the Newcastle circuit was in darkness on Saturday evening. He located a fault on one of the pillars at West-road. On Sunday evening the lamps at Church-road failed to light, and he had located the fault in this case. Under the present system these faults were unavoidable, as many as 10 to 20 pillars being protected by one pair of fuses only. If this pair of fuses blew out, it meant putting the whole circuit in total darkness. If each pillar were protected by fuses, only one pillar would be affected. He strongly recommended that each pillar be fitted with fuses, and that quotations be obtained for fuses to suit the existing boxes. It was decided to obtain the fuses as recommended.

Barnsley.—At the Council meeting a discussion was raised on the subject of street-lighting, when the establishment of an electric arc lamp in Old Mill-lane was advocated in the place of four gas lamps, which were described as "four flickering lights that were a disgrace to the borough." Alderman Rideal said they could not expect to have the electric light in all parts of the borough, but he thought the time had arrived when the committee should be inclined to do what other boroughs had done, utilise the incandescent gas light in street lamps. By that means they would get far better lights in some of their streets that had not the electric light, and a few pounds spent in the incandescent light would be a very great boon to people living in streets that were not properly lighted now. Alderman Brady replied that Barnsley's experience of incandescent gas had not been of a very encouraging character. They were putting in the new tantalum electric light wherever they could, and it was answering extremely well, but they could not put new electric cables everywhere. Besides, their contract with the gas company referred to a minimum of 500 lamps, and they were getting very near to that number. Personally, he was opposed to the use of incandescent gas mantles. Barnsley had a very windy situation, and mantles often required to be replaced.

Luton.—The electrical engineer has reported to the Electric Light Committee that since Aug. 23 last 167 212 units had been generated, an equivalent of 480 8-c.p lamps and three motors of 33 h.p connected, making a total of 430 consumers with 23 796 lamps and 207 motors of 1,312 h.p.; that the units generated showed an increase of 78 per cent. over the number generated during the corresponding period of last year, and that at the present time applications were in for over 1,300 additional lamps and 20 h.p. in motors. The electrical engineer has reported to the same committee that the mechanical stoker which had been fixed on trial by Messrs. Edward Bennis and Co., of Bolton, was satisfactory, and greatly increased the evaporating capacity of the boilers, and upon his report it was unanimously resolved to recommend that the Council accept the tender of the firm in question to supply three mechanical stokers for the sum of £395, and instruct the town clerk to complete the necessary agreement in the matter and affix the common seal thereto. The cost for this work has been provided for in the general scheme of extension, and the loan in respect thereof already obtained. The Electric Light Committee have recommended that the main in the Dunstable-road be extended from Dallow-road to Waldeck-road at an estimated cost of £450 in order to cope with the increased load at present and in future anticipated in that neighbourhood. This has been decided upon by the Council.

Southend.—The Council have resolved to accede to an application from the National Telephone Co. to carry two telephone wires across Hamlet Court-road, pending the laying of their underground cables, subject to the height of such wires being approved by the borough surveyor, and to the Telephone Co. removing the same at the termination of three months. A letter has been received from the managing director of the Reno Electric Stairways and Conveyors, stating that, owing to the condition of the handrail and chain on the electric stairway on the cliffs, the company's engineer advised them not to work the machine, and the same was, therefore, shut down for the season on Sept. 29. The Council have ordered that lamps be placed as follows: one lamp at the corner of Fairfax-drive and Holyrood-drive, one at the corner of South-avenue and Lonsdale-road, one at the corner of Oban-road and Branksome-road. With reference to the provision of two 500-kw. steam generators at the generating station, a letter has been submitted from Messrs. Belliss and Morcom, the makers of the last 500-kw. set supplied, as to the terms upon which they were prepared to supply the necessary plant to the dynamo makers from whom the Corporation obtained the plant provided that their engines were specified. The electrical engineer has been directed to obtain and submit alternative tenders from certain firms for the provision of one or two 500 kw. sets, the first for delivery in June, and the remaining one at any time upon six months' notice from the electrical engineer for that purpose.

Liverpool.—At the last meeting of the Electricity Committee the chairman stated that the supply department continued its satisfactory progress. The equivalent number of incandescent 16-c.p. lamps connected to the supply mains had increased from 346,566 in 1906 to 382,828, and the number of consumers from 6,340 to 6,592. Electrical energy for lighting purposes showed an increase of about 8·5 per cent. over last year, and for power purposes about 9 per cent. The supply of electric motors on the hire-purchase system was aiding the adoption of electricity for manufacturing purposes, and during the past 12 months 19 motors, aggregating 62 h.p., had been supplied under this arrangement. The equipment of the third section of the Lister-drive high-tension generating station with three Curtis steam-turbines and alternators and auxiliary plant was nearing completion. High-tension mains from Lister-drive had been extended to the Highfield-street station, where transforming plant had been installed, enabling a portion of the steam plant previously in use to be dispensed with, and economy in working secured. Additional high-tension plant had also been installed in the Lodge-lane distributing station. The area of supply had been increased in many districts by the extension of the network of distributing mains to meet the increasing demands. Since the year 1901 a contribution of £87,412 to the rates of the city had been made out of the profits of the undertaking, after providing for all charges in connection with interest, sinking, reserve, and renewal funds, including £20,827 for last year.

Walsall.—The Electricity Committee has reported to the Council that the total number of consumers on Sept. 30 last was 522, as compared with 477 at the same date last year. During the past month the total units generated at the station was 158,683, as compared with 148,295 for the same period last year; the total output from the main generators was 154,275 units, as compared with 143,987; the total units registered on the meters was 114,406, as compared with 103,843 units for the same period last year. The machinery was run for 703 hours, as compared with 680 for the same period last year. The wages paid amounted to £132, as against £121 last year. The electrical engineer has reported that, owing to the recent increase of the plant and the number of the sub-stations, it is desirable to appoint a sub-station superintendent so as to enable the station superintendent to give sufficient attention to the valuable machinery at the station. The committee have been informed that it was the intention of their late electrical engineer, had he remained in Walsall, to have recommended that an addition should be made to the staff to cope with the additional work to be performed, and after careful consideration the committee have authorised the electrical engineer to appoint a sub-station superintendent at a salary of £2 per week, rising to £2. 10s. per week for approved service. An application has been received for the cable to be extended to premises in Tasker-street, but as the cost of doing so is estimated at £220, and as there is no probability of any other customers in the street taking a supply, the committee do not feel justified in incurring the outlay.

Watford.—At the last Council Electricity Committee meeting the electrical engineer reported that 12 consumers had been connected to the system during the past month, the net total number of consumers now being 554, a net increase of 90 during the past 12 months. The sub-committee recommended that Mr. Taylor, mains superintendent, be granted an increase in salary of £10 per annum this year, and a further increase of £10 a year hence, in lieu of the promised annual increase of £5. This was agreed. The engineer submitted the following comparative statement of costs of generating electricity for the half-years ending September, 1906 and 1907: Units generated—1906 365,624; 1907, 496,110; increased number of units generated in 1907

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130,486. Expenditure — 1906, generation, £2,118; distribution, £192; management, £368; interest and sinking fund, £1,574; 1907, generation, £2,237; distribution, 245; management, £305; interest and sinking fund, £1,922. Total costs—1906, £4,252; 1907, £4,709. Total costs per unit generated—1906, 2·79d.; 1907, 2·29d.; saving in 1907, 5d., or ½d. per unit generated. It should be borne in mind that (1) coal has risen in price from 12s. 9d. in 1906 to 14s. 7d. per ton in 1907; (2) that the figures for 1907 include a sum of £76 paid to permanent employés engaged in capital work and previously charged to capital account; (3) that the interest and sinking fund has increased by £348. The committee congratulated Mr. Weston on this satisfactory decrease in the cost of generating electricity, a result which they largely attribute to his constant and painstaking attention to the details of the electricity undertaking. The report has been adopted.

PROVISIONAL PATENTS, 1907.

Oct. 14.

19378A/06. Improvements in electrical signalling apparatus for use on and in connection with railway locomotive engines and the like. Alexander Charles Bounevialle, 149, Strand, London. (Date applied for under Rule 5 of the Patents Rules, 1905, March 28, 1907.) (Complete specification.)

22581. Improvements in electric battery sub-stations fed from alternating-current systems. Alfred Mills Taylor, Avondale, Ashfield-road, King's Heath.

22605. Improvements in systems of electric power transmission for driving ships' propellers and other apparatus. Siemens Bros. Dynamo Works, Limited, 139, Queen Victoria-street, London. (Siemens Schuckertwerke, G. m. b. H., Germany.) (Complete specification.)

22612. Improvements in or relating to electric switches. Oscar Kjellberg, 111, Hatton-garden, London. (Date applied for under Patents Act, 1901, Nov. 1, 1906, being date of application in Sweden.) (Complete specification.)

22619. Improvements in the manufacture of electric conductors. Sherard Osborn Cowper-Coles, 82, Victoria-street, Westminster.

22620. Improved process for the production of aluminium. Sherard Osborn Cowper-Coles, 82, Victoria-street, Westminster.

22621. Improvements in electro-galvanising. The Cowper-Coles Galvanising Syndicate, Limited, and Sherard Osborn Cowper-Coles, 82, Victoria-street, Westminster.

22624. Improved reversing key or switch for electrical circuits. Guy Oliver Harrison, 77, Colmore-row, Birmingham.

22638. Improvements in coils and telephones. Edward Wythe Smith, 19, Newburgh-road, Acton, Middlesex. (Complete specification.)

22648. Apparatus for electrically firing mines. Konrad Schaffler and David Weiss, Birkbeck Bank-chambers, Southampton-buildings, London.

Oct. 15.

22676. Improvements in or connected with boxes for electrical switches and the like. Ivor Victor Zelander and Thurston Woods, 139, Dale-street, Liverpool.

22719. Improved method of and apparatus for controlling electrical circuits. Alfred Julius Boult, 111, Hatton-garden, London. (Joseph Lester Woodbridge, United States.) (Complete specification.)

22728. Improvements in balancing the lines of electric circuits, particularly those employed in duplex systems of telegraphy. Philip Middleton Justice, 55, Chancery-lane, London. (The Rowland Telegraphic Company, United States.) (Complete specification.)

22729. Improved construction of apparatus for applying electrical heat to the human body or places. Anthony Bernard Tubini, 173, Fleet-street, London.

22736. Improvements in air brake systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

22737. Improvements in the transmission of electrical energy. William Frederick Gradolph and William Carl Halme, 1, Broad-street-buildings, Liverpool-street, London. (Complete specification.)

22745. Improvements in telephone exchanges. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, London. (Siemens und Halske Akt.-Ges., Germany.) (Complete specification.)

22746. Improved manufacture of incandescence filaments for electric incandescence lamps and apparatus therefor. Siemens und Halske Akt.-Ges., Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Oct. 16, 1906, being date of application in Germany.) (Complete specification.)

22747. Improved manufacture of incandescence filaments for electric light from difficultly fusible metals. Siemens und Halske Akt.-Ges., Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Oct. 26, 1906, being date of application in Germany.) (Complete specification.)

22756. Improvements in apparatus for the electric lighting of railway carriages. Edwin Mumford Preston and Alfred Ernest Kennard, 77, Chancery-lane, London.

22761. Improvements in electrical circuit-closing devices. George Lee Anders and Arthur Thomas Milnor Thompson, Norfolk House, Norfolk-street, London. (Complete specification.)

Oct. 16.

22803. Improvements in or relating to electrical contact breakers, particularly for use with internal-combustion engines. Peter August Poppe, 18, Hertford-street, Coventry.

22831. Improvements in or relating to vapour electric apparatus. Charles Orme Bastian, Birkbeck Bank-chambers, Southampton-buildings, London.

22832. Improvements relating to armatures for dynamo-electric machines Benjamin Garver Lamme, Westinghouse Building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Nov. 3, 1906, being date of application in United States.) (Complete specification.)

22833. Improvements relating to armature windings for dynamo-electric machines. Frank Conrad, Westinghouse Building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Nov. 3, 1906, being date of application in United States.) (Complete specification.)

22850. Improvements in electrical indicating thermometers. Nalder Bros. and Thompson, Limited, and Francis Henry Nalder, 1, Birkbeck Bank chambers, Southampton-buildings, London.

22868. Improvements in electric motor control systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

22869. Improvements in electric resistance material. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

22870. Improvements in and relating to starting devices for electric motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Allgemeine Elektricitäts-Ges., Germany.)

22871. Improvements in and relating to track, switch, and signalling systems, and apparatus therefor. Allgemeine Elektricitats-Ges., 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Oct. 17, 1906, being date of application in Germany.) (Complete specification.)

Oct. 17.

22929. Improved terminal holders for wires or rods. John Thomas, 321, High Holborn, London.

22939. Improvements in switch mechanism and safety devices for use in surface-contact systems of electric traction. Allen West, 118, Queen Victoria street, London.

Oct. 18.

23004. Improvements relating to generating and distributing electric current for lighting and other purposes. Joseph Jackson and Thomas Jackson, 15, Hill-street, Park-road, Regent's Park, London.

23037. Improvements relating to alternating electric current motors. Frank Conrad, Westinghouse Building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Nov. 3, 1906, being date of application in United States.) (Complete specification.)

23043. Improvements in and relating to arc lamps. Dagobert Timar and Carl von Dreger, 7, Southampton-buildings, London. (Complete specification.)

23064. Improvements in devices for controlling the operation of electric switches. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

23065. Improvements in incandescent electric lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

Oct. 19.

23066. Electrically-heated oven. Ernest Brown, 25, Charlotte-street, King's Cross, London.

23090. Electric device for calling the attention of drivers on locomotive engines on railways to the fact that they are passing or approaching a danger or safety signal, or, in other words, a fog signal alarm. Ramsey George Kendal and Ramsey Kendal, 19, Gladstone-street, Darlington.

23098. Improvements in the manufacture of electric incandescent lamps. Schott and Gen, Jena, Germany. (Date applied for under Patents Act, 1901, Nov. 5, 1906, being date of application in Germany.) (Complete specification.)

23138. Improvements in or relating to fuse-controlled electrical apparatus. Arthur Francis Berry, 46, Lincoln's-inn-fields, London. (Complete specification.)

23142. Improvements in and relating to dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Allgemeine Elektricitäts-Ges., Germany.)

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23143. Improvements in single-phase dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

23144. Method for transforming electric energy of any desired kind into direct currents of any desired tension. Albert Lotz, 4, South-street, Finsbury, London. (Date applied for under Patents Act, 1901, Oct. 20, 1905, being date of application in Germany.) (Complete specification.)

23145. Improvements in apparatus for purifying electrolytes. Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London. (Complete specification.)

23148. Improvements in electric arc lamps. Johnson and Phillips, Limited, and Charles Franklin Tubbs, Birkbeck Bank-chambers, Southampton-buildings, London. (Complete specification.)

23150. An improved bracket for holding the non-conducting buttons used for laying electric conduits. Joseph König, 53, Grabenstrasse, Essen/Ruhr, Germany. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Nov. 7.)

1906.

22547. Electric batteries. Joel.

22911. Method and means for sealing electric conductors in or through glass or like vitreous material. Bastian and Calvert.

22911A. Method and means for sealing electric conductors in or through glass or like vitreous material. Bastian and Calvert. (Date applied for under Rule 5, Patents Rules, 1905, Oct. 16, 1906.)

23094. Application of the surface-contact system of electric traction. Brown.

23251. Submarine cable telegraphy. Brown.

23256. Construction and application of direct-current electric motors. Felten und Guilleaume-Lahmeyerwerke Akt.-Ges. (Date applied for under International Convention, Oct. 19, 1905.)

23385. Telegraphy. Kitsee.

23467. Electrical and clockwork advertising novelties. Pye.

23519. Telephone circuits. Jacobs.

23854. Instrument for measuring and gauging arc lamps, carbons, and the like. Richter and Häser.

23882. Regulation of the period of inductance of high-frequency circuits. Ferrié.

24390. Ears or supports for suspending electric trolley wires. Dixon and Dodwell.

26933A. Vibratory controlling devices for induction coils and the like. Justice. (Oraswell Igniter Company.) Date applied for under Rule 5, Patents Rules, 1905, Nov. 27, 1906.)

28192. Construction of core grid for direct and alternating electric current machines. Deacon.

29284. Railway and like signalling systems, and apparatus therefor. British Thomson-Houston Company. (Kintner.)

29296. Method of and means for automatically recording telephone calls. Ireland and Thomson.

1907.

383. Electrically-controlled point or switch operating mechanism for railways. Stoffels.

4046. Electrical switching and controlling installations. Felten und Guilleaume-Lahmeyerwerke Akt.-Ges. (Date applied for under International Convention, Feb. 17, 1906.)

5957. Method of reducing depreciation in lead storage batteries. Rodman. (Date applied for under International Convention, March 24, 1906.)

7245. Arc lamps. Knapton and Bagnall.

7249. Electrical battery dry cells. Knowles. (Lincoln Electric Company.)

7358. Means for electrically lighting and extinguishing gas burners. Fischer.

10827. Systems for working electric motors for the driving of machinery, and for analogous purposes. Siemens Bros. Dynamo Works. (Siemens-Schuckertwerke-Ges.)

11716. Manufacture of a plastic mass from tungsten compounds. Siemens und Halske Akt.-Ges. (Date applied for under International Convention, May 19, 1906.)

12389. Wireless telegraphy or transmission. Yarnell.

13265. Controlling alternating-current motors and controllers therefor. Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, June 8, 1906.)

16974. Direct-current electric motors. Soc. Anon. Westinghouse and Brun. (Date applied for under International Convention, July 26, 1906.)

17698. Commutators and brush carriers of electric machines. Krieger and Compagnie Parisienne des Voitures Electriques. (Procédés Krieger.) (Date applied for under International Convention, Jan. 29, 1907.)

18900. Electric furnaces. Pauling.

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £	Last price. £
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-⅝
—— Ord., 1,125 000	1 ..	¼-½
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 ..	5/32-9/32
British Aluminium Co., Ordinary, 2 001-40 000	5 ..	4-5
—— 7 per cent. Cum. Pref., 1-40 000	5 ..	4⅞-5⅛
—— "A" 6 per cent. Cum. Pref., 1-20 000	5 ..	4½-5
—— 4 per cent. Funding Certificates, 1-20 000	5 ..	3¾-4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	100 103
—— 5½ per cent Loch Leven Deb. (Reg.) Red., 1-3 000	100 ..	96 99
British Insulated and Helsby Cables, Ord., 1-100,000	5 ..	6½-7
—— 6 per cent. Cum. Pref., 1-100 000	5 ..	5⅞-6¼
—— 4½ per cent. Mortgage Debentures	100 ..	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	85-89
British Westinghouse Elec. and Manuf. 6 per cent Pref., 275,001-375 000	3 ..	1-1½
—— 4 per cent. Mortgage Debenture Stock	100 ..	62-67
Brush Electrical Engineering, Ordinary, Nos. 1-105 751	2 ..	⅛-¼
—— Non. Cum., 6 per cent., Pref.	2 ..	⅛-1⅛
—— 4½ per cent 1st Debenture Stock	100 ..	85-86
—— 4½ per cent. 2nd Debenture Stock	100 ..	67-70
Callender's Cable, Debentures	100 ..	105-107½
—— Ordinary	5 ..	9⅜-10⅜
—— 5 per cent. Pref.	5 ..	5⅛-5⅜
Consolidated Electrical Co., Ordinary, 1-110,000	1 ..	7/16-9/16
Crompton and Co.	3 ..	1⅞-2
—— 5 per cent Debentures	100 ..	96-99
Dick, Kerr and Co., Ordinary, 1 260 000	1 ..	1¼-1½
—— 6 per cent. Cum. Pref., 1-305,000	1 ..	1-1¼
—— 4½ per cent. Debenture Stock, Red.	100 ..	101-104
Edison and Swan United, "A" Shares, 1-79 261	3 ..	1 1/16-1 5/16
—— "A" Shares, 01-017,139	5 ..	2¼-2⅜
—— 5 per cent. Debentures	100 ..	87-90
—— 4 per cent. Deb. Stock, Red.	100 ..	83-85
Electric Construction, Nos. 1 to 112 100	2 ..	⅛-¼
—— 7 per cent. Cumulative Pref.	2 ..	⅛-¼
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	77-81
Electrolytic Alkali Co., Ordinary, 1-202,218	1 ..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock. Red	100 ..	—
General Electric Company (1900) 5 per cent. Cum. Pref.	10 ..	8-8½
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	90-95
W. T. Henley's Telegraph Works, Ordinary	5 ..	10½-11½
—— 4½ per cent. Preference	5 ..	5-5½
—— 4½ per cent. Debentures	100 ..	105½-107½
India Rubber, Gutta Percha, and Telegraph Works	10 ..	13½-14½
—— 4 per cent. Debentures	100 ..	96-98
National Electric Construction Co., 1-170,000	1 ..	13/16-15/16
Parker, Thos., Limited, Ordinary	10 ..	10-10½
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-30,000	5 ..	—
Telegraph Construction and Maintenance	12 ..	30-32
—— 5 per cent Bonds	100 ..	99½-102½
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10 ..	8¾-9¼

Electric Lighting and Supply.—

Name.	Amount paid. £	Last price. £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5 ..	4½-5
Bournemouth and Poole, Ordinary	10 ..	9⅞-10⅛
—— 4½ per cent. Cum. Pref., 7 501-15 000	10 ..	9⅞-10¼
—— 6 per cent. Cum. second Pref., 15 001-22,500	10 ..	9⅞-10¼
—— 4½ per cent. Debenture Stock, Red.	100 ..	98-102
Bromley (Kent) Electric Light and Power Co.	5 ..	4⅞-5⅛
—— 4½ per cent. 1st Debenture Stock, Red.	100 ..	98-100
Brompton and Kensington, Ordinary	5 ..	7½-8
—— 7 per cent. Preference	5 ..	7¼-½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5 ..	6½-7⅛
—— Nos. 80,000-100 000	4 ..	6¼-7¼
Cambridge Electric Supply Company £10 Ord.	8 ..	12½-13½
Canadian General Electric Co., Common Shares	$100 ..	105-109
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100 ..	98-101
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5 ..	3⅝-4⅛
—— 4½ per cent. Cum Pref., 1-80,000	5 ..	3½-4
—— 4 per cent. Debenture Stock, Red.	100 ..	95-99
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5 ..	3⅜-3¾
—— ditto (1903) 40,001-80 000	5 ..	3¼-4¼
Chelsea Electricity Supply	5 ..	3¼-4¼
—— 4½ per cent Debentures	100 ..	102-105
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000 ..	97-100
City of London, Ordinary	10 ..	8¾-9¾
—— 6 per cent. Cumulative Pref.	10 ..	1 ¼-1½
—— 5 per cent. Debenture Stock	100 ..	122-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	97-100
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1 630	£0 ..	50-53
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100 ..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5 ..	3¼-4¼
—— 5 per cent Preference, 1-50,000	5 ..	4⅜-4⅞ xd
County of London Elec. Supply, Ordinary	10 ..	6¾-7⅜
—— 6 per cent. Cum Pref.	10 ..	10-11
—— 4½ per cent. Debentures Prov. Certs. All pd., Red.	100 ..	107-110
—— 4½ per cent. 2nd Debentures Prov Certs	100 ..	96-99
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5 ..	½-1
—— 6 per cent. Cum Pref.	5 ..	1-1½
—— 4½ per cent First Mort. Deb	100 ..	76-81
Electrical Development Co. of Ontario 5 per cent. 1st Mort. 20-year Gold Bonds, 10 751-15 750	— ..	76-79 p.c.
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5 ..	2¼-2¾
—— 5 per cent Debenture Stock, Red	100 ..	85½-89
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red	100 ..	94-96
Folkestone Electric Supply, Ord., Nos 1-10 000	5 ..	4⅜-4¾
—— 4½ per cent. First Deb Stock, Red.	100 ..	96-99
Hove Electric Lighting, Ord., 1-13 000	5 ..	6½-7
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red	100 ..	101-104
Isle of Wight Elec. Lt. and Pr., 4½ p.c. Db. Stk., Red	100 ..	94-97
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150 000	1 ..	—
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000	5 ..	8½-9¼
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100 ..	97-101 xd
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10½
London Electric, Ordinary	3 ..	1¼-1⅜
—— 6 per cent. Pref.	5 ..	⅛-⅜
—— 4 per cent 1st Mortgage Debenture Stock, Red.	100 ..	89-93

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Name.	Amount paid. £	Last price. £
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100	92-95 xd
Metropolitan Ordinary, 100,001-150,000	5	5½-5⅝
—— 4½ per cent. First Mortgage Debenture Stock	100	103-107
—— 4½ per cent. Cum. Pref.	5	4⅞-5⅛
—— 3½ per cent. Mortgage Debenture, Red.	100	£7-9⅛
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds. 1935, C 1-1,000 ($100), D 1-3,000 ($500), M 1-4,400 ($1,000)	—	72-74 p.c.
Mexican Light and Power Co., Capital Stock	$100	41-43
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14,000 ($1,000)	—	82-84
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	95-98
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009	5	6¼-6⅜
—— do., 57,010-75,000	5	6¼-6⅜
—— do., 75,001-87,500 (issued at £2 prem., 10s. paid)	5	6¼-6⅜
—— 5 per cent., Pref., 1-57,009	5	5-5¼
—— do., 75,001-87,500 (issued at 10s. prem., 4s paid)	5	5-5¼
Notting Hill Electric Lighting	10	11-12
—— 4 per cent. First Mort. Debs. Nos. 1 500 (Reg.)	100	96-97
Oxford Electric, Ordinary, 1-96 and 40 14,310	5	5¼ 6
—— 4 per cent. Debenture Stock	100	96-97
River Plate Electricity Co., Ord., 1-119 687 & 120,501-120 507	1	⅜-½
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	⅝-1
—— 5 per cent. Debenture Stock, Red	100	95-98
Rosario Electric Co., 6 per cent Cum Pref., 1-20 000	5	4⅞ 5⅛
—— 6 per cent. Cum 2nd Pref., 1-15,000	5	4⅞ 5⅛
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	96 98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	—	99-101 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5	½-1⅛
—— 4 per cent. Debenture Stock	100	71-75
South London Ordinary	5	1⅞-2⅛
South Metropolitan Electric Light and Power, Ord.	1	½-¾
—— 7 per cent Cum Pref.	1	15/16-1 1/16
—— 4½ per cent. 1st Mort Deb.	100	99 102
St. James's and Pall Mall, Ordinary, 101-20,000	5	7½ 8½
—— 7 per cent. Pref.	5	6-7
—— 3½ per cent. Deb.	100	86-91
Urban Electric Supply Co., Ordinary, 8-30 007	5	1⅜ 2⅛
—— 5 per cent. Cumulative Preference, 50 001 80,000	5	1⅝-2⅝
Westminster, Ordinary	5	8¼-9¼
—— 4½ per cent. Cum. Pref., 110,101-135,251	5	4⅜-5¼

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine, 5½ per cent. Cum. Pref., 1-260,007	5	5 15/16-6 3/16
—— Ord.	5	7⅜-8
—— Permanent 6 per cent. Debenture Stock, 1888	100	131-134
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	102-105
Barcelona Tramways, Ord., 1-20,000	10	—
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	—
—— 5 per cent Deb., Red., 1-600	100	—
—— 4½ per cent. Red. Deb. Stock	100	—
Bath Elec. Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1	11/16 13/16
—— 5 per cent. Cum. Pref. Shares, 1-59 394	1	½-1
Birmingham and Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100	94-97
Blackpool and Fleetwood Tramroad	10	13⅜-17⅝
Bombay Elec. Supply and Trams. Co., 6 per cent. Cum. Pref.	8	7½-8
—— 4½ per cent. Deb. Stock, Red.	100	94-96
Brisbane Tramway Invest., Ord., 1-75 000	5	⅞-1
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4⅞ 5⅛
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	96-100
British Columbia Electric Railway Co., Ord Def.	100	130-135
—— Ord. Pref.	100	112-116
—— 5 per cent. Cum. Perpetual Pref. Stock	100	104 107
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	£8-101 xd
—— 4½ per cent. Vancouver Power Deb.	100	102-104
British Electric Traction, Ord. 1-300,000 & 60,001-90 000	10	1⅜-2⅛
—— 6 per cent. Cm Pf., 30,0001-60 000	10	5⅛ 6
—— 5 per cent. Perpetual Debenture Stock	100	96-99
—— 4½ per cent 2nd Deb. Stock	100	78-81
Bueno Ayres and Belgrano Trams	5	4 7/16 4 11/16
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	4⅛-5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4⅜ 5⅛
—— 5 per cent. Deb. Stock, Red.	100	105 115
—— Prov. Cert., all paid	100	104-105
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100	92-97
Buenos Ayres Gd Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100	99-103
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	98-103
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	91-94
Calcutta Tramways, 1-105,000	5	7-7½ xd
—— 105,001-137,610	5	5 5½
—— 4½ per cent. 1st Deb. Stock, Red.	100	100 104
Cape Electric Tramways, Nos. 1-480,000	1	½-⅝
City of Birmingham Tramways, 5 per cent. Cum Pref.	5	4¼-4⅜
—— 4 per cent 1st Mortgage Deb., 1-3 000 (1917)	100	95-99 xd
City of Buenos Ayres Trams. Co. (1 04), 1-248,000	5	5⅛-5⅜
—— 4 per cent. Deb. Stock, Red 1885	100	98-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	94-98
Cork Electric Tramway and Lighting Co., Ordinary	10	13-14
—— 6 per cent. Cum. Pref.	10	12½-13½
—— 4 per cent. Debentures	100	£0-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	13-14
—— 6 per cent. Pref., Nos. within 1-60 000	10	12¾-13⅛
—— 3½ per cent. Mort. Debs., 1-3,000 Red	100	90-95
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100	97-100
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1,000	82 87
Imperial Tramways, Ordinary	all	18-19
—— 6 per cent. Cum. Pref.	all	14-14½
—— 4½ per cent. Deb. Stock	100	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 20 001-60,000	5	⅞-1⅛
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100	60-71
Kalgoorlie Electric Tramways, 1-250,000	1	3/32-5/32
—— 5 per cent. "A" Deb. Stock	100	89-93
—— 6 per cent. "B" Deb. Stock	100	74-78
Kidderminster and District Lighting and Traction, Pref.	5	10- 0½
Lancashire United Tramways, Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	94-97
—— £296 500 2nd Mort. Deb. Stock	—	—
—— £83,730 Deferred Deb. Stock (all fully paid)	—	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1	1-1¼
—— 6 per cent. Cum. Pref., Nos. 1-425,553	1	1-1¼
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100	92-97
London United Trys. (1901), 5 per cent. Cum. Pref.	10	7½-8¼
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100	82-86
Madras Elec. Trams. (1904) 5 per cent. Deb. Stk., Red.	100	96-99

Name.	Amount paid. £	Last price. £
Manila Elec. R.R. and Lightg. Corp., 5 p.c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-1,635	$1,000	90-92
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 23,436 25 000	—	4¼-5
—— 4½ per cent 1st Mort. Deb Stock, Red.	100	96-99
Metropolitan Elec Trams., Defd., 1 000,001-1 314 016	1	1/16 3/16
—— 5 per cent. Cum Pref., 500,001-1,000 000	1	27/32-31/32
—— 4½ per cent. Deb. Stock, Red.	100	94-97
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	—	80½-82½ p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con. Mort Bonds, 1926 1-5,500 and 7,001-8,000	$1,000	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., £01-2,000 1922	100	101-103
New General Traction, 6 per cent. Cum Pref., 1-10 000 and 24 001-74 000	5	¾-1⅛
Oldham, Ashton, and Hyde Tramway, Ordinary	10	2
—— 5 per cent. Cum. Pref.	10	8¾-9
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk.	100	101-105
Potteries Electric Traction, Ordinary 1-245.000	1	5/16-9/16
—— 5 per cent Cum Pref., 300,001-545 000	1	½-⅝
—— 4½ per cent Debenture Stock	100	95 98
Provincial Tramways Co., Ordinary 1-24 912	10	4¾-5¼
—— 6 per cent. Cum. Pref., 1-10 000	10	10¼-11¼
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-20,000	5	5⅛-5⅝
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100	97-99
Sao Paulo Tramway, Light, and Power Co.	$100	103-107
—— 5 per cent. 1st Mort Deb., Red. 1929, 1-11,000	$500	93-95 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent. Cum. Pref., 18,571-169,570, Prov. Certs.	1	½-1
—— 4 per cent. Deb St ck, Red. 1940	100	83-84
Sunderland District Electric Tramways, 5 p.c 1st Mort. Debs., Red., 1-1 600	100	84-88
Yorkshire (West Riding) Elec Tram. Co., Ord., 70,001-110,000	5	1-1½
—— 6 per cent. Cum. Pref., 1-46,261	5	3¼ 3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	£7-90

Electric Railways.—

Name.	Amount paid £	Last price. £
Central London, Ordinary	100	60-62
—— 4 per cent. Pref.	100	87-89
—— " " deferred	100	42-45
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	102-105
City and South London, Consolidated Ordinary	100	45-47
—— 4 per cent Debenture Stock	100	102-105
—— 5 per cent. Pref. Stock '91	100	116-119
—— " " " '96	100	113-116
—— " " " '01	100	113 116
—— " " " '05	100	108-111
Liverpool Overhead, 5 per cent. Pref	10	10-10½
—— Ordinary, 1-50 000	10	3⅜-4⅛
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	46-51

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price. £
Amazon Telegraph Co., 1-25,000	10	3-3½
—— 5 per cent. Debs., Red., within 1-1,059	100	85-88
American Telephone and Telegraph Co. 1st Trust 4 per cent. Bonds, 1-28 000 and 53,001-78 000	$1 000	89-91
Anglo-American Telegraph Co., Ordinary	100	52-55 xd
—— 6 per cent. Preferred Ordinary	100	91-94 xd
—— Deferred Ordinary	100	13½-14
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100	99-102
Chili Telephone Co., 1-44,000	5	6¾ 7¼
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100	90-94
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	6 7
—— 10 per cent Preference, 1-6,000	10	15¾-16¼
Direct Spanish Telegraph Co., Ordinary	5	3¼-3½
—— 10 per cent. Cum. Preference	5	9-9½
—— 4½ per cent. Debs., 1-600	50	£8-101
Direct United States Cable Co.	20	12-13 xd
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100	100-102
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100	97½ 100½
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8 000, 1913	25	100-102
Eastern Extension, Australasia and China, 1-300,000	10	11-11¼ xd
—— 4 per cent. Mort. Deb. Stock, Perp.	100	99-102 xd
Eastern Telegraph Co., Ordinary Stock	100	121-125 xd
—— 3½ per cent. Preference Stock	100	83¼-86¼ xd
—— 4 per cent. Mortgage Debenture Stock	100	101-103
Great Northern Telegraph Co. (of Copenhagen)	10	34-36
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1,200, Red.	100	100-102
Indo-European Telegraph Co.	25	54-56
Marconi's Wireless Telegraph Co., 1-256,127	1	¾-1⅛
—— 255,128-784,190	1	½-1
Monte Video Telephone Co., Ordinary, 1-72,680	1	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492	—	½-1
National Telephone, Preferred	100	106-108
—— Deferred Stock	100	105-108
—— 6 per cent. Cum. First Pref.	10	10½-12½
—— 6 per cent Cum. Second Pref.	10	10-12
—— 5 per cent. Non Cum. Third Pref.	5	5¼-5⅝
—— 3½ per cent. Deb. Stock, Red.	100	9 -98
—— 4 per cent. Deb. Stock, Red.	100	98½-101½
Oriental Telephone and Electric Company	1	1 7/32-1 11/32
—— 6 per cent. Cum. Pref.	1	1 3/16-1 5/16
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100	97-100
United River Plate Tele. Co., Ordinary, 1-100,000	5	7-8 xd
—— 5 per cent. Cum. Pref., 1-40,000	5	5-5½
—— 5 per cent. Debenture Stock, Red.	100	—
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	99-102
West African Telegraph Co.	10	10-10½
West Coast of America, 1-30 000 and 53 001-53,008	2½	1¼-1⅜
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100	97 100
West India and Panama Telegraph Co., Ordinary	10	7/16-9/16
—— 6 per cent. Cum. 1st Preference	10	7-8
—— 6 per cent. Cum 2nd Preference	10	6¼-7½
—— 5 per cent. Debs., Red., 1-800	100	99-102
Western Telegraph Co., 1-207,930	10	12¼-13½
—— 4 per cent. Debenture Stock, Red.	100	96½-101½

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.							Cost per car mile
	Ending	1907.	1906.	Week.	Current year.	1907.	1906.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Mile of track. Pass'nger	Receipts per Mile of track. Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Oct 16	1,362	1,215	+ 47	− 1,485h	25½	25	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	,, 19	213	196	+ 17	—	8	8	,, 15	14,328	3,316,380	353,945	1	9·71	1,830	5·16
Baker Street and Waterloo Ry.	,, 19	2,730	1,740	+ 990	—	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 20	1,051	1,056	− 5	− 463	23·53	23·53	March 31	55,025	11,145,531	1,309,903	1·18	10·08	2,338b	6·03
Birmingham Corporation	,, 19	5,410	—	—	—	56½	—	,, 31	17,133	4,709,788	266,526	86	14·5	8,866	—
Blackburn Corporation	,, 16	1,085	1,009	+ 75	+ 2,016	24	24	,, 25	48,875	8,661,720	986,953	1·35	11·29	2,036	7·44
Blackpool Corporation	,, 17	689	594	+ 95	− 1,511	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	,, 19	399	503	− 104	− 1,171	16½	16½	Dec. 31	31,846	2,325,677	573,264	3·28	13 19	—	7·27
Bolton Corporation	,, 20	2,200	2,047	+ 153	+ 3,912	42	40	March 31	95 766	20,205 196	2,161,130	1·13	10·63	2,394	6·14
Bournemouth Corporation	,, 16	1,399	1,523	− 124	+ 968	17·41	16·82	,, 31	55,276	10,058,288	1,121,623	1 32	11·83	3,226	7·19
Bradford Corporation	,, 19	4,660	4 428	+ 232	+ 2,150	96	95	,, 31	230,085	47,108,000	5,053,392	1 172	10 927	2,396	—
Brighton Corporation	,, 20	808	902	− 94	− 2,865	9½	9½	,, 31	60,339	11,321,160	1,152,82	1·06	10·48	,914·8	8·014
Bristol Tramway Company	,, 18	5 040	5,110	− 70	—	51½	51½	Dec. 31	259,799	15,312,373	6 127,135	—	—	—	—
Burnley Corporation	,, 19	1,210	1,208	+ 2	—	40	40	March 31	67,982	11,092,704	1,197,772	1·31	11·61	5,388	8 17
Burton Corporation	,, 20	233	—	− 9	− 421	8½	8½	,, 31	17 950	3,878,269	454,082	1·07	9·21	2,018	6·76
Cardiff Corporation	—	—	—	—	—	32 62	†32·26	,, 31	112,209	24,134,363	2,770,049	1·12	9·72	3,782	9·44
Carlisle Tramways Company	Sept. 7	193	229	− 36	− 505	8·5	8·5	Dec. 31	10 713	2,935 002	359,756	—	7·14	—	5.18
Central London Railway	Oct 19	5 643	6,527	− 882	—	6	6	,, 31	347,588	4,875,547	1,281,214	1·86	65·10	57,931	35·80
Charing X, Euston, & Hamp. Ry.	,, 19	2,700	—	—	—	8	—	—	—	—	—	—	—		
City and South London Railway	,, 20	3,084	2,762	+ 322	—	6½	6½	,, 31	—	—	—	—	—		—
Colchester Corporation	,, 2	240	233	+ 7	—	8	8	March 31	10,588	2 457,653	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	,, 17	432	467	− 35	− 797	15½	15½	Dec 31	24,895	5,814 376	882,256	1·01	6·64	—	4 68
Croydon Corporation	,, 18	1,376	—	—	—	12c	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 18	254	257	− 3	− 33	7 23	7·23	March 31	—	—	—	—			
Dover Corporation	,, 19	209	243	− 14	− 986	4½	4½	,, 31	11 250	2 853,200	284,343	·94	9·49	2,500	
Dublin and Lucan Electric Ry.	,, 18	114	93	+ 15	— h	6½	6½	Dec 31	6 358	402,511	113,738	3·79	13·78	942	7 33
Dublin U.T.	,, 18	6 010	4 767	+1,243	+ 25 510	48½	48½	,, 31	267,489	50,050,949	7,077,372	1·28	9·07	691	5·55
Dundee City Tramways	,, 16	1,253	—	+ 219	+ 628	22	22	May 15	50 154	13 086 396	1,005 911	·906	11·96	2,180	7·42
East Ham Corporation	,, 19	879	858	+ 21	− 252	14	14	March 31	16,652	3,689,658	863,816	·64	10·18	2,994	6 79
Glasgow Corporation	,, 19	18,465	15,944	+1,521	+ 8,740h	79½	79½	May 31	756,480	195,767,519	17,946,595	—	10·12		—
Gloucester Corporation	July 10	278	304	− 26	—	15	15	March 31	15,465	3,902,077	563,595	·80	6·58	999	5·32
G.N., Piccadilly, and Brompton	Oct. 19	4,620	—	—	—	9	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	37	37	,, 31	74 019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 19	1,578	1,520	+ 58	+ 2,149	35	35	,, 31	63,938	12 838,150	1 665,262	1·24	9·71	1,923	—
Hull Corporation	,, 19	5,137	4,714	+ 422	+ 3,640	26	26	,, 31	112,651	27,104,921	2,910,698	1	9·29	—	—
Ilford Corporation	—	—	—	—	—	10½	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 17	143	131	+ 12	+ 231	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	11,586	3,626,656	419,800	·737	6 62	1,480	5·22
Lancashire United Tramways	,, 16	1,321	1,171	+ 150	+ 12,902	38½	28	—	—	—	—	—	—	—	—
Leeds Corporation	,, 19	6,569	6 201	+ 368	+ 8,174	89½	89½	March 25	298,233	64,223,666	7,121,038	1·10	10 02	351	—
Leicester Corporation	,, 19	2,269	2 226	+ 42	—	42	42	Dec. 31	26,011	12 039,252	1,229,507	1	9·79	—	4 82
Liverpool Corporation	,, 12	11,161	11,146	+ 15	+ 7,554	104	104	,, 31	547 625	116,642 663	12,166 419	—	—	—	—
Liverpool Overhead Railway	,, 20	1,421	1,405	+ 16	+ 1,387h	6·65	6·65	June 30	81 302	11 171,865	1,024 275	—	—	—	—
London County Council	,, 12	32,054	27,124	+4,930	+145,412	98	98	—	—	—	—	—	—	—	—
Lowestoft Corporation	Sept 28	262	242	+ 20	—	6	6	Sept. 30	14 511	3,128 867	359,435	1 08	9·68	2,630	6 48
Maidstone Corporation	—	—	—	—	—	2	2	March 31	4,740	850.121	112,227	1 33	10 13	2,370	
Manchester Corporation	Oct 19	14,959	14 114	+ 845	+31,775	149	149	,, 31	631,956	126,900,875	14,123,124	1·19	10·73	4,299	6·99
Metropolitan District Railway	,, 19	3,377	3,156	+ 221	− 565	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 20	15,529	15 277	+ 252	+ 5,719	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 19	136	145	− 8	− 20	2⅔	2⅔	,, 31	6 159	1,992,647	206,358	82	7 14	2,239	—
Newcastle-on-Tyne Corporation	,, 19	4 140	4,277	+ 137	+ 232	50	50	,, 31	197 849	43,061,934	4,326,152	1 07	10·98	3,957	7·0
Newport (Mon.) Corporation	June 29	639	628	+ 11	+ 1,397	15½	15½	,, 31	30.356	7,252.535	783 435	—	9 29	—	6·4
Oldham Corporation	—	—	—	—	—	34	34	,, 25	65 553	15,466,245	1,504,740	1 16	10·45	1,886	—
Portsmouth Corporation	May 25	2,330	1 578	+ 752	+ 632	28½	28½	,, 31	95,702	19 625,329	197,499	1·17	11 63	—	—
Reading Corporation	Oct. 17	624	622	+ 2	− 146	33½	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	11·29	21·29	,, 31	14,881	2,837,110	386,547	1·24	9·24	1,102	7 92
Rotherham Corporation	—	—	—	—	—	9½	9½	,, 31	23 569	6,251,472	593,054	1 07	9 53	2,612	7·49
Salford Corporation	,, 21	4 618	4,437	+ 211	+ 3,732	70¾	70¾	,, 31	214,111	39 213,560	4,894,590	1·28	10 29	—	—
Scarborough Tramways Co.	—	—	—	—	—	4½	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 20	5 533	5,378	+ 155	+ 7,409	35½	35½	,, 25	240,545	63 952,283	,049,899	903	9 543	3,653	5 94
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,365	9 294,771	1,108,369	1·27	11·02	—	7·63
Southend-on-Sea Corporation	,, 16	305	305	+ 40	− 129	9	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	,, 31	39,550	6,766,031	1,027,730	—	9 23	—	4 75
Sunderland Corporation	,, 20	1,347	1,345	+ 2	− 557	20	20	,, 31	64,858	15.364 463	1,495,885	1·004	10·36	—	6·37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	4,937	1,315,757	102,751	0·87	11 53	1,371	—
Torquay Tramways	Oct 17	175	—	—	—	5 16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 19	783	751	+ 32	+ 640	12 68	12·43	,, 31	43,607	7,995,451	862,12	9·27	12·14	3,132	7·59
Warrington Corporation	—	—	—	—	—	9	9	,, 31	17,057	4,418,225	403,363	—	9 85	—	6·33
West Ham Corporation	,, 17	2,198	2,248	− 50	+ 1,215	14·7	14·7	,, 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	,, 16	877	826	− 49	+ 255	20	20	,, 31	41,905	8,847,066	950,338	—	10 583	2,062	6·15

† And 98 miles of interlacing track. a Train mile. b Per mile of single track. c Miles of route. h Half-year's figure k Double track.

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NOTES.

University of London.—At the annual general meeting of the Old Students' Association at University College, Dr. Tempest Anderson was elected president of the association for the year 1907-08 Mr. George A. Aitken was elected treasurer, and Mr. E. Denison Byles, B.Sc., secretary. The annual dinner of the association will be held on Thursday, Dec. 5. Dr. Tempest Anderson will preside. The new wing that has recently been added to the college will be completed by that time, and will be open to inspection. Former students of the college who desire to be present should communicate with Mr. George A. Aitken at 42, Edwardes-square, Kensington, W.

Wireless Telegraphy.—An interesting service of wireless telegraphy is that promised between Queensland and British New Guinea (Papua). This installation will, of course, be owned and controlled by the Australasian Government, and will be more or less in the nature of an experiment, for we are informed by a Tasmanian correspondent that if the experiment to be tried at Papua is successful, there will be a considerable extension of the application of wireless telegraphy to the needs of the various portions of our Commonwealth and her territories. We understand that the Postmaster-General for Australia is calling for tenders for the first connection (between Queensland and Papua). The tenders will be open to the world, but companies submitting their systems will have to sell them right out to the Federation, as the Government is determined that no private monopoly shall be given a footing in the Commonwealth. The stations at Port Moresby and on the Queensland coast must be capable of receiving messages by any of the recognised systems installed on passing merchantmen and warships.

Gas Plant in Iron and Steel Works.—At a recent meeting of the German Eisen-und Stahlwerkes Verband, Herr Fritz Sellge gave an account of the difficulties which have arisen during the past years in working gas-engines, and how they were overcome. To illustrate what an important question gas-engines have become for iron and steel works, Herr Sellge (who is gas-engine manager for the Differdinger Iron and Steel Works) narrated the experiences of his own company. In November, 1905, the coal consumption under boilers was 5,300 tons, the iron production 21,400 tons; of this 70 to 80 per cent. was converted into steel and rolled in the mills to partially or wholly manufactured material, and about 20 per cent. was turned out as billets. After the gas-engine plant was completed the coal consumption steadily declined, and to-day is only about 500 tons per month, whereas the production of iron now amounts to 30,000 tons per month, this still being further manufactured as before. The coal costs 18 marks per ton delivered, so that the saving can easily be determined. Besides the money saved here, the expense of unloading, firing, and attending to the boilers is also very largely diminished.

Leeds Local Section.—The opening meeting of this section of the Institution of Electrical Engineers took place last week. It is satisfactory to note that the membership of this (as of other sections) steadily increases, as the following figures will show: the membership of the Leeds Section in October, 1904, numbered in all 211; to-day the society numbers 34 members, 124 associate members, 43 associates, and 53 students, or in all 254 members—an increase of 20 per cent. in three years and of 5 per cent. during the past year, which is satisfactory in view of the interchange of members continually taking place between the various sections. Mr. G. D. Aspinall Parr, M.Sc, delivered his presidential address at the opening meeting. He dwelt mainly upon the progress of the section, and upon the importance of technical education. With respect to the latter, he pointed out the advantage to the student of entering electrical works after his college training, and he appealed to manufacturers and station engineers to afford facilities to young men for entering their works after a college training. With a view to facilitating this matter, Mr. Parr advocated co-operation between chief engineers and the heads of training colleges.

China.—Sir A. Hosie (Acting Commercial Attaché to H.M. Legation at Pekin) has forwarded to the Foreign Office a report on a visit to the southern ports of China. At Canton, he says, the electric light works of the China Electric Power and Light Company stand near the wharves. He reports a proposal to widen the road on the Chinese side of the canal which separates Shameen from the city by taking in 10ft. of the canal, whose present width is 40ft., the idea being to secure a road wide enough to construct a tramway connecting the termini of the Kowloon-Canton and Canton-Hankow Railways, but this project has not yet matured. The terminus of the latter will be at Wong Sha on the river bank, about a mile above Shameen and directly opposite Shek-wai-tong, the terminus of the Canton-Samshui line on the right bank of the river. He has been informed that the average cost of the permanent line, including rolling-stock, of the 720 miles between Canton and Hankow will be about 75,000dol. per mile. The line has been divided up into sections, the first and second of which, at the Canton end, have been placed in charge of Chinese and Japanese engineers respectively, while the construction of the remaining five sections will be superintended by engineers of different nationalities. Although there is considerable friction among the Chinese shareholders, the work of construction is proceeding with the capital already paid up. Magnetite has been found in large quantities in the Kowloon extension, and a company with a capital of 1,00,000dol. has recently been formed to worked the deposit.

The Heating of Tramcars.—This subject will doubtless be to the fore in the minds of many tramway managers at the present moment, and its discussion will not be out of place. We seem to have overcome the difficulty to some extent in this country by fitting electric heaters inside the cars and supplying them with current from the trolley, the common size of heater in use being one to take about 1 kw. But the temperate climate experienced in England obviates to a large extent the use of electric heaters on tramcars, and so avoids a source of no inconsiderable expense, for not only do the heaters absorb a relatively large amount of current, but they require also a good deal of attention. Thus, while we have still our troubles with the problem of heating tramcars, especially in those parts of the country where the climate is colder than in others, we are much better off in comparison with other countries, where severe climates render the problem more acute. In parts of Germany several methods have been tried, but the results were not very reassuring. Trials were made during the winter 1906-07 to heat four out of the 300 Munich electric cars (which, by the way, have passed from the hands of a private company into the possession of the municipality) by means of electricity. The heating apparatus, as described in a consular report, runs underneath the seats, along the sides of the cars, and is protected by a perforated iron casing. The conductor controls the apparatus by means of a switch inside the car. The cost of this heating by electricity amounts to 3d. per hour, and if the 300 Munich cars were to be warmed thus for 15 hours daily on the average 50 coldest days of the

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year, the total cost would be £2,800. The trials, however, were scarcely satisfactory enough to induce the municipality to introduce the innovation.

The Effect of Gas Lighting upon Health.—Dr. W. Dewar, writing in the *Daily News* on Monday, explodes the unsound theory laid down by Prof. Vivien Lewis in a recent lecture that gas is healthier than electricity because it assists ventilation. Dr. Dewar's letter will doubtless prove of interest to our readers. He says: "I know it is a common argument of gas advocates that burning gas promotes ventilation by causing streams of heated air to rise upwards, thus displacing the impure air breathed out by human beings. But this does not promote ventilation unless the room is provided with air-shafts. Besides, these gas advocates do not mention that an ordinary gas flame is not only vitiating the atmosphere continually with carbonic acid gas and other noxious products, but at the same time absorbing from the air as much oxygen as ten men. Why, it would have enough to do to promote ventilation on its own account, to say nothing of the people in the room. Why is it that after sitting in a room lit by gas, with the windows and doors closed, for a few hours one has that dizzy feeling in the head, and sometimes singing in the ears? Our lungs are made to breathe pure, not impure air. I have too often experienced this effect On the other hand, I have occupied a room lit by electricity for long periods, and, of course, felt as fresh after as before. For our health's sake we must take care to keep the air indoors as fresh as possible in order to conserve our supply of oxygen, excluding all that pollutes, etc. Now, gas not only robs us of the life-giving oxygen, but actually replaces it with poison. In proof of this, notice how plants droop and die in gas-lighted rooms. The electric lamp gives light only, but gas gives light with dirt, damp, and noxious fumes thrown in, and this moist heat is highly favourable to the cultivation of microbes. It is not too much to say that a clean and healthy home is impossible where gas is the illuminant.—Yours, W. DEWAR, M.D."

The Institutions' Winter Arrangements.—Our column devoted to the announcement of forthcoming meetings is now beginning to wear the bloated aspect usual at this time of the year. The various institutions and technical and engineering societies are throwing off their summer lethargy and resuming their activities. A number of such societies have already commenced their programmes, but the majority will have resumed their meetings ere few weeks more have elapsed. The meetings of the Institution of Electrical Engineers commence on Thursday, Nov. 14, with a paper on "The Dielectric Strength of Insulating Materials" by Mr. Alexander Russell. The presidential address, to be delivered by Lord Kelvin, is being keenly looked forward to, and it is a pity that the regrettable illness through which Lady Kelvin has passed (from which we are pleased to say she is now recovering) should have prevented his lordship from preparing his address in time for presentation at the opening meeting. Meanwhile, many of the local sections are already in harness. The Dublin Local Section have arranged to hold seven monthly meetings (commencing on Nov. 14) in the Royal College of Science, Dublin. The opening meeting of the Institution of Civil Engineers takes place on Tuesday, Nov. 5, at which meeting Sir William Matthews, the president, will deliver an address and present the medals and prizes awarded by the council. The second meeting takes place on Nov. 12, when a paper will be submitted by Mr. H. T. Ker on "The Extension, Widening, and Strengthening of Folkestone Pier." The following paper will be "The Tranmere Bay Development Works," by Mr. F. H. Ellis. The Students Section (I.E.E.) will visit the Bow works of the North London Railway at 10 a.m. on Saturday, Nov. 9, and those wishing to attend are asked to send their names to the hon. sec., Mr. W. Bernard Thompson, Ewhurst, Hendon, N.W.

Bradford Tram Accident.—Lieut.-Colonel Druitt, of the Board of Trade, has issued his report on the accident which occurred on the Bradford Corporation tramways on July 31, when a car ran away on Church Bank and overturned, causing injury to 10 persons. As a result of his inquiries, the Board of Trade inspector has come to the conclusion that when the car was rounding the curve into Barkerend-road the leading axle broke, and as a result the hand brake was suddenly rendered useless, and to a large extent the electric brakes as well. The driver was using the hand brake, and as the slipper brake was not fully applied, the car began to gain speed after going a short distance on the gradient of 1 in 17, and almost at once was quite out of control, as the mechanical slipper brake, unless applied fully before a certain rate of speed is reached, will not stop a car on a steep gradient. Had the slipper brake been more fully applied when the car got into Barkerend-road, and alone used to take the car down the hill, no runaway would have occurred through an axle breaking. Colonel Druitt recommends that for cars on steep gradients there should be provided a mechanical slipper brake that can be applied practically instantaneously, as once a car gets out of control on a steep gradient it is almost impossible to stop it with the brakes at present in ordinary use. There are some mechanical track brakes under experiment at present which can be applied instantaneously, and it is to be hoped that the committees which are at present considering this question will shortly be able to recommend the adoption of a pattern of such a brake. The broken axle had travelled 54,640 miles previous to the accident, and 21 of similar pattern broke on the Bradford tramways in the year ended with July last. Stronger axles are now being fitted to the cars, but 68 of the old pattern are still in use. Colonel Druitt thinks that they ought to be renewed as soon as they have run the average mileage of those that have failed.

The Regulation of Motor Currents.—Among the patents which have recently been granted is one (to Messrs. Siemens Bros. Dynamo Works) relating to a device for regulating electric currents, especially the exciting currents of electric machines. The device consists of a main relay with step contacts, which completes the circuits of secondary relays, and the latter insert or cut out resistance. The relay, r' (Figs. 1 and 2), is shown as a three-phase motor, the stator of which is connected to a generator, g. The armature of the relay is short-circuited and carries a contact arm, l, which occupies the position shown in full lines in

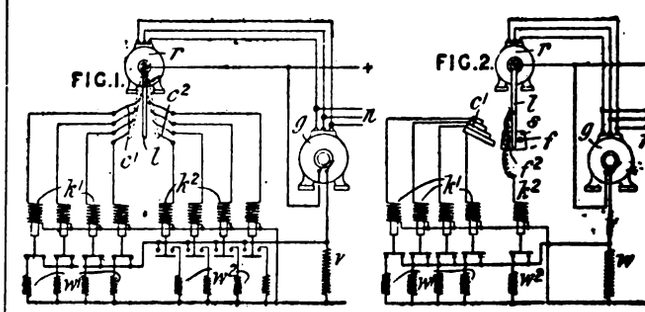

Fig. 1 when the generator is giving its normal potential, the arm being balanced between a spring and the torque of the motor. Spring contacts, c^1, c^2, on each side of the bar, l, are connected to secondary relays, k^1, k^2. As the voltage on the mains, n, rises or falls, the arm, l, moves to the left or right, touching successively the contacts, c^1 or c^2, and completing the circuits of the relays, k^1, k^2. These

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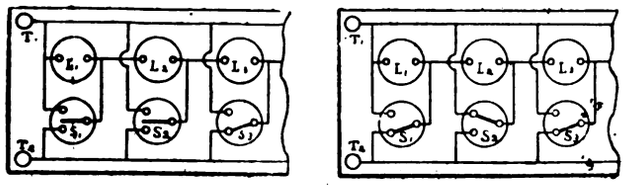
relays cut out resistances, w^1, or insert resistances, w^2, in shunt with the constant resistance, w, in the exciting circuit. In a modified form (Fig. 2) the arm, l, moves a contact block, s, to slide over a contact, c^1, with a series of steps connected to the relay k^1. The arm, l, is free to move between two stops, f, f^2, the latter being insulated and connected to the relay k^2. The stop f may be a contact connected to another relay, similar to k^2, but arranged to act on the circuit in the opposite manner.

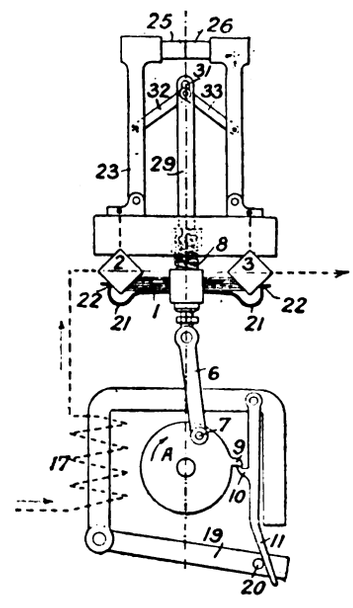
Series-Parallel Lamp Resistance.—Among the papers presented at the opening meeting of the Faraday Society on Tuesday evening was a note on a series-parallel lamp resistance, communicated by Mr. N. T. M. Wilsmore, M.Sc. The accompanying diagrams represent a method of arranging lamp resistances which has been found very convenient for electrochemical work. The arrangement was devised some years ago by Prof. J. D. Cormack, of University Colloge, London; but, as no account of it has been published by him, and as it does not seem to be generally known, Prof. Cormack very kindly allowed an account of it to be presented to the Faraday Society. In the figures only three lamps with their connections are shown, but the number of lamps may be increased indefinitely. The lamp sockets, L_1, L_2, L_3, etc., are connected permanently in series with each other and with the terminal T_1; but by means of the two-way switches, S_1, S_2, S_3,



etc., they may be connected up further in several different ways, so as to produce a wide variation in the total resistance between the terminals T_1 and T_2. Thus, with three lamps of the same size, the following six combinations are possible: three lamps in series (Fig. 1), two lamps in series, one lamp, one lamp in parallel with the other two in series, two in parallel, or three in parallel (Fig. 2). If the lamps have a resistance of 100 ohms each, the resistances corresponding to the above steps will be respectively 300, 200, 100, 66·6, 50, and 33·3 ohms. With lamps of different sizes, or with a larger number of lamps, the number of possible combinations becomes much greater. A further advantage of the system is that no movement of the switches can cause a short-circuit between T_1 and T_2 The two-way switches must have a well-defined central "off" position. For this reason, and also because one can follow the connections from the positions of the knobs, Lundberg's "Duplex" tumbler switches have been found suitable.

Bequests to Engineering Science.—The will of the late Prof. L. F. Vernon Harcourt, M.I.C.E, discloses some notable bequests to be devoted to the promotion of engineering science. After providing £500 for his assistant, Mr. Edward Blundell, in recognition of his services, the testator gave £1,000 to the Institution of Civil Engineers, in memory of the many advantages he had derived from its library and lectures, to found a yearly or biennial lecture, medal, premium, or prize, in connection with river, canal, or maritime engineering. Subject to his wife's life interest, he bequeathed to the University of Oxford, if there shall have been founded there in the lifetime of himself and his wife a school of engineering or mechanical science, £1,000 for the promotion of the teaching of engineering science there, and also his "Transactions and Proceedings of the Institution of Civil Engineers" and 20 volumes of the "Annales des Ponts et Chaussées," and a selection of his other engineering works, to form the basis of a library; a selection of his engineering works to the Institution of Civil Engineers; and £200 to the University College, London, for a yearly prize in civil engineering. In connection with the bequest to Oxford University, it is interesting to note that on the same day as the contents of the will were disclosed, the congregation of the university met and approved (by 152 votes to 20) the new statute proposing to establish a professorship of engineering. There was, of course, the usual clerical opposition to the statute, which was based on the ground that Oxford should not seek to develop studies not in harmony with the spirit of the university. But Prof Miers, in introducing the statute on behalf of council, remarked that in travelling in America he had noticed that all the highly-paid posts in the engineering line were held by Americans. Some of these he hoped Oxford men would fill in the future. To supply such engineers was for Oxford a national duty. The proceeds of the late Prof. Harcourt's bequest will be a valuable help towards the establishment of an effective department of engineering. The engineering sciences owe much to such public-spirited workers as the late Prof. Harcourt, whose labours have helped considerably in the development of these sciences, and who make ample provision for the continuance of the work after they have gone.

Switches.—A patent issued to Mr. J. G. Statter, of Birmingham, relates to a modified switch design. As seen in the diagram, in order to obtain a strong pressure of the brush, 1, upon its contacts, 2, 3, and at the same time to provide a releasing device which can be actuated by the application of a small amount of energy, the brush, 1, is connected by a link, 6, to a crank disc, 4. The spring, 8, tends to force the link downwards, and is at its maximum compression when the pin, 7, is at its highest position. The handle is connected through a free wheel to the crank disc, so that the latter can only be rotated in the direction shown by the arrow, A. On turning the handle until the pin, 7, is at its highest position, the spring, 8, is compressed, and the brush, 1, is compressed against the contacts, 2, 3.



Immediately after passing this position the spring forces the disc onwards until the projection, 9, engages with the stop, 10, on the lever, 11. The automatic release for an overload is provided by the solenoid, 17, which attracts the armature, 19, carrying a stop, 20, which forces the lever, 11, to the right, releasing the stop, 9, and allowing the spring, 8, to act. To prevent arcing between the brush, 1, and contacts, 2, 3, a replaceable strip of brass or copper, 21, 22, is provided, which break contact after the main bridge, 1, and take the arc. Carbon contacts, 25, 26, carried

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by hinged arms, 23, 24, may also be provided. These are drawn apart when the switch is opened by means of toggle arms, 32, 33, which engage with a slot, 31, in the prolongation of the rod, 29.

The Hardness of Corrugated Rails.—There is apparently to be no end to the discussion regarding that annoying phenomenon of rail corrugation. Many theories have been put forth to account for corrugation, but, in spite of all, we are as far off as ever from the exact cause or causes. One of these theories is that the hardness of the rail varies in spots, and that the soft places are worn away by the action of the wheels, leaving the hard sections raised in relief. These alternate portions of hard and soft places are supposed to be caused by unequal action of the rolls in the manufacture of the rail, or by segregation of carbon or other elements. But all revert to the original proposition, that spots of unequal density or hardness prevail in the head. It might serve as some check upon the accuracy or the fallacy of this theory if we examine the experiments carried out by Mr. G. L. Fowler in America, and described in our esteemed contemporary, the *Street Railway Journal*. Mr. Fowler examined samples of rails obtained from the Boston Elevated, the Milwaukee Electric Railway and Light Company, and the Twin City Rapid Transit Company, of Minneapolis, Minn. The rails were accurately measured for their elevations at 1in. intervals for their whole length. The method of doing this was as follows: The rail was levelled on horses at a convenient working height, and beside it a pair of angle-iron guides were placed parallel to it, but a little higher, and these were accurately levelled. A straight-edge was then fitted with a micrometer head reading to ·0001in. The straight-edge was laid across the guide, and the micrometer brought down to a bearing on the rail. It was shown that the T-rail from Milwaukee, and rolled by the Lorain Steel Company, was not truly corrugated as the term is generally understood. It was badly worn, and had three distinct waves in its length of 15ft. The crests of the waves thus formed were 4ft. 5in. and 7ft. 6in. apart, with some minor corrugations in between, noticeably between the 10ft. and 14ft. marks. The girder rail from the Boston Elevated Railway showed a general crowning extending throughout its whole length of 15ft. 10in., with continual minor corrugations over the whole surface, with an average pitch from crest to crest of about 3in. The short length of girder rail from the Twin City Rapid Transit Company was a piece of truly corrugated rail, the pitch of whose corrugations varied from 2in. to 6in. The test for hardness was made by means of a drop, and worked out on the Martel scale. With the T-rail from Milwaukee there was practical uniformity of hardness throughout. The variations were more pronounced in the girder rail from the Boston Elevated. The results did not show that variations of hardness had anything to do with corrugation, and Mr. Fowler concludes that we may eliminate this variation of hardness from among the possible causes of rail corrugation.

Publications Received.—"An Introductory Course of Continuous-Current Engineering," by Alfred Hay, D.Sc., M.I.E.E. (London: A. Constable and Co., Limited, 10, Orange-street, Leicester-square, W.C. Price, 5s. net.) Dr. Hay explains in his preface that the present work is introductory in the sense that only elementary methods of treatment are made use of throughout, and that no attempt is made to cover the entire field of continuous-current engineering. His aim, he explains, has been to present a simple and by no means exhaustive account of the component parts of a continuous-current lighting and power plant—dynamos, motors, secondary cells, measuring instruments, lamps, etc. The selection and arrangement of these component parts to form a connected system are subjects, he says, lying outside the scope of his present work. Although introductory in the sense already explained, the work is not intended for absolute beginners, and an elementary knowledge of magnetism and electricity is assumed on the part of the reader.—"The Metric and British Systems of Weights, Measures, and Coinage," by F. Mollwo Perkin, Ph.D. (London: Whittaker and Co., 2, White Hart-street, Paternoster-square. Price, 1s. 6d. net.) Those who advocate the adoption of the metric system as a national system in this country would surely have a better chance of reaping some of the fruits of their labours if, instead of devoting their energies towards compulsory change, they concentrated their efforts upon the task of providing adequate teaching of the metric system in the schools. The trouble has been, however, the absence of a suitable text-book which would enable the student to obtain a mastery of the metric system of notation. Dr. Perkin's book should supply this want to a large extent, especially as it is applicable in the teaching of chemistry, physics, engineering, or general elementary science. The chapter on specific gravities, and that upon the use of the balance, should simplify the teaching of these subjects to large classes. A large number of arithmetical examples have not been inserted, but in each case one or more worked examples have been given, so that the student can easily work out examples for himself.—The contents of the September issue of the *Proceedings* of the American Institute of Electrical Engineers include: "The Transmission Plant of the Niagara, Lockport, and Ontario Power Company," by Ralph D. Mershon; "Line Constants and Abnormal Voltages and Currents in High-Potential Trans missions," by Ernst J. Berg; discussion on "The Telephone Wire Plant"; "The Grounded Neutral, with and without Series Resistance, in High-Tension Systems," by Paul M. Lincoln; "Experience with a Grounded Neutral on the High-Tension System of the Interborough Rapid Transit Company," by George I. Rhodes; "The Grounded Neutral," by F. G. Clark.

Metropolitan Railway Collision.—The collision between two electric trains which occurred during a fog last Saturday morning on the Metropolitan line at West Hampstead was, unfortunately, attended with fatal results. But, so far as it is possible to gather at this moment, the accident does not present any feature of especial interest from an engineering standpoint. Whether it is a fact that there was a defect in the mechanism at the down starting signal at West Hampstead, as alleged by the signalman Hollis in his evidence at the Board of Trade inquiry, will doubtless be ascertained at a later stage. The evidence so far shows, however, that the signalling apparatus was in good order prior to the accident. Hollis, when questioned by Major Pringle, who is conducting the inquiry, remarked that failings had previously occurred in the signal box. On the last occasion, some months ago, he explained that the disc working in the home signal had failed to drop to "clear" when it should have done so, and had dropped to "clear" when it should not. He accounted for the presence of the first train in the station by saying that he must have put the starting signal to "danger" too quickly before the train left the station, which would probably keep the train back. He could not, however, account for the other disc showing "line clear" when he turned round, unless it was that the locking had failed. He said he had known the treadle in the signal box fail during the last year. It got right again for the next train and he made no report on the matter. The statement made by the signalman to the chief traffic inspector, after the accident, was to the effect that the disc

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broke down and he could not see the train because the fog was so thick. The evidence of Mr. E. G. Phillips, telegraph engineer on the Metropolitan Railway, was to the effect that even if the treadle were out of order it would be absolutely impossible unless the starting signal lever was pulled over to obtain release for the disc. He examined the apparatus at West Hampstead between 11 and 12 o'clock on the morning of the disaster. It was working properly towards Kilburn, and after the road was clear and put right and the treadle adjusted the whole of the apparatus worked properly. There had been only one or two cases a year of improper action of the treadle on the whole system, and in all the cases the signal lever connected with the treadle would be over and the signal locked. He had never heard of such a failure as was alleged in this case, where the signal was at danger and the disc had not been operative. He went further and said it was impossible. As the inquiry has been adjourned (for the purpose of obtaining evidence from the driver of the Neasden train), it would be improper to comment upon any of the evidence tendered. The accident, however, draws attention to defects in the lock-and-block system of signalling, and we may doubtless see the installation of automatic signalling on the Metropolitan in the future. Where that system is in use, it would be impossible for a driver to bring his train into a station already occupied by another train.

Railway Electrification Progress.—The Board of Trade railway returns for 1906 present some valuable proofs of the progress of railway electrification in this country. It appears from the report that at the end of 1906 the length of line (in equivalent of single track) worked solely by electricity was 197½ miles, and that 157½ miles were being worked partly by electricity. The corresponding lengths of line at the end of 1905 were 140½ and 170½ miles respectively. The total quantity of electrical energy used in 1906 was 159,581,401 Board of Trade units, as compared with 100,977,467 in 1905. The electric railway returns are, unfortunately, somewhat incomplete, as they do not include particulars of certain lines (such as the North-Eastern, Lancashire and Yorkshire, etc.) worked partly by electricity. On the other hand, the total includes a small portion of certain lines worked by steam. Without, therefore, taking these lines into consideration, we find that the total length of line open on Dec. 31, 1906, including sidings (in equivalent of single track) was 331 miles (or 127 miles in length of line). 267,826,481 passengers were carried, of which 10 millions were first, two millions second, and 255 millions third class passengers, while there were 54,918 season tickets issued. The receipts from passengers amounted to £2,021,508, made up as follows: first class, £146,968; second, £20,194; third, £1,703,527; season tickets, £150,819. The only railways dealing with goods traffic were the Metropolitan and Metropolitan District, who carried minerals and general merchandise, and the Whitechapel and Bow, carrying only general merchandise. The total receipts from goods traffic amounted to £108,212. Taking the same lines, we find that the total working expenditure amounted to £1,424,322. The total gross receipts from all sources of traffic was, as we have already seen, £2,288,942; thus the percentage proportion of expenditure to total receipts was 62. Only one light railway is worked by electrical power in Ireland—*i.e.*, the Bessbrook and Newry Tramway. The length of line is three miles (3ft. gauge). The total working expenditure last year amounted to £1,472 and the total receipts to £1,652, the proportion of expenditure to total receipts being 89 per cent. The foregoing statistics take no account of the working of the railways opened during the past year—viz., the Charing Cross, Euston, and Hampstead and the Euston Extension of the City and South London Railways. The progress so far has been quite satisfactory, and may be said to justify the enterprise of the directors of railway companies in extending electrification. At present the electric railways under construction include the London Bridge-Victoria section of the Brighton line, and the Midland lines between Lancaster, Heysham, and Morecambe. The London and North-Western Company have obtained powers to electrify their 19 miles of line between Euston and Watford, while the construction of other electric lines are under consideration.

The Effect of Joints in Alternator Armature Cores.—With the recent widespread introduction of high-speed turbo-alternators a peculiar effect has occasionally become noticeable in the bearings. The latter become eaten away, and often a small voltage is found to exist between the shaft and the bearing. Mr. F. Punga and Dr. W. Hess, in a paper in a recent number of *Elektrotechnik und Maschinenbau*, show how the occurrence can be explained by the presence of the joints in the body of the stator core. Fig. 1 shows an ordinary four-pole alternator with stationary armature divided into two halves at the horizontal diameter, and having revolving magnets. The butt joints at *a a* act as a small additional air-gap in certain positions of the field. In the position of Fig. 1 the flux is passing normally through the sections *a a*, and it is clear that, owing to the joints, the flux per pole will divide into two unequal parts—path I. carrying a flux $\frac{M}{2} + M_w$, and path II. a flux $\frac{M}{2} - M_w$, where M is the total flux in megalines entering the armature from one pole. In Fig. 2 the other extreme

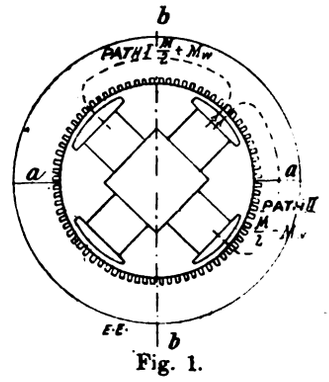

Fig. 1.

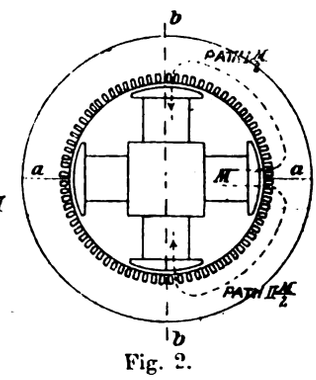

Fig. 2.

position of the poles relatively to the joints is shown, and here the two flux paths are of equal resistance, and each carries $\frac{M}{2}$ lines. A little consideration will show that in the time taken to change from the conditions of Fig. 1 to those of Fig. 2 the flux M_w has cut across the rotor at right angles to the spindle, and has induced a voltage in the latter. The frequency of this voltage is the same as that of the terminal voltage, and its value (assuming that it is of sine form) is given by the usual formula: $\sqrt{M}S$ shaft voltage $= 4{\cdot}4 \times \sim \times M_w \times 10^{-2}$, M_w being the difference in flux along any one path in the positions of Fig. 1 and Fig. 2, stated in megalines. The value of M_w for any particular case can be readily calculated if the quality of the armature iron and the width of the gap at the joints are known, and experiments carried out by the authors on an Alioth four-pole 1,000-revolution generator showed that such calculation agreed very fairly with the measured shaft voltages. The joint gap was successively varied from a well-machined facing to a 1mm. gap, a 4mm. gap, and a 20mm. gap. The highest values of the shaft voltage were: for well-machined joints, 4·6 volts; for 1mm. gaps, 12 volts; for 4mm. gaps, 20·5 volts; for 20mm. gaps, 29 volts.

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LARGE GAS-ENGINES IN GERMANY.

The Key Engineering Company's Tour.

(Continued from page 583.)

In order to test the working of these large gas-engines an ordinary indicator is hardly satisfactory. It does not show the variations in the behaviour of the valve gear while governing against very variable loads. To get a true record under these conditions, a continuous indicator diagram is needed. An apparatus for taking a series of indicator diagrams for a succession of strokes was perfected by Messrs. Ehrhardt and Sehmer for use on their rolling-mill engines, where the load varies between maximum and zero every time a bloom passes through the rolls. This indicating device advances the paper on which the record is taken by a definite amount once every revolution. Fig. 7 shows the record obtained by this continuous indicator on one of the large gas-engines made by the firm. It at once reveals any inequality in working due to any cause whatever.

It seems to us to be interesting at the present time to compare to a certain extent the output obtained from a given size of cylinder made by Messrs. Ehrhardt and Sehmer with the output which our prominent gas-engine builders in England obtain. The following table gives, for all the engines we saw, the number and diameter of cylinders, the length of stroke, the volume of the cylinders in cubic feet, and the horse-power developed by the engine at 100 r.p.m. per cubic foot of cylinder capacity. The mean effective pressure on the working stroke is given in the last column.

Details of Ehrhardt and Sehmer Engines.

Name.	Cylinders. Number.	Diameter.	Stroke.	Volume, cubic feet.	Revolutions per minute.	Horse-power.	H.P. at 100 r.p.m. per cubic foot of cylinder.	Approximate M.E.P. Lbs. per sq. in.
Homécourt...	2	3′ 5⅜″	3′ 11¼″	74	95	1,650	23·5	64
Neunkirchen	2	2′ 9½″	3′ 3½″	40·3	100	1,000	24·8	67
Hemitz	2	2′ 0¾″	2′ 5½″	16·6	150	600	24·1	65
Dortmund ...	2	4′ 3¼″	4′ 3½″	88	94	2,200	26·6	72

Details of English Engines.

Crossley	2	2′ 8″	3′ 0″	33·4	120	540 to 620 b.h.p.	15·5*	75
Do.	2	3′ 2″	3′ 3″	51	105	650 to 750 b.h.p.	14*	65
Richardsons, Westgarth, and Co.	2	3′ 3½″	3′ 7½″	61	100	1,575 to 1,600 i.h.p.	26·2	66

* Single-acting engines.

Some of the best English makers of gas-engines, who have years of experience to back their opinions, have kindly written us on this subject. Their views show in some cases a wide divergence from Continental practice, but in engineering the very best results commercially are often arrived at by diverse methods. Messrs. Crossley Bros., Limited, of Openshaw, Manchester, whose engines are working in every town where gas is available in this country, and with producer gas elsewhere, write as follows:

"For the larger type of gas-engines we believe that single-acting cylinders are better than double-acting cylinders for several reasons In the first place, the pistons and parts of the cylinders are open to inspection during running; secondly, the lubrication of the cylinders can be regulated to ensure ample lubrication without an excessive supply of oil. This is a more important point than appears on the surface, as an excess of oil in the cylinders is one of the great sources of trouble in gas-engines, and with an enclosed cylinder such an excess of oil must of necessity be given to prevent any risk of a deficiency of oil, which would lead to serious wear and tear, and possibly other troubles of a still more serious nature. For the larger sized engines we prefer to place two such single-acting cylinders in tandem fashion in preference to using double-acting cylinders in tandem—in the one case only one piston-rod gland is required compared with four in the other case, and one set of cross-head guides against three sets. In the case of single-acting cylinders the front piston is mainly supported by the cross-head guides which take the angular thrust of the connecting rod, whilst the back piston is supported in the cylinder itself, having ample surface for this purpose. The pistons, therefore, are in more favourable conditions.

"In contradistinction to most of the Continental engines, we make the cylinder itself with a separate liner fixed on one end only, so that it is free to expand without imposing any strain whatever upon the outer casting of the cylinder. We are thus enabled to put very hard close-grained metal in the liner, ensuring not only lengthened service, but a possibility of cheap renewal should it after many years' wear require to be renewed. We have made four engines having two such cylinders in tandem, 32in. diameter and 36in. stroke, to run at 120 r.p.m. These engines are sold to give 540 b.h.p., having a mean pressure in the cylinder of 75lb. per square inch—as a matter of fact, they have given as much as 620 b.h.p., but 540 is assumed to be a good working load for them. These engines have a mechanical efficiency of at least 88 per cent., corresponding to an indicated horse-power of 613·6 when giving 540 b.h.p. One of them was recently tested by Prof. Nicolson, D.Sc., M.I.C.E., of the Manchester University. The brake horse-power was 559, the gas per brake horse-power being 51·94 cubic feet, having a thermal value of 156½ B.Th.U. per cubic foot, consequently a brake horse-power was obtained with 8,128 B.Th.U., and the thermal efficiency on the indicated horse-power would thus be 35·6 per cent., and the thermal efficiency on the brake horse-power was 31 32 per cent., probably one of the best results that has ever been obtained with an engine of this size. The engines were fitted with our patent admission valve, which in a very simple manner regulates the amount of gas required to give a working stroke proportioned to the power the engine is required to give out for the time being. It is so arranged that on reduced loads the gas enters towards the end of the suction stroke, the contents of the cylinder being thus stratified, so as to ensure there being a rich mixture at the firing point. The regulation is obtained by means of a vacuum piston to which air is admitted in regulated quantities by means of small slide valves controlled by the governor, which thus has extremely little work to do, but with certainty controls the effect of the vacuum pistons, which thus can be given any desired amount of power to control the amount of gas admitted. Prof. Nicolson tested this governing action, and stated in his report:

"'*Variation of Speed, Full to Light Load.*—The engine speed varied only from 119·4 r.p.m. to 121·4 r.p.m. when the horse-power was instantaneously dropped from about 600 to about 50. The total variation in speed was, therefore, 1⅔ per cent. of the mean speed. The full load was then thrown on again as quickly as possible, and so on in succession. The speed of the engine under such circumstances never varied more than the above percentage. This system of governing must, therefore, be admitted to be a very good and close one. No back firing of any kind took place. The engine supply valves, which had been adjusted at the commencement of the trial, were not touched or altered in any way while the trials were being made.' The engine was tested by gas made from bituminous coal in a Crossley producer, the analysis of the gas being:

(CO_2)	11·4
(C_2H_4, etc.)	none
(O_2)	1·0
(CO)	15·1
(H_2)	24·3
(CH_4)	3·5
(N_2)	44·7
	100·0

"We have at present two more engines of this size in hand. We have also in hand a larger engine of the same type having two single-acting cylinders 38in. diameter and 39in. stroke, intended to run at 105 r.p m., and giving a safe continuous load of 650 b.h.p. or a maximum load of 750 b.h.p. with a mean pressure of about 75lb. per square inch."

Messrs. Richardsons, Westgarth, and Co., Limited,

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of Middlesbrough, write us as follow: "We shall be glad to give you any information we can to enable you to discuss large gas-engines in the interest of English makers. With regard to the power obtained from large gas-engines, unfortunately at present we have none at work over 1,000 i.h.p., but we are now building several engines having tandem double-acting gas cylinders 39½in. diameter by 43½in. stroke, designed to run at 100 revolutions and to drive dynamos. These engines are sold to develop 1,575 i.h.p. to 1,600 i h.p. in everyday regular work with blast-furnace gas, but they are capable of giving much more power if required and

H. BELL R. W. WEEKES R. DRAWE PROF. W. C UNWIN A. CLOUGH E T. RUTHVEN MURRAY
W. H WHYTE E. G. SEHMER W. E. WARRILOW E. W COWAN R B. SLACKE ALD. SMITH SIR VEZEY STRONG S. E. FEDDEN MR. EHRHARDT
A. H. ALLEN S. ROGET VESEY BROWN MR. JEANS T. ROLLS W HANDCOCK F. BARTHOLOMEW L. ANDREWS L. PREECE.

under favourable conditions, as you will see from a report on a very careful series of tests made by Prof. Hubert on similar engines at the works of our friends, the Cockerill Company, Seraing. From the information contained in this you will find that an engine of the same size as those we are now building gave up to 1,755 i.h.p. on test. With regard to the power to be obtained from large gas-engines built by German or English engineers, there is really very little, if any, difference in power from engines of the same size under similar conditions, because the designs of double-acting four-cycle engines of large size are very much the same. We believe, however, that German engineers are not prepared to guarantee quite so much power from the same engines as English engineers, and this, perhaps, accounts for the impression that English makers obtain higher outputs for a given size of cylinder than do the Germans."

The British Westinghouse Company write us that "the Westinghouse engine is of the single-acting type, and the largest cylinder at present being built is 22in. diameter. Unlike other builders, we prefer to work with a multiple of cylinders small in diameter to arrive at an aggregate horse-power rather than adopt the use of double-acting type of cylinder of larger diameter. The reason for this is to avoid water-cooled pistons and water-cooled exhaust valves, and it is obvious to anyone who has had experience with large gas-engines that this is a very important feature. Of course, using a number of cylinders naturally brings us to an increased number of cranks on the shaft. This in itself is a positive advantage, as the turning moment is considerably improved as against the single-crank tandem double-acting cylinder type of engine. For instance, on a Westinghouse 1,000-b.h.p. engine having four cranks with eight cylinders arranged in tandem as in ordinary high-speed steam-engine practice, we receive on the crank-shaft four impulses per revolution, which brings us to a point where we can almost do without any flywheel, excepting of a small weight for barring purposes, and guarantees at the same time a cyclic irregularity better than any double-acting tandem gas-engine yet on the market.

"Another important point in connection with the construction of the Westinghouse engine is that although it has a number of cylinders compared with the double-acting tandem engine, the number of valves employed remains equal to the tandem double-acting type of engine. In the Continental double-acting tandem engine each cylinder end has a separate inlet, exhaust, and mixing valves, whereas in the Westinghouse engine one mixing valve is used for all cylinders. Another important point is that all the valves are operated through straight push rods direct from the camshaft, without the use of bell-crank levers, such as are usual in the double-acting tandem engines. The system of ignition is by the high-tension coil, and not the magneto system, thereby avoiding all trip gears which, in working, give so much trouble.

"Coming to actual construction, it is not generally known that all Westinghouse cylinder castings are annealed after being rough machined, so that any distortion which is likely to occur owing to temperatures has already taken place before the finishing cuts are put on the material,

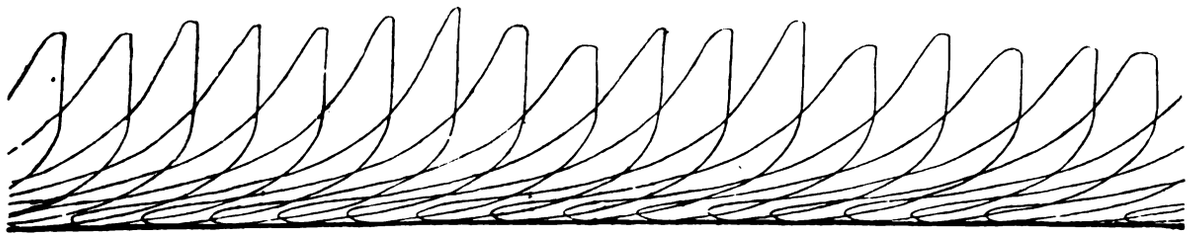

FIG. 6.—A Continuous Indicator Diagram for a Gas-Engine by Ehrhardt and Sehmer.

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Regarding the claim put forward by certain builders of the horizontal type of engine in connection with loose liners being fitted to the cylinders, we would point out that this practice is not adopted by any up-to-date builder of double-acting tandem gas engines, it being understood in general practice that it is cheaper to make your cylinder and water-jacket in one piece, and replace the whole cylinder, if necessary, at a cost which certainly does not exceed stripping the engine and fitting a new liner. It has the further advantage of avoiding unnecessary joints when liners are dispensed with. The principal advantage claimed by firms using the loose liner is that expansion can take place freely at the front end of the horizontal cylinders. This point has been well taken care of in the construction of the Westinghouse engine. A rolling joint both for water and gas is fitted at the bottom of the water-jackets, independent of the gas-cylinder body. All working parts are case hardened, and the material used is of such a nature as to resist deterioration when in contact with sulphurous fumes from the exhaust gases. With regard to lubrication, the system of forced lubrication is used throughout the Westinghouse engine, and is controlled by sight-feed lubricators, which may be regulated to any given consumption which may be necessary. The oil-pumps are fitted in duplicate, with the oil sieves so arranged that they can be removed for cleaning while the engine is in operation.

"We have at present in operation a plant at the Castner-Kellner Works, Runcorn, consisting of four 500-kw. sets, direct current, and operating on the electrolytic process at a full-load capacity continuously. These engines have cylinders 21in. and 22in. by 24in. stroke, and run at 200 r.p.m., and are operated from producer gas. The exhaust gases are carried through exhaust boilers which give off steam at about 90lb. pressure for use in other parts of the works. It has been demonstrated at these works that a continuous run night and day, including Sundays, of one month can be obtained in ordinary commercial use. The gas consumption on these engines, as proved on the test-plate in our works, is 9,800 B.Th.U. per brake horse-power hour, when the gas has a calorific value of 135/140 B.Th.U. per cubic foot lower value, and the mechanical efficiency is 87 per cent. The cyclic irregularity of the 1,000-b.h.p. engine equals 1/350.

"In an installation of large size, where ground space is of importance, four Westinghouse 1,000-b.h.p. combined sets can be placed in the same space as that which is occupied by one of the Continental type of engines of, say, 1,200 b.h.p., as the length of the Westinghouse engine is approximately the same as the width of the horizontal type of engine over the flywheel end of the engine when the generator is direct coupled, and the length occupied by the horizontal engine gives enough space for these extra engines of vertical type. The question of foundations and buildings is also considerably reduced when considering an installation on the above lines.

(To be continued.)

THE SCOPE AND FUTURE OF ENGINEERING.*

BY DR. C. V. DRYSDALE.

In opening the address, Dr. Drysdale congratulated the society on the success which it had hitherto attained, and hoped that the session now commencing would be as successful as the past ones had been. He considered that such societies were of the greatest value to students, in that it caused them to come into closer personal contact with their work, and gave opportunity for the exchange of ideas among themselves. The scope of engineering was a remarkably wide one; in fact, it was, perhaps, easier to enumerate the subjects which were outside its province rather than to deal completely with those included under engineering. It had been said that engineering was the direction of the forces of nature to the use and profit of mankind, a definition which, though somewhat comprehensive, served to indicate the position of the engineer in society, and the aim to be kept before him. It was not too much to say that the engineer is more essential to the advance of mankind than any other individual. Although history deals with the parts played in the development of nations by rulers, statesmen, and generals, the real progress of mankind has been due to the engineers who have been working behind them, designing and constructing the tools, buildings, vessels, and weapons which have been required.

The commencement of engineering may probably be found in the art of tool making, an art which has become of ever-increasing importance from the most primitive state of mankind to the highest civilisation. Not long behind must have come the construction of edifices, beginning with the rudest of huts and continuing to the construction of the large buildings and other structures of the present time. Next to this came the making of roads and the development of the means of transport. Among the Romans the idea prevailed that the first three steps in civilisation were to make roads, more roads, and more roads still. It could not be gainsaid that the facility of locomotion and of interchange between various tribes and nations was the greatest possible agency not only for the improvement of social conditions, but for the elimination of misunderstandings and wars. The importance of this facility of locomotion is even greater to-day than it has ever been, the tendency of modern industrialism having been to consolidate factories and people into towns, with consequent serious injury to the physique of the race, and every effort should be made to facilitate and cheapen transport until the necessity for condensation in large centres became unnecessary. The easy communication between nations also was one of the greatest importance towards the promotion of international good feeling and universal peace. There were three vehicles at our disposal for locomotion—the solid, the liquid, and the gaseous. In transportation on the surface of land or water a considerable degree of success had already been achieved, and it now looked as if the conquest of the air was within measurable distance. Other branches of engineering of great importance were the obtaining and treatment of raw materials, as in mining and metallurgical operations; the carrying out of hygienic and sanitary works; the provision of water supply; and military applications, both for protection and offence. Also, we have the sphere of agriculture, in which, although engineering has taken an important part, it was to be hoped that it would play a still more important one in future.

Finally, a very wide field for the engineer lies in the conversion of energy from one state to another. This energy is generally provided for us by Nature, either in the chemical form, as in coal, or in the mechanical energy of water. From the point of view of engineering energy could be recognised in five principal forms—chemical, mechanical, heat, electrical, and light—and it could be converted from any one of these forms to any other. It was of interest to see what had been done in this direction—in which conversions we were most successful and which showed the greatest opportunity for progress. In this country the great interest lay in the conversion from chemical energy to the other forms. It was of interest to notice that there was no case of the direct conversion of chemical energy into mechanical work other than through the muscular systems of animals. By combustion or othewise, chemical energy was easily transferred into heat with an efficiency of 100 per cent., and by means of a battery chemical energy could also be transformed into the electrical form with an efficiency of from 80 to 90 per cent. In this case, however, the fuel employed—namely, zinc—was very costly, and no battery would be employed to a large extent unless coal or other cheap fuel could be employed in it; up to the present no possibility of producing such a battery had been foreshadowed.

Our chief means of obtaining mechanical power in this country was from the heat developed by chemical action through the agency of a heat engine; in this case the efficiency of the conversion was generally low (in the neighbourhood of 10 per cent.), although the best forms of internal-combustion engines had reached efficiencies of something approaching 40 per cent. Further progress in this direction was of great importance, but unfortunately

* Abstract of address delivered before the Northampton Institute.

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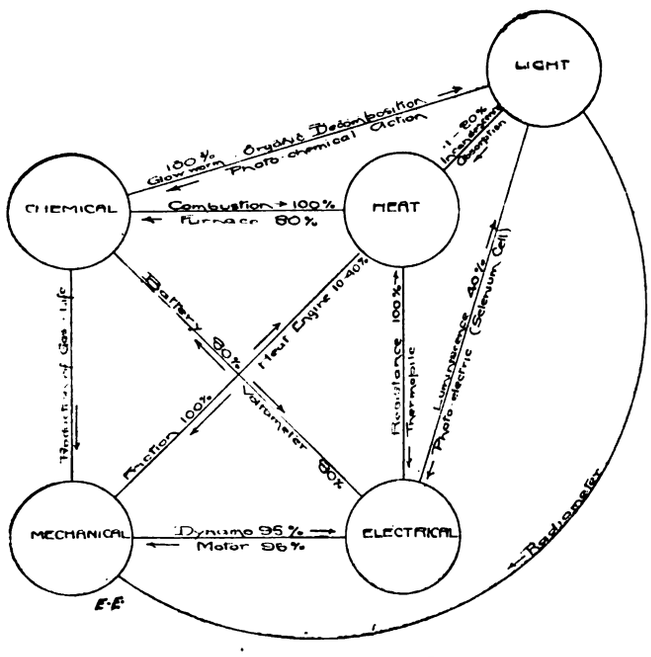
appeared to be barred to a considerable extent by the second law of thermo-dynamics, which insisted that high efficiencies could only be obtained by working between wider limits of temperature. The conversion of mechanical to electrical energy, and *vice versâ*, effected by a dynamo-generator or motor was one of the most satisfactory and efficient of conversions, and as its efficiency was very high there was little likelihood of further advance in this direction, except in the cheaper construction of the machines.

Of all conversions of energy, however, the most unsatisfactory hitherto had been the conversion to light. Light had chiefly been produced in the past from chemical energy through the agency of combustion and incandescence, with an efficiency of only about one or two tenths per cent. The incandescent mantle had increased this to about 1 per cent.; the ordinary carbon-filament incandescent lamp converted about 2½ per cent. of the electrical energy supplied to it into light, while the new metallic-filament lamps had raised this figure to nearly 9 per cent.; arc lamps might have efficiencies from 10 to 20 per cent., or sometimes higher. This was a direction in which great progress had recently been made, and in which there seemed a possibility of still greater developments. The glow-worm and fire-fly, the light of which apparently had an efficiency of something like 100 per cent., showed that there was no



DIAGRAMS & CONVERSIONS OF ENERGY

natural barrier to the attainment of a perfectly efficient light, and this when found should give us something like 10 to 15 candles per watt.

Although immense benefits to mankind have resulted from engineering, it must be remembered that modern scientific engineering is only about a century old, and its development has been so rapid that many evils have arisen with it. Its benefits are shown in the fact that the luxuries of a century ago are the everyday possessions of all but the poorest at the present day. It has also made possible an enormous increase of the population of this country. Prior to the beginning of the nineteenth century it took about 500 years for the population of the British Isles to double to about 11 millions. In the single century which followed, the population, roughly speaking, doubled twice, being about 43 millions at its close. This increase has been almost entirely due to engineering, the improvement of the means of transport, the producing of manufactured articles to exchange for food grown in other countries, and the cold-storage process. But as numbers and competition have increased, it has been realised that large schemes and specialisation are essential to success. The result of this, however, is that labour and capital become less mobile, and the majority of the people in the country are too specialised to be able to change their occupation; hence, with any great improvement in manufacture or change of demand, depression and unemployment result in some industries. This, coupled with the aggregation of industries into large towns, where the people are crowded together amid unnatural surroundings, has caused serious deterioration of the physique and character of the workers. This result of industrialism, which tends to increase with its progress, is a grave economic and social question, and should be kept before all who are entering the sphere of engineering.

The only evil from which humanity suffers is ignorance. Nature has certain inflexible laws which govern existence, and those who are ignorant of these laws inevitably suffer. Our business is to study these laws, some of which assist and others which are injurious to us; to take advantage of those which are advantageous, and to avoid or circumvent the evil ones. The greatest difficulty of our time is that the mass of mankind are absolutely ignorant of these natural laws and their effects, and frequently desire what is useless or hurtful. As education progresses, however, the demand for things of real value will increase, and the wise engineer or business man is he who realises in advance what this demand must be, and prepares to supply it. Diamond or gold digging is of little real value to mankind except that a certain quantity of gold is convenient as a medium of exchange. All articles of fictitious or fancy value will tend to become less in demand as education progresses, and in any case such articles are the first to be dispensed with in times of depression. The grocery will succeed where the fancy shop fails, although during prosperous times the latter may flourish. The lesson to be derived from this is that the engineer, like the financier, must be alive to the real necessities of his fellow-men, and thus intelligently anticipate their requirements, instead of attempting to meet or create an artificial or temporary demand. One of these requirements to which the engineer should turn his attention is the provision of a greater food supply. There is an almost universal but false idea that the world produces ample food for its inhabitants, but, on the contrary, this supply is only about two-thirds of that required to nourish the race properly. The engineer who, by his improvements in agricultural machinery or otherwise, assists in improving this state of affairs will not only be a successful man, but will earn the gratitude of the community. Let it be clearly understood, however, that there is no necessity for self-sacrifice in attempting to make such improvements. What is wanted is simply the enlightened self-interest which realises that intelligently serving the public interest is really the best way of getting on oneself. At the same time, a realisation of the important part which science and engineering play in social welfare naturally brings high ideals with it. It is very difficult to preserve such ideals among the rush of unenlightened self-interest which exists to-day, but that should not involve the throwing of these ideals overboard, nor should it involve the shipwreck of the individual holding them. The rational course was to keep one's ideals like a star in sight, and, while going along with the currents and avoiding the rocks, to take every possible opportunity of turning one's face towards the desired goal.

FITTINGS FOR ELECTRIC LIGHTING.

Some Season's Specialities.—II.

Messrs. W. McGeoch and Co., Limited, of 28, West Campbell-street, Glasgow, have just issued their new catalogue of electric ship fittings—an elegant and finely-illustrated production, which displays to advantage a great variety of manufactures, and shows at the same time the firm's versatility, for, besides electrical fittings and appliances, a numerous variety of articles are illustrated. The first few pages of the catalogue present views of the exterior and interior of the works and showrooms in Glasgow and Birmingham. Though the catalogue itself is not a large one, it embraces all the recognised standard patterns of ship fittings, ranging to the best class of saloon and state-room fittings, figures for newel posts, etc. It is divided into three sections—section "S" showing guarded and unguarded pendants and brackets, Admiralty pattern pendants and

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brackets, ceiling fittings, chased ormolu pendants, illumi nated sign lanterns, etc. Fig. 1 illustrates a Louis XVI.

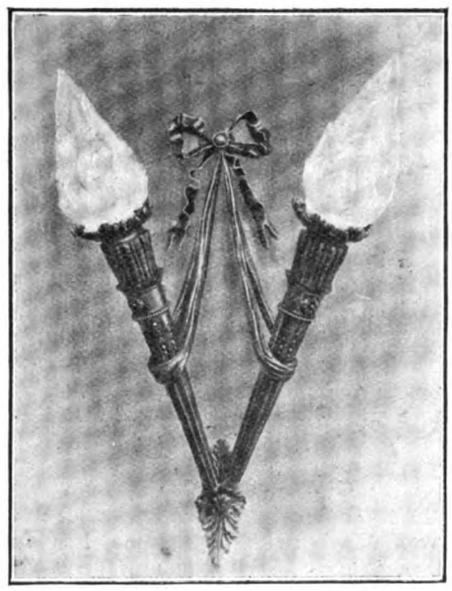

FIG. 1.—Louis XVI. Bracket (McGeoch and Co.).

FIG. 2.—Vase Pendant (McGeoch and Co.).

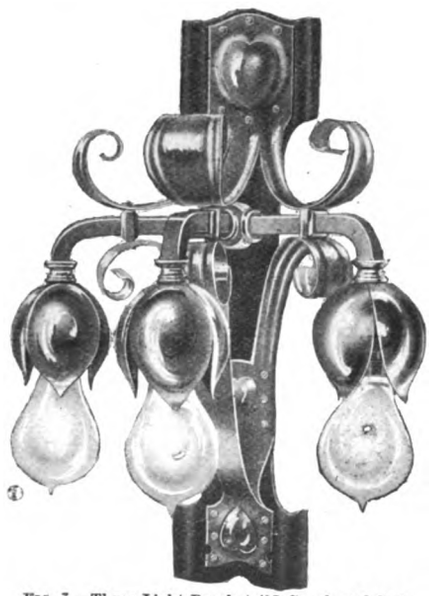

FIG. 3.—Three-Light Bracket (McGeoch and Co.).

two-light bracket. A fine specimen of vase pendant, also of the Louis XVI. type, is depicted in Fig. 2, while Figs. 3 and 4 are typical examples of brackets which are suitable for saloon and special rooms. Section "F S" of the catalogue deals with bronze figures, of which many very artistic patterns are shown. Section "P" relates to Admiralty electric lighting and bell material. The latter section should appeal very much to the many contractors engaged in this class of work.

FIG. 4.—Two-Light Georgian Bracket (McGeoch and Co.)

The special lines which are being placed on the market this year by Mr. G. Braulik, 217 and 218, Upper Thames-

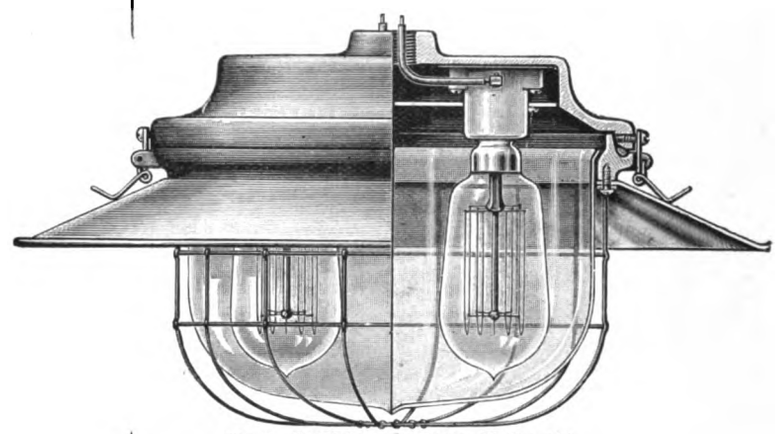

FIG. 5.—Multiple Lamp Fitting (G. Braulik)

FIG. 6.—Table Standard (G. Braulik).

street, London, E.C., do not include any patterns of fittings which are particularly unique. Nevertheless, a visit to the spacious showrooms in Upper Thames-street will serve to bring to notice a well-assorted selection of fittings for elec tric lighting from which artistic design is not lacking

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Serviceability, however, seems to be the chief aim in the design of these appliances, another feature of which is the relative cheapness of cost. Mr. Braulik is to the fore with a multiple lamp fitting for carbon or metal filament lamps.

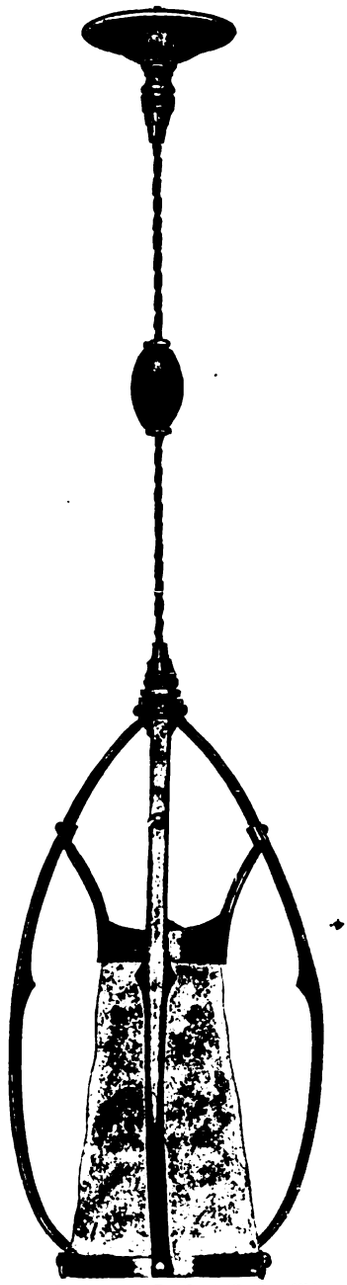

FIG. 7.—Lantern Pendant (G. Braulik).

The lamps can be connected in parallel or series of 1 c.p. to from 50 c.p. ordinary or 25 c.p tantalum, or 1-3-50 c.p. tantalum or 1-4-50 c.p. Osmi or Wolfram. Fig. 5 shows a type of this fitting which is suitable not only for the lighting of halls, but may be used in streets, works, etc. A neat

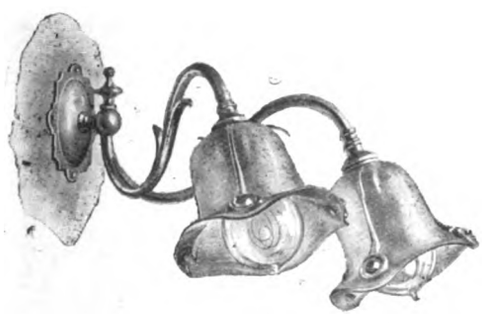

FIG. 8.—Two-Light Bracket (Electrical Co.).

and inexpensive table standard is that shown in Fig. 6. At the enlarged warehouses there is to be seen a very great variety of artistic hall and lantern pendants and types which cannot fail to meet the most diverse demands of contractors.

The Electrical Company, Limited, 121-5, Charing Cross-road, London, W.C., are introducing a new type of candle fitting, to which the name "Ideal" has been given. The fitting consists of a hollow insulated stem, which is adjustable to any desired length, and a separate porcelain tube. Any size or shape of candle lamp can be used, but a special lamp has been designed to partly illuminate the porcelain tube, giving a perfect imitation of the wax candle. The "Ideal" is shadowless, having neither supporting rings nor springs, and is easily and rigidly fixed in any candle cup without alteration. The lamp and holder are completely insulated from fitting, hence the chance of earthing is obviated.

FIGS. 9 AND 10.—Hall Lanterns Electrical Co.).

Many tasteful designs are to be seen in the fittings showrooms, which are located at 162, Shaftesbury-avenue. Fig. 8 illustrates a bracket (which can be supplied either one-light or two-light) of twig pattern, made in polished brass or black bronze, and having ornamental cast back plate. Figs. 9 and 10 illustrate hall lanterns, the

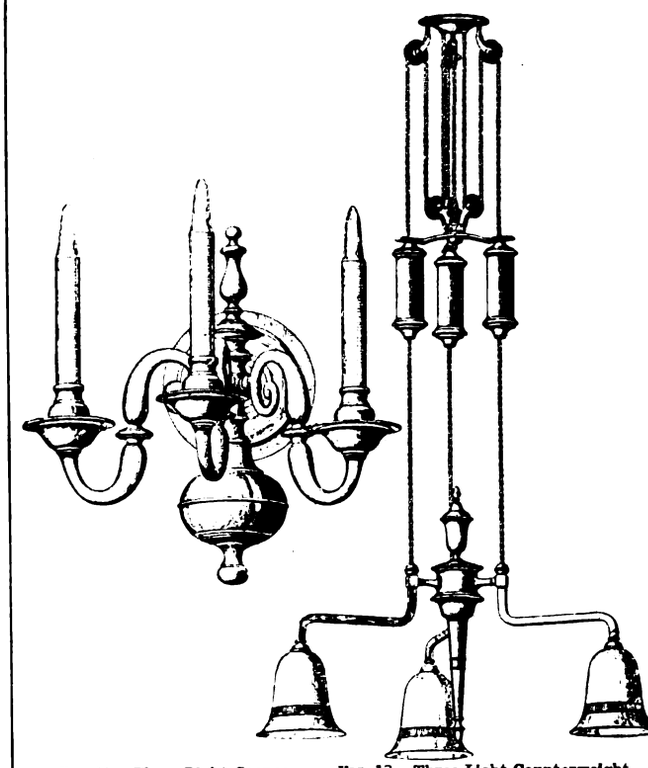

FIG. 11.—Three-Light Sconce (L.E F.Co.).

FIG. 12.—Three-Light Counterweight (L.E.F.Co.).

former being an Old English pattern, which is made either in wrought iron or polished brass, while the latter depicts a polished oxidised copper hall lantern with hammer marks and flint cathedral glass.

At the showrooms of the London Electrical Fittings

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Company, Limited, in 15, Newman-street, Oxford-street, London, W., are to be seen some good examples of fittings designed in Old English styles, especially in the Georgian. Fig. 11, which is a heavy three-light sconce, is a good example of this. Fig. 12 shows a novel form of three-light counterweight, the novelty being in the fact that three weights are employed instead of one, thus steadying the fitting, which can have a free movement.

UNITS USED IN DISTRIBUTION.

BY W. A. TOPPIN, A.M.I.E.E.

It is impossible for supply authorities to avoid losing a certain number of units between the generators and the consumer's terminals. As these units represent energy that has been produced and lost in a variety of ways, bringing in no financial return, it is highly necessary to keep this total as low as possible. This can only be done by finding out all the different ways in which this energy is dissipated, and taking steps to avoid any useless waste that may be discovered to be going on. Unless everything is accurately metered and the same system used throughout, it is impossible to compare the figures given by one town with another.

With alternating-current systems there is an unavoidable loss in transformers, the power absorbed by the shunt circuits of consumers' meters is considerable, and the idle current losses in the system may be large. This latter question has been the subject of a recent paper read by A. J. Cridge before the Municipal Electrical Association. The writer's remarks will chiefly deal with the losses in direct-current systems.

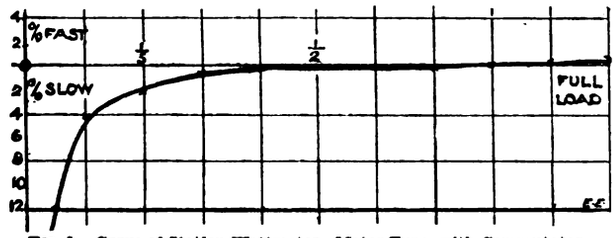

FIG. 1.—Curve of Station Wattmeter—Motor Type, with Commutator.

Let us deal first of all with the generators in the central station. The energy required to excite the magnets will amount to a considerable number of units per annum, but these are generally not metered. This is really immaterial, as it is an unavoidable loss, and no economy can be effected. It is most important that the meters connected in circuit with each generator to measure the units delivered to the switchboard should be absolutely correct. The generating staff are anxious for these meters to err on the fast side, so that the works costs per unit generated should be as low as possible, while the mains staff are equally anxious for them to err on the slow side, so as to apparently reduce the number of units lost in distribution. The testing of these meters is only carried out with difficulty, because they are almost continuously in use. To obtain a sufficiently large steady current and pressure for a stop-watch test is in many cases also difficult. The curve shown in Fig. 1 was obtained from a wattmeter of a type largely used in generating stations. It shows plainly how inaccurate would be the results of adjusting a meter of this type if only a small testing current was used. Inaccuracy at low loads is not very important where the meter is used for measuring generated units, as the generator is usually working at or near full load. The most satisfactory way of testing station meters is to put a portable meter in series with them for a short period. They can be tested in rotation, and each meter is tested at the actual load it generally has to work at. The portable meter can at any time be taken away and subjected to the most careful tests.

Turning our attention now to the switchboards, it is an easy matter to see that all switches, 'bus bars, and connections are of sufficient cross-section and the contacts kept sufficiently clean and tight to ensure as little loss as possible through heating effects. Types of circuit breakers that depend upon a rather loose contact for their automatic action should be avoided. All motors and lights used at the works should, of course, be metered. It is so easy to connect up motors or lights direct to the 'bus bars instead of running a wire to a meter and back again to the 'bus bar, that it is very likely in many works that some current-consuming apparatus is adding to the number of "stray" units. The energy so consumed may, of course, be estimated, but unless it is metered there is no tendency for the apparatus to be used economically. While too many meters are not advisable in a station, yet a certain number are necessary to ensure that current is not wastefully used. A meter for the stoker motors, feed-pump motors, and economiser motor, for example, check extravagance on the part of the boiler-house attendants. A meter for the motors driving the air-pumps, circulating pumps, and boosters will do the same for the engine-house staff, and a separate meter for the station lighting is also advisable. A discharge and charge meter in circuit with each battery is most necessary, as it is such an easy matter to waste an enormous amount of energy in the useless gassing of cells.

The numerous voltmeters, recording and otherwise, and wattmeters are found to consume a surprising number of units during the year if the question is gone into. Take, for example, 12 wattmeters, the shunt current for each being 0·05 ampere at 500 volts. We find that 2,620 units are used per annum in supplying these 12 meters with shunt current. A voltmeter will probably take 0·02 ampere, which, at 500 volts, will represent 87·3 units per annum, assuming that the voltmeter is constantly in circuit. As there are many of these in every station quite a respectable number of units can be accounted for in this manner. It is the usual custom to illuminate the dials of voltmeters and ammeters by means of lamps, and care should be taken

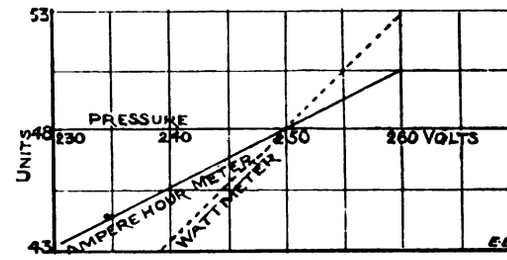

FIG. 2.—Effect of Pressure on Units registered by Two Types of Meter.

that the energy used by these is included in the works lighting units. A brilliant illumination is quite unnecessary, as, besides being wasteful, it is trying to the eyes of the attendants on duty. The above remarks also apply to sub-stations, except that the energy used to excite the magnets of the machines is metered. There are additional transformation losses to take into account. These in many sub-stations are very large, and can only be minimised by attention to the two following points: The machines, whether rotary converters or motor-generators, should be carefully chosen for high efficiency. One of the largest central stations in the country loses 9 per cent. of the energy supplied to the sub-stations in transformation losses. It is especially important where the cost of coal is high and the works cost per unit correspondingly high that as few generated units as possible should be lost in transformation, and, therefore, a few extra pounds spent in a more efficient machine in a sub station is capital wisely laid out. The other point depends on the attendants in charge of the sub-stations. Machines are most efficient at or near full load, and a large machine kept running for a small load means an unnecessary transformation loss. An attendant has, therefore, the chance of running the most efficient machinery inefficiently.

Let us turn our attention now to losses in feeders and distributors. The engineer of an undertaking here finds himself confronted by a problem which only a careful study of local conditions can solve. If he reduces the $C^2 R$ losses in the cables by working them at a low current density, the extra cost of the cables will increase his capital charges per unit, whereas, if he uses small cables, the $C^2 R$ losses per annum may be excessive. Thomson's law for conductors is rather difficult in practical application, as the cables are working at different loads during the 24 hours, and the loads vary greatly according to the period of the year. The question calls for careful judgment. Short-circuits on the cable system cannot cause much loss, as they

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quickly clear themselves. Earth leakages on direct-current three-wire systems may easily account for a large number of stray units if allowed to remain some time before they are located and removed.

We have now to deal with losses in consumers' premises, and the writer will point out some possibilities of loss that may appear at first sight too insignificant to demand investigation. It is a general practice amongst power consumers to have voltmeters connected up that are continuously in circuit. It is highly improbable that any supply meter will register the small current required to actuate the meter, and so each voltmeter will represent between 50 to 100 units per annum, for which no payment is made. Where there are a large number of power consumers the resulting loss will be considerable. In some towns power consumers are allowed to have pilot lamps on their switchboards or large motors in order to show them if the supply fails. These will be a source of loss, as the power meters will be of large size, and, owing to the very small current required by the lamps, it will either not be registered at all or else registered very inaccurately. If wattmeters are employed in consumers' premises, there will be a considerable amount of energy lost in supplying the shunt circuits, as this energy is not registered by the consumer's meter, though it will be by the generator meters in the works. The higher the pressure of supply the greater will this loss be. The makers of a certain well-known motor type of wattmeter state that the shunt loss of a 250-volt meter is eight watts per hour, and 16 watts per hour for 500 volts. From actual measurements made

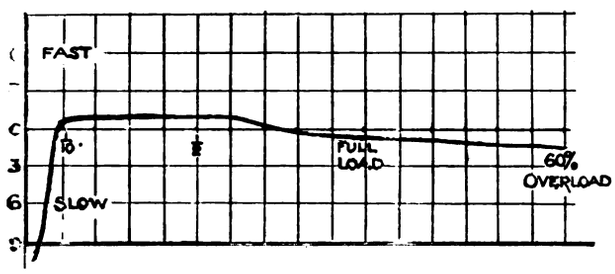

FIG. 3.—Curve of Ampere-Hour Meter—Mercury Motor Type.

by the writer, 500-volt meters were found to take 25 watts per hour. Taking four different types of wattmeters by well-known makers, the average watt consumption per hour was found to be 13·9 for 500-volt circuits and half this figure for 250-volt meters. The number of units expended in the shunt circuit of a 500 volt meter per annum will be, therefore, 121·43 Board of Trade units. If the exact declared pressure is maintained at the consumer's terminals, it will not pay the supply authority to go to the extra expense of wattmeters with their extra shunt losses. If, however, this pressure is often exceeded, wattmeters will register more than ampere-hour meters. With an increased pressure the lamps in circuit take more current, but this increase is registered by ampere-hour meters and wattmeters alike. In Fig. 2 the percentages gained or lost according to the increase or decrease of the supply pressure by using wattmeters is shown. As a general rule, it appears that there is more to lose than to gain by the use of wattmeters in consumers' premises. The curve shown in Fig. 3 was obtained from an ampere-hour meter of the mercury type, and compares very favourably, indeed, with the curve (Fig. 1) obtained from a motor-type wattmeter. Both meters were by well-known makers, and the curves are just average results.

The next point to come to is the correct registration of small currents. Unfortunately, from the supply authorities' standpoint, 5-c.p lamps do exist, and, worse still, turn-down lamps, which are meant to be used all night. A turn-down lamp with both filaments in series showed a current consumption of only 0·07 ampere, whilst with one filament only in use 0·14 ampere was registered. A very large percentage of meters in use at the present time would either not register these low currents at all or else register them incorrectly. It may safely be assumed that no ordinary commercial meter that has any moving parts can be depended on to correctly register currents less than 0·12 ampere, makers' statements and the performances of sample meters notwithstanding. The three-ampere size meter is usually the smallest size kept in stock, and very few makers will guarantee the accuracy of meters at below one-twentieth full load. The writer has made careful tests extending over long periods with a small current, using different types of meters that were not specially adjusted for accuracy at low loads, and the only type that was perfectly satisfactory was the Bastian. This type of meter, unfortunately, has various disadvantages, and cannot be made in large sizes. These small candle-power lamps are the very ones that are chosen by consumers for places where light is required all day or all night, and, consequently, the loss through incorrect registration is no trifling matter if a number are in use. Supply authorities who also supply lamps to consumers could make it a rule not to stock turn-down lamps or 5-c.p. lamps. If metallic filament 8-c p. and 16-c.p. lamps are brought out, the trouble will be aggravated. A most important point is to always keep the size of meters supplied to consumers as small as possible. The amount of money spent on meters is thereby reduced, the consumer is obliged to acquaint the supply authority of any large increase in his lighting or power, and the energy is as accurately registered as possible. Ampere-hour meters are very accurate on overloads, and are practically unaffected by overloads up to 100 per cent., even if of many hours' duration.

The choosing of the types of supply meters is a most important subject. One type of meter may not suit all classes of consumers. For power or heating purposes a meter not very accurate at low loads may be used, whilst for lighting purposes a type should be used having the lowest possible starting current and accuracy over a large range. Power consumers with very fluctuating loads require a meter accurate under these conditions, for some meters may test perfectly correct on a steady current, but be very incorrect if the current fluctuates rapidly.

To show how large a number of units generated may be wasted in the above-mentioned ways, the writer will assume that a certain supply authority has 1,000 consumers connected to the mains and that the supply is three-wire direct current with 500 volts across the outers. Wattmeters are used throughout, 300 consumers having 500-volt meters and 700 having 250-volt meters. No sub-station is used, and no account is taken of units used for excitation of generators, works power and lighting, $C^2 R$ losses in mains, or losses due to leakages between or from feeders or distributors :

	Units.
12 wattmeters in station constantly in use. Shunt loss per annum	2,620
6 voltmeters, recording and otherwise	524
24 voltmeters in consumers' premises, energy not recorded by meter	2 096
5 turn-down or 5-c.p. lamps used 10 hours per day or night, all the year round, and not recorded by meter	3,640
300 wattmeters, 500 volts, energy loss in shunts per annum	36,429
700 wattmeters, 250 volts, loss in shunt	42,500
Total lost units	87,809

If the generating cost are 0·75d. per unit, these lost units represent a loss of £274. 8s. Next to the economical transformation of coal into electrical energy, it is important to receive payment for as large a proportion of this energy as possible.

SHEFFIELD TRAMWAYS.

Mr. C. F. Wike, the city engineer of Sheffield, ought to be congratulated at the excellent work he has done in relaying portions of his tramway track, and especially in relaying the junctions and crossings as shown in the accompanying photographs. This network of points and crossings is at the junction of High-street, Haymarket, Commercial-street, and Fitzalan-square. This interesting piece of engineering work was carried out on Sunday, Oct. 6. The series of junctions shown are practically the pivot of the Sheffield tramway system, nearly all the cars running in the city passing this point in their respective journeys. The junction was relaid about six years ago, and then consisted of Hadfields' manganese steel. It has since taken about six million cars, the traffic averaging now about 3,000 cars per day. The

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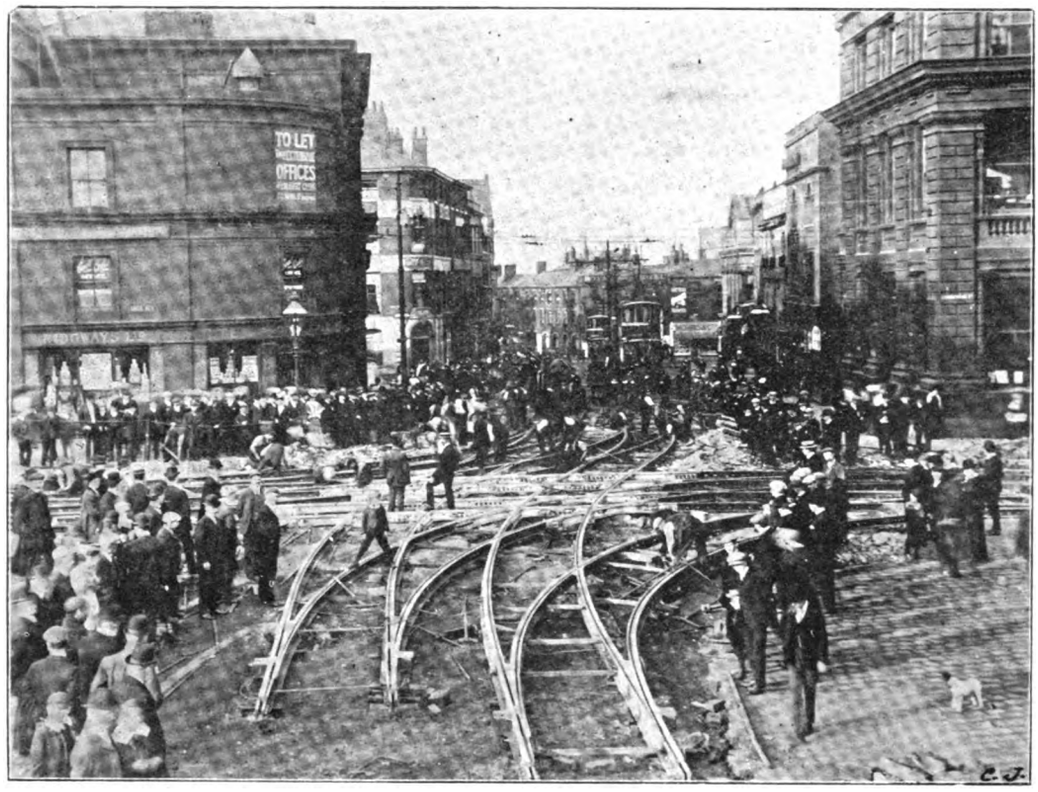
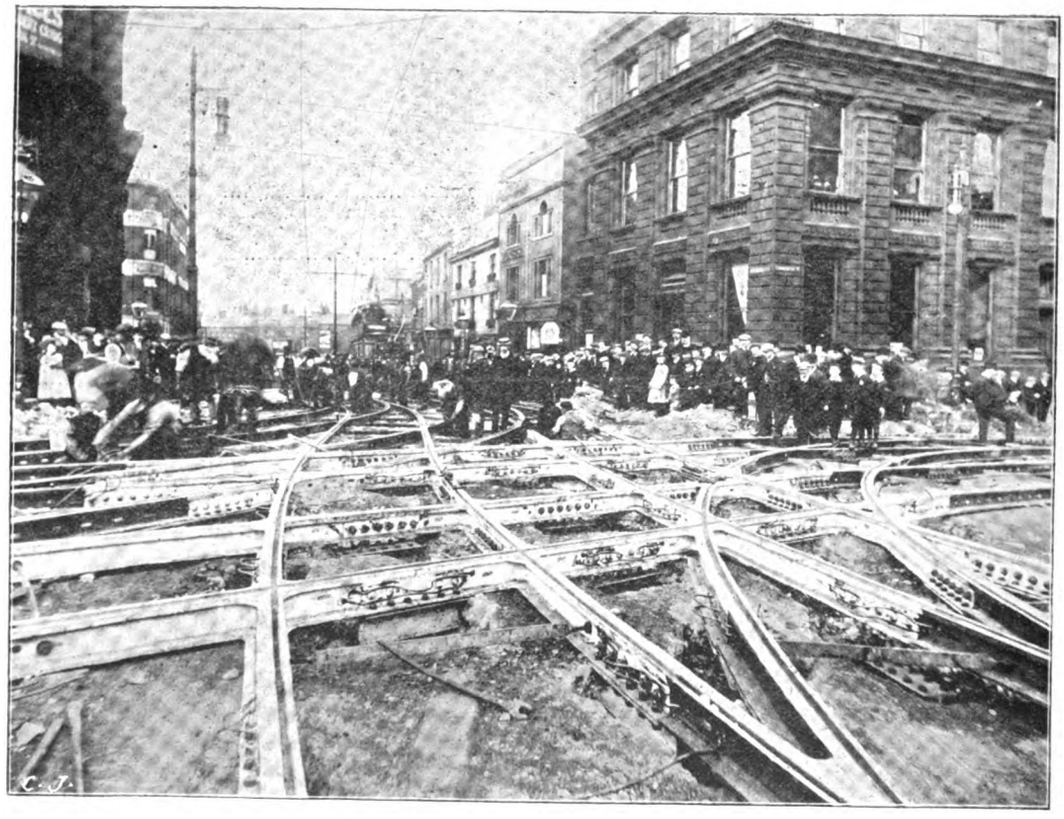
new castings have also been supplied by Messrs. Hadfields, their weight being about 38 tons.

Upwards of 120 men were hard at work in shifts from midnight on Saturday, all through Sunday, Oct. 6, and the adjoining square during the week previous to the renewal of the crossing. When the cars had ceased running at about midnight on Saturday, Oct. 5, the old junction was torn up and the new one moved into place. By about



Relaying Junctions and Crossings, Sheffield Corporation Tramways.

Sunday night. The electric light department took the opportunity of illustrating the power of their flare lamps. Five of these were used, and provided an excellent light for the men. Some idea of the work before them when eight o'clock on Sunday morning most of it was in position, it was afterwards anchored and concreted up, and on Monday morning at four o'clock the cars began using the main curve. The whole was in use on Wednesday,



Relaying Junctions and Crossings, Sheffield Corporation Tramways.

they started on Saturday night may be gained from the fact that after removing all the old rails they had new rails to lay, each weighing one ton, and 38 tons of manganese castings to fix.

A considerable part of the work was fitted together in except the siding in the foreground, which is entirely new work on a new bed of concrete. There are about 150 anchors in this junction, about 4,000 nuts and bolts were used, and the whole of the work was designed and carried out by the city surveyor, Mr. Chas. F. Wike, M.I.C.E.

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ON THE INDICATED POWER AND MECHANICAL EFFICIENCY OF THE GAS-ENGINE.*

BY PROF. BERTRAM HOPKINSON.

In the report of the committee of the Institution of Civil Engineers on the efficiency of internal-combustion engines the following remark occurs: "It would be desirable but for one circumstance to calculate the relative efficiency only from the indicator horse-power. But it appears that in the case of gas-engines, and especially gas-engines governed by hit-or-miss governors, the indicator diagrams do not give as accurate results as is generally supposed. The diagrams vary much more than those of a steam-engine with a steady load, and the mean indicator horse-power from the diagrams taken in a trial may, it appears, differ a good deal from the real mean power." This statement is fully borne out by the tests of the committee, which show that the mechanical efficiency taken as the ratio of brake to indicated power varied from 80 per cent. to 94 per cent. in the three engines tested. These engines were of similar type, but of different sizes, and whereas the smallest of 5 h.p. showed a mechanical efficiency of 90 per cent., the intermediate engine of 20 h.p. showed a lower efficiency of 80 per cent. The committee remarked that these values were obviously incorrect, and the values adopted by them for the mechanical efficiency were obtained by running the engine light and making an estimate of the indicated horse-power under these conditions. Assuming that the mechanical loss is constant at all loads, the indicated power at full load can be determined by adding the power absorbed at no load to the brake power. The mechanical efficiencies of the three engines found in this way were respectively:

Engine	L	R	X
Mechanical efficiency	0·86	0·866	0·888

These results are just what would be expected, the mechanical efficiency showing a slight improvement with the size of the engine.

The opinion of the committee quoted above is obviously important, and may be expected to have a widespread effect in gas-engine testing. It throws doubt upon many of the efficiency tests on gas-engines which have hitherto been made and published. Moreover, the method which the committee themselves adopted for getting the indicated power from the brake power seems to require further investigation before it can be accepted as accurate. It may no doubt be assumed on the evidence of steam-engine tests that under given conditions of lubrication the friction is practically independent of the pressure in the engine. But whereas in the steam-engine the whole of the mechanical losses are to be ascribed to friction, that is not the case in the gas-engine, in which a considerable amount of power is wasted in pumping, and is usually included in the mechanical losses. Moreover, with a given supply of oil, lubrication conditions in the steam-engine are practically constant, but in the gas-engine that is by no means the case. Great changes can take place in the temperatures of the cylinder walls in a comparatively short time, and this will affect the viscosity of the oil, and, therefore, the work spent in friction. The author, therefore, determined to undertake an investigation with the object of finding whether the indicator power of the gas-engine does, in fact, vary so much and is so difficult of determination as the report of the committee referred to suggests. If it were found that the indicated power could be accurately determined directly, it was further desired to test, by direct comparison of brake and indicated power, the validity of the committee's method of getting the mechanical efficiency. Briefly, the conclusions reached are:

1. If precautions are taken to keep the pressure of the gas supply constant, the diagrams given by the engine are remarkably regular, and, whether the engine be missing ignitions or not, it is possible, by the use of a sufficiently accurate indicator, to obtain the indicated power from diagrams within 1 or 2 per cent. It seems probable that the difficulty experienced by the committee was due either to the essential defects, for this purpose, of the ordinary form of indicator, or to casual variations in the gas supply per suction due, perhaps, to variation in the gas pressure at the engine.

2. The difference between indicated horse-power and brake horse-power is rather less than the horse-power at no load under the same conditions of lubrication mainly because of the difference in the power absorbed in pumping. In the particular engine tested by the author the error from this cause in obtaining the indicated power would amount to about 5 per cent. The friction is substantially constant from no load to full load, provided that the temperature of the cylinder walls is kept the same, but the influence of temperature is very great.

The engine used in the tests was kindly placed at the author's disposal by Messrs. Crossley Bros. It is intended to give a maximum output of 40 h.p. on the brake, and the following are the particulars of it:

Cylinder	11½in. diam. by 21in. stroke.
Speed	180 r.p.m.
Compression space	407 cubic inches.
Compression ratio	6·37.
Compression pressure	175lb. per sq. in. absolute.

When exploding every time, the indicated horse-power at 180 r.p.m. is 0·495 times the mean effective pressure. The engine works the ordinary "Otto" cycle, governed by hit-and-miss. The ignition is by magneto. The engine was loaded by belting it to a dynamo (lent by Messrs. Mather and Platt), which also served to motor it round when required. The fuel used was Cambridge coal gas. When an accurate measurement of brake power was desired all round rope brakes were used, one on each flywheel, and as the measurements were such that the brake tests only lasted a few minutes it was not necessary to use any water cooling. The engine was fitted with an exhaust gas calorimeter of the spray type.

For measuring the gas supply a standard holder by Messrs. Parkinson and Cowan, having a capacity of 10 cubic feet, was placed between the main gas supply and the engine, and as close as possible to the latter. In the ordinary running of the engine the holder stood at a constant level, the flow of gas into it just balancing the flow out, and under these conditions it served as a gas-bag, coming down by about one-tenth of a cubic foot at each suction of the engine. In a measurement of gas consumption the supply to the holder was cut off, so that the engine took gas only from the holder, and the quantity taken in a definite number of suctions (usually about 50) was noted. The indicator diagrams were photographed at the same time as this measurement was made. After the completion of the measurement the inlet pipe to the holder was opened and the counterweights adjusted so that the holder slowly rose to nearly its highest position, when the measurement could, if necessary, be repeated. It was possible in this way to read off the gas consumption correct to one part in 500, and, allowing for possible inaccuracies in the gasholder divisions, small changes in temperature and pressure, etc., it may be taken as certain that the gas consumption given is within ½ per cent. of the truth. This method of gas measurement is, of course, especially adapted for cases like the present, in which the actual gas used in a particular cycle or series of cycles is desired, but it may be noted that it is almost equally suitable for the measurement of gas consumption for a long period. It was found that it made no perceptible difference to the power given by the engine whether the inlet pipe to the holder was open or closed, and it may be assumed, therefore, that the gas consumption remains the same under these two conditions. The rate of consumption determined by the holder may, therefore, be assumed to hold during the interval, when the holder is filling or is standing at a constant level. This method of measurement, which is much superior in accuracy to any meter, and is very convenient, might easily be applied to much larger engines, since all that is required is a holder of capacity sufficient to run the engine for about one minute.

The work of making the tests and reducing the results was done almost wholly by two students of the engineering laboratory—Messrs. A. R. Welsh, of Trinity College, and A. L. Bird, of Peterhouse. To these gentlemen the author must express his thanks. Without their assistance it would have been impossible for him, with the time at his disposal, to have carried through the series of tests which is here described. The first requirement for the investigation proposed was an accurate indicator. In order to get at all satisfactory results, it was necessary to construct an instrument which could be relied upon absolutely to give the indicated power within 2 per cent. Further, it was necessary that the instrument should be capable of working for long periods without breaking down, so that large numbers of diagrams could be taken under given conditions. The author's experience of indicating gas-engines has convinced him that it is quite impossible to fulfil the first of these conditions, to say nothing of the second, with any form of pencil indicator. It is unnecessary to discuss here the various sources of error in the pencil indicator, but it may be noted that two of them—namely, the inertia of the piston and looseness in the joints—are of especial importance in the gas-engine. In the engine on which the experiments here described were made the pressure rises on explosion from 170lb. to 500lb. or 600lb. per square inch in less than one hundredth of a second. Now, the natural period of oscillation of a Richards indicator of the kind made by Casartelli, of Manchester, for gas-engine work when working with a three-hundred spring is of the same order—that is, about one hundredth of a second. In consequence of this, as is well known, violent oscillations may be set up by the explosion and continue along the expansion line of the indicator. The magnitude of these oscillations depends upon the relation between the time taken by the pressure to rise to its full value and the period of oscillation of the indicator. Thus with certain gas charges there will be practically no oscillation, while with a slightly different mixture the oscillations may become so great as to make accurate measurement of the diagram impossible. The effect of indicator inertia on gas-engine diagrams is well known, but the other

* Paper read before the Institution of Mechanical Engineers.

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defect referred to—namely, back lash in the mechanism—has not, I think, been fully appreciated, though it is fairly obvious. The maximum pressure in a gas-engine in which the compression ratio is 6 is 500lb. to 600lb. per square inch, and it is necessary, therefore, to use a very stiff spring. Stiffness is also required to reduce the natural period of the instrument, and so to bring within reasonable limits the oscillations due to inertia. In practice the author has found that in the Crosby indicator a spring giving a deflection of 1in. with a pressure of 300lb. per square inch is barely stiff enough. Now, the mean pressure is about 100lb. per square inch, giving a mean height with this spring of 0·3in.; slackness in the joints amounting to a total movement of the pencil of 1-100in. will, therefore, cause an error in the diagram area of 3 per cent.

The author has examined a considerable number of pencil indicators for back lash, and has not yet succeeded in finding one, even when perfectly new, in which it amounts to less than 1·5-100in., and in very few is it less than 2-100in., giving an error of 6 per cent. in the diagram area. It is by no means surprising that this should be so when one considers that in the Crosby indicator motion there are four pin joints between the piston and the pencil, and that the motion is magnified six-fold. Thus a movement of 1-100in. at the pencil corresponds to only 1-2400in. at each joint. Another error of the same kind is that due to the deformation of the lever carrying the pencil set up by friction of the pencil on the paper. The combined effect of this and of back lash is to increase the mean height of the diagram by an amount which, from the nature of the case, is quite uncertain, but which may easily reach 1-30in. even with a new indicator in perfect adjustment. This error is in most instruments counterbalanced to some extent, and in many over-balanced, by that due to motion of the pencil at right angles to the piston bore. The pencil motion should, of course, be accurately parallel to the piston motion, but in all indicators looseness in the joints prevents this motion from being perfectly definite. The pencil can move anywhere between two parallel lines, and the friction between pencil and drum is quite sufficient to make it take either of these. In the diagram the expansion line and compression line are both shifted inwards, and the area and mean pressure reduced. This defect is sometimes rather serious in the Crosby indicator, which in other respects is as good as a pencil indicator can be for gas-engine testing. The author has never found it amount to less than 2-100in., and the mean pressure taken with this instrument is, in consequence, often too small. Using a three-hundred spring, the mean pressure taken from a diagram 2½in. long from a gas-engine compressing to 170lb. per square inch absolute, will be 3½ per cent. too small if the horizontal back lash amounts to 2-100in. Stretching of the cord caused by drum friction of the kind discussed by Prof. Osborne Reynolds acts in the same way. It would appear that on account of these disturbances, in themselves so minute, gas-engine diagrams taken with a pencil indicator cannot be relied upon as accurate to within 5 per cent., and the error must often be more like 10 per cent. When the indicator is subjected for any considerable time to the wear and tear involved in recording the explosions of a gas-engine with high compression and using heavy charges, its joints rapidly become so slack as to destroy its value for any but the roughest measurements. Indeed, it may almost be said that the life of a pencil indicator (as an instrument of precision) when used on such a gas-engine is limited to a few hundred explosions.

To overcome both these defects of inertia and back lash it is necessary to reduce very much the motion of the moving parts of the indicator and to use optical means for magnifying that motion. The diaphragm manograph first proposed by Perry, and now in use to some extent as a commercial instrument in the form of the Hospitalier-Carpentier manograph, is unsuited for accurate quantitative work for a number of reasons, the chief of which are that the displacement is not proportional to the pressure, so that the diagrams cannot be integrated by a planimeter, and that it is inconvenient to calibrate. The author, therefore, determined to get a new design of indicator of the piston and spring type with optical magnifying mechanism. In the form finally adopted, after a considerable amount of experimenting, the spring consists of a straight piece of steel strip held as an encastred beam in a steel frame. A piston slides in a bore communicating with the engine, the axis of this bore being at right angles to the spring and passing through its centre. The pressure on the piston deflects the spring, and so tilts a small mirror about an axis at right angles to the bore, the pivots of this mirror being carried on a steel frame. To give the other motion to the mirror the whole apparatus (straight spring and mirror with its pivots) is positively connected to an eccentric on the crank axle, by which it is rocked about the axis of the bore, thus giving the piston motion of the diagram without the possibility of any lost motion. This instrument is practically indestructible, and it has been left open to the engine for considerable periods without giving it any attention. The vertical deflection is accurately proportional to the pressure, so that the diagrams can be integrated with a planimeter. Finally, the period of oscillation is only about seven-hundredth of a second with such strengths of spring as were used in the mechanical efficiency tests. The indicator is very easily calibrated by dead weights. The diagrams used in these measurements were photographed, but for many purposes it has been found sufficient to observe them direct by means of a telescopic arrangement by which they are projected as a bright line of light on to a transparent screen with vertical and horizontal scales. It is easy to plot the diagram on to a piece of squared paper, and its area can thus be obtained within 5 per cent. without the trouble of photography.

Fig. 1 is a facsimile of a normal diagram taken with this instrument—it represents about a dozen consecutive explosions. In order to determine the accuracy with which the indicated power can be determined three diagrams similar to this were taken, each comprising 20 consecutive explosions, and these were integrated by separate observers directly from the negatives, each diagram being dealt with by two observers so as to get six independent integrations. In the result the mean of all the measurements was found to be 0·954, the maximum being 0·963 and the minimum 0·940. This test was considered to have established the accuracy of the instrument subject to the calibration being correct. It also proves that the diagram, when the engine is exploding continuously, is quite remarkably regular. It is certain that in a continuous series of, say, 100 explosions the diagram area does not vary more than 1 per cent. on either side of the mean value. When the governor cuts out charges of gas, however, a slight enlargement of the diagram is sometimes perceptible in the cycle following a miss. Occasionally this enlargement amounts to as much as 4 per cent., while at other times it disappears completely. On theoretical grounds it is to be expected that the gas taken after a miss will be, if anything, slightly less than after an explosion.

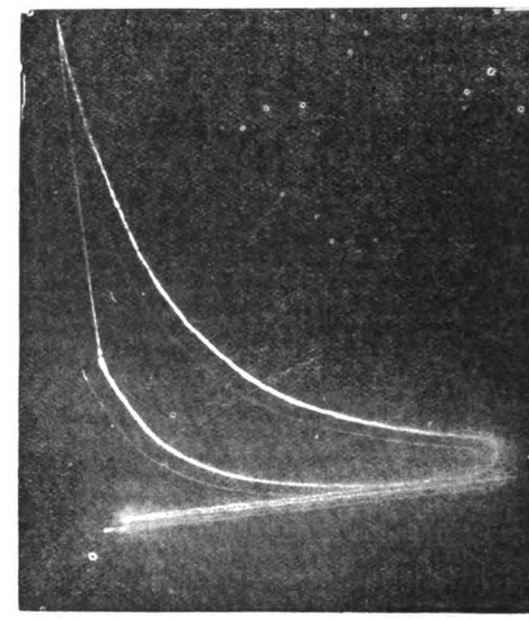

FIG. 1.—Facsimile of a Normal Diagram, representing about a dozen consecutive explosions, taken with Indicator (Figs. 4 and 5).

On the other hand, the efficiency is slightly higher. But, whatever the cause of the slight difference in area, it is clear that it can have no practical effect in an ordinary full-load trial, since it only happens once in five or six cycles. It may, therefore, be taken as definitely established that, given a sufficiently accurate indicator and constant conditions, the indicated horse-power of a gas-engine may be determined from diagrams with an accuracy which is probably superior to that attainable in the steam-engine.

The indicated horse-power of the engine is dependent, of course, upon the gas supply. In the tests described above the amount of gas taken per cycle was, no doubt, very constant, but it is probable that under certain circumstances there may be casual variations of gas supply which give rise to varying diagrams. The gas taken per suction with a hit-and-miss governor is determined by the temperature of the cylinder walls and piston, and by the opening of the gas-cock. So long as these variables and the pressure in the mains are kept constant there is no reason why the gas consumption should vary. In the trials described in this paper a gasholder of considerable capacity was placed close to the engine and the pressure in the holder was no doubt very nearly constant, but that, of course, may not be so in all practical tests. The mean pressure in the cylinder during the suction stroke is about 2lb. per square inch below atmosphere, equivalent to about 55in. of water. A variation of 2in. or 3in. of water in the pressure outside the engine, therefore, gives a substantial change in the gas supply. Such a variation would naturally occur after a missed ignition, if the gas-bag were not of very ample capacity and placed close to the engine, and this may to some extent account for the very considerably enlarged diagrams which in some engines

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have been observed to follow a miss. Changes of cylinder temperature considerably modify the gas consumption per cycle with the same opening of the gas-cock, but these changes are, of course, comparatively slow, and do not affect the accuracy of an estimate of indicated power where the conditions are fairly constant. As an indication of their amount the following test may be cited. The engine was first run light with a large flow of jacket water. It was then fully loaded, and the jacket water throttled until the temperature at exit rose to 185deg. F. (85deg. C.). The load was then suddenly thrown off, and the engine was allowed to run light for a short time with the hot jacket. A large quantity of water was then passed through the jacket, so that the temperature of the cylinder rapidly fell to 61deg. F. (16deg. C.). The gas taken per suction was measured at intervals with the results shown in Table I. It will be noted that the gas consumption varies between limits differing by 12 per cent., and the indicated power would change in almost the same ratio. The change in the gas consumption at and following the points marked * is mainly due to the change of temperature of the piston which very rapidly follows any change of load.

TABLE I.

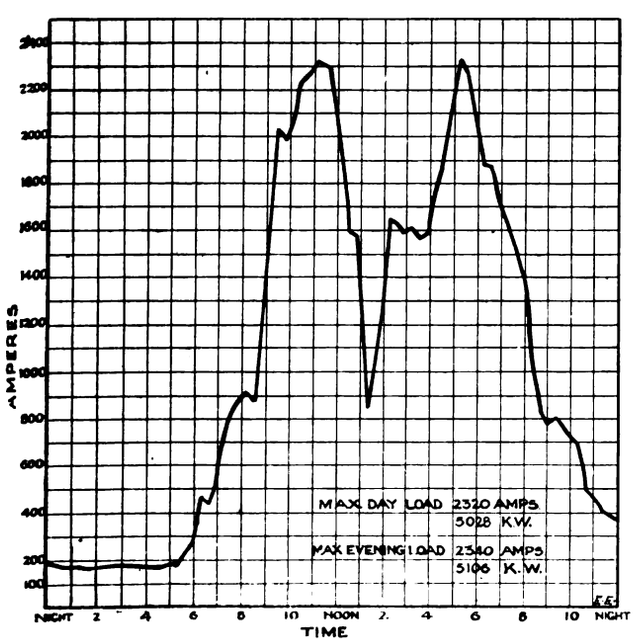
Jacket temperature. (Outflow.)	Load.	Gas. (Cub. ft. per suction.)
58–65° F. (14°–18° C.)	Nil	0·1217
*72° F. (22° C.)	Full	0·1124
114° F. (45° C.)	Full	0·1103
185° F. (85° C.)	Full	0·1072
*196° F. (91° C.)	Nil	0·1117
185° F. (85° C.)	Nil	0·1141
179° F. (81° C.)	Nil	0·1159
61° F. (16° C.)	Nil	0·1205

It will be desirable to give a statement of the meanings which will be attached in this paper to the terms "indicated power," "mechanical loss," etc. "Indicated power" is the area of the positive loop of the indicator diagram multiplied by the number of explosions per minute and by the appropriate constant for reducing to horse-power. "Mechanical loss" is the difference between indicated power and the brake power delivered at the circumference of the flywheels. It includes the negative loop of the working diagrams and also the negative work done when the engine takes no gas. "Mean effective pressure" is the mean pressure calculated from the positive loop of the indicator diagram. It is sometimes convenient to speak of the "mean pressure effective on the brake," and this is equal to the mean effective pressure multiplied by the mechanical efficiency. "Mechanical efficiency" is, as usual, the ratio of brake to indicated power (the latter being defined as above). "Thermal efficiency" is the ratio of indicated power to the lower calorific value of the gas used, the two quantities being, of course, reduced to the same units.

(To be continued.)

FOG LOAD IN SHEFFIELD.

The curve below, which we are able to reproduce through the courtesy of Mr. S. E. Fedden, shows the



maximum load charts for Monday last. There was a fog that day which made the day load practically equal to the evening lighting peak. The fog in question was not a particularly black one, but was evenly distributed over the city. Thus it affected all classes of lighting consumers.

A LOT ABOUT A SLOT.

'Twas just as the peak was waning,
On a dark and stormy night.
The engineer played diabolo,
And the stokers had a fight.
The arcs shone out so brightly,
And incandescents, too;
The mainsmen were writing Limericks—
They had nothing else to do.

At last there came a tinkle
From the door-bell ringing clear,
The greasers smacked their lips and smiled,
Thought 'twas their supper beer.
But 'twas only a sweet young maiden,
In a Tammy hat and cloak,
Saying, "Oh, sir! we have no light!
And I tell you it's no joke!

"I come from Dinkham Mansions,
From number twenty-six;
We only had it on to-day,
And it starts to play it's tricks.
I'd sooner have a candle—
You can get a light with that,
But with these electric light things
You want to be a cat."

Then spoke the boss most wisely:
"Brownson! pray take with you
A screwdriver and test lamp,
And see what you can do
To dissipate this darkness
And give these people light."
Then Brownson said, "Come on, miss!"
And went out in the night.

They arrived at Drinkham Mansions,
At number twenty-six,
And were greeted by the consumer,
Who said: "This is a fix!
Now, over in America
This wouldn't happen there,
For there our men are smarter,
And we get light and to spare."

But Brownson simply grunted,
Nor ventured to reply;
He simply started looking,
And the fuses met his eye.

He saw the fuses all intact,
The main switch on O K.,
But when he saw the meter
He almost said "Hooray!!"
He stopped himself from grinning,
Then to the gent he spake:
"Your men, *they* may be smarter,
But *you* fair take the cake!

"Here you've been a 'owling
For your light this day,
And look at what you'd do to get it.
Well, if you aint a jay!
You've 'ere a bob slot meter,
So give us up a bob.
I shoves it in the meter—there!
The coin does the job.

"Now then, Mister 'Merica,
You'll think before you shouts
And calls us freeborn Englishmen
An ignorant lot o' louts.
I aint no 'yde Park orator,
But I tells without fake,
Just ter put yer 'and out
And see if you're awake."—P. A. E.

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THE

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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LARGE GERMAN GAS-ENGINES.

During the past few weeks articles have appeared in our columns describing briefly a number of large gas-engine plants in Germany. It is natural that this should lead some of our readers to suppose that when gas-engines of 1,000 h.p., 1,500 h.p., and 2,000 h.p. are common in Germany, the English gas-engine builders must be very backward because they cannot show any quantity of similar size engines at work. Again, the article might lead the very casual reader to conclude incorrectly that large gas-engines had displaced steam-engines and steam-turbines in Germany. In order to correct the first impression we have obtained some valuable information from the leading gas-engine makers in this country, which appears in this issue, and which we shall be pleased to supplement in following issues as further matter reaches us as promised. The idea that our manufacturers of gas-engines are behind in what they make is absolutely incorrect, and it is also impossible, with few exceptions, to compare what they do with what we saw on the Continent. For example, all the plants visited were supplied either by blast-furnace gas or by gas from coke ovens, which is a very much richer product. They were working thus on a gas which, if not used in gas-engines, would either be turned into the atmosphere as a poisonous waste product or else burned under a boiler to produce steam for driving engines. In one of the works visited there were steam-engines in the same station as the gas-engines, but the higher thermal efficiency of the gas-engine enabled it to secure the extension orders. How can such a method of using gas-engines with a by-product from a metallurgical operation be compared with the gas-engines manufactured, for instance, by Messrs. Crossley Bros.? This firm, whose name is a household word, have supplied thousands of engines annually which are driven mostly by town gas, and in other cases by producer gas. While the firm have built engines up to 600 h.p., the small power user is the main stay of their business, and their small engines are keen competitors of the electric motor. Messrs. Ehrhardt and Sehmer, of Saarbrucken, on the other hand, make no small gas-engines at all. Their engineering business was built up, as described in our issue of Oct. 18, for the supply of plant to blast furnaces and rolling mills. Their gas-engines are all of a large size, but they did not show us any that were being worked on producer gas. We are sure that there is a great field for such engines in the iron-producing areas of Great Britain. We have now to deal with the second impression, which, as explained by Mr. E. J. Fox, cannot avoid some reference to the Johannesburg fiasco. The problem there was quite a new one, in that a producer working with local coal supplied the gas. We believe we are not disclosing any secret when we say that the gas produced in Johannesburg was much richer in hydrogen than is advisable for gas-engine use. Otherwise we do not wish to comment on the failure of the gas plant there, because it may be the subject matter of litigation. We would only express our belief, after seeing what was to be seen in Germany, that there are no engineering difficulties in the Johannesburg situation which have not, or cannot, be solved if the best experience is brought to bear upon them. To conclude with an expression of dogmatic opinion is, perhaps, unwise, but we hold that the English maker of moderate gas-engines has every reason to be proud of the engineering and commercial success which has resulted from his pioneering work. While these firms may or may not take up the manufacture of very large units for working on blast-furnace gas, we feel sure that those English firms that do will in the long run be as successful as Messrs. Ehrhardt and Sehmer have been.

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THE LONDON COUNTY COUNCIL TRAMWAYS.

If there exists an heavenly condition of things upon this earth, that condition must be the constant state of politicians and politic councillors. In either case, everything that is of their own side is right and everything pertaining to the opposite side is wrong. Of course, when parties change office there is always a convenient lapse of memory to enable the then ins to ignore the statements made when they were outs, or the change is attributed to not being fully informed when in opposition. The position of parties as to the tramway question is like the Heathen Chinee—peculiar. It is like Harcourt's ideas of Socialism—if Socialism is defined according to his dictum, then he is not a Socialist; but if it includes such fancies as "old age pensions," then he must reconsider his position. Happy man. Define everything "as you like it," then you are or are not a partisan according to your own definitions. Unfortunately, all the definitions in the world do not necessarily make for truth, hence it is very difficult to know when a man commends or condemns a tramway undertaking like that of the London County Council. You cannot argue with men who have no fixed common starting point—you can only dogmatise. Hence it is absolutely impossible to argue questions of tramway organisation with councillors or politicians. Any unbiassed individual who desires to know the truth looks in vain for help to the discussion of accounts and reports in the London County Council. Each member gets up and dogmatises, and his contribution to the student who desires information is *nil*. One says the accounts are misleading, the tramways do not contribute their fair share to improvements; another gets up and contradicts, maintaining they contribute more than their share. Now, what is the fair share under certain conditions, and why? The why is important. Again, one gets up and dogmatises about depreciation and a renewals fund. So far as we can gather, no two persons agree upon any of these things.

Let us come to a more useful and interesting topic. The politicians may fret and fume and fight; but what of the workers? Mr. Fell, the manager, Mr. Rider, the electrical engineer—these are the men whose work makes or mars the undertaking. In our estimation that work is admirably done. Think over these figures. The total capital expenditure up to March 31, 1907, was £6,946,310. 11s., the outstanding capital was £6,133,563. 17s. 8d., the total having been reduced by repayments of £603,173. 7s. 9d. out of revenue and £209,573. 5s. 7d. sales of horses and materials. In our earnestness we have long been inquiring as to what name is to be given to this eight hundred thousand odd. The surplus on the year's working was £339,487. 11s. 10d., which has practically been used for (1) interest £171,501 (we leave the shillings and pence), and (2) the remainder (after deducting about £10,000 for incidental payments—*i.e.*, income tax, parliamentary expenses, etc.) for depreciation, as we hold repayment of capital is real depreciation. Perhaps the great test in organisation is in relation to operating expenses. These were: (1) electric, 7·06d. per car mile run; (2) horse, 10·33d. per car mile. The receipts electric were just over 12·2d. per car mile, being £829,258. 10s. 5d for 16,267,579 car miles for 183,062,063 passengers. It would not be fair to compare the figures relating to the horse traction, because these were influenced to a greater extent by unfavourable conditions, principally due to reconstruction. But allowing for these, the cost of horse traction was 10·33d. per car mile; hence the conclusion is roughly warranted that reconstruction leads to economy. We must here emphatically dissent from those who would draw exact conclusions from figures really incomparable. The number of passengers per car mile (1) electric, (2) horse is no criterion of the value of the systems unless all conditions (population, distribution of population, class of population, fares, etc.) are identical. It may safely be said, if the comforts and facilities of travel be increased, the number of travellers will also increase. One other point. The Greenwich generating station was opened on May 26, 1906, and between that date and the end of the financial year generated 25,009,345 units at a cost of about ·676d. a unit, including interest and sinking fund charges. Not bad for a beginning, and not working to full capacity. The London County Council has now—October, 1907—in operation 62·34 miles electric and 54·23 miles horse traction, and is continuing the policy of reconstruction, though at a decreasing rate. If all are agreed upon the policy of reconstruction, we can think of nothing, except the conditions of the money market, which should not suggest get through the work as quickly as possible, and so minimise the losses due to the work. London traffic is said to be a non-party question. This was emphasised by a late chairman of the Council—Sir E. Cornwall—and the present chairman—Mr. P. Harris—at the Municipal and County Club on Wednesday. Both agreed that most of the work of the Council was on non-party lines, and the traffic problem was cited as one of these non-party questions. It would be well for London, for the officials responsible, and for the travelling public if absolute accord could be reached, and, if it is agreed that tramways are inevitable, to combine forces and get the whole system into order at the earliest moment.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

LARGE GERMAN GAS-ENGINES.

SIR,—I hope the figures recently published in your journal on the subject of large German gas-engines—giving a comparison between the running costs of gas-engines and steam-turbines—will not be accepted as final.

The comparison between these forms of prime mover favours the gas-engine to so pronounced an extent that, beyond pointing out that the difference in the running costs between these two forms of prime mover, *even on paper*, is not as great as the published figures would tend to denote, little further comment is required.

Steam-turbines have been somewhat handicapped in the comparison by their capital cost being rated on a basis which is, unfortunately, higher than our free trade country will permit. Then, again, the comparison in the items for (1) repairs, (2) labour, and (3) depreciation are so unfair in favour of the gas-engine as probably scarcely to require correction.

It might, however, be pointed out that 10 per cent. will scarcely cover interest and depreciation, and if 10 per cent. be increased to 15 per cent., which the managers of most industrial concerns would consider prudent, the advantage in favour of steam-turbines is much emphasised so far as this item for annual capital charges is concerned, and would be still further emphasised if the comparison between the capital cost of steam-turbines and gas-engines were placed, as already named above, on a more equitable basis.

Engineers have recently had an opportunity of re-reading the supposed advantages in favour of gas-engines when recommended in connection with the Johannesburg tramway scheme, and the contrast between the results then promised on paper and those actually obtained in practice will probably be the best answer to the claims put forward in your article in favour of large gas-engines at the present time.

That large gas-engines undoubtedly have their advantages under certain circumstances no one will deny, but it

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seems to me that their progress will not be advanced by the extravagant claims which are made in their favour in many quarters.—Yours, etc., E. J. Fox.

[We are pleased to publish Mr. Fox's letter, which deals with figures in Mr. Leonard Andrews's paper. There are large fields for both the steam-turbine and the large gas-engines, and it is only right for the advocates of each system to endeavour to extend the scope of their opera tions.—Ed., *E. E.*]

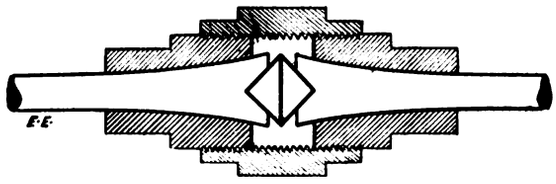
110-VOLT LAMPS ON VARIOUS VOLTAGES.

Sir,—I am requested by a travelling engineer to obtain information respecting the electrical equipment of his portable stage. He says that he only wants to carry one class of lamp—viz, 110-volt 25-c.p.—and to be able to quickly connect his 110-volt lamps in parallel on 110-volt circuit, or two in series on 220-volt circuit, as he does not want to carry different classes of lamps to suit the different voltages of electric supply. Also he desires to know about a regulator to effect a constant voltage at the lamp terminals, should the supply be higher or lower than 110 volts or 220 volts. I hope you will understand the information he desires, and shall be greatly obliged if you will be kind enough to send an early reply.—Yours, etc, S. F. F.

[We have given the writer some information which will help him, and are sure he would welcome any further advice in this column from any reader.—Ed, *E. E.*]

CABLE CLAMPS.

Sir,—I shall be much obliged for the address of the maker of special clamps for jointing electric cables, which were, I believe, advertised in your valuable paper. The clamp is similar to the rough sketch appended.



They were placed on the market some months ago, but I have not seen them advertised lately.—Yours, etc.,

Herbert J. G. Webb.

[Can any of our readers oblige us with the above information?—Ed, *E. E.*]

ADDRESS WANTED.

[A letter from F. Thomas desiring information cannot be answered as no address is given.—Ed., *E. E.*]

THE CENTRAL-STATION MAN AND THE LOCAL PRESS.

The function of the borough electrical engineer or the manager of the electricity company in any town, is not only to efficiently manage the technical side of the undertaking, but to make himself generally agreeable to everyone in the town. It is, therefore, probable that he is on good terms with the editor of the local paper, and he may from time to time not wisely, but too well, estrange that friendly relation by endeavouring to get information of a character which is rather tainted with electrical engineering into the news columns of the journal. Now, the editor, although he may be a good fellow and anxious to oblige a friend, is not going to give away the status of his paper and bore his readers by obvious puffs, more particularly when he is asked to do it for nothing.

The average supply authority has not yet risen to the height of advertising which renders the allocation of a fund for newspaper payments a necessity, and so the engineer has to very carefully consider in what way he can get his article into the paper so that he may benefit his business without damaging the position of his friend, the editor. Newspaper men are always after articles that will appear to the public as news, and there is no element of news more attractive to the journalist than that of novelty. Something unusual in the news must be one of the prime essentials An article in *Selling Electricity*, one of our clever American contemporaries, gives a very good illustration of this In a city daily's office news came in of a man shooting and killing his brother in a fight. The murder of the brother insured a big headline on an inside page, although the persons involved were neither rich or prominent, but when a supplementary account came in that the brothers were twins, the story reached the dignity of a front pager. The editor wants to get hold of what the public wishes to read, and not what he wishes to read himself, and central-station engineers must consider the little-known features of their work, and try to find out the unusual things, and then they may often be able to get articles into the local Press that will greatly assist them. Without doubt there are many men in all parts of the country who have stowed away in their heads particulars of their supply business that would make good readable news. They should consider it part of their duty to see how far they can get those features before the public.

Another point, which is given emphasis in the article, is that the time for giving out the suggestions for local news is very important. For example, it is no use trying to get a good account into a paper when there has been a big football match in the town, a fire that has destroyed half a street in the central part of the city, and a Church congress. Newspaper reporters themselves are very careful on this point. The public has a way of thinking of only one thing at a time. Some days of the week are better suited to news than others. Certain seasons of the year offer better opportunities. For example, news is particularly scarce after a heavy snowstorm, or a rain that has paralysed the society functions of a place At such times the newspaper officials would go out of their way to give more space to the electric supply company's news feature than it might legitimately be worth.

The great point to be remembered is that the central-station manager should cultivate the constant asking of the question, "Would the public like to read about it?" and to answer it from the point of view, not from his own position, but that of the average newspaper reader. The third point is how to tell the story. Usually the safest plan is to get a reporter with whom he is on terms of personal friendliness to come and talk things over in a quiet way, and then to leave the journalist to work things up in his own way. The lurid imagination of the newspaper man may, perhaps, be brought to bear on the subject-matter in a way that will horrify the technical susceptibilities of the station man, but that, after all, will be to some extent an advantage, inasmuch as the public will know that a technical man could not possibly have written it.

In another part of the journal appears a little story, which, whether it was intended as an illustration or not, affords a concrete example of the way in which a sheer shout as regards the production of a certain firm may be turned into quite an interesting news paragraph. This is so clever an example of this type of thing that we venture to produce it in full.

Lansingh and the Statistician.

A man in cowhide boots and a furry plug hat found his way to the desk of Mr. V. R. Lansingh, of the Holophane Company, the other day. V. R., who is polite, even to people who do not buy holophane, extended his hand in cordial greeting.

"I am Gustave Sykes, statistician." He waited for this to sink in. "I can help you," he pronounced, solemnly.

Mr. Lansingh pointed to a sign which hung at the doorway, "No help wanted"; but he of the sepulchre voice was above levity. He drew up his chair and continued: "The statistics of your company if carefully gathered—— "

"But we don't want statistics; we want orders," objected the man who makes holophane hollow.

"Just so; these statistics will help you to get them."

"Look here. Last year you sold 52,000 reflectors of one

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model—No. 2,631. Think of the statistics one can make out of that one item!"

"Observe, 52,000—4,333⅓ dozen—packed 10 dozen to the barrel, that makes 433 barrels; 190 barrels make a car—three cars practically. Each barrel weighs 105lb.—45,507lb. of reflector No. 2,631 were sold last year—more than twice the weight of the defunct elephant Jumbo!"

"But——" Lansingh was cut short.

"Think, sir," interrupted he of the home-made statistics. "Think what this tiny reflector—No. 2,631, I believe you call it—means to the electrical industry! Think what it means to mankind!"

Lansingh thought.

"Every one of those reflectors harbours a 16-c.p. lamp—52,000 reflectors, 20 lamps to the kilowatt—you have 2,600 kilowatts capacity in engines, boilers, generators, transformers, wire, conduit, cleats, and fixtures, which are made essential and necessary all because of the small piece of scientificially designed glass!"

"And the boon to humanity! Each of those reflectors increases the practical efficiency of the lamps 400 per cent. Four hundred per cent. of 52,000 16-c.p. lamps means, roughly, that you have with this small reflector literally created over 2½ million candle-power of light!"

There was a pause, while Lansingh looked at his watch. It may be remarked that V. R. is something of a lightning calculator himself.

"Sir," he said gently, "there is nothing in it. Those figures are what J. Robert Crouse characterises as 'bunk.' While you have been sitting here eight precious minutes have elapsed. In that time four of those small No. 2,631 reflectors should have been sold if we are to keep up our average of sales Those four reflectors are worth to us, at retail, approximately 52 cents each. Please pay the cashier on your way out."

And he bowed him past the door.

Most of our readers will admit that the above, although very American in style, has a distinctly useful moral.

"MARTYN'S PATENT" WATERTIGHT FUSE.

A new type of watertight fuse of a very simple and ingenious design has been placed on the market by Messrs. S. W. Martyn and Co., of 11, Pratt-street, Camden Town, London, N.W. Referring to the illustration showing the cross-section, it consists of a nipple, A, which screws into a socket, B, on a conduit system or into a cast-iron column as the case may be, and it is held in position by the lock-nut, C. Through this nipple the two wires, D, are brought, and on to them are threaded a porcelain disc, E, which has a slot for the brass-wire clip holder referred to later on, the cross-section of slot and clip being clearly shown; then a rubber disc, F, then another but thinner porcelain disc, G, and then another rubber disc, H. At this stage the wires are shown connected to their socket terminals, O, by a cone joint, J, and securely fastened.

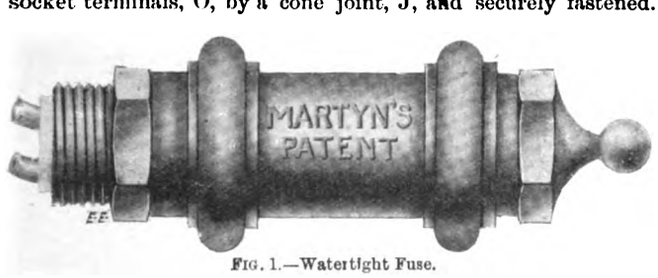

FIG. 1.—Watertight Fuse.

Over these terminals a porcelain piece, K, with a shoulder for resting on the edge of the nipple, is placed, which completely covers up all live metal parts. Through the combination a brass-wire clip passes, having two nuts for tightening-up purposes which are embedded in porcelain, although no part of this holder is alive, being there for the sake of convenience. The clip presses all the porcelain parts so far mentioned together, thereby expanding the rubber discs against the inside of the nipple and against the cables, making everything secure and watertight. The fuse wire, L, is protected by an asbestos tube, M, as shown, and is still further protected by being enclosed in porcelain, the ends being connected by a cone joint to the terminals, which have split pins for inserting into the sockets on the main body part. Over the various parts a cast-iron cover is screwed on to the nipple, a hexagon part being provided, as shown. This fuse can be used wherever a really watertight, gastight, or airtight article is required, for the makers state it will stand a pressure of 50lb., and for colliery work it should be a speciality. All current parts being completely embedded in porcelain, and the fuse wire being still further protected by being enclosed in an asbestos tube, there can be no risk, even to the person, should the fuse blow on replacement. The fuse part itself can be withdrawn like a wall plug, and to put in a new fuse no tools are required—in fact, once the cover is off, nothing is required but a piece of ordinary fuse wire. Owing to the porcelain and asbestos protection and the long fuse break, about 6in., no arcing can take place, and on high-voltage circuits it is very satisfactory. The cone joints are very simple, and the makers state are superior to soldering methods, and can be made in one-tenth of the time. The fuse, being very simple, is easily

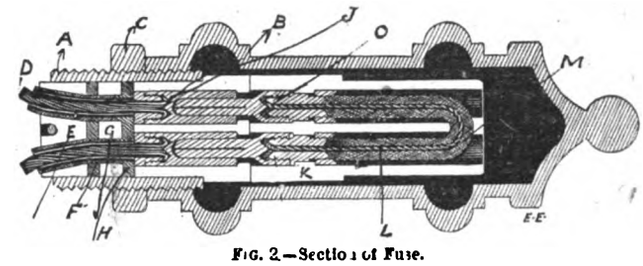

FIG. 2.—Section of Fuse.

erected, and being well thought out it should be largely in demand by electrical engineers. At present it is made only in one size, to take all currents up to 15 amperes at all pressures up to 650 volts.

FORTHCOMING EVENTS.

FRIDAY, NOV. 1.

Institution of Mechanical Engineers.—At 8 p.m., adjourned discussion on Prof. Hopkinson's paper.

TUESDAY, NOV. 5.

Institution of Civil Engineers.—At 8 p.m., address by the president, Sir William Matthews.

WEDNESDAY, NOV. 6.

Dynamicables.—At 7 p.m., dinner at Trocadero.

THURSDAY, NOV. 7.

Association of Engineers-in-Charge.—At 2.30 p.m., visit to Kodak photographic works, Harrow.

Rontgen Society.—At 8.15 p.m., at 20, Hanover-square, "The Production of High-Frequency Oscillations," with Demonstrations, by Mr. W. Duddell, F.R.S.

FRIDAY, NOV. 8.

Electro-Harmonic Society—At 8 p.m., ladies' night, at the King's Hall, Holborn Restaurant.

Physical Society.—At 8 p.m., in the Physics Laboratory, Royal College of Science, Imperial Institute-road, South Kensington, discussion on Mr. Campbell's paper, "On the Use of Variable Mutual Inductances"; "A Graphic Method for Stream-Lines and Equipotential Surfaces," by Mr. L. F. Richardson; "On the Lateral Vibrations of Bars supported at Two Points with one end overhanging," by Dr. J. Morrow.

Northampton Institute Engineering Society.—At 5.30 p.m., debate on "The Relative Merit of College and Workshop Training for the Engineer." Dr. R. M. Walmsley in the chair.

SATURDAY, NOV. 9.

Institution of Electrical Engineers.—At 10 a.m., students' visit to Bow works of North London Railway Co.

Institution of Civil Engineers.—Tuesday, Nov. 12, at 8 p.m., "The Extension, Widening, and Strengthening of Folkestone Pier," by Mr. T. H. Ker.

Association of Engineers-in-Charge.—Wednesday, Nov. 13, at 8 p.m., at St. Bride's Institute, Bride-lane, Fleet-street, E.C., "Economic Considerations on the Management of Plant," by Mr. W. H. Patchell.

Institution of Electrical Engineers.—Thursday, Nov. 14, at 8 p.m., at Great George-street, "The Dielectric Strength of Insulating Materials and the Grading of Cables," by Mr. Alexander Russell, M.A. Thursday, Nov. 28, at 8 p.m., "Development of Turbo-Generators," by Dr. R. Pohl.

I.E.E. Dublin Local Section.—Thursday, Nov. 14, at 8 p.m., at the Royal College of Science, opening meeting.

I.E.E. Manchester Students' Section.—Tuesday, Nov. 19, at 7.30 p.m., at Municipal School of Technology, "Power for Works and Factories, with Costs," by Mr. L. J. Lepine.

I.E.E. Glasgow Local Section.—Tuesday, Nov. 12, at 8 p.m., meeting at 207, Bath-street; Friday, Nov. 15, at 8 p.m., students' meeting at Glasgow Technical College; Wednesday, Nov. 20, at 6.30 p.m., annual dinner at Grosvenor Hotel.

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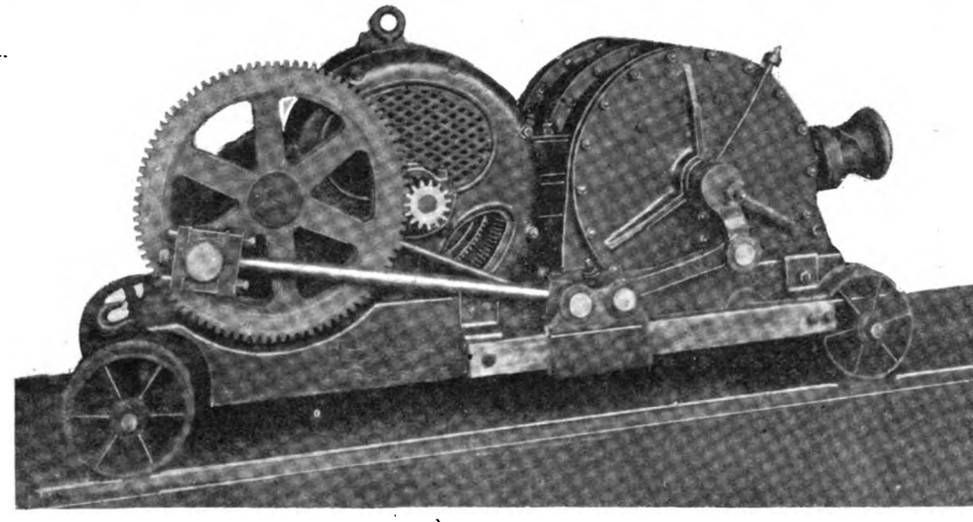
A NEW PORTABLE AIR COMPRESSOR.

The accompanying illustration shows a portable air compressor recently invented by Messrs. Simpson and Lishman. It was specially designed for use in coal mines for the purpose of driving coal-cutters and such like machinery, where economy and space available are very important factors, and almost the governing features. The small size of the machine allows of it being taken as near to the coal face as may be deemed advisable, as the small size of motor required, due to the friction of the machine being reduced to a minimum, enables a type of motor to be used without slip-rings, thereby considerably reducing the risks due to sparking. The inventors being closely connected with the management of some large collieries in the North of England have been fully alive to the importance of compact machinery for mining purposes, and they believe their machine to be without a rival with regard to the small space required and its portability for a given horse-power.

A brief description of the machine may not be out of place. It is electrically driven, power being transmitted through the motor pinion to a countershaft fixed on the back of the motor. The countershaft has a crank disc at each end, from which, by means of connecting rods or otherwise, a semi-rotary motion is obtained at the compressor, which is fixed on the bedplate at the opposite end to that of the motor. The illustration shows one connected by connecting rods, the power being transmitted through a link



New Portable Air Compressor.

motion to the compressor arms. The compressor itself is in two parts, a diaphragm dividing them, the idea being to distribute the compression points over the whole revolution, one crank being set at 90deg. with the other, thus producing steady running and a continual flow of air. Each part is fitted with two pistons fixed to the shaft. By this means four compressions take place every revolution. The inlet portways are on the top of the compressor, these being opened and closed by the pistons themselves. This assures a full supply of air, due to a partial vacuum being made on the suction side of the stroke. The air is then compressed by the rotating arm or piston against a fixed delivery box provided with delivery valves, and thence to the receiver. No water jackets are required. The diameter of each part of the compressor is 26in., each piston having 100 square inches area and a circular stroke equivalent to 2ft. The cranks make 118 r.p.m. At this speed the compressor has a capacity of 600 cubic feet of free air per minute and a combined efficiency of 75 per cent. The height of the compressor from rail level is 3ft., width 2ft. 10in., length over all 7ft., and the total weight 3 tons approximately.

ELECTRIC SUPPLY METERS.

British Standard Specification.

An important report (No. 37) has just been issued by the Engineering Standards Committee giving the specification for supply meters, which, we see, is confined to meters of the motor type for use on continuous and alternating current circuits. The specification has been prepared after very exhaustive inquiry into the matter, and the points to which the committee have confined their attention are most necessary to the proper working of a meter. The capacities which the committee stipulate for recognition as standard are 3, 5, 10, 25, 50, 75, and 100 amperes. They recommend that the meter be contained in a substantial dust-tight metal case, which must be capable of being sealed in such a manner that access to the working parts and the electric and magnetic adjustment of the meter can only be obtained by breaking all the seals, the case to be provided with one or more dust-tight windows, glazed with a substantial sheet of glass which cannot be removed without breaking all the seals of the case or breaking the glass. The terminals are to be enclosed by a separate cover or contained in an external compartment, separately sealed. The terminals of the pressure circuit are to be adapted to receive a conductor $\frac{1}{16}$in. diameter. For the purpose of sealing the case at least two sealing places must be provided—one to be sealed by the manufacturer and the other to be sealed by a testing authority.

The recommendations of the committee with regard to dials, records, and rotation are of special importance. Thus:

11. The dial plate shall indicate the total consumption directly in units, either by means of a number of index hands each travelling round a circular dial on which divisions are marked and figured to indicate units, tens of units, etc, or by means of counter wheels on which digits are marked to indicate units, tens of units, etc., provided that only one digit on each counter wheel shall be visible at a time.

12. The faster moving index hand or counter wheel shall indicate one unit per division or per digit, and the dial plate shall bear a statement to that effect. A convenient testing index shall be provided in addition which shall be quite distinct in appearance from the dial proper.

13. The dial plate shall have a sufficient number of dials or counter wheels to record and indicate a total quantity not less than that which would pass through the meter if its full load were maintained for 999 hours.

14. The speed of the rotor at full load shall not exceed 150 r.p.m., and the correct direction of rotation shall be clearly indicated.

After dealing with other matters of minor importance, the committee report on minimum running current and limits of error, specifications of which are laid down in the following clauses:

19. When a current equal to one-hundredth of the capacity of the meter (provided this current is not less than one-tenth of an ampere) traverses its main circuit for a period of not less than five minutes, the meter shall start and continue running steadily during this test. If the meter has a pressure circuit, the marked pressure shall be applied to it throughout this test.

20. The error of a meter when tested at a marked temperature, pressure frequency, and unit power factor shall not exceed 2½ per cent.: at any part of the range below one-tenth of full load down to and including one-twentieth of full load the percentage error shall not exceed the figure which is obtained by dividing, by 4, the denominator of the fraction expressing the proportion the load bears to the full load—that is to say, at 1/Nth of the full load the error shall not exceed N/4 per cent.

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The manufacturer is not required to provide for a greater overload capacity than 25 per cent. When a meter has a pressure circuit the rotor must not run when no current is flowing in the main circuit, and any pressure from zero up to 10 per cent. above the marked pressure is applied to the pressure circuit. The committee provide for independent tests in the event of a difference between the purchaser and the manufacturer as to the accuracy of the meter. If the meter in dispute is intended for a public electric supply system, independent tests shall be made by an inspector appointed under the Electric Lighting Acts; in other cases the dispute is to be referred to the National Physical Laboratory.

The committee have completed their work in a most successful manner, and the conditions laid down in the specification, if adopted, should tend to a marked improvement in the instruments, as well as the removal of a number of difficulties which at present hamper the meter industry. The specification was drawn up by a sub-committee on electrical plant accessories over which Mr. C. H. Wordingham presided. The committee included many names well known in the electrical industry, but mention should be made of the services rendered by Mr. Leslie T. Robinson, M.I.C.E., secretary, and Mr. C. Le Maistre, A.M.I.C.E., electrical assistant secretary.

PICTURESQUE EXAGGERATIONS.

The tendency of modern journalism is to publish the truth in a picturesque and attractive form. At times the touching-up process renders the final statement absolutely misleading. As an example we take the following case. The *Daily Mail* in its issue for Saturday last published the following:

STAFFORDSHIRE.

Town in Darkness.—When Hanley lay under a thick fog on Saturday afternoon the town was suddenly thrown into darkness by the failure of the Corporation electric light supply. Throughout the whole business centre of the town the greatest inconvenience was caused, and the curious sight was presented of lighted candles having to be introduced into shops, houses, and offices. The breakdown of a cable was the cause of the mischief, and it was some time before the district affected could be connected up by other cables.

Mr. C. H. Yeaman, who sent us the above cutting, writes:

Dear Sir,—I enclose for your information cuttings from the *Staffordshire Sentinel* of Saturday and Monday, as well as a copy of a letter to the *Daily Mail*. The daily Press have a habit of grossly exaggerating the picturesque. All that happened on Saturday was a breakdown in insulation of a 2,000-volt feeder cable in the centre of the town, caused by mechanical damage to the troughing and sheathing during the opening of the ground in the vicinity a few days before when the gas company put in a gas service. The load at noon on Saturday was only 392 kw. A light-grey misty fog overhung the town, but as our load is 1,000 kw., the proportion of supply affected was small. Moreover, the voltage was down for less than five minutes during the period the suction fuses were intact and another generator was going in, and the whole incident was over by 3.30 p.m., so that the late afternoon and regular evening load was not affected at all. I thought you might like to know the facts at first hand, hence this letter.

Mr. Yeaman's letter to the *Daily Mail* reads:

Staffordshire "Town in Darkness."

Dear Sir,—Your paragraph under above heading in Saturday's issue is very misleading and is literally incorrect, differing considerably from the *Staffordshire Sentinel* report: (*a*) the town could not be in darkness, as we supply under 1,000 customers out of 12,000 premises in the borough; (*b*) the pressure generally was low for only three minutes—*i.e.*, from 12 noon to 12.3 p.m. and everything was normal at 12.5 p.m. except *one* small area; (*c*) this area—Piccadilly, Miles Bank, and Lamb-street—was on again partially at 1.30, and the complete supply was resumed at 3.30 p.m. To say that the town was in darkness in the afternoon, and that the whole business centre was affected, is not only an exaggeration, but is literally not true, and in common fairness I ask you to amend your statement.—Yours faithfully, C. H. YEAMAN.

We need only add that the reports of the breakdown in the *Staffordshire Sentinel* bear out Mr. Yeaman's statements.

FACTORY AND WORKSHOPS ACT, 1901.

Draft of New Regulations.

In our last issue we published the objections offered by the Incorporated Municipal Electrical Association to the draft regulations for the generation, transformation, distribution, and use of electrical energy in premises under the Factory and Workshops Act, 1901. The electrical section of the London Chamber of Commerce has now sent to the Right Hon. Herbert Gladstone, M.P., the Secretary of State for the Home Department, the following letter and detailed objections. The letter reads:

Draft Home Office Regulations for the Use of Electricity in Factories.

Sir,—I have the honour to enclose list of objections drawn up by a special committee appointed by the electrical section of the London Chamber of Commerce, and adopted by the section at their meeting on the 22nd inst. In submitting these for your consideration I am desired to point out:

1. That during the past 18 years the Board of Trade, who are charged by Parliament with the duty of making regulations to ensure the safety of the public, have gradually relaxed the stringency of their regulations, and in 1895, following a special report by Lord Kelvin, Sir William Preece, and Major Cardew, acting as a committee appointed by the Board of Trade to report upon the definition of low pressure, the Board of Trade allowed the use of electrical pressures up to 250 volts on all premises.

2. Following the experience obtained in the 10 years from 1895 to 1905 the Board of Trade again revised their regulations in 1905, allowing the use of electricity on all premises supplying up to 250 volts without the use of special precautions, and in the opinion of this section the number of accidents through the use of low-pressure electricity since 1905 does not warrant the issue of regulations to deal with this pressure.

3. That the Home Office have had the power to issue special regulations since 1901, and have taken no action for six years, except to issue draft regulations in 1904 which were withdrawn, from which it may be inferred that the matter was not one of extreme urgency.

4. That the present draft regulations for ordinary factories are more stringent than the regulations issued in 1904 for the use of electricity in mines, although the latter industry has for years been recognised to be a dangerous trade.

5. That the present draft regulations are restrictive, and will not only involve great expense in modifications of existing systems, but will add to the cost of new work.

6. That while it is admitted that manufacturing processes can in many cases be more economically carried on by the use of electricity (to the benefit of the health of all workers) than by the continued use of steam, gas, or other forms of power, yet by these regulations difficulties are being placed in the way of the increased use of electricity while its power competitors are free from such harassing regulations.

Having regard to the foregoing considerations, the electrical trade section desires to urge that the new regulations should only apply to those factories where the present Board of Trade regulations are inoperative, and that the new regulations issued to cover these factories should be on similar lines to the present Board of Trade regulations—viz., dealing with pressure over 250 volts. If, however, his Majesty's Government consider that the present Board of Trade regulations are inefficient to protect the workpeople, it is further submitted that a common standard could be arrived at by the two departments so that there may be no confusion through the use of two different sets of regulations on the same premises.—I am, sir, yours faithfully, KENRIC B. MURRAY, secretary.

OBSERVATIONS AND AMENDMENTS SUGGESTED BY THE ELECTRICAL SECTION.

Paragraph 2.—There should be an extension of one year from the date of the issue of the regulations for all existing work in all factories, including electrical stations, and for all work which is in hand at the date the new regulations take effect.

In the case of existing work special latitude should be given and the regulations modified to meet each individual case.

Definitions.

These should be in conformity with the Board of Trade regulations, so that the Government departments may have a standard set of definitions.

Exemptions.

Paragraph 1.—This regulation should be amended to read 250 volts in view of the report of the Special Committee on the Board of Trade regulations in 1895 appointed to report on the definition of "low pressure." The committee consisted of Lord Kelvin, Sir Wm. Preece, and Major Cardew, and they recommended that the previous discrimination between alternating and continuous current should be abolished and that 250 volts

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should be recognised as low pressure. The effect of this decision was to remove the previous prohibition of the Board of Trade to the use of this pressure without special regulations. The returns of the last 12 years do not afford any ground for the retrograde step now proposed by the Home Office.

Paragraph 4.—In order to prevent the local inspectors (who may not be fully informed) from acting in an arbitrary manner, there should be a right of appeal to the head inspector at the Home Office, who should have special powers to deal with existing work.

Regulations.

Regulation 1.—This regulation should be amended and a clause on similar lines to No. 1 (*a*) of the mining regulations should be inserted. The conditions in factories are not more dangerous than the conditions pertaining to mining work. If the proposed regulation stands, the ordinary factory is treated as if more dangerous than a mine. The mining regulation reads: No. 1 (*a*). "All electrical apparatus and conductors shall be sufficient in size and power for the work they are called upon to do, and, so far as is reasonably practical, efficiently covered or safeguarded, and so installed, worked, or maintained as to reduce the danger through accidental shock or fire to the minimum, and shall be of such construction and so worked that the rise in temperature caused by ordinary working will not injure the insulating materials."

Regulation 2.—To secure uniformity this regulation should be replaced by Clauses 25 and 26 of the mining regulations—*i.e.*, unless fixed so far as is reasonably practicable out of reach of injury, all conductors, other than armoured cables, must further be protected by a suitable covering. Where lead-covered cable is used, the lead shall be earthed and electrically continuous throughout. Overhead bare wires on the surface must be efficiently supported on insulators and clear of any traffic, and provided with efficient lightning arresters.

Regulation 3.—This should be amended by Clauses 31 and 32 of the mining regulations: Fuses and automatic cut-outs shall be constructed as effectually to interrupt the current when a short-circuit occurs or when the current through them exceeds the working by 200 per cent. Fuses shall be stamped or marked or shall have a label attached, indicating the current with which they are intended to be used, or where fused wire is used each coil in use shall be so stamped or labelled. Fuses shall only be adjusted or replaced by an authorised person. *On circuits of medium and high pressure* all live parts of switches, fuses, and cut-outs not in machine rooms or in compartments specially arranged for the purpose must be covered. These covers must be of incombustible material, and must be either non-conducting or of rigid metal, and, as far as practicable, clear of all internal mechanism.

Regulation 4.—Line 3: After "circuit" insert "except isolating switches."

Regulation 5.—In view of Clauses 31 and 32 of the mining regulations this should be eliminated.

Regulation 7.—After "every" insert "installation or main."

Regulation 8.—Delete "and every circuit arranged to carry more than 750 volts shall be separately so protected."

Regulation 9.—After "thereto" add "except in cases where the system is earthed through a limiting resistance, and switches are necessary to disconnect generators not in operation from the earthed connection."

Regulation 11.—After "transformer" insert "exceeding 1/3 h.p."

Regulation 12.—Paragraph 2: Where alternating machinery is used, the expense of fitting every motor with a no-volt release would be prohibitive. Paragraph 3: Delete.

Regulation 13.—In order to make this section in accordance with the I.E.E. wiring rules, the word "independently" should be deleted from paragraph 2.

Regulation 15.—After "enclosed" add "except that in the case of a testing department of an electrical manufacturer, which shall be considered as an area set apart, provided none but an authorised person, or person acting under his immediate supervision, shall be allowed to work therein."

Regulation 17.—Paragraph 1: Special considerations must be given to existing electrical stations. In some cases it is not physically possible to put in new boards with the clear space front and back suggested. Delete from "For low pressure" to "respectively." Greater protection can be secured by the use of protecting barriers, screens, or the like, or an arrangement being made so that access is obtained to a portion only of the switchgear at one time. Paragraph 2.—Delete.

Regulation 18.—Paragraph (*a*), Line 3: Delete "prevent" and insert "minimise."

Regulation 19.—Line 5: Delete "prevent" and insert "minimise."

Regulation 20.—In order to secure uniformity, Clause 9 of the Board of Trade regulations should be incorporated.

Regulation 21.—This appears to be already covered by parts of 18 (*b*) and (*c*).

Regulation 23.—This regulation is unnecessary in view of the preceding regulations.

Regulation 25.—After "free" insert "as far as reasonably practicable."

Regulation 28 (*a*).—In case of a factory having its own generating station, similar regulations should apply to those now in existence where a public supply is given under Board of Trade regulations. (See Board of Trade Regulation 6 *a*.) (*b*) If the whole of the metal work is earthed, this inspection is unnecessary. (*c*) In view of the stringency of the regulations the last sentence of the paragraph should be deleted, as the regulations should cover all necessary points, and there should not be an attempt to cover up omissions by making a third party responsible.

Regulation 30.—If this regulation stands, it should only apply to places where high pressure and extra high pressure is in use, and not to low pressure. The number of accidents with low and medium pressure does not warrant the fixing of the instructions referred to. Line 3: Delete "for incandescent lighting at" and insert "at medium or."

Regulation 31.—Line 3: After "no" insert "unauthorised."

Regulation 33.—Line 3: After "no" insert "live parts of the."

SOUTH WALES ELECTRICAL POWER DISTRIBUTION COMPANY.

A meeting (called by the South Wales Electrical Power Distribution Company) of the principal power users in and around Cwmbran, Pontypool, Abersychan, Abercarn, and Cross Keys, was held at the King's Head Hotel, Newport, on Monday for the purpose of considering the desirability of forming a limited liability company, similar to that which has already been formed for the Treforest area of the South Wales Electrical Power Distribution Company, for the purpose of carrying on the Cwmbran generating station, and also to make certain additions to the plant and to the mains in order to put the station into a thoroughly satisfactory condition for safe and economical production and distribution of electricity in the district. Mr. W. Gascoyne Dalziel, the chairman of the company, presided, and amongst those present were Mr. W. A. Chamen (engineer and general manager), Mr. T. Braithwaite (Cardiff), Mr. Alex. Taylor (Pontnewydd), Mr. W. H. Routledge (Partridge, Jones, and Co.), Mr. L. Llewellin (Hoskins and Llewellin), Mr. A. Mollett (Newport-Abercarn Colliery Company), Mr. Jones (Avondale), Mr. Hugh Bramwell, Mr. Southwood Jones (Danygraig), Colonel D. Ellis Williams (Pontypool), and Mr. Nicholas (Tirpentwys Company). The following report of the meeting appeared in the *Western Mail*:

The CHAIRMAN gave a financial history of the South Wales Electric Power Distribution Company, the available funds of which were exhausted in May, 1906. The four generating stations had only been kept going since that time at the expense of the principal consumers, the stations being at Treforest, Bridgend, Neath, and Cwmbran. A new company, called the Treforest Electrical Consumers Company, Limited, with a nominal capital of £100,000, and consisting up to the present time of five of the principal consumers, had entered into an agreement with the South Wales Company and the debenture holders of that company to take over the working of the concern in the Treforest area. The new Treforest Company have to find whatever capital expenditure they consider necessary (now estimated at £30,000) to complete and increase the capacity of the Treforest station and the mains. It had been arranged that the board of directors of the South Wales Company should consist of five members nominated by the Treforest Consumers Company, Limited, two members nominated by the debenture holders, and one nominated by the creditors, nearly all of whom have agreed to become preference shareholders of the South Wales Company in full satisfaction of their claims. There are also two vacancies retained upon the Board for the nominees of a Cwmbran Consumers Company, Limited, if such company could be formed. The stations at Bridgend and Neath were being sold outright to the respective local authorities, who had provisional orders granted by the Board of Trade. With reference to the Cwmbran station it was possible to arrange a satisfactory scheme, as had been done in the Treforest case. The Treforest Electrical Consumers Company were promoting a Bill in Parliament in the coming session in conjunction with the South Wales Company confirming the arrangements and completely securing the whole position. The Cwmbran station and mains cost about £161,000. It included 12 Lancashire boilers, of which at present only six are connected up and in use, four engines and alternators of 300 kw. capacity each (one of which, however, is not yet erected), and one engine of 750 kw., making a total of 1,950 kw. The station could easily deal with a continuous output of 1,200 kw., and to supply motors connected to the mains to the total extent of 2,280 kw., or, say, 3,050 h.p. He thought it was probable that over 2,000,000 units per annum would be sold. Beyond those already supplied with power, other users had indicated a desire to take supplies from the company, and it seemed certain that

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if arrangements could be made to prevent the whole concern from shutting down there would be a considerable increase in the demand. There was a cooling tower at Cwmbran, but the condensing plant which the company intended to put in was never delivered, owing to the financial difficulties which arose. The cost of completing the station would be some £5,000 to £6,000, but there were certain improvements necessitating a further expenditure of about £1,300. All that was required, therefore, was the formation of a limited company which would find, roundly, £7,000, and the adherence of sufficient consumers to bring in the necessary revenue. Such a company could then enter into the same working agreement as in the case of the Treforest consumers.

Mr. HUGH BRAMWELL, chairman of the Treforest Consumers Company, stated that it was intended to have a fixed charge of £5 per horse-power per annum on the maximum horse-power in any one hour and 0·15d. per unit.

Mr. CHAMEN, the general manager of the South Wales Company, answered a number of technical questions with regard to the estimated cost of the station.

After some discussion it was decided by those present to recommend their respective companies to form a limited company for carrying on the Cwmbran generating station similar to that formed in the case of the Treforest area. Arrangements were made for definite information to be obtained from the various companies who would be prepared to join the scheme, so that full details might be prepared and set before the prospective members of the proposed new company as soon as possible.

LEGAL INTELLIGENCE.

TOWNSEND v. MAYOR, ETC., OF SWINDON.

An appeal was made last week before Lord Justice Vaughan Williams, the President of the Probate, Divorce, and Admiralty Division, and Mr. Justice Bingham, by the defendants for a new trial in an action tried before Mr. Justice Walton and a special jury at Bristol Assizes. The action arose out of an electric tramcar accident at Swindon, and was brought by Mr. R. W. Townsend, a managing director, to recover damages for personal injuries sustained in a tramway accident, due, he alleged, to the negligence of a servant of the defendants, who are proprietors of the tramway system, and £8,000 damages were awarded.

Mr. Foote, K.C., now stated that the parties had come to terms, and asked that the appeal, by consent, be dismissed, on the terms agreed upon.

Mr. Salter, K.C., for the respondents, consented, and the appeal was accordingly dismissed.

It was understood that the terms agreed upon were £7,200 damages, and costs.

FRYER AND CO. v. HAMMERSMITH GUARDIANS.

An action was heard in the King's Bench Division on Wednesday, before Mr. Justice Lawrence and a special jury, in which Mr. Walter John Fryer, trading as W. J. Fryer and Co., Bravington Works, Bravington-road, Harrow-road, sought to recover the balance of an account against the Hammersmith Guardians. Mr. Fryer's tender for the electric light installation was accepted, and the dispute had reference to the price charged for certain special fittings. The Guardians contended that it was understood that it was not to exceed £400. This, however, plaintiff denied, and claimed £606. 18s. 4d.

Mr. ELDON BANKES, K.C., on behalf of the plaintiff, explained that Mr. Fryer's tender for the electric lighting was accepted by the Guardians and sanctioned by the Local Government Board, and it was not suggested that he had not done the whole of the work he agreed to do properly. In September, 1905, the work was sufficiently advanced for a decision to be arrived at with regard to the special electric fittings—that was, standard lamps for the outside, and the fittings for some of the principal rooms in the building. Mr. Fryer submitted to the Guardians drawings and samples, with the prices marked, but, of course, nobody could say what the total cost would be, because nobody knew the quantity which would be required. The Guardians made their selections, and their clerk noted down the prices. Mr. Fryer had had to purchase the fittings, etc., himself, and he had paid for them. It turned out that the price was £606, which was in excess of £400, but that had nothing to do with Mr. Fryer, who was bound to supply what these people had selected. An inquiry was commenced, and, apparently, considerable criticism was levelled against the Guardians who had authorised such a large expenditure on the workhouse buildings. As a result counsel supposed that some of these gentlemen wanted to save their skins in the public estimation, and to make the cost as little as possible. Counsel, however, asked the jury not to allow the Guardians to do that at the expense of tradesmen who had done work which they had been ordered to do, and who had admittedly done it well and who had charged a proper sum.

PLAINTIFF, who stated that he had already received £5,900 in respect of work done by him, denied that £400 was fixed upon as the limit for the special electric fittings. The certificate of the engineer had been obtained in accordance with the contract, but still the Guardians declined to pay.

Mr. HILLS, for the defence, said the Guardians had felt obliged in the interests of the ratepayers to contest this claim, because they felt that when a man who knew that the price in a contract was £400 came forward with a claim over 50 per cent. in excess, such a circumstance ought to be investigated.

After hearing further evidence the jury returned a verdict in favour of the plaintiff, who was awarded the amount claimed, with costs.

MULLEN v. DUBLIN UNITED TRAMWAYS.

An action was heard last week in the King's Bench Division, Dublin, before Mr. Justice Gibson, Mr. Justice Boyd, and Mr. Justice Kennedy, which was brought against the tramways company for damages in respect of a collision between the plaintiff's cart and one of the tramway company's electric cars at Dalkey in April last. The defendant company deny liability, and they refused to give the plaintiff's solicitor access to the reports of their servants concerning the accident. The motion was brought to obtain from the Court an order for discovery of the documents in question.

It was argued on plaintiff's behalf that the documents, which were not written in anticipation of an action at law, were not privileged. In all sorts of accidents it was the rule that the inspectors and conductors should supply reports to the manager of the company, and this report was of that class, and, therefore, not privileged.

The Court refused the application, holding that the reports in question were privileged.

CERAMIC CO. v. LEO SUNDERLAND CO.

The case of the Ceramic Co. *v.* Leo Sunderland Co., which came before his Honour Judge Woodfall in the Westminster County Court on Thursday and Friday last week, raised a very important question of trade custom. The claim was for making electrical fittings which required special tools, and a counterclaim was to recover the tools, plaintiffs claiming that they were entitled under a trade custom to charge defendants for the tools, but to retain possession of them.

Counsel for the plaintiffs said that both parties were eminently respectable electrical firms, and were fighting a question of trade custom. Defendants ordered certain electrical fittings, and in order to make them it was necessary to obtain special tools, for which plaintiffs had claimed £12. The order was by letter dated Nov. 14 last, in which defendants stated, "It is understood that you credit cost of tools upon the receipt of further order." The order was executed, and defendants paid, except the £12 for the tools. Plaintiffs sued for the amount, and defendants had admitted the claim and paid £12 into court, but counterclaimed for possession of the tools.

The case for the defendants was that plaintiffs said these tools were necessary for making the caps and porcelain interiors ordered, and the price charged for the goods should be reduced by the amount charged for the tools or the tools should be given to the defendants when they paid for them. The price of the tools had now been paid into court, and defendants asked for the delivery, therefore, of what they had paid for.

Evidence was given on behalf of the plaintiffs that it was the custom when giving orders for special taps to ask for special tools. The cost of such tools was added to the amount charged for the goods, and when the customer had given sufficient orders the cost of the tools was deducted. The making of these tools was a secret trade, and if they were parted with it would be revealing a trade secret. The tools belonged to the customer, but the manufacturer of the goods for which they were necessary did not part with them. The customer had to pay for them, and when he had given sufficient orders he was recouped.

The JUDGE said it was quite clear what the bargain was between the parties, but it had been a little difficult to get hold of it. He saw the importance of the case. The contract was in the letter of Nov. 14—that was the basis of the contract, and the matter was really simple. He quite appreciated plaintiffs were in a position in which they could not let these tools leave their possession, because if they did they would part with a trade secret. It was clear defendants contemplated they would never obtain possession of the tools, but, on the other hand, it was perfectly clear defendants gave their order on the understanding—on the agreement—that although they would never have the tools they would have what they cost to make eventually. The contract was on the terms stated in the letter of Nov. 14, that they should in the future be credited with the cost. The date was not fixed. It was to be when there was a further order, and that order might be one merely given for the purpose of getting back the cost of the tools. When defendants gave that further order, and not till then, they would be entitled to be credited with the cost. He was quite convinced the tools were never to become their property, but they were to pay for them, and when they had given the further order they were to be credited with the value. It was the value of the tools that remained the defendants'. It was clear defendants had to pay the value of the tools until they gave the further order, and it was impossible for him to say defendants could have delayed payment of the £12 beyond the date of paying for the goods, for which the tools were necessary. The money for the tools accrued due and payable at the same moment the money was due for the goods manufactured. That disposed of the case, and, by way of observation, he would say if plaintiffs regarded the dealings with reference to these tools as of such paramount importance, he could not understand why they were so unbusinesslike as to leave it in doubt and difficulty as they did on the correspondence. He dismissed the counterclaim with costs.

TRAM DRIVER'S CLAIM.

At the local county court last week, Leslie R. Cox sued the Ilfo Urban Council for £1. 6s. 3d., which he claimed was due to him holiday money. He stated that when he was in the employ of the

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Council as a motorman the Council sanctioned a bonus of 10s. per quarter on certain conditions. All who received these bonuses in a year were entitled to five days' (45 hours) holiday, with pay. He remained in the service of the Council until April 1. He contended that the bonuses which he had earned entitled him to five days' holiday with pay. He now claimed the pay.

Mr. A. H. SHAW, the Council's electrical engineer, said that as each bonus year began on July 1 plaintiff was not entitled to his third bonus until April 1, the day he left.

HIS HONOUR (Judge Tindale Atkinson) said it was clear that the plaintiff was not entitled to succeed. It was impossible to say that a man could have a holiday in his employment after his employment had ceased.

COMPANIES' MEETINGS AND REPORTS.

WESTERN TELEGRAPH.

The ordinary general meeting of the Western Telegraph Co. was held on Wednesday, Sir John Wolfe Barry presiding.

The CHAIRMAN said that, having regard to the recent statements which had appeared in the Press with respect to the opening for commercial business of a wireless telegraph system between Ireland and Canada, he had been requested by some shareholders to make a statement on the subject. He would say at once that, as far as he could judge, he did not look upon any system of wireless telegraphy as being a serious competitor for their cables. Some years ago he made a similar statement, and he saw nothing now to alter the views which he then expressed. At that time wireless messages were sent, perhaps, some 300 or 400 miles, and he then stated that with the development of science it was probable that greater distances would be compassed. The fundamental difficulty, however, remained the same—namely, the want of certainty in transmission, the want of secrecy, and the confusion which might arise when numerous messages were conveyed, not by a direct conductor such as a telegraphic cable, but were thrown with great violence into the ether, into which they radiated in all directions, and had to be disentangled and interpreted on the other side of the globe. He was well aware that by tuning or "syntonising" the receiving instrument to the wave-length of the sending instrument some of these difficulties could to a certain extent be eliminated, but secrecy was only obtainable so long as third parties refrained from tuning their instruments so as to intercept the messages, which he understood was a very easy thing to do. He appreciated most highly the efforts of those interested in the development of wireless telegraphy, but complained of the abnormal secrecy which from the first had enshrouded the operations of those who had the conduct of the business. He believed that wireless telegraphy would certainly be of great advantage to the world in certain localities and for certain purposes. This Company was now engaged under its concession from the Portuguese Government in making a sub-wireless installation for a moderate distance in a locality where a system of cables was, for a variety of reasons, difficult and undesirable. He moved the adoption of the report and accounts, and the declaration of a dividend of 3s. per share, making, with the interim dividend, 6 per cent. for the year, together with a bonus of 2s. per share, making in all 7 per cent.

Sir JOHN DENISON-PENDER seconded the motion, which was carried unanimously.

ROSARIO ELECTRIC.

The annual general meeting of the shareholders of the Rosario Electric Co. was held on Tuesday, Mr. W. T. Western, chairman of the Company, presiding.

In moving the adoption of the report (*Electrical Engineer*, Oct. 18), the CHAIRMAN explained that the number of lamps installed and of motors, reckoned in their equivalent of lamps, had increased by one-third, and the gross receipts, the expenses, and net revenue had each increased by one-third. At the same time, the capital sunk in the business had increased by one-sixth. The actual work done, or units sold, had increased in a still larger proportion, for the directors had thought it right and fair to grant a reduction in the price charged to consumers—which, so far, had shown satisfactory results. The net result for the first two months of the current year was to show an increase of 20 per cent. over the results of the corresponding months of last year. The demand for motive power had been a feature of the year's working. The long negotiations as to public street-lighting had led to a definite result, for the directors had now made a new arrangement with the municipality to supply the electric energy for the lamps at a fixed price per unit, and the municipality supply and maintain the lamps. The price is a very moderate one, and will not do much to affect the dividends one way or the other. Some of the new lamps are already installed. It was proposed early next year to offer £25,000 of second preference convertible shares already created, in order to provide for additional plant. The dividend recommended was 5s. a share on the ordinary shares, making, with the interim distribution, 8 per cent. for the year.

Mr. W. F. LESSE seconded the resolution, which was carried.

METALLIC SEAMLESS TUBE.

The annual meeting of the Metallic Seamless Tube Co. was held on Friday last at Birmingham, Mr. W. Neale (the chairman) presiding.

In moving the adoption of the report, the CHAIRMAN said the net profit, which amounted to £2,309, was £500 less than last year. That did not occur because they had done less business, because in reality they had done rather more, but through the cutting competition which lessened prices, so that every year they had to do more business and get less profit. Their creditors were slightly more than last year, and their stock amounted to £13,265, against £11,000 the previous year. They had large works and good plant, there were no debentures or mortgage debt, and they carried forward this year the satisfactory sum of £3,683. Considering the competition and the smallness of the profit, he though the balance-sheet was very satisfactory.

The report was adopted and a 5 per cent. ordinary dividend declared.

ELECTROLYTIC ALKALI.

The report of the Electrolytic Alkali Co. for the year ended Aug. 31 last, to be submitted at the meeting at Liverpool on the 4th inst., states that the net profit for the year, after allowing for depreciation, mortgage debenture interest, and expenditure on renewals, repairs and general upkeep of buildings, plant, machinery, tools, etc., is £8,212, to which is to be added the amount brought forward—namely, £2,127—making £10,339. The directors regret that the hope expressed in the last annual report that further developments during the ensuing year would show better results has not been realised. It will be obvious to all who are familiar with manufacturing operations that the causes of this result have been entirely beyond the control of the Board, the further increase during the year in the price of fuel, packages, and other commodities which form the chief items of cost of the Company's manufactures being mainly responsible for the decreased profit. The market prices of the Company's products are abnormally low compared with those of other heavy chemicals, and the Company has not participated in the advanced prices which were obtained during the period in other branches of the trade. Notwithstanding the result now shown, the directors have the fullest confidence that when normal prices have been re-established the Company will be able to make a satisfactory return to all the shareholders. Two and a-half years' dividend on the preference capital has now accrued, but in view of the unsettled state in that portion of the chemical trade in which the Company is engaged the directors recommend that only one half-year's dividend be paid upon such shares, leaving £6,841 to be carried forward. The erection of the additional plant referred to 12 months ago is nearing completion. It has not been possible to get any benefit from this during the past year, while the expense of issuing debentures needed to pay for such plant and the interest on them has been charged against revenue. The same rates of depreciation as in past years have been maintained, and an increased amount for renewals and repairs necessary to keep the buildings, plant, machinery and tools in a high state of efficiency is also charged against the year's revenue. The demand for the products of the Company is eminently satisfactory. The directors hope to have the new installation in operation at an early date, when they will be in a better position to deal with the increased volume of business which has already been secured.

NEW COMPANIES REGISTERED.

Stearn Electric Lamp Co.—Registered Oct. 21. Capital, £4,070 in £10 shares. Objects: to adopt an agreement for the acquisition of the business carried on at Kew by the Zurich Incandescence Lamp Co. (incorporated under Swiss law), and to carry on the business of electric lamp manufacturers, etc. No initial public issue. Registered offices: 47, Victoria-street, S.W.

Bude Electric Supply Co., Limited.—Registered Oct. 7. Capital, £7,000 in £1 shares. Objects: to adopt an agreement with Christy Bros. and Co., and to carry on the business of electricians, engineers, suppliers of electricity for light, heat, motive power, or otherwise, etc. Minimum cash subscription, 3,000 shares. Registered office: The Strand, Bude, Cornwall.

Wolfram (Tungsten) Metal-Filament Lamps, Limited.—Registered Oct. 12 by F. Samuelson, 46, Queen Victoria-street, E.C. Capital, £100,000 in £10 shares (7,500 A and 2,500 B). Objects: to adopt an agreement between the International Wolfram Gesellschaft of Budapest, the Deutsche Gasgluhlicht Acktien-Gesellschaft (Auergesellschaft), and this company, and to carry on the business of manufacturers of and dealers in metal-filament and other lamps and electrical goods, electricians, engineers, suppliers of electricity for light, heat, motive power, or otherwise, etc. No initial public issue. Registered office: 31, Copthall-avenue, E.C.

Liens Registered.

P. P. Motor Co. (Bournemouth), Limited.—Lien registered Oct. 14 for £700 5 per cent. debentures. No trustees. Charged on the undertaking and property.

Phœnix Electric Heating Co., Limited, London, W.C.—Lien registered Oct. 16 for £1,625 6 per cent. debentures, part of £1,725 authorised. No trustees. Charged on the assets and effects.

Pullcar Motor Co., Limited, Preston.—Lien registered Oct. 16 for £2,000 6 per cent. debentures, part of £10,000. Amount previously issued, £500. No trustees. Charged on the business and assets.

Electrolytic Alkali Co., Limited, Middlewich.—Lien registered Oct. 18 for £400 4½ per cent. debentures, part of £50,000. Amount previously issued, £32,700. Trustees: Liverpool Mortgage Insurance Co. Charged on the entire assets.

North Wales Power and Traction Co., Limited, London, E.C.—Trust deed registered Oct. 21 for securing a series of second mortgage debentures for £100,000. Trustees: J. Tomkinson, M.P., and R. H. Guild. Secured by a fixed charge on all the lands and hereditaments belonging to the company, together with the buildings and fixed plant thereon; also by a floating charge on the whole of the other assets for the time being, present and future, including the uncalled capital, subject to £80,000 first mortgage debenture stock.

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PERSONAL.

The Battersea Borough Council have appointed Mr. John Crowthorne Milton, of The Drive, Northampton, to the position of shift engineer at a commencing salary of £117 per annum.

Mr. T. G. Hopkins has been appointed as the South Wales representative at the Cardiff branch of C. Pullan, electrical engineer and contractor (head offices at Bradford), in succession to Mr. Brinley Rees.

We regret to announce the death of Mr. Howell Cyffin Jones, who was an electrical engineer in the gold mines at Oorgaum, Mysore, India. He was the son of the late Mr. Morris Jones, J.P., Plasnewydd, Dolgelley.

We understand that Mr. A. A. Day, A.M.I.C.E., M.I.E.E, the borough electrical engineer and general manager of the Bolton tramways, has been called in by the Wigan Corporation to go over their tramway system and electricity department and report thereon.

We are happy to be able to announce that Mr. Leonard W. Holmes, the London partner of Messrs. J. H. Holmes and Co., electrical engineers, of Newcastle-on-Tyne, has now returned to business after his severe illness, which we mentioned in this paper last March. Mr. Holmes desires to thank his many friends for their kind inquiries regarding his progress during illness and convalescence.

APPOINTMENTS VACANT.

Overhead Linesmen for tramway system in the North of England. Applications to Box E T 7, office of this paper. See advertisement.

Travellers (two) required by an electrical firm. Salary, £300 per annum and liberal commission. Applications to Thermo, office of this paper. See advertisement.

Junior Electrician with practical electrical experience to assist generally in work of electrical department and testing. Applications to Harland and Wolff, Belfast. See advertisement.

Lecturer at the Glasgow and West of Scotland Technical College. Salary, £150-£200 per annum. Applications to be addressed to Prof. Magnus Maclean, D.Sc., by Nov. 12. See advertisement.

Professor to Chair of Electrical Technology, Indian Institute of Science, Bangalore, India. The salary attached to the chair will be £1,000 per annum at the commencement, and the professor will be provided with a residence. See advertisement.

Assistant to Borough Electrical Engineer, Eccles Corporation Electricity Department. Salary, £120 per annum. Applications to Mr. Edwin Parkes, town clerk, by Nov. 11. See advertisement in last issue.

OPENINGS FOR CONTRACTORS.

ABERDEEN—Hall for St. Margaret's Episcopal Church, Gallowgate; fish-curing premises at South Esplanade West; new science-room in the higher-grade school at Queen's Cross for the Convent of the Sacred Heart.

AUCHTERLESS—Alterations to Badenscoth School for School Board.

BARNET—Isolation hospital for Hospital Committee.

BARNOLDSWICK—Twelve houses in North-avenue for Mr. Proctor Barrett; stables in Calf Hall-lane, for Mr. F. Harrison.

BARNSLEY—Additions to premises, Peel-street, for Master Builders' Co.; shops, Town End; two dwelling-houses and stable, Spring-street, for Mr. Peter Dalby; nine dwelling-houses and shops, Agnes-road, Lee Summerscales; dwelling-house for Mr. F. W. Drewery, Blenheim-road; Y.M.C.A. buildings, Eldon-street, for the trustees and committee; one dwelling-house, shop, and business premises, Racecommon-road, for Mr. Wm. Beavers; four houses, Oakwell-terrace, for Mr. G. Haigh; additions to two houses, St. John's-road, for Mr. Sam Dryden; 20 dwelling-houses, Queen's-terrace, for Mr. Thomas Wilkinson.

BARRY—Alterations and additions to Council schools for Education Committee.

BATLEY—Steam laundry for Dewsbury Co-operative Society.

BELGROVE—Hall for United Free Church (£2,500).

BEXHILL—Enlargement of town hall (£2,750). Architect, Mr. H. Ward.

BINGLEY—Additions to house in Slevingford-terrace for Mr. J. Hartley.

BIRMINGHAM—Extension of Council House for Corporation (£150,000).

BLACKBURN—Primitive Methodist church, Cedar-street (£1,800). Architect, Mr. J. T. Henshaw.

BLACKPOOL—Congregational school (£1,100). Architect, Mr. W. Wade, St. Annes.

BLYTH—Reconstruction of Primitive Methodist church (£1,800). Architects, Messrs. Davidson and Sons, Newcastle.

BONNYRIGG—Public library for Corporation (£2,000).

BOURNEMOUTH—Elementary school in Middle-road for Education Committee.

BRADFORD—Mill and warehouse (architects, Messrs. J. Young and Co., 62, Market-street); Baptist Sunday school, £4,000 (architect, Mr. F. Holland).

BRAY—Workmen's dwellings for Urban District Council.

BRYNMAWR—Six shops for Mr. Nuth, Mason's-yard, Station-road; three houses, King David Inn, for Mr. Connop; house in Clarence-street for Mr. Morgan Walters.

BUMBLE—Police station for Carnarvonshire County Council (£1,300).

BURLEY—Anglican church (£7,000).

BURTON JOYCE—Wesleyan chapel. Architect, Mr. A. E. Lamb.

CAERAU—School for Glamorgan County Council.

CAMBORNE—Four dwelling-houses, Cross-street and Bassett-street. Mr. A. Walters.

CAPEL—Alteration and additions to Anglican schools (£500).

CASTLEFORD—Secondary school for West Riding Education Committee.

CASTLETON—Two new mills to be erected at Castleton, near Rochdale, by the Cromer Spinning Co., Middleton.

COLCHESTER—Council school (£9,450).

COLLYWESTON—Elementary school for Northampton County Council.

CORNSAY—Elementary school for Parish Council (£1,600).

COWDENBEATH—Drill hall (£1,600). Architects, Messrs. Gillespie and Scott, St. Andrews.

CREWE—Extension to Corporation electric lighting (£3,000).

CROMER—Extension to Corporation electric lighting (£8,000).

CROWMARSH—Council school for Oxford Education Committee (£1,000).

CYMMER—Erection of 250 cottages for Glyncorrwg Building Club.

DARLINGTON — Additional laboratory accommodation at technical college.

DAVYHULME—Boys' club to be erected in School-road in connection with the Church of England school.

DEAL—Baths and concert hall. Councillor H. Barron, Deal

DEWSBURY—Extensions to workhouse for Guardians (£100).

DUBLIN—Electric lighting at technical schools for Education Committee.

DUDLEY—Extension of grammar school for Education Committee (£2,700).

DUNDEE—Dwelling-houses for Mr. Alexander Speed, Blackness-road and Leven-street; alteration to property for Mr. T. G. Lawson; additions and alterations to house for Messrs. Charles Ower and Co., in Harefield-road; alterations to shop for Mr. James Ramsay's trustees, High-street.

DUNFERMLINE—School of Textile Industries (£11,000). Architects, Messrs. H. and D. Barclay, Glasgow.

EARL SHILTON — New shops and stores for Barwell Co-operative Society.

EBBW VALE—Alterations and additions to the goods shed for Great Western Railway Co.

EDGELEY—Council school for Education Authority.

EDINBURGH—Installation of electric light at Towerbank School. Architect, Mr. J. Carfrae, 3, Queen-street, Edinburgh.

ELDWICK—Timber shed for Messrs. J. and R. Bruce; two houses at The Heights for Mr. W. Rhodes.

ELLENBOROUGH—Reading-room and village hall. Architect, Mr. J. Brown, Netherton.

ETON—Additions to shop, Farnham Royal, for Messrs. Spong and Purser; house, Wraysbury-road, for Mr. J. Ware; house for Mr. H. J. Dowsing, The Avenue, Farnham Common.

FERNDALE—Rebuilding of Ferndale Club and Institute. Architects, Messrs. Morgan and Morgan, Pontypridd.

FLIXTON—Two detached houses for Mr. Dawson.

FOLKESTONE—Enlargement of Harvey Grammar School (£2,000).

FORDYCE—Additions to academy. Architect, Mr. W. Ingram, Portsoy.

FULWELL—Houses in Gertrude-street. Particulars of Rural District Council, Sunderland.

GLASGOW—Extension of Belvedere Hospital for Corporation.

GLOWETH—Private residences. Architect, Mr. S. Hill.

GREENOCK—Additions to Greenock Academy for School Board.

HAMPTON—Alterations to grammar school (£5,990).

HANDSWORTH — Anglican church for the parish of St. Andrews (£8,000).

HARROW—Baptist church (£5,000); architects, Messrs. McKilliam and Proctor. Eighteen houses, Butler's-road, for Messrs. Clarke and Co.; three houses, Sumner-road, for London Grounds Rents Co.

HARWICH—Secondary school for Education Committee.

HASTINGS—Nurses' duty-room, union workhouse infirmary; architects, Messrs. A. W. Jeffrey and Son. Alterations to steam laundry, Bexhill-road, for Messrs. T. Bradford and Co.; architect, Mr. F. H. Humphreys. Alterations to 10, East Ascent for Mr. R. Dengate.

HATFIELD—Alterations and additions to Council schools.

HEALING—Elementary school for Lindsey County Council.

HILLINGDON—Extensions to hospital for County Committee (£5,693).

HORSHAM—Extensions to electricity works for Urban District Council (£1,500).

HOWICK—School-chapel. Architect, Mr. J. T. Henshaw, Blackburn.

HOYLAND—Council school for Elsecar.

HUNCOTE — Primitive Methodist church and schools (£1,027). Architect, Mr. H. Harper, Nottingham.

HUTTON—Extensions to school buildings for Poplar Borough Council.

ISLEWORTH—Roman Catholic church (£10,000).

LANCASTER—Thirteen dwelling-houses in Wingate, Saul-road, for Mr. R. L. Dilworth; alterations to outbuilding in Anchor-lane for Messrs. Clark, Oglethorpe, and Sons; 14 dwelling-houses in Frankland-street for Mr. W. H. Sexton.

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LEATHERHEAD—Public mortuary for Council.
LEE, S.E.—Improvement of Northbrook Schools (£1,000).
LEEDS—Additions to workhouse. Architects, Messrs. T. Wynn and Sons.
LITTLE COATES—Elementary school for Lindsey County Council.
LONDON—Electric wiring of tramway sub-stations at Holloway, Hackney, and Clapton for the London County Council.
LONDON, E — Blocks of dwelling-houses, Adelina-grove-terrace, Stepney, for Mr. A. N. Calnan.
LONDON, N.E.—Tramway car-shed at Hackney for London County Council.
LONDON, N.W. — Residential flats, Park-road, Regent's Park. Messrs. A. Blomfield and Sons.
LONDON, S.W.—Tea-house and conveniences at Hyde Park for H.M. Commissioners of Works.
LONDON, S.W.—County court at Westminster. Commissioners of H.M. Works and Public Buildings.
LONDON, W.—Fifteen houses, High Lever-road, Kensington, for Messrs. Trant, Brown, and Humphreys.
LOWESTOFT—Extensions to electric lighting undertaking (£16,950).
LUTTERWORTH—House, Bitteswell-road, for Mr. W. K. Bedingfield; wash-houses in Bank-street for the trustees of the Town Estate.
MANOR HAMILTON—Labourers' dwellings for Rural District Council (£31,469).
MEDOMSLEY—Fourteen houses for Annfield Plain Industrial Co-operative Society.
METHIL—Eighteen dwelling-houses and nine shops on a site opposite bowling green for the Methil Land and Property Investment Co. Architect, Mr. Birrell, Kirkcaldy.
MOIRA—Workmen's dwellings for Rural District Council.
MONK BRETTON—School for West Riding Education Committee. Architect, Mr. D. E. W. Dyson, Barnsley.
MONMOUTH—Baptist church, Monk-street (£2,480). Architect, Mr. B. Lawrence.
MUMBLES—Bungalow for Mr. T. J. Morgan. Architect, Mr. A. L. Lewis.
NELSON—Four houses for Mr. T. Leaver; extension to engine and boiler houses for Mr. James Nelson; eight houses in Railway-street for Messrs. L. and H. Nutter; seven cottage homes in Walton-lane for the executors of Mr. W. Walton; 16 houses in Rake House-road for Messrs. J. Crowther and Co.; house in Napier-street for Messrs. J. and W. Ormerod.
NEWBURY—Shops and dwelling-houses, St. Mary's-hill. Architect, Mr. W. H. Bell.
NEWCASTLE—Additions to hospital for Guardians.
NEWTOWN—Congregational church (£4,720).
NORTHAMPTON—Church for Holy Trinity parish (£8,542). Architect, Mr. M. H. Holding.
NORWICH—Gymnasium, etc., for Corporation (£500).
OLDHAM—New theatre (£20,000). Architect, Mr. H. A. Turner.
ORFORD—Parish church. Architect, Mr. A. Warburton.
OXFORD—Enlargement of Witney Grammar School (£2,000).
PETERHEAD—Shops, workrooms, and dwelling-houses, Marischal-street, for the trustees of Robertson's Mortification.
POLLOKSHAWS—Rebuilding St. John Maxwell School (£12,000).
PORTRUSH—Electricity installation for Town Council.
PORTSMOUTH—Enlargement of Trafalgar Institute (£2,500)
PURLEY—Baptist church (£1,500).
PWLLHELI—Market for Urban District Council.
RADYR—Anglican church (£2,500).
RAMSGATE Elementary school for Corporation (£800).
RATHMINES—Additions to hospital for Joint Hospital Board.
READING—Public library (£3,800). Architect, Mr. F. W. Albury.
RICKMANSWORTH—Alterations to Eight Bells Hotel, Church-street, for Messrs. Harman and Co.
RIPON—Sanatorium at grammar school (£2,000).
RYHOPE—Houses, Cliff-road. Particulars of Sunderland Rural District Council.
ST. BLAZEY—Classroom for Cornwall Education Committee.
ST. IVES—Church at Tregenna.
SALTERFORTH — Elementary school for West Riding Education Committee.
SHORTLANDS—Congregational mission hall (£2,476). Architects, Messrs. G. Baines and Son, London.
SKETTY—Additions to St. Paul's Church. Architect, Mr. G. Moxham, Swansea.
SKIPTON—School for West Riding Education Committee.
SLOUGH—Additions to Orchard Cottage, Iver, for Mr. Ward; alterations and additions to Alderbourne Manor for Mrs. Bell White; new bank at Gerrards Cross for the London and South-Western Bank; and new houses at Gerrards Cross for Mr. A. White and Messrs. Fowler and Buttle.
SMALLTHORNE—Alteration of Council school for Staffs Education Committee (£5,300).
SOUTHAMPTON—Central fire station for the Council (£5,200).
STANLEY FERRY—Elementary school for West Riding Education Committee.
STEETON—Elementary school for West Riding Education Committee.
STICKFORD—Elementary school for Lindsey County Council.
STIRLING—Elementary school for Education Committee.
STOKE-ON-TRENT — Extension of Corporation electricity scheme (£9,400).
SUNDERLAND—Electric sub-station; houses, Violet-street, Ford.
SWANAGE—Enlargement of parish church (£4,700). Architects, Messrs. Clifton and Robinson.
TAYPORT—Shop and dwelling-houses in Castle-street for Messrs. Borthwick and Nelson.
TEDDINGTON—114 working-class dwellings for Urban District Council.
THURLSTONE—Council-room, offices, caretaker's house (£650). Clerk to the Council, Mr. J. Wadsworth.
TODDINGTON—Alteration and addition to isolation hospital for Little Hampton Urban District Council.
TUNSTALL—Electric light in town buildings for Urban District Council.
WAKEFIELD—Elementary school for West Riding Education Committee.
WEDNESBURY—Public library for Council (£5,000).
WEYMOUTH—Pavilion for Corporation.
WIMBLEDON—Pair of houses in Durham-road. Architects, Messrs. Belfrage and Saville, 27, Chancery-lane, W.C.
WORKINGTON—Pavilion. Architects, Messrs. W. G. Scott and Co., 2, Park-lane, Workington.
WORKSOP—Extensions to electricity undertaking (£700).
WOOD GREEN—Council school for Education Committee.
WOOLWICH—Working-men's club and institute, Abbey Wood. Mr. W. Wadman.
WORTHING—Alteration at workhouse for Guardians (£1,564).

CONTRACTS FOR ELECTRICAL SUPPLIES.

Perth (Australia).—The Postmaster-General invites tenders for dry cells. Tenders by Nov. 29.

Antwerp.—The Municipality invite tenders for one 30-ton electric crane. Deposit £280. Tenders by Nov. 12.

Perth (Australia).—The Postmaster-General invites tenders for 80 accumulators for telegraph purposes. Tenders by Dec. 11.

Paris.—The Post and Telegraph Department invite tenders for commutator tablets for central telephone station. Tenders by Nov. 16.

London, N.E.—The London County Council invite tenders for the erection of a tramways car-shed at Mare-street, Hackney. Tenders by Nov. 12.

Western Australia.—The Albany Municipality invite tenders for public lighting for 15 years. Particulars from the Town Clerk. Tenders by Nov. 18.

Wakefield.—The Corporation invite tenders for the supply of coal required at the electricity works for the year ending Dec. 31, 1908. Tenders to the Town Clerk by Nov. 9.

Walsall.—The Corporation invite tenders for the supply of stores to the tramways department for the year 1908. Particulars from the Tramway Manager. Tenders by Nov. 9.

Gloucester.—The Light Railways Committee invite tenders for the annual supply of stores. Particulars from the General Manager, Bristol-road, Gloucester. Tenders by Nov. 9.

Edinburgh.—Tenders are invited for well-boring at McDonald-road electricity generating station. Particulars from the Engineer's Office, Dewar-place, Edinburgh. Tenders by Nov. 11.

Glasgow.—The Corporation invite tenders for supply of uniform caps for the tramways employés. Particulars from the Tramways Manager, 46, Bath-street, Glasgow. Tenders by Nov. 6.

Newcastle-on-Tyne.—The Tramways Committee invite tenders for the supply of uniforms for 12 months ending March 31, 1909. Tenders to the Chairman of the Tramways Committee by Nov. 16.

Melbourne.—The Postmaster-General's Department invite tenders for 11 sets and a common-battery switchboard, and 3,000 subscribers telephones, etc., for the Windsor exchange. Tenders by Jan. 7.

Napier (New Zealand).—The Town Council invite tenders for lighting and power plant and an electric tramway equipment. Particulars from Mr. F. Bowen, town clerk. Tenders by Dec. 31.

Stretford (Manchester).—The Urban District Council invite tenders for lighting and traction mains. Particulars from Messrs. Miller and Wilson, 19, Brazennose-street, Manchester. Tenders by Nov. 4.

London.—The London County Council invites tenders for the installation of electric lighting at the Lawn-lane School, Kennington, S.E. Tenders to the Clerk, County Hall, Spring-gardens, S.W., by Nov. 5.

London.—The London General Omnibus Co., of 6, Finsbury-square, E.C., invite, among other things, tenders for electrical appliances and tools, and leather machine belting. Tenders by Nov. 18.

Sydney.—The Postmaster-General invites tenders for 1,000 common-battery wall telephones and 100 portable telephones. Particulars from the Commonwealth Offices, 72, Victoria-street, Westminster. Tenders by Dec. 11.

Buenos Ayres.—Tenders are invited for the construction of underground electric tramways. Particulars from the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London. Tenders by June 1, 1908.

Dublin.—The Dublin United Tramways Co. invite tenders for stores, including electric supplies, for the year ending Dec. 31, 1908.

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Tenders to Chairman, 9, Upper Sackville-street, Dublin, by Nov. 11. See advertisement in last issue.

Dublin.—Tenders are invited for the supply and erection of one low-pressure switchboard of three-phase type. Tenders to the Chairman of the Cleansing Committee, 3, Cork-hill, Dublin, by Nov. 4. See advertisement in last issue.

London, S.W.—The London County Council invite tenders for the supply of stores for one year from Jan. 1, 1908 including electric fittings, lamps, cables, etc., and tramway car fittings. Tenders to the Clerk, County Hall, Spring-gardens, by Nov. 9.

Buenos Ayres.—Tenders are invited for (1) the construction of and (2) the concession to work the two principal sections of the underground electric railway. Particulars from the Argentine Legation, 12, Rue van Moer, Brussels. Tenders by May 1, 1908.

Stepney.—The Electric Light Committee invite tenders for work in connection with the Council's projected new generating station at the riverside at Blyth's Wharf, Limehouse, and sub-station at Osborn-street, Whitechapel. Tenders by Nov. 11. See advertisement in last issue.

Adelaide.—The Deputy Postmaster-General for Queensland invites tenders for a common battery switchboard and 3,000 subscribers' telephones. Specification No. 166. Particulars may be obtained from the Commonwealth Offices, 72, Victoria-street, London, S.W. Tenders by Jan. 8, 1908.

Leicester.—The Tramways Committee invite tenders for the supply of 450 suits and caps, to be delivered in April next, for inspectors, motormen, and conductors. Samples may be seen on application and tender forms obtained from the Tramways Manager, 20 and 22, Humberstone-gate, Leicester. Tenders by Nov. 9.

Victoria.—The Deputy Postmaster-General at Melbourne invites tenders for the supply and delivery at Melbourne of 11 sections of a common-battery switchboard and 3,000 subscribers' telephones and other apparatus for telephone exchange, Windsor, in accordance with Victorian specification No. 148. Tenders by Jan. 7.

Glasgow.—The Caledonian Railway Co. invite tenders for the supply of stores for 12 months from Jan. 1, 1908, including telegraph appliances, telephones, etc., electric lighting material and fittings, galvanised wire, asbestos and guttapercha goods, etc. Tenders to the Secretary, 302, Buchanan-street, Glasgow, by Nov. 4.

Sydney (Australia).—Tenders are invited for the supply and delivery of integrating alternating-current energy meters and integrating direct-current energy meters, or ampere-hour meters. Specification, etc., from Messrs. Preece and Cardew, 8, Queen Anne's-gate, Westminster, to whom tenders must be sent by Nov. 13.

Adelaide (Australia).—Tenders will be received up to noon on Nov. 26, addressed to the Chairman, Municipal Tramways Trust, Adelaide, for the supply and delivery c.i.f. Port Adelaide of steel rails and fishplates for tramways. Specification, etc., from the Agent-General for South Australia, Threadneedle House, 28, Bishopsgate-street Within, London, E.C.

Edinburgh.—Tenders are invited for (Contract No. 6) junctions and pits in connection with the tramways extensions. Specification, etc., from the consulting engineer, Sir Alexander B. W. Kennedy, 17, Victoria-street, Westminster, London S.W., on payment of a deposit of £2. 2s., which will be refunded on receipt of a bona fide tender. Tenders to the Town Clerk, City Chambers, Edinburgh, by Nov. 8.

RESULTS OF TENDERS.

Falkirk.—The offer of Crompton and Co. for the supplying of arc lamp carbons has been accepted.

Rangoon.—The Rangoon Electric Tramway and Supply Co. have received the contract for the electric lighting and fitting of fans in the cathedral, Rangoon.

Burnley.—The Board of Guardians have accepted the tender of Simpson Bros., Hapton, for £331. 18s. 6d. for work at the electric lighting station at the workhouse.

London.—The tender of C. Wall, Limited, at £25,303, for the erection of the first portion of Bow car-shed, for the London County Council, is recommended for acceptance.

Tunstall.—The Urban District Council have accepted the tender of C. Pullan, 52, King's-arcade, Bradford, at £298, for the electric lighting and ventilating of Tunstall Town Hall, Staffs.

Bradford.—The Corporation have accepted the tenders of Baily and Wall, 5, Aldermanbury, and Brown, Muff, and Co., Market-street, for the supply of uniform clothing for the tramway employés.

Erith.—The Urban District Council have accepted the tender of the Ingersoll Rand Co. for duplex air compressor, with Brush Electrical Engineering Co.'s motor and pipework complete, at £587. 10s.

Finchley.—The Urban District Council have accepted the tender of the Callender's Cable and Construction Co., at £8,999. 10s. 6d., for the supply of feeders, distributing mains, and other cables, network boxes, joint-boxes, etc.

Huddersfield.—The Corporation have placed a contract with Willans and Robinson, of Rugby, for two 2,500-k.v.a. turbo-alternators, the plant being required in the early spring of next year for supplying electric power to certain textile mills in the neighbourhood who have decided to adopt electric motor driving.

Sedgefield.—The Rural District Council have received the following tenders for the installation of electricity into the manor house and the workhouse:

Baker Bros., Middlesbrough	£260	0	0
Hind and Son, Stockton*	238	10	0
Watson and Son, Stockton	230	0	0

* Recommended for acceptance.

BUSINESS NOTES.

TRACTION.

Cleckheaton.—The Assistant Secretary to the Board of Trade has intimated that the completion of the tramway line authorised by the original order with regard to Westgate has been extended to Dec. 14 next.

Maidstone.—The Board of Trade have confirmed the Headcorn and Maidstone Junction Light Railway (Amendment) Order, 1907, amending the Headcorn and Maidstone Junction Light Railway Order, 1906.

Stirling.—As the National Electric Construction Co. have been unable to come to terms with the local authorities, the provisional agreement with that company for the purchase of the tramway company's undertaking has fallen through.

Hammersmith.—The London County Council have agreed to an expenditure of £26,000 for the supply of the overhead electrical equipment and low-tension cables, etc., and the laying of cable ducts, for the tramways from Hammersmith to Harlesden.

Newport.—The Trades' Council having complained to the Tramways Committee of the Corporation of the want of transfer tickets for the cars for different routes, the committee have directed the manager (Mr. Collings Bishop) to inquire into the whole question of transfers and report.

Buenos Ayres and Belgrano Electric Tramways Co.—The traffic receipts for the week ended Oct. 28 amounted to £3,847; corresponding week last year, £3,641—increase, £206. Aggregates from Jan. 1, 1907, £164,861, and from Jan. 1, 1906, £155,668—increase, £9,193.

Gloucester.—A long and animated discussion took place at the last meeting of the City Council concerning the report of a special committee who had considered terms upon which the tramways could be leased to a company for a term of years. In the end the Council decided against the proposal.

Wigan Tramways v. South Lancashire Tramways.—Wigan Corporation tramways employés on the 23rd ult. played a Rugby football match with the South Lancashire Tramways Co.'s employés on the Mather-lane ground. The Wiganers won by a goal and three tries (11 points) to a try (three points).

Walthamstow.—A statement has been issued by Mr. J. Williams Durnford in regard to the traffic over the District Council's tramways, from which it appears that in the six months ending Sept. 30 last the early morning cars ran 55,020 miles, their running expenses being £1,203. 11s. 3d. and the income £636. 19s. 10d.

Bilston.—The Council have directed their clerk to inform the tramway company that they were not prepared to complete the agreement for intercommunication until more experience had been gained as to the through service to Sedgeley; also that the committee protested against the withdrawal of the charge of half-fares for children.

Stockport.—At a meeting of the Tramways Committee the borough surveyor reported upon the advisability of lowering the roadway under Wellington Bridge in order to allow all top-covered cars to pass underneath. After fully considering the matter, it was resolved that the roadway be lowered in accordance with the recommendations of the borough surveyor.

Silksworth.—Coroner Cadle held an inquest on 25th ult. touching the death of Thomas Mattimore, who was knocked down by one of the Sunderland district tramcars, and who died from his injuries. Dr. Bernard said death was due to shock following concussion of the brain and from injuries received. The jury concurred with the doctor's evidence, and complimented Driver McGovern on the smartness he had shown in stopping his car.

Edinburgh.—While a cable car was turning from Princes-street into North Bridge on the 25th ult, Alexander Weir, a message boy, was thrown from the stair on to the street, and had to be taken to the Royal Infirmary, where it was found he was suffering from concussion of the brain. Weir was going up the stair on the car with a parcel in each hand, and as he had no hold he was apparently pitched over the rail as the car jerked in turning the corner.

Howden.—A Bill is to be promoted in the ensuing session of Parliament for a proposed light railway to join the Hull and Barnsley Railway near Howden, turning off at the Selby-road, and crossing Knedlington-road, going near the farm at Boothferry, and joining the proposed new bridge. It is understood the Hull and Barnsley Co. favour the scheme, but the Lancashire and Yorkshire and N.E.R. have not yet given any decison in the matter.

Belfast.—At the weekly meeting of the Tramways and Electrical Committee on Monday—Sir Robert Anderson presiding—the projected Ligoniel extension came up for a discussion, and after a thorough ventilation of the subject the committee passed a resolution recommending the completion of the extension within the two years. A resolution was also passed approving of a Bill being brought in the House of Commons to confirm the purchase of the Whitewell and Cavehill tramway.

Accrington.—The newly-laid section of the Accrington electric tramways in Burnley-road was inspected by Colonel Druitt, of the Board of Trade, on Oct. 25. The colonel rode over the full length in a "double decker," being accompanied by aldermen, councillors, and officials, including Mr. Wilson, the tramways manager. Colonel Druitt expressed satisfaction at the way in which the lines had been laid and with the general arrangements. The route was opened to the public on Saturday morning.

Bacup.—The Town Council jointly with the Rawtenstall Council have decided to offer the sum of £5,200 to the Rossendale Valley

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Tramways Co. for their undertaking within the borough, and in the event of the Rawtenstall Corporation not expressing their satisfaction, the Bacup Corporation having power under their agreement to purchase the Rossendale Valley tramways within the borough upon the terms provided by Section 43 of the Tramways Act, 1870, the town clerk has been instructed to take such steps as may be necessary for the promotion of a Bill in the next session of Parliament for the purpose.

Lancaster.—The chairman of the Tramways Committee, in moving the minutes of the committee at the last Council meeting, said they had adopted the experiment of continuing the summer service, which, especially to the park, had proved so satisfactory that there was an increase in passengers of nearly 12,000, and a saving in expense of £50. 4s. 2d., as compared with the corresponding period last year, so that they were £55 better off that 12 months ago. It seemed that the public appreciated this service, and the committee were quite willing to meet them in any way so long as they could keep down the cost. The minutes were adopted.

St. Helens.—In the report of the auditor upon the Corporation tramway accounts the following appears: "I have carefully scrutinised the accounts of this important undertaking of the Corporation, and am fully satisfied with not only the soundness of the investment, but also with the correctness and soundness of the borough accounts, and of the balances shown. I may add that I look upon the undertaking as one which justifies the views of those who negotiated the terms of the purchase on the town's behalf, and that in the due course of time the town will possess a very valuable property on most favourable terms as to cost."

Gwalior (India).—The Maharajah Scindia has given a concession for the construction of an electric tramway, the lighting of streets, and the supply of electric power for the three municipalities of Lashkar, Morar, and Old Gwalior, which together constitute the capital of Gwalior State. The contract includes provisions for the cheap supply of electric power to private enterprise, the intention of the Maharajah being to foster the growth of the capital as an industrial centre. The Ajmere Import and Export Co. are the concessionaires, with Rai Bahadur Seth Sohagmal, one of the great Ajmere bankers, as agent, and Mr. S. J. Tellery as managing director.

Aberdeen.—Some slight inconvenience was occasioned on Saturday night on the Corporation tramway system by the falling of one of the overhead wires in Union-street at the junction with Crown-street The breakdown occurred about 10 o'clock, and though there were large crowds of people on the street, no one was injured by the falling of the wire. The repair motor was procured, and a temporary arrangement made for the continuance of the traffic. In order to prevent any accident, the cars were run from Bridge-street at almost full speed, and when near the repaired part the trolley was detached, and the cars, having sufficient way, got past the weak point. Huge crowds gathered in the vicinity and watched with curiosity the progress of the cars for a considerable time.

Luton.—Bad weather is interfering somewhat with the rapid construction of the Luton tramway system, though it is being extended with considerable rapidity. Already the rails are laid almost continuously from the lodge gates of Wardown Park to the Midland Railway bridge in New Bedford-road. Concreting has been done for two-thirds of this distance, and the paving of granite setts has been laid for about half the length of the park. The opening of the roadway on the Park-street route has been carried through very smartly, and the trench now extends from the car-shed to Park-square, the rails being also fixed in position for a distance of about 200 yards. All the columns which are intended to carry the overhead equipment will be erected by the end of this week, and the other sections of the route are to be started.

Handsworth.—The adjourned meeting of the Handsworth Traders' Association to consider the trams question was held on the 27th ult., when it was contended that the Handsworth Council had electrified the Birchfield route without first coming to an arrangement for through running with the British Electric Traction Co. Complaint was made of the disastrous effect the high fares charged and the absence of through running was causing on the trade of the district. Councillor T. Silver expressed the opinion that the Tramway Committee was to blame for the muddle by stiffening their backs against the British Electric Traction Co. instead of adopting a more conciliatory tone. After a discussion a resolution was adopted to the effect that the Handsworth Council should make an endeavour to obtain through running from Perry Barr to Birmingham at a through fare of 2d.

"Live Rail" Dangers.—A parliamentary return has been published giving the number of persons killed and injured on electrically-equipped railways by coming in contact with electric "live rails." The return covers the years 1904, 1905, and 1906, and the first eight months of 1907. During that period 16 persons have been killed and 71 injured. Eight of the deaths and 28 cases of injury occurred on the North-Eastern Railway, and five deaths and 19 cases of injury on the Lancashire and Yorkshire Railway. The other electrically-equipped railways are mostly in London and the suburbs. Of the 16 killed 12 were trespassers, and of the 71 injured 25 were trespassers. There is only one case of injury to a passenger, which was not fatal. Four railway servants were killed and 40 injured, and five of the injured were persons who were on the railways on business.

Liverpool.—The City Council have resolved to make application to the Board of Trade for a provisional order for the construction of a line of tramways from the Black Bull, junction of Warbreck Moor, *viâ* Walton-vale, Rice-lane, County-road, Hale-road, Selwyn-street, Westminster-road, Melrose-road, Commercial-road, Sandhills-lane, and Derby-road to its junction with Strand-road. The proposal is to lay a single line, with passing places, in Hale-road and Selwyn-street, commencing by a junction with the existing tramway in County-road, Walton, passing along Hale-road and Selwyn-street, thence turning southerly into Westminster-road, and continuing as far as Melrose-road as a double line, thence along Melrose-road by a double line and terminating by a junction with the existing tramways in Stanley-road. The length of these new lines would be approximately 1,180 yards of double line and 540 yards of single line, or equivalent to about 1 mile 1,140 yards of single track.

Woolwich.—At the last Borough Council meeting the Works Committee reported having received a letter from the chief officer of the London County Council tramways department, enclosing drawing showing proposed position of tramway poles from Bereaford-square to the Plume of Feathers public-house. A detail drawing of the poles had also been sent, showing that it was intended to have the wires at a height of 22ft. 6in. above the road surface. Although the tramway will at present only start from the east side of the Arsenal main gate, a pole was shown to be erected at the corner of Beresford-street, against the side of the present London County Council sewer-ventilating column. This pole was intended to serve the double purpose of at once taking strain wires for the end portion of the line now to be reconstructed and hereafter as an ordinary pole when the overhead work is continued to Greenwich. It was resolved, on the recommendation of the committee, that the plan submitted by the London County Council be approved.

East and West Ardsley.—At the last meeting of the Urban District Council the clerk intimated that he and a representative of the Council had attended a conference at Wakefield to oppose the dropping of the tramway line between Wakefield and Ardsley. He said they had been successful in their objection, and that the line would have to be constructed as the company at first agreed. They would have five years to construct the lines. A letter was read from the Board of Trade *re* the Wakefield and District Light Railways Order, 1901-2, stating that, after careful consideration, they had granted an extension of time for two years, from Oct. 19, 1907, in respect of the whole of the lines. The Board had at the same time informed the company that in thus prolonging the powers conferred by the light railways order they desired to afford further opportunities for an endeavour on the part of the company to meet the strong wish of the localities affected by the construction of the other lines in question, as well as the Alverthorpe line; and the Board had expressed the opinion that the company should continue to keep their object in view.

Llandudno.—The Llandudno and District Electric Tramway Construction Co. have given notice to include in the draft order under the Light Railways Act, 1896, for which application was made to the Light Railway Commissioners in May, 1907, provisions to authorise the company to acquire compulsorily or by agreement for the purposes of widening the street or road in connection with railway No. 8, authorised by the Llandudno and Colwyn Bay Light Railway (Extension and Amendment) Order, 1907, the following lands and buildings, or some of them: In the parish of Eirias, in the county of Denbigh, certain property in Abergele-road, Colwyn Bay (four poles or thereabouts in area), comprising a portion of the premises known as the old steam laundry, together with land adjoining and situate on the northern side of the road between points respectively 50 yards or thereabouts measured in an easterly direction, and 40 yards or thereabouts measured in a north-westerly direction from the junction of Groes-road with the said Abergele-road. Also to carry out a widening of the said Abergele-road by throwing the property above mentioned, or some part thereof, into the footpath and roadway.

Leeds.—The city tramways department continues to flourish. A statement just issued by the general manager (Mr. J B. Hamilton) to the members of the committee, shows a net profit of £51,051 for the six months ended Sept. 30. This is £351 more than the balance available for the corresponding period of last year. Although the past summer was far from ideal, the cars were well patronised, the total receipts amounting to £176,698, as compared with £169,818 for the similar period of last year. The other side of the balance-sheet reveals an expenditure of £86,671, or an increase of £4,686. Of this extra outlay, £2,100 is represented by the enhanced price of coal, and £2,000 by increased maintenance of cars. The difference between £90,026, the balance carried to the net revenue account, and the actual profit of £51,051, is represented by payments for interest and income tax and sinking fund charges. During the six months 38,705,607 passengers were carried, as compared with 37,289,126, and the mileage was 3,871,241, or 200,000 more miles than were covered in the corresponding six months of 1906. The receipts averaged 10·84d. per mile, or ·18d. less. The average fare per passenger was exactly the same as in the corresponding period of last year—viz., 1·08d. The number of passengers carried is equal to the population of Leeds multiplied 83·50 times, and the aggregate receipts are equivalent to 7s. 6d. per head of the population. The committee have received the statement of accounts with satisfaction, and have expressed by resolution their thanks to Mr. Hamilton for maintaining the efficiency of the department.

West Ham.—The South-West Ham Free Church Council wrote asking the Council to consider the practicability of establishing the "double shift" on Sundays, so that tramway employés who had a desire to do so might have a better opportunity than at present to attend divine service at least once on the Sabbath. On this the tramways manager brought up a lengthy report at the last Council meeting, which concluded: "Of the 81 cars which furnish the Sunday time tables, 20 run between 14 and 15 hours, 39 between 13 and 14 hours, whilst the remaining 22 run less than 13 hours. If a double shift were run on these, 324 of the men would be required on duty every Sunday, and not 10 per cent. would ever have a Sunday free. The increased amount which would be required in wages alone would be £1,189 per annum, apart altogether from the considerably greater cost of running cars which were not necessary for traffic requirements. This increased amount

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in wages could not, of course, be paid to additional employés, as motormen and conductors cannot be trained and employed for one day's work per week. As showing the unpopularity of such a plan here, it is only necessary to say that on one of the routes a Sunday time table is provided, giving 22 duties, each of which enables the employé to attend a service, and gives him the greater portion of the day off duty. The average pay assigned to these duties is 1s. 2d. less than the normal day's pay. It is found that not 30 per cent. of these duties are applied for, the remaining 70 per cent. being worked by men told off for same from the spare list." The committee were unable to recommend the Council to accede to the request of the South-West Ham Free Church Council.

LIGHTING AND GENERAL

Malacca Rubber Plantations Co.—The first annual report to Dec 31 last shows a net profit of £3,840.

Torquay.—The Town Council have made a profit of £2,606 on the electric light undertaking in the last 9½ years.

Partick.—Exchange buildings are to be erected by the National Telephone Co. and a telephonic exchange installed at an estimated cost of £20,000.

Retford.—Sanction has been received from the Local Government Board to the borrowing of £1,700 by the Corporation for electric lighting purposes.

Bukit Rajah Rubbor Co.—The directors of the Bukit Rajah Rubber Co. have declared an interim dividend of 10 per cent. (being 2s. per share) on the ordinary shares.

Sedgefield.—The Board of Guardians have decided to obtain a supply of electricity from the asylum for the manor house and workhouse. The cost of the installation will be £239.

Craigpark Electric Cable Co.—The Craigpark Electric Cable Co. have declared an interim dividend for the six months ended Sept. 30 at the rate of 6 per cent. per annum on the preference shares.

Barry.—At a meeting of the Barry Chamber of Trades and Improvement Society it was decided to appoint a committee to report on the question of the District Council's scheme for lighting the town by electricity.

Mirfield.—The Yorkshire Electric Power Co. have written to the District Council expressing the hope that the Council would draw attention to the facilities there were in the district for the use of electrical energy.

Stock Exchange.—Application has been made to the Stock Exchange Committee to allow the British Electric Traction Co.'s further issue of £118,758 4½ per cent. second debenture stock to be quoted in the official list.

Church.—A deputation from the Urban District Council has been appointed to interview the chairman of the Accrington Electricity Committee with a view to arranging for the providing of electric arc lights at the tram terminus at Church.

Ascot.—New capital is being issued by the Ascot Gas and Electricity Co, Messrs. Chancellor and Sons having been instructed to offer at auction on the 20th inst. 300 7 per cent. original ordinary shares and £3,500 4 per cent. perpetual debenture stock.

Paignton.—The gas company have notified the Council their decision to raise the prices of gas 3d. per 1,000 cubic feet. A scheme for electrically lighting the town is in the hands of a company, and is likely to be pressed forward at an early date.

Horsham.—The electrical engineer having prepared an estimate of the probable cost of extensions during the next three years the Urban District Council have agreed to apply to the Local Government Board for sanction to the borrowing, if necessary, of £1,500.

Antwerp.—The telephone exchange at Antwerp has been completely destroyed by a fire which broke out on Tuesday morning last. The flames spread to the great Tietz Emporium in the same building. The telephone service will be interrupted for several days.

St. James's and Pall Mall Electric Light Co.—The amount of electricity sold for the nine months ended Sept. 30, 1907, is returned at 6,193,750 units, estimated to produce £79,943, as against 5,468,373 units, which produced £73,430, for the corresponding period of last year.

"Howler" for Telephone Users.—The French telephone authorities have invented a new apparatus which is to be called the "howler." It is to prevent anyone from forgetting to replace his receiver at the end of a call, and emits a sound resembling that of a dog in pain.

Cromer.—A prolonged inquiry has been held by Mr. H. R. Hooper into the application of the Cromer Urban District Council for sanction to borrow £8,000 for electric light purposes. The subject aroused much local interest, and this was shown by the large number of ratepayers present.

Surbiton.—Mr. H. R. Hooper opened a Local Government Board inquiry on the 29th ult. relative to the application of the Council for sanction to a loan of £20,000 for the purpose of electric lighting. There was some opposition, and the inspector has adjourned the inquiry until Nov. 10.

Dover.—The Town Council have agreed, on the recommendation of the Electricity Committee, to install two larger type of boilers into the station at a cost of £450. Mechanical stokers are to be fitted, and an application is to be made to the Local Government Board for sanction to the necessary loan.

Wolverhampton.—The District Electric Co., of 39 and 40, Berry-street, Wolverhampton, have been favoured with instructions to carry out an installation for electric lighting, bells, and telephones at the nurses' home now in course of erection for the Wolverhampton and Staffordshire General Hospital.

Kashmir (India).—A large electrical scheme is being developed by which Srinagar will be lit electrically, the silk factory will be heated, the dredging fleet will be operated, power supplied to light railways and various factories, in addition to generating power to supply the districts of Abbottabad and Rawalpindi.

Rotherham.—The Council have adopted a recommendation of the Electric Light and Tramways Committee, which recommended that the electric light stokers, tramway shedmen, and others in the permanent employ of the department should be granted one week's holiday with pay each year after 12 months' service.

Tendring.—The National Telephone Co. have applied for permission from the Rural District Council to erect about 54 poles between a point on the Colchester and Thorpe main road near Hill House and Thorington Station, and consent has been given subject to the poles being erected on spots approved by the surveyor.

Wireless Telegraphy to Canada.—It is computed that about 14,000 words were sent over the Atlantic on the opening day of the wireless telegraphy service from the United Kingdom to Canada. At the office of the company in London it was stated that the service was working splendidly, and the inaugural day passed without a hitch.

Cleckheaton.—At the last meeting of the District Council it was stated that an experiment was to be made with electric public lighting in the Whitcliffe part of the town, not because there was any special reason why that district should be selected other than that the gas-mains there were the oldest in the town, and that some readjustment was necessary.

Poplar.—Mr. J. H. Hallett, J.P., principal of the firm of J. H. Hallett, Pattison, and Co., engineers, etc., Cardiff, has been appointed commissioner, with Mr. A. A. Hudson, barrister-at-law, to inquire into the causes and circumstances of the explosion of a boiler at the Poplar borough electricity works, when one person was killed and another injured.

Stourbridge.—At the monthly meeting of the Town Council the Electric Powers Committee reported that the clerk had been instructed to take such legal steps as might be necessary to obtain payment of the consideration (£500) undertaken to be paid by the Worcestershire, Shropshire, and Staffordshire Electric Power Co. for the transfer of the Stourbridge electric lighting order.

Heckmondwike.—The Spen Valley Iron and Steel Works Co. have applied to the District Council for a supply of electricity for motor purposes, and the matter has been referred to the Electricity Committee for consideration and report. The question of providing coal-storage accommodation and extra cooling-pond accommodation at the electricity works is also to be considered.

Aberdeen.—At the last meeting of the Electric Lighting Committee of the Town Council authority was given to the city chamberlain to renew bonds in connection with the electric department to the extent of £24,575. It was reported that at the electricity works during September there had been generated 440,421 units, compared with 423,104 in September of last year.

Cwmbran.—A company is to be formed among the principal power users in the Eastern and Western Valleys of Monmouthshire for the purpose of carrying on the Cwmbran generating station, and to consider the desirability of making additions to the plant and mains in order to put the generating station into a thoroughly satisfactory condition for the safe and economical production and distribution of electricity in the district.

Erith.—The clerk to the Urban District Council has reported that as the result of a further canvass of the occupiers of the municipal cottages, 37 out of 40 occupiers have expressed their willingness to take electric light if it were installed. The committee are, therefore, recommending that the electric light be installed in the 48 municipal cottages, and to ask the electrical engineer to draw up specification and invite tenders for the work.

Leicester.—A meeting of the Electrical Contractors' Association was held on the 25th ult. at the Grand Hotel, when Messrs. E. L. Berry and L. G. Tate, A.M.I.E.E., attended from the London centre. The new clauses proposed by the Gas and Electric Lighting Committee were discussed, and it was decided to offer the most strenuous opposition to these clauses, and to ask the central association to undertake to oppose the omnibus Bill should the clauses be embodied in it.

Edinburgh.—The Electric Lighting Committee of Edinburgh Town Council have agreed to recommend the Council to supply current to the forthcoming Scottish National Exhibition at a charge of 2d. per unit, with a minimum charge of £1,900. It is estimated that 328,000 units will be required both for power and lighting, and this is calculated to be equal to a charge of between £2,000 and £3,000. In connection with the exhibition the electric light mains will be extended from Gorgie and Murrayfield to Saughton.

Penzance.—At the Guardians' meeting the Visiting Committee's report contained the following recommendation: "The committee having had before them the form of application to the National Telephone Co. for supplying a telephone from their exchange at Penzance to the workhouse, together with the condition of service, recommend that the clerk sign the same on behalf of the Board. The annual subscription for 700 calls and extra mileage will be £15 per annum, and the term is for five years." This was adopted.

Nottingham.—At a meeting of the Chamber of Commerce a letter was received from the delegates to the associated chambers from Bradford, Cardiff, Southampton, and Kendal reporting the passing of a resolution by the Associated Chambers of Commerce with reference to the increased telephone charges of the National Telephone Co., demanding the withdrawal of the new rates and the restoration of the inclusive charges. They also suggested that the Nottingham Chamber should pass a resolution on the matter, but this had already been done.

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Correspondence Classes.—We have received a syllabus of the courses of correspondence education which is being carried on by the British Correspondence School of Electrical Engineering at 36, Maiden-lane, Strand, London, W.C. The technical directors of the school are Mr. Frank Broadbent, M.I.E.E., and Mr. Andrew Stewart, A.M.I.E.E. The scope of the school is to specialise in practical electrical engineering, and courses in wiring work, the management of installations, and elementary electrical engineering are especially to be recommended.

Liquidations.—The *London Gazette* announces that the Chelmsford Electric Lighting Co. has been wound up voluntarily, and the directors of the company appointed liquidators. The Totnes Electricity Supply Co. has been wound up voluntarily, and the directors appointed liquidators (Major C. Heaton-Ellis, chairman, Salisbury House, London-wall, E.C.). A general meeting of the members of the Portable Accumulators, Limited, will be held at 119, Victoria-Street, Westminster, on Nov. 26 at 2 p.m., for the purpose of receiving the liquidator's report.

Falkirk.—At the last Town Council meeting the minutes of the Electric Light Committee showed that there was laid before last meeting the wiring rules of the Institution of Electrical Engineers, and it was agreed to embody these rules in place of those of 1903. An application for a supply of electric energy to Messrs. R. and W. Baird's new offices at West Bridge-street had been before the Electric Light Committee, and the electrical engineer reported that it would be necessary to extend the main for about 100 yards for the purpose. The extension was authorised by the Council.

Portraits by Telegraph.—The method invented by Herr Korn, of Munich, of transmitting photographs by telegraph has been perfected to such a degree that transmission is now possible over long distances. Some tests carried out recently between Berlin and Paris were completely successful. A photograph of the Kaiser was telegraphed from Berlin to Paris, and a photograph of President Fallieres from Paris to Berlin, and both were reproduced to perfection. The length of the wire is approximately 800 miles. The subsequent transmission of other photographs proved equally successful.

Canada.—The Canadian General Electric Co. is making an issue of 2,000,000dol. 7 per cent. cumulative preference stock in shares of 100dol. each at par, or £20. 11s. per share. The proceeds of the issue are required to meet the cost of the large extensions of the company's factories at Toronto and Peterborough, which have been necessitated by the company's constantly increasing business, to redeem the outstanding 300,000dol. 6 per cent. preferred stock, and the balance will be applied towards paying off the company's overdraft with the bank. The shares now offered are perpetual, but the company reserve to themselves the right to redeem them at 115 per cent. on Jan. 1, 1913, or at any subsequent interest date, on giving six months' notice. These shares are preferential both as to capital and dividends.

Eastbourne.—In the minutes of the Electric and Street-Lighting Committee, submitted at the last meeting of the Council, it was recommended that further electric extensions should be made to Hampden Park at an estimated cost of £500. The town clerk suggested that a valuer should be engaged to advise the committee in connection with their appeal against the revised assessment. The matter was left to the chairman, town clerk, electrical engineer, and borough accountant. It was pointed out that the raising of the assessable value would increase their indebtedness something like £1,100, but the committee hoped to get the assessment reduced. An amendment was proposed that the matter of the extension of the mains to Hampden Park should be referred back, and this was decided upon. The minutes, thus altered, were adopted.

Windsor.—In July last it was decided that an expert engineer should be employed to advise the Board of Guardians upon certain subjects having reference to the lighting, etc., and a committee of seven was appointed to draw up terms of reference. Those terms of reference were drawn up, and sent on to the clerk to be printed, in order that each guardian should be supplied with a copy. At the last meeting of the Board several guardians said they had not received a printed copy of the terms of reference, and as a result the matter was deferred until each guardian had been supplied with a printed copy of the terms of reference. A resolution was also to be moved in connection with the electric company as follows: "That the Windsor Electric Light Co.'s offer of Dec. 11, 1906, be accepted, and that the company be asked to quote a price per 1,000 gallons for pumping water, also price for power for driving laundry machinery." In view of the decision to defer the other business, this was also adjourned.

Fleetwood.—The Fleetwood and District Electric Light and Power Syndicate, or rather the receiver, has declined the offer of £12,000 for the whole undertaking made by the Fleetwood Urban Council. The company have also declined to fix a price, preferring that it should be the subject of arbitration. The electric lighting company has been making steady progress of late years, and is now a valuable concern. In the year ending March, 1905, the profit was £170, after paying all working expenses; in 1906 the amount of profit was £539; and last year the figures worked out at a profit of £1.108. The number of units sold in 1905 was 113,000; in 1906, 134.000; and in 1907, 197,000. There are 15,000 lights connected with the concern, and 225 actual connections for private consumers. Just recently new machinery has been put in, and the full effect of this will be seen in the winter's working. Providing the Council do not make an amended offer of a more reasonable amount it is probable that arbitration proceedings will ensue.

St. Helens.—The auditor, in reporting upon the electricity accounts of the Corporation, states that the balance standing to the credit of the revenue account is £143. 0s. 10d., being a decrease of £580. 5s. 4d. as compared with last year. At the same time, it must be remembered that this sum does not represent the whole profit of the undertaking, as the sum of £5.355. 16s. 3d. has been paid out of profits in the repayment of loans and in the redemption of stock, in addition to £3,798. 18s. 10d. paid in respect of interest. In an ordinary business undertaking this sum of £5.355. 16s. 3d. would in the ordinary course of things be mostly divided amongst the shareholders in the shape of dividend, but in this case, as in the case of all the Corporation undertakings, it goes to pay off the Corporation's borrowed capital, with the result that in time the whole of the electrical undertaking will belong to the town free of cost. In addition, the auditor points out that the working expenses have been greater this year than last in respect of coal, etc., so that the result on the year is very satisfactory, showing, as it does, good and efficient management.

Salford.—The employés of the Salford Electricity Committee, with their ladies, were on Saturday night last entertained to tea by the committee at the Pendleton Town Hall. This was the first of what it is hoped will be an annual gathering, and the proceedings followed on the same lines as those adopted by the Salford Gas Committee for a number of years. After tea had been served Councillor Hodgson, J.P., chairman of the Electricity Committee, presided, some 250 ladies and gentlemen being present. The chairman was supported by Councillors Sackville, Nuttall, J.P., McDougall, Grundy, and Dudley, and Mr. V. A. H. M'Cowen (electrical engineer). Councillor Hodgson said it had been unanimously decided by the Electricity Committee that it was a desirable thing they should meet the employés of the electricity works at a social gathering of that sort at least once a year. He assured them that the committee extended to them a hearty welcome, and they were pleased that so many ladies had accepted their invitation. The Electricity Committee were very pleased that such an excellent feeling should prevail between themselves and their employés. They hoped this would continue to exist, and it would not be the committee's fault if it did not.

Arbroath.—The Chamber of Commerce last week had under consideration the new rates which are being pressed on users of the telephone by the National Telephone Co. and the Postmaster-General. The executive committtee reported having considered the subject, and while not objecting to the principle of measured service as laid down by the Postmaster-General in his communication to the Newcastle Chamber they took exception to the method adopted of giving effect to it, regarding it as inequitable. The executive proposed a resolution for the approval of the chamber setting forth that the imposition of a new tariff by the National Telephone Co. and the Post Office authorities which entailed an increased cost for the telephone on the part of the large majority of users was unnecessary and uncalled for, and that the chamber urge upon his Majesty's Government to insist on instituting a searching parliamentary inquiry into the whole question before any of the facilities or rates hitherto enforced were interfered with, and that copies of the resolution be forwarded to the Prime Minister, the Postmaster-General, the Right Hon. John Morley, and the Right. Hon. John Sinclair, member for the county. The resolution of the committee was unanimously adopted.

Crewe.—On the 23rd ult. Mr. F. H. Tulloch held an inquiry into an application by the Town Council for sanction to borrow an additional £3,000 for extensions and improvements in connection with the electric lighting undertaking. The Borough Treasurer said that the total capital expended on the undertaking up to March 31 last was £50,669. The local authority began to light the town electrically in December, 1900, and the scheme had proved so successful that they had made a surplus each year since 1901, the total amount being £5,040. Mr. F. Kinsey, solicitor, formally opposed the application on behalf of Mr. H. Brown, of Sydney Grange, who desired to ventilate the grievances of the residents of Sydney, a remote part of the borough, who had to pay towards the public lighting without being able to have the advantage of the electric light either for private consumption or for the lighting of that particular area. Mr. Brown was willing to become a private consumer, and the names of other residents were mentioned as likely customers. The Inspector suggested that, in view of the fact that the undertaking was fairly successful, the Council might consider the advisability of running cables to Sydney, at all events for private consumption. He promised to make a note of the points raised by Mr. Kinsey in submitting his report to the Board.

Hanley.—At a meeting of the General Purposes Committee a letter was read from the National Telephone Co. acknowledging receipt of the communication from the Council urging the company to resume the former telephone charges in lieu of the recently adopted schedule, and stating that the Council must have been misinformed on the subject of telephone charges generally, or they would hardly have taken up the position they had; also, that the new system of charge which had been brought into force had been designed specially to enable the small tradesman and the residence user to get his telephone service at a lower rate than heretofore, as this would tend to develop the telephone service in Hanley generally and to the general prosperity of the borough; and also adding that it was not the company's intention that the new rates should apply to existing subscribers so long as their present installations remained, the new rates only applying to new subscribers. At a meeting of the Electric Lighting Committee the monthly report for August, 1907, was submitted. In that month the equivalent of 97,916 units were sold, against 53,448 in August, 1906. The total generated was equivalent to respectively 117,542 and 71,663, and the maximum load 818 kw. and 718 kw. The equivalent coal consumption per unit sold was 11·2lb., against 14·16 a year ago, and the works cost 1·20d., compared with 1·76d. per unit sold. The electrical engineer reported that in the month of September, 1907, there had been connected five new lighting consumers, taking an equivalent of 86 lamps; that extensions had been made in the premises of six lighting consumers, equivalent to 91 lamps, and that two power consumers had extended, the latter representing 92 lamps.

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PROVISIONAL PATENTS, 1907.

Oct. 21.

7941A. **Improvements in electric arc lamps.** Henry Bevis and Arthur Ernest Angold, 3, Brown-street, Market-street, Manchester. (Date applied for under Rule 5 of the Patents Rules, 1905, April 5, 1907.)

23152. **Portable fire-alarm (electric).** George Thomas Simmons, 74, Culverley-road, Catford, London.

23199. **Improvements in and relating to arc lamps.** Dagobert Timar and Karl von Dreger, 7, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Sept. 4, 1907, being date of application in Germany.) (Complete specification.)

23206. **Improved hanger for the overhead wires of electric cars.** David Amos and Alice Maud Carroll, 1, Queen Victoria-street, London.

23215. **Electric arc lamp.** Deutsche Beck-Bogenlampen-Ges. m. b. H., 27, Chancery-lane, London. (Date applied for under Patents Act, 1901, Oct. 20, 1906, being date of application in Germany.) (Complete specification.)

23216. **Improved means, in connection with electric circuits, for altering the difference of potential of two points of a circuit between which a practically constant current has to flow.** Felten und Guilleaume Lahmeyerwerke Act.-Ges., 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Oct. 19, 1906, being date of application in Germany.) (Complete specification.)

23224. **Improved means for obtaining motive power from single-phase circuits.** Valére Alfred Fynn, 70, Chancery-lane, London.

23225. **Improvements in and relating to arc lamps.** Dagobert Timar and Karl von Dreger, 7, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Sept. 6, 1907, being date of application in Germany.) (Complete specification.)

23230. **Improvements in devices for controlling electric circuits.** The British Thomson-Houston Company, Limited, 83 Cannon-street, London. (General Electric Company, United States.)

23231. **Improvements in adjuncts for aluminium cell lightning arresters.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

23239. **Improvements relating to electric switches.** Christian N. Bergmann, 31, Bedford-street, Strand, London. (Complete specification.)

Oct. 22.

23273. **Improvements in electric insulating materials.** James Hargreaves, 4, Clayton-square, Liverpool.

23280. **Improvements in and relating to the protection of electrical circuits.** Charles Cornfield Garrard and Ferranti Limited, 18, Southampton-buildings, London.

23303. **Improvements in electric lifts.** Charles George Major, Edwin Charles Stevens, and Percy Herbert Stevens, "Janus" Works, Queen's-road, Battersea, London.

23311. **Electromechanical means for controlling belt gearing.** Willie Ernest Clark, 43, Southampton-buildings, London.

23318. **Improvements in magnet inductors furnished with pole armatures.** Hartmann und Braun Akt.-Ges., Clun House, Surrey-street, Strand, London. (Date applied for under Patents Act, 1901, Oct. 24, 1906, being date of application in Germany. (Complete specification.)

23329. **Improvements in means for causing an electric current of variable direction to flow always in one direction only.** Felten und Guilleaume Lahmeyerwerke Act.-Ges., 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Oct. 22, 1906, being date of application in Germany.) (Complete specification.)

23351. **Improvements in electric searchlights.** Gebrüder Siemens und Co., Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Nov. 6, 1906, being date of application in Germany.) (Complete specification.)

23353. **Improvements in protective devices for electric conductors and systems.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

Oct. 23.

23358. **Improvement in enclosed arc lamps.** Charles Petitjean, 4, Robert's-place, Bowling Green-lane, London.

23416. **Improvements in electrically-controlled pendulums.** Charles Féry, Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Patents Act, 1901, March 1, 1907, being date of application in France.) (Complete specification.)

23418. **Turn-down device for low-voltage incandescent lamps.** Henry Winthrop Turner, 34, Norfolk-street, Strand, London.

23429. **Improvements in and relating to electrodes for electric arc lamps.** Edwin Rudolph Grote and the Foster Arc Lamp and Engineering Company, Limited, 40, Chancery-lane, London. (Complete specification.)

23432. **Improvements in or relating to alternating electric current distributing systems.** George Berry, 46, Lincoln's-inn-fields, London.

23435. **Improvements relating to electric incandescent lamps.** Alfred David Williamson, 7, Southampton-buildings, London.

23440. **Improved electric switch.** John William Ewart and William Seal, 33, Cannon-street, London.

23441. **Improved electrical sound intensifier.** Alexander von Nikiforoff, 4, South-street, Finsbury, London.

23448. **Improvements in alternating-current commutating electric machines.** Allgemeine Elektricitäts-Ges., 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Oct. 24, 1906, being date of application in Germany.) (Complete specification.)

23449. **Improvements in electric switches or circuit breakers.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

23450. **Improvements in and relating to prepayment electric meters.** Ernest Schattner and Richard Amberton, 83, Cannon-street, London.

Oct. 24.

23456. **Timing the spark of magnetos and the like.** Samuel Griffin, Kingston Ironworks, Bath.

23472. **Improved depth recorder for navigational sounding machines.** William Thomson (Baron Kelvin of Largs) and Kelvin and James White, Limited, 154, St. Vincent-street, Glasgow.

23497. **Spring support for an electric motor arranged on the axle of a vehicle.** Siemens-Schuckertwerke, G. m. b. H., Queen Anne's-chambers, Broadway, Westminster, London. (Date applied for under Patents Act, 1901, Oct. 25, 1906, being date of application in Germany.) (Complete specification.)

23520. **Improvements in and relating to the control of electric motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Allgemeine Elektricitäts-Ges., Germany.)

Oct. 25.

23554. **Improvements in or connected with electric cables.** James Naughtie Duff Burgess, 4, Clayton-square, Liverpool.

23562. **Improvements in ceiling roses used in connection with electric lamps.** Percy Turner Barlow, 4, Corporation-street, Manchester.

23570. **Improved compass suspension for use on board ship.** William Thomson (Baron Kelvin of Largs), Francis Wood Clark, and Kelvin and James White, Limited, 154, St. Vincent-street, Glasgow.

23583. **Automatic electric signalling device for electric tramways and railways.** Herbert Brown, 33, Chancery-lane, London.

23585. **Method of producing electric illuminating bodies by causing raw metallic threads to become incandescent by means of the electric current.** Glühlampenwerk Anker, G. m. b. H., 65, Chancery-lane, London. Date applied for under Patents Act, 1901, May 2, 1907, being date of application in Germany.) (Complete specification.)

23586. **Galvanic element and method of manufacturing the same.** Sven Alfred Weman, 65, Chancery-lane, London. (Date applied for under Patents Act, 1901, Oct. 27, 1906, being date of application in Sweden.) (Complete specification.)

23609. **Improvements in electric signalling systems.** William Edward Lake, 7, Southampton-buildings, London. (International Telemeter Company, United States.) (Complete specification.)

23641. **Improvements in or relating to electric light pendants.** Herbert William Hanwell, 111, Hatton-garden, London. (Complete specification.)

Oct. 26.

23647. **The harnessing of electrical and thermal sources of energy for the cultivation of organic vegetable matter.** Benjamin Howarth Thwaite, 29, Great George-street, Westminster.

23707. **Improvements in and relating to the control of alternating electric current motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

23708. **Improvements in and relating to the control of alternating-current electric motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

23709. **Improvements in dynamo-electric machines.** Louis Edward Underwood and and Charles Porter Smith, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Oct. 27, 1906, being date of application in United States.) (Complete specification.)

23711. **Improvements in the manufacture of electric conductors of refractory metal, applicable more especially for use as incandescing bodies in electric lamps and other apparatus.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

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23681. Improvements in electric contact or connecting plugs. William Paul Steinthal and Louis Jessop, 55, Market-street, Manchester. (Complete specification.)

23710. Improvements in dynamo-electric machines. Henry Gerber Reist, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Oct. 26, 1906, being date of application in United States.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Nov. 14.)

1906.

16357. Direct-current dynamo-electric machines. Elektrizitäts-Akt.-Ges. vorm. W. Lahmeyer und Co. (Date applied for under International Convention, July 20, 1905.)

23119. Manufacture of incandescent bodies or filaments for electric lamps. Bourdos, Rothschild, and Sutcliffe.

23422. Regulation devices for electric currents. Caballero.

24161. Method of constructing masts for wireless telegraphy and other purposes. Fairweather. (Brown Hoisting Machinery Company.)

24162. Masts for space or wireless telegraphy. Fairweather. (Brown Hoisting Machinery Company.)

24163. Electric insulators for tension guys used in connection with masts for wireless telegraphy and the like. Fairweather. (Brown Hoisting Machinery Company.)

25319. Fire-alarms and other electrical contact mechanism. Sutton, Sutton, and Mundy.

27112. Apparatus for starting and regulating electric motors. Fricker.

27303. Gearing for electric motors. British Thomson-Houston Company. (General Electric Company.)

28369. Electric time switches. Thorpe

28671. Signalling systems and apparatus therefor, especially applicable to railway and like signalling. British Thomson-Houston Company. (Allgemeine Electricitäts Ges.)

28673. Electrically-operated railway coupling apparatus and the like. Kilburn. (Georgiade.)

1907.

865. Electromagnetic brakes for railway and like vehicles. Schaake.

1006. Brush-holders for dynamo-electric machinery. Wood and Lancashire Dynamo and Motor Company.

1098. Supply conductors of electric railways and the like. British Thomson-Houston Company. (General Electric Company.)

1158. Time-controlled commutator switches. Briones.

1395. Insulators for electric conductors. Lake. (Clark.)

1855. Alternating-current distribution systems, especially applicable to electric railways. British Thomson-Houston Company and Woodbridge.

2499. Automatic telephone exchanges operating with electro-magnetically-controlled selecting devices. Siemens Bros. and Co. (Siemens und Halske Akt.-Ges.)

2752. Controllers for electric hoists or elevators. Von Zweigbergk. (Date applied for under International Convention, Nov. 28, 1906.)

3067. Printing telegraphs. White.

4175. Method and apparatus for producing a desired distribution of magnetic flux in motors, generators, and other electrical apparatus. Mershon.

4419. Holders for incandescent electric lamps. Epps.

5548. Apparatus for electrically operating and controlling semaphore signals. Siemens Bros. and Co. and Ferreira.

6095. Space telegraphy. Cabot. (Date applied for under International Convention, April 4, 1906.)

7651. Insulators for electric conductors. Lake. (Clark.)

9028. Oscillatory circuits of radio-telegraph systems. Amalgamated Radio-Telegraph Company. (Rosenthal.)

10126. Systems of electrical distribution by means of vapour-electric apparatus. Thomas. (Date applied for under International Convention, May 5, 1906.)

10431. Single-line intercommunication telephone systems. Birnbaum and White.

11285. Trolley wheels or collectors for electricity. Schneider.

11383. Indicating apparatus for electric meters. Baumann. (Date applied for under International Convention, May 16, 1906.)

12050. Dynamo-electric machines and motors. Siemens Bros. Dynamo Works and Kloss.

13943. Insulation of electric conductors and compounds therefor. Phillips and Hutchins.

14637. Electromagnetic appliances for playing pianos and other musical instruments. Schübbe.

16027. Arc lamps. Chalmers and Robertson.

17066. Holders or fittings for electric incandescent lamps. Lobel and British Ever Ready Electrical Company.

17309. Electric candle lamps. Bonnella and Bonnella.

18901. Electric furnaces. Pauling.

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £	Last price. £
Alliance Electrical Co., 5 per cent Cum Pref., Nos. 1-70,000	1 ..	½-⅝
—— Ord., 1,125 000	1 ..	⅛-¼
Aron Electricity Meter, 6 p.c Cum. Pref. Shares, 1-125,000	1 ..	5/32-9/32
British Aluminium Co., Ordinary, 2 001-40 000	5 ..	4-5
—— 7 per cent. Cum. Pref., 1-40 000	5 ..	4⅞-5⅛
—— "A" 6 per cent. Cum. Pref., 1-20 000	5 ..	4½-5
—— 4 per cent. Funding Certificates, 1-20 000	5 ..	3¾-4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	100-103
—— 5½ per cent Loch Leven Deb. (Reg.) Red., 1-3 000	100 ..	96-99
British Insulated and Helsby Cables, Ord., 1-100 000	5 ..	6¼-7
—— 6 per cent. Cum. Pref., 1-100 000	5 ..	5⅞-6⅛
—— 4½ per cent. Mortgage Debentures	100 ..	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	85-89
British Westinghouse Elec. and Manuf. 6 per cent Pref., 275,001-375 000	3 ..	1-1¼
—— 4 per cent. Mortgage Debenture Stock	100 ..	62-67
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	¼-⅜
—— Non. Cum., 6 per cent., Pref.	2 ..	⅜-1⅛
—— 4½ per cent 1st Debenture Stock	100 ..	85-86
—— 4½ per cent. 2nd Debenture Stock	100 ..	67-70
Callender's Cable, Debentures	100 ..	105-107½
—— Ordinary	5 ..	9¾-10¾
—— 5 per cent. Pref.	5 ..	5¼-5⅜
Consolidated Electrical Co., Ordinary, 1-110,000	1 ..	7/16-9/16
Crompton and Co.	3 ..	1¾-2
—— 5 per cent Debentures	100 ..	96-99
Dick, Kerr and Co., Ordinary, 1 260 000	1 ..	1¼-1½
—— 6 per cent. Cum. Pref., 1-305,000	1 ..	1-1¼
—— 4½ per cent. Debenture Stock, Red.	100 ..	101-103
Edison and Swan United, "A" Shares, 1-99 261	5 ..	1 1/16-1 5/16
—— "A" Shares, 01-017,139	5 ..	2¼-2⅜
—— 5 per cent. Debentures	100 ..	87-90
—— 4 per cent. Deb. Stock, Red.	100 ..	83-85
Electric Construction, Nos. 1 to 112 100	2 ..	⅛-¼
—— 7 per cent. Cumulative Pref.	2 ..	¼-1
—— 4 per cent. Perp. 1st Mort. Deb	100 ..	77-81
Electrolytic Alkali Co., Ordinary, 1-202,218	1 ..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock. Red	100 ..	—
General Electric Company (1900) 5 per cent. Cum. Pref.	10 ..	8-9¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	89-92
W. T. Henley's Telegraph Works, Ordinary	5 ..	10½-11½
—— 4½ per cent. Preference	5 ..	5-5½
—— 4½ per cent. Debentures	100 ..	105½-107½
India Rubber, Gutta Percha, and Telegraph Works	10 ..	13½-14½
—— 4 per cent. Debentures	100 ..	6-8
National Electric Construction Co., 1-170,000	1 ..	13/16-15/16
Parker, Thos., Limited, Ordinary	10 ..	10-10¼
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-30,000	5 ..	—
Telegraph Construction and Maintenance	12 ..	30-32
—— 5 per cent. Bonds	100 ..	99½-102½
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10 ..	8¾-9¼

Electric Lighting and Supply.—

Name.	Amount paid. £	Last price. £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5 ..	4½-5
Bournemouth and Poole, Ordinary	10 ..	9¾-10
—— 4½ per cent. Cum. Pref., 7 501-15 000	10 ..	8¾-10¼
—— 6 per cent. Cum Second Pref., 15 001-22,500	10 ..	8¾-10⅜
—— 4½ per cent. Debenture Stock, Red	100 ..	99-102
Bromley (Kent) Electric Light and Power Co.	5 ..	4⅝-5⅛
—— 4½ per cent. 1st Debenture Stock, Red.	100 ..	97-100
Brompton and Kensington, Ordinary	5 ..	7½-8
—— 7 per cent. Preference	5 ..	7¼-7½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5 ..	6-7
—— Nos. 80,000-100,000	4 ..	5¾-6¾
Cambridge Electric Supply Company, £10 Ord.	8 ..	12½-13½
Canadian General Electric Co., Common Shares	$100 ..	10-10 9
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100 ..	98-101
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5 ..	3⅞-4⅛
—— 4½ per cent. Cum Pref., 1-80,000	5 ..	3⅝-3⅞
—— 4 per cent. Debenture Stock, Red.	100 ..	94-99
—— "City Undertaking," 4½ p.c Cum. Pref., 1-40,000	5 ..	3⅜-3¾
—— ditto (1905) 40,001-80,000	5 ..	3¼-3¼
Chelsea Electricity Supply	5 ..	3¼-3⅜
—— 4½ per cent. Debentures	100 ..	102-105
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000 ..	97-100
City of London, Ordinary	10 ..	8¼-9¼
—— 6 per cent. Cumulative Pref.	10 ..	1 ¼-1½
—— 5 per cent. Debenture Stock	100 ..	122-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd)	100 ..	97-100
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1 630	£0 ..	50-53
Corjoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100 ..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5 ..	3¼-4¼
—— 5 per cent Preference, 1-50,000	5 ..	4⅜-4½ xd
County of London Elec. Supply, Ordinary	10 ..	6¾-7¾
—— 6 per cent. Cum Pref.	10 ..	10½-11½
—— 4½ per cent. Debentures Prov. Certs. All pd., Red.	100 ..	107-110
—— 4½ per cent. 2nd Debentures Prov Certs	100 ..	96-99
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5 ..	½-1
—— 6 per cent. Cum Pref.	5 ..	1-1⅛
—— 4½ per cent. First Mort. Deb	100 ..	76-81
Electrical Development Co. of Ontario. 5 per cent. 1st Mort. 30-year Gold Bonds, 10,751-15,750	— ..	76-79 p.c.
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5 ..	2¼-2⅜
—— 5 per cent Debenture Stock, Red	100 ..	85½-89
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red	100 ..	94-96
Folkestone Electric Supply, Ord., Nos 1-10 000	5 ..	4¾-5¼
—— 4½ per cent. First Deb Stock, Red.	100 ..	96-99
Hove Electric Lighting, Ord., 1-13 000	5 ..	6½-7 xd
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red	100 ..	101-103
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk., Red	100 ..	94-97
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1 ..	—
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000	5 ..	8¼-9¼
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red	100 ..	97-101 xd
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9½-10½
London Electric, Ordinary	3 ..	1¼-1⅜
—— 6 per cent. Pref.	5 ..	⅝-¾
—— 4 per cent 1st Mortgage Debenture Stock, Red.	100 ..	89-93

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Name.	Amount paid. £	Last price. £
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red. (Prov. Certs), all paid	100	92-95 x l
Metropolitan Ordinary, 100,001-100,000	5	5½-5¾
—— 4½ per cent. First Mortgage Debenture Stock	100	103-107
—— 4½ per cent. Cum. Pref.	5	4⅞-5⅛
—— 3½ per cent. Mortgage Debenture, Red.	100	87 92
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Pds. 1935, C 1-1,000 ($100), D 1-3,000 ($500), M 1-4,400 ($1,000)	—	72-74 p.c.
Mexican Light and Power Co., Capital Stock	$100	40½-42½
—— 5 per cent 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14 000 ($1,000)	—	82-84
Midland Electric Power Dis., 4½ p.c 1st Mort. Deb.	—	95-98
Newcastle-upon-Tyne Electric supply, Ordinary, 1-57,009	5	6¼-6⅜
—— do., 57,010-75.000	5	6¼-6⅜
—— do., 75,001-87.500 (issued at £2 prem., 16s. paid	5	6¼-6⅜
—— 5 per cent., Pref., 1-57,009	5	5-5⅛
—— do., 75,001-87,500 (issued at 10s. prem., 4s. paid)	5	5-5⅛
Notting Hill Electric Lighting	10	11-12
—— 4 per cent. First Mort. Debs. Nos. 1 500 (Reg.)	100	95-97
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	5¼ 6
—— 4 per cent. Debenture Stock	100	95-97
River Plate Electricity Co, Ord., 1-119 687 & 120,501-120 507	1	⅝ ¾
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	⅞-1
—— 5 per cent. Debenture Stock, Red.	100	95-98
Rosario Electric Co., 6 per cent. Cum. Pref., 1-20 000	5	4⅞ 5⅛
—— 6 per cent. Cum 2nd Pref., 1-15,000	5	4⅞ 5⅛
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	96 98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	—	99-101 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5	⅛ 1⅛
—— 4 per cent. Debenture Stock	100	71-75
South London Ordinary	5	1⅞-2⅛
South Metropolitan Electric Light and Power, Ord.	1	½-¾
—— 7 per cent Cum Pref.	1	15/16-1 3/16
—— 4½ per cent. 1st Mort. Deb.	100	99 102
St. James's and Pall Mall, Ordinary, 101-20,020	5	7¼ 8¼
—— 7 per cent. Pref.	5	6-7
—— 3½ per cent. Deb.	100	86-91
Urban Electric Supply Co., Ordinary, 8-30,007	5	1⅜ 2⅛
—— 5 per cent. Cumulative Preference, 50 001 80,000	5	1⅞-2⅛
Westminster, Ordinary	5	8¼-9¼
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	4¾-5¼

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine, 5½ per cent. Cum. Pref., 1-260,007	5	5 15/16-6 3/16
—— Ord.	5	7¼-7⅝
—— Permanent 6 per cent. Debenture Stock, 1888	100	131-134
Auckland Elec Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	102-105
Barcelona Tramways, Ord., 1-20,000	10	—
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	—
—— 5 per cent Deb., Red., 1-600	100	—
—— 4½ per cent. Red. Deb. Stock	100	—
Bath Elec Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1	11/16 13/16
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	⅞-1
Birmingham and Midland Trams., 4½ p. c. 1st Db. Stk., Red.	100	94-97
Blackpool and Fleetwood Tramroad	10	13⅜-13⅞
Bombay Elec. Supply and Trams. Co., 6 per cent. Cum. Pref.	8	7½-8
—— 4½ per cent. Deb. Stock, Red.	100	94-96
Brisbane Tramway Invest., Ord., 1-75,000	5	3¼ 3½
—— 5 per cent. Cum. Pref., Nos. 1-76,000	5	4⅜ 5⅛
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd	100	96-100
British Columbia Electric Railway Co., Ord Def.	100	130-135
—— Ord. Pref.	100	112-116
—— 5 per cent. Cum. Perpetual Pref. Stock	100	104-107
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	98-101 xd
—— 4½ per cent. Vancouver Power Deb.	100	102-104
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	1⅝-2¼
—— 6 per cent. Cm Pf., 30,001-60 000	10	5¼ 5⅝
—— 5 per cent. Perpetual Debenture Stock	100	90-93
—— 4½ per cent 2nd Deb. Stock	100	76-80
Bueno Ayres and Belgrano Trams.	5	4 7/16 4 11/16
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	4⅜-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4⅜ 5¼
—— 5 per cent. Deb. Stock, Red.	100	105-115
—— Prov. Cert., all paid	100	102-105
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100	92-97
Buenos Ayres Gd Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100	99-103
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	98-103
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	91-94
Calcutta Tramways, 1-105,000	5	6¾-7¼ xd
—— 105,001-1 7,610	5	5 5¼
—— 4½ per cent. 1st Deb. Stock, Red	100	100 104
Cape Electric Tramways, Nos. 1-480,000	1	¼-⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	4¼-4⅜
—— 4 per cent 1st Mortgage Deb., 1-3 000 (1917)	100	95-99 xd
City of Buenos Ayres Trams. Co. (1'04), 1-248,000	5	5⅛-5⅜
—— 4 per cent. Deb. Stock, Red. 1985	100	98-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	95-99
Cork Electric Tramway and Lighting Co., Ordinary	10	13-14
—— 6 per cent. Cum Pref.	10	12⅜-13⅜
—— 4 per cent. Debentures	100	90-95
Dublin United Tramways (1896), Ord., Nos 1-60,000	10	13-14
—— 6 per cent. Pref., Nos. within 1-60 000	10	12⅜-13⅜
—— 3½ per cent. Mort. Debs., 1-3,000 Red	100	90-95
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100	97-100
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1,000	82 87
Imperial Tramways, Ordinary	all	18-19
—— 6 per cent. Cum. Pref.	all	13-14½
—— 4½ per cent. Deb. Stock	100	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref, Nos. 20 001-60,000	5	⅞ 1⅜
—— 4 per cent. 1st. Mt. Db Stock, Red.	100	66-71
Kalgoorlie Electric Tramways, 1-250,000	1	3/32-5/32
—— 5 per cent "A" Deb. Stock	100	89-93
—— 6 per cent. "B" Deb. Stock	100	74-78
Kidderminster and District Lighting and Traction, Pref.	5	10-10½
Lancashire United Tramways, Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	94-97
—— £296 500 2nd Mort. Deb. Stock	—	—
—— £83,330 Deferred Deb. Stock (all fully paid)	—	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1	1-1¼
—— 6 per cent. Cum. Pref., Nos 1-425,553	1	1-1¼
—— 5 per cent. Mort Deb., 1-5,000 Red.	100	92-97
London United Trys. (1901), 5 per cent. Cum. Pref.	10	7⅞-8⅛
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100	82-86
Madras Elec. Trams. (1904) 5 per cent. Deb. Stk., Red.	100	96-99
Manila Elec. R.R. and Lightg. Corp., 5 p.c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000	90-92
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 23,436 25 000	—	4½-5
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100	96-99
Metropolitan Elec Trams., Defd., 1,000,001-1 314.016	1	1/16 3/16
—— 5 per cent. Cum Pref., 500,001-1,000 000	1	27/32-31/32
—— 4½ per cent. Deb. Stock, Red.	100	94-97
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	—	80½-82½ p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., £01-2,000	100	101-103
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34 001-74 000	5	¾-1⅛
Oldham, Ashton, and Hyde Tramway, Ordinary	10	2
—— 5 per cent. Cum. Pref.	10	8¾-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. stk.	100	101-105
Potteries Electric Traction, Ordinary, 1-245.000	1	5/16-9/16
—— 5 per cent Cum Pref., 300,001-545 000	1	½-⅝
—— 4½ per cent Debenture Stock	100	95 98
Provincial Tramways Co., Ordinary, 1-24,912	10	4⅜-5⅛
—— 6 per cent. Cum. Pref., 1-10,000	10	10¼-11¼
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-20,000	5	5⅛-5⅜
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100	97-99
Sao Paulo Tramway, Light, and Power Co.	$100	104-108
—— 5 per cent. 1st Mort. Deb., Red. 1929, 1-11,000	$500	93-95 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1	⅞-1
—— 4 per cent. Deb Stock, Red. 1940	100	80-84
Sunderland District Electric Tramways, 5 p.c 1st Mort. Debs., Red., 1-1 600	100	84-88
Yorkshire (West Riding) Elec Tram. Co., Ord., 70,001-110,000	5	1-1½
—— 6 per cent. Cum Pref., 1-46,261	5	3⅛ 3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	87-90

Electric Railways.—

Name.	Amount paid £	Last price. £
Central London, Ordinary	100	58-60
—— 4 per cent. Pref.	100	85-87
—— " " deferred	100	40-43
—— 4 p c Deb. Stock (Prov. Script Certs., fully paid)	100	101-104
City and South London, Consolidated Ordinary	100	44-46
—— 4 per cent Debenture Stock	100	102-105
—— 5 per cent. Pref. Stock '91	100	116-119
—— " " " '96	100	113-116
—— " " " '01	100	113 116
—— " " " '05	100	108-111
Liverpool Overhead, 5 per cent. Pref	10	10-10½
—— Ordinary, 1-50,000	10	3¾-4⅛
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	44-49

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price. £
Amazon Telegraph Co., 1-25,000	10	3-3½
—— 5 per cent. Debs., Red., within 1-1,069	100	85-88
American Telephone and Telegraph Coll. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78 000	$1 000	89-91
Anglo-American Telegraph Co., Ordinary	100	51-54 xd
—— 6 per cent. Preferred Ordinary	100	91-94 xd
—— Deferred Ordinary	100	13¼-13⅜
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100	99-102
Chili Telephone Co., 1-44,000	5	6¾-7⅛
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100	89-91
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	6-7
—— 10 per cent Preference, 1-6 000	10	15⅜-16⅜
Direct Spanish Telegraph Co., Ordinary	5	3¼-3⅜
—— 10 per cent. Cum. Preference	5	8-9⅛
—— 4½ per cent. Debs., 1-600	50	98-101
Direct United States Cable Co.	20	12½-13½ xd
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100	100-102
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100	97½-100½
—— 4 per cent. Reg. Mort. Debs. (Mauritius subsidy), 1-8 000, 1913	25	100-102
Eastern Extension, Australasia and China, 1-300,000	10	11-12 xd
—— 4 per cent. Mort. Deb. Stock, Perp.	100	98-102
Eastern Telegraph Co., Ordinary stock	100	120-125 xd
—— 3½ per cent. Preference Stock	100	80-83 xd
—— 4 per cent. Mortgage Debenture Stock	100	101-104
Great Northern Telegraph Co. (of Copenhagen)	10	32-34
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1,200, Red.	100	99-101
Indo-European Telegraph Co.	25	54-56
Marconi's Wireless Telegraph Co., 1-256,127	1	¾-1⅛
—— 256,128-784,190	1	¾-1
Monte Video Telephone Co., Ordinary, 1-72,680	1	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492	—	⅞-1
National Telephone, Preferred	100	106-108
—— Deferred Stock	100	106-108
—— 6 per cent. Cum. First Pref.	10	10¼-12½
—— 6 per cent Cum. Second Pref.	10	10-12
—— 5 per cent. Non. Cum. Third Pref.	5	5¼-5½
—— 3½ per cent. Deb. Stock, Red.	100	95½-97½
—— 4 per cent. Deb. Stock, Red.	100	99½-101½
Oriental Telephone and Electric Company	1	1 3/16-1 5/16
—— 6 per cent. Cum. Pref	1	1 3/16-1 5/16
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100	97-100
United River Plate Tele. Co., Ordinary, 1-100,000	5	7-8 xd
—— 5 per cent. Cum. Pref., 1-40,000	5	5-5½
—— 5 per cent. Debenture Stock, Red.	100	—
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	98-102
West African Telegraph Co.	10	10-10½
West Coast of America, 1-30 000 and 53 001-53,008	2½	1-1¼
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100	97 100
West India and Panama Telegraph Co., Ordinary	10	7/16-9/16
—— 6 per cent. Cum. 1st Preference	10	7-8
—— 6 per cent. Cum 2nd Preference	10	6¼-7¼
—— 5 per cent. Debs., Red., 1-800	100	99-102
Western Telegraph Co., 1-207,930	10	12½-13½
—— 4 per cent. Debenture Stock, Red.	100	98½-101½

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.							Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1907.	1906.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Passenger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Oct 23	1,232	1,223	+ 68	— h	25½	25	May 31	64,071	15,530,351	1,373,723	0·98	11·14	2,512	6·45
Ayr Corporation	,, 19	213	196	+ 17	—	8	8	,, 15	14,328	3,316,380	353,945	1	9·71	1,830	5·16
Baker Street and Waterloo Ry.	,, 25	2 700	1,765	+ 935	+ 15,325	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 27	1,042	1,009	+ 33	- 437	23 53	21·53	March 31	55,025	11,145,531	1,309,903	1·18	10·08	2,338b	6·03
Birmingham Corporation	,, 26	5 232	—	—	—	56½	—	,, 31	17,133	4,709,798	266,526	86	14·5	8,866	—
Blackburn Corporation	,, 25	1,133	933	+ 143	+ 2, 49	24	21	,, 25	48,875	8,661,720	986 953	1·35	11 89	2,036	7·44
Blackpool Corporation	,, 21	543	485	+ 58	- 1,455	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	,, 26	311	279	+ 32	- 1,139	16½	16½	Dec. 31	31,846	2,325,677	573,264	3·28	13 19	—	7·27
Bolton Corporation	,, 27	2,181	2,183	+ 93	+ 4,037	42	40	March 31	95 766	20,205 196	2,1 1,130	1·13	10 63	2 394	6·14
Bournemouth Corporation	,, 25	1,477	1,531	- 54	+ 9·4	17·41	16·82	,, 31	55,276	10,058,288	1,121,623	1 32	11 83	3 226	7·19
Bradford Corporation	,, 27	4,382	4 412	- 30	+ 2,120	95	95	,, 31	230,085	47,108,000	5,053,392	1 172	10 927	2,396	—
Brighton Corporation	,, 27	811	851	- 40	- 2,905	9½	9½	,, 31	50,339	11,321 160	1,152,82	1 06	10·48	,914·8	8·0·4
Bristol Tramway Company	,, 25	4 994	5,011	- 17	—	51½	51½	Dec. 31	259,799	45,312,373	6 127,135	—	—	—	—
Burnley Corporation	,, 26	1,206	1,189	+ 17	—	40	40	March 31	57,992	11,093,704	1,197,772	·31	11 61	5,388	8 17
Burton Corporation	,, 27	263	—	- 3	- 423	8½	8½	,, 31	17,950	3,878,269	454,082	·07	9·21	2,0 8	6·76
Cardiff Corporation	—	—	—	—	—	32 62	†32·26	,, 31	112,209	24,134,363	2,770,049	1·12	9 72	3,782	9 44
Carlisle Tramways Company	,, 26	173	175	- 2	- 530	8·5	8·5	Dec 31	10 713	2,935 002	359,756	—	7 14	—	5 18
Central London Railway	,, 26	5,649	6,499	- 850	- 13,3 1	6	6	,, 31	347,588	4,875 547	1,2s1 214	1 86	65·10	57,931	15·80
Charing X, Euston, & Hamp. Ry	,, 25	2.715	—	—	—	8	—	—	—	—	—	—	—		
City and South London Railway	,, 27	3,289	2,920	+ 369	+ 8 039	6¼	6¼	,, 31	—	—	—	—	—		—
Colchester Corporation	,, 23	203	218	- 15	—	8	8	March 31	10,588	2,457,553	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	,, 24	434	448	- 14	- 812	15¼	15¼	Dec 31	24,895	5,814 376	882 256	1 01	6·64	—	4·69
Croydon Corporation	,, 25	1,381	—	- 70	—	12 c	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 25	263	257	+ 6	- 28	7 23	7·23	March 3	—	—	—	—	—		
Dover Corporation	,, 26	205	224	- 18	- 1 005	4½	4½	,, 31	11,250	2,853 200	284,343	·94	9·49	2,500	
Dublin and Lucan Electric Ry.	,, 25	114	93	+ 16	+ 220h	6¾	6¾	Dec 31	6 358	402,511	110,738	3 79	13·78	942	7 33
Dublin U.T.	,, 25	5,933	4 745	+1 188	+ 27 8 4	48½	48½	,, 31	267,489	50,050,949	7,077,572	1·.8	9·07	691	5 55
Dundee City Tramways	,, 23	1,108	—	+ 20	+ 648	22	22	May 15	50 154	13 086 396	1,005 911	·906	1·96	2,180	7·42
East Ham Corporation	,, 25	874	875	- 1	- 253	14	14	March 31	56,652	3,689,658	863,816	·64	10 18	2,994	6 79
Glasgow Corporation	,, 26	17,947	17,037	+ 860	+ 9,539h	79½	79½	May 31	756 480	195,767,519	17,945,595	—	0 12		—
Gloucester Corporation	,, 23	259	259	—	- 197	15	15	March 31	15,465	3,902,077	553,595	·50	6·68	939	5·32
G.N., Piccadilly, and Brompton	,, 26	4.610	—	—	—	9	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	37	37	,, 31	74 019	17,849,642	1,540,707	—	11 53	2,085	8·56
Huddersfield Corporation	,, 26	1,510	1,480	+ 30	+ 2,178	35	35	,, 31	69,938	12 838,150	1 665,262	1·24	9 71	1,923	—
Hull Corporation	,, 26	2,401	2,305	+ 95	+ 3,736	26	26	,, 31	112,651	27,102,921	2,910,698	1	9 29	—	—
Ilford Corporation	—	—	—	—	—	10½	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 23	178	173	+ 5	+ 236	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	11,586	3,626,656	419,800	·927	6 62	1 480	5·22
Lancashire United Tramways	,, 23	1,212	1,067	+ 155	+ 13,064	38½	28	—	—	—	—	—	—	—	—
Leeds Corporation	,, 19	6,569	6 201	+ 368	+ 8,174	83½	89½	March 25	298,233	64,223 666	7,121,038	1 10	10 02	351	—
Leicester Corporation	,, 26	2,080	2 082	- 32	—	42	42	Dec. 31	26,011	12 039,252	1,229,507	1	9·79	—	4 82
Liverpool Corporation	,, 19	11,018	10,978	+ 70	+ 7,623	104	104	,, 31	547 625	116,642 663	12,166 419	—	—	—	—
Liverpool Overhead Railway	,, 26	1,598	1,370	+ 223	+ 1,615h	6·65	6 65	June 30	81,302	11,171 865	1,024 275	—	—	—	—
London County Council	,, 19	31,972	25,303	+5,669	+151,081	98	98	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 26	188	196	- 8	- 51	6	6	Sept. 30	14,511	3,128,867	359,435	1 08	9 68	2 630	6·48
Maidstone Corporation	—	—	—	—	—	2	2	March 31	4,740	850 121	112,227	1 33	10 13	2,370	—
Manchester Corporation	,, 26	14,853	14 220	+ 633	+ 32 371	149	149	,, 31	631,956	126,900,875	14,123,124	1 19	10 73	4,299	6·99
Metropolitan District Railway	,, 26	8,184	8,080	+ 104	- 461	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 27	15,374	15,351	+ 23	+ 5,742	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 26	132	133	- 6	- 26	2¾	2¾	,, 31	6,159	1,992,647	206,358	82	7 14	2,239	—
Newcastle-on-Tyne Corporation	,, 26	4,348	3,981	+ 354	+ 597	50	50	,, 31	197,849	43,06 ,934	4,326,152	1 07	10 98	3,957	7·0
Newport (Mon.) Corporation	,, 26	632	639	- 7	+ 1,674	15¼	15¼	,, 31	30,356	7,252 535	783 435	—	9 29	—	6·4
Oldham Corporation	—	—	—	—	—	34	34	,, 25	65 553	13,466,245	1,504,740	1 16	10 45	1,885	—
Portsmouth Corporation	May 25	2,330	1 578	+ 752	+ 632	28½	28½	,, 31	95,702	19,625 329	197,499	1·17	11 63	—	—
Reading Corporation	Oct. 24	601	610	- 9	- 756	33½	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	11·23	21·29	,, 31	14,881	2,837,110	386,547	1·24	9·24	1,102	7 52
Rotherham Corporation	—	—	—	—	—	9½	9½	,, 31	23,569	5,251,472	593,054	1 07	9 53	2,612	7·49
Salford Corporation	,, 28	4,521	4,421	+ 100	+ 3 832	70¾	70¾	,, 31	214,111	39,213 560	4,884,560	1·28	10 29	—	—
Scarborough Tramways Co.	—	—	—	—	—	4½	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 29	5,587	5,267	+ 320	+ 7,730	35¾	35¾	,, 25	240,565	63 952,283	,049,899	903	9 543	3,653	5·94
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,365	9 294,771	1,108,369	1·27	11·02	—	7·83
Southend-on-Sea Corporation	,, 23	320	308	+ 12	- 117	9	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	,, 31	39,550	6,766,031	1,027,730	—	9 23	—	4 75
Sunderland Corporation	,, 20	1,347	1,345	+ 2	- 557	20	20	,, 31	64,858	15,364 463	1 495 f85	1·004	10·36	—	6·37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	4,937	1,315,757	102,751	0·87	11 53	1,371	—
Torquay Tramways	Oct 24	173	—	—	—	5·16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 26	759	7 3	+ 26	+ 665	12 68	12·43	,, 31	43,607	7,995,451	862,12	9·27	12·14	3,132	7 50
Warrington Corporation	—	—	—	—	—	9	9	,, 31	17,0.7	4,418 225	403 363	—	9 85	—	6·33
West Ham Corporation	,, 21	2,224	2,315	- 91	+ 1,124	14·7	14 7	,, 31	—	15,773,742	1,23 ,165	—	—	—	—
Wolverhampton Corporation	,, 23	892	830	- 28	+ 226	20	20	,, 31	41,905	8,847,066	950,338	—	10 583	2,062	6·1o

† And 98 miles of interlacing track. a Train mile. b Per mile of single track. c Miles of route. h Half-year's figure k Double track.

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NOTES.

Royal Institution.—A general monthly meeting of the members of the Royal Institution was held on Monday afternoon (the 4th inst.), Sir James Crichton-Browne, treasurer and vice-president, in the chair. Dr. R. J. Collie, Sir Murland Evans, Bart., and Mr. H. Richardson were elected members.

Poor-Law Inquiry.—The inquiry which has been ordered by the Local Government Board on the subject of the machinery and engineering staff at poor-law institutions is not without interest to many of us, considering that at many of the institutions electrical equipments are installed and employment given to electricians. The departmental committee to whom the inquiry has been delegated was appointed this week, and consists of Mr. A. B. Lowry (chairman), Mr. B. T. Kitchin, and Mr. H. Ross Hooper, with Mr. I. G. Gibbon as secretary.

Northampton Polytechnic Institute.—The annual prize distribution and conversazione will be held on Friday and Saturday, Nov. 29 and 30 next. His Royal Highness the Duke of Connaught, K.G., has consented to distribute the prizes on Nov. 29, and after the prize distribution the whole of the laboratories, workshops, drawing offices, and studios of the institute, both in the main building and in the British Horological Institute adjoining (the technical optics department), will be on view in working order. The conversazione of members and students will be held on the following evening (Saturday, Nov. 30) in both buildings.

Royal Society.—The following have been recommended by the president and council of the Royal Society for the election into the council for the ensuing year at the anniversary meeting on Nov. 30: president—the Right Hon. the Lord Rayleigh, O.M.; treasurer—Mr A. B. Kempe; secretaries—Prof. J. Larmor and Sir A. Geikie, K.C.B.; foreign secretary—Prof. J. R. Bradford; other members of council—Dr. H. F. Baker, the Right Hon. A. J. Balfour, Sir William Crookes, Mr. Francis Darwin, Sir George Darwin, K.C.B., Prof. J. C. Ewart, Prof. D. Ferrier, Mr. C. T. Heycock, Prof. S. J. Hickson, Prof. John Joly, the Hon. Charles Algernon Parsons, Dr. A. Scott, Prof. A. C. Seward, Prof. F. T. Trouton, Dr. A. Désiré Waller, Mr. William Whitaker.

Spain.—It is stated in a consular report from Malaga that the Sociedad Hidro-Eléctrica del Chorro, which already furnished electric power to Malaga generally as well as to the British and German electric light and electric tramway companies, etc., has now completed an auxiliary station on the outskirts of the town which is fitted with a most up-to-date steam-turbine plant with three-phase generators. This installation has been furnished by one of the best-known British firms, and the work has been carried through under the personal supervision of British engineers. The above-mentioned firm has also erected plants for the manufacture of cement and calcium carbide, for which there is a fair demand. The electrification of the tramway, which had been in progress for a considerable time, was completed last November by the Belgian company which owns it.

The Association of Engineers-in-Charge.—The Association of Engineers-in-Charge, who hold their meetings at St. Bride's Institute, are evidently determined that their members shall not be wanting in information relative to electrical engineering, and we can only congratulate their educational committee in making the study of this subject of such importance as they have in the arrangements for the ensuing session. Economy, or means thereto, appropriately receives prominent attention in the programme of lectures, for from the first, or presidential address, which is to be given by Mr. W. H. Patchell on the "Economic Consideration on the Management of Plant," on Nov. 13, to the last, which is on "Indicators and Indicator Diagrams," the practical needs of the members have not been overlooked. The subjects seem well chosen, while the authors and the chairmen are all engineers of considerable eminence, which can only point to one thing, and that is, progress of the association.

The Board of Trade and Surface-Contact Traction.—The Board of Trade have given their approval to the "G. B." surface system of electrical traction which the London County Council propose to experiment with on the portion of their tramways from Aldgate to Bow. But this approval is not altogether unqualified, for in a communication from the Secretary of the Board of Trade to the London County Council it is stated that such approval does not extend to the details of construction, and the Board ask the Stepney Council to furnish them with any observations which the Council may wish to offer as to this. It does not seem clear why the Stepney Council should be called upon to offer such observations, when they are apparently satisfied with the assurances of their technical advisers that the details warrant the construction to be undertaken. Either the Board of Trade have their doubts as to the feasibility of surface-contact traction and wish to avoid saying so by sheltering themselves, in this case, under the cloak of the Stepney Borough Council, or (we hesitate to suggest it) their technical advisers do not thoroughly understand the matter. It is surely incumbent upon the Board to make themselves acquainted with all developments in electrical traction by the means of independent inquiry, so as to be in a position to give a frank and fearless opinion on any matter when required.

Institution of Civil Engineers.—The council of the Institution of Civil Engineers have made the following awards for the year 1906-1907: The Howard quinquennial prize to Mr. T. E. Vickers, C.B., in recognition of the part he has taken during his career in developing and improving the production of steel for important engineering purposes; Telford gold medals to Messrs. Dugald Clerk (London) and E. J. Way (Johannesburg); Watt gold medals to Messrs. J. T. Milton (London), A. W. Brightmore, D.Sc. (Egham), and C. W. Lloyd-Jones (Secunderabad); George Stephenson gold medals to Messrs. G. A. Hobson (London) and W. C. Copperthwaite (London); Telford premiums to Messrs. C. F. Jenkin, B.A. (London), W. A. P. Tait, B.Sc. (Edinburgh), A. P. Trotter, B.A. (London), M. Kellow (Penrhyndeudraeth), H. J. S. Heather (Johannesburg), A. M. Robeson (Johannesburg), and J. W. Hitchin (Bristol); a Crampton prize to Mr. R. F. Thorp (London); Manby prizes to Messrs. S. A. Frech (London) and G. D. McGlashan (Blyth); the Miller scholarship and the James Forrest medal to Mr. A. C. Anderson (Wolverhampton); Miller prizes to Messrs. R. A. Whitson (Basutoland), C. A. Ablett, B.Sc. (Addiscombe), E. H. Heathcote, M.A. (Henbury, near Macclesfield), G. B. G. Hull (Stockport), H. Stringer (Stoke-on Trent), G. F. Walton (Edenfield, near Manchester), and A. T. Weston, M.Sc. (Woolwich); Bayliss prizes, awarded on the results of the October and February examination, 1906-1907, respectively, to Messrs. F. C. R. H. Boyd (Luxor, Upper Egypt) and D. J. Morris (Swansea).

Publications Received.—*Science Abstracts* (in two parts, price 1s. 6d. each). The October issues have now come to hand from the publishers, Messrs. E. and F. N. Spon, 57, Haymarket, London, S.W. As usual, this publication is divided into two sections, Section A being

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devoted to physics and Section B to electrical engineering, the abstracts appearing in both sections being taken from most of the important sources in Europe and America.—An interesting publication has been issued by the University of Wisconsin, U.S A., bearing an account of an investigation of the borides and the silicides by Oliver Patterson Watts, Ph.D., instructor of chemical engineering at the University of Wisconsin. During the last two decades notable contributions have been made to the field of chemistry through the use of the electric furnace. The high temperatures, made available by the conversion of electrical into thermal energy, have resulted in the discovery of many new compounds. Dr. Patterson in his work (which was a thesis submitted for the degree of Ph.D. of Wisconsin University) presents the results of an experimental investigation of some of these compounds, together with a brief yet comprehensive account of the two series of chemical compounds—borides and silicides—which have become of scientific and commercial importance through the advent of the electric furnace. One of the problems dealt with was the possibility of the preparation of the borides and the silicides from their commercially available oxygen compounds by a single reaction in the electric furnace. Another problem investigated was the production by means of the electric furnace of a new series of definite chemical compounds, the silico-borides.

Electric Power for the Rand.—Mr. Ralph D. Mershon recently expressed himself in sanguine terms as to the prospects of a supply of power from the Victoria Falls to the Rand, and Mr. H. Wilson Fox, manager of the British South Africa Company, who with Mr. Mershon and Mr. Alfred Wright (the company's chief electrical engineer) and others has been visiting the Falls, gave his opinion on his return from South Africa last week in no less emphatic terms. Mr. Fox declares that the leaders of the mining industry in Johannesburg are viewing with favour the business of the Victoria Falls Power Company. He states the case of a mining group which offered to take 2,500 kw., but which the company were unable to supply as their two existing stations were fully occupied. These two stations, he explained, were bought for £500,000, of which nearly the whole amount has been paid in preference shares and debentures, and the company are earning from them cash profits of upwards of £80,000 a year (of course, no allowance is here made for depreciation of plant, etc.). He added that so far none of the new plant was at work. But they hoped their profits would be increased with the commencement of the operation of the 24,000-h.p. station. They did not expect to have any of their plant standing idle. Even when the full plant is at work they would only be supplying a comparatively small fraction of the total used by the industry. They had also been very fortunate in some of the arrangements which they had made, which were hoped to effect large savings on the estimates prepared by the engineers for the prospectus. The various sites proposed for the power station have been inspected. Mr. Fox characterised the prospects of the company as extremely bright.

Manchester Local Section. — The provisional syllabus of the meetings of the Manchester Local Section for the session 1907-8 has just come to hand, and, as will be seen later from the list of papers promised, the session promises well. We notice that the syllabus for this session is marked "provisional." This is owing to the new regulations passed by the Council of the Institution regarding papers read either in London or at any of the provincial centres. These regulations may involve changes in the dates or subjects of papers. The opening meeting will be held in the banqueting hall of the Midland Hotel, Manchester, on Tuesday, Nov. 12, at 7.30 p.m., when the chairman, Mr. M. B. Field, will deliver his address. A smoking concert will follow the address. The remaining meetings of the session will, by the kind permission of the authorities, be held at the physical laboratory of the University of Manchester. On Nov. 26 Mr. H. W. Wilson will read a paper entitled "Further Remarks on the Electrical Operation of Textile Factories." The remaining arrangements are as follows: "The Reluctance of the Air-Gap in Dynamo-Machines," Mr. Thos. F. Wall; "Magnetic Oscillations in Alternators," Mr. G. W. Worrall; "High-Voltage Transmission and Distribution from a Mainsman's Point of View," Mr. C. H. K. Chamen; "Protective Devices for High-Tension Transmission Lines," Mr. J. S. Peck; "Direct-Current Turbo-Generators," Mr. W. Hoult; "Investigations on the Operation of Enclosed Fuses," Prof. A. Schwartz and Mr. W. H. H. James; "The Management of Engineering Workshops," Mr. Eustace Thomas; "Electrolytic Corrosion," Prof. W. W. H. Gee; "Alternating-Current Turbo-Generators," Mr. M. Kloss. The annual dinner will be held on Feb. 28, 1908.

Channel Ferry Scheme.—The attempt to pass a scheme for bridging the Channel by means of a tunnel having failed, the way is now clear for the promoters of rival schemes to urge their claims. It is evidently proposed to proceed actively with the project of a Channel ferry and the company formed for the purpose has been in close communication with the railway companies and the different authorities concerned. There can be no doubt that the prospects of the successful carrying out of such a scheme is now exceedingly bright, for both the English and French Governments have given it their blessing. An important deputation met Mr. Lloyd-George at the Board of Trade last week, and he promised to do everything in his power to assist in carrying out the project, while during the same week the deputation crossed over to Paris and there interviewed M. Clemenceau (the French Premier), who not only gave a similar assurance to that of the British Minister, but even declared his belief that if the scheme was feasible, it was eminently desirable. There could never be any doubt as to the attitude of the English Government on the subject, for not only has the Prime Minister explicitly declared in favour of the ferry scheme, but he has been no less emphatic in his condemnation of the "tunnel" scheme. The carrying out of the ferry scheme involves no insuperable engineering difficulties. There are likely to be very extensive dock alterations both at Calais and Dover. Apart from the merits or demerits of the rival schemes, we believe that the manufacturing and exporting classes in this country will welcome the impetus to trade which the bridging of the Straits of Dover is likely to give. Our interest in the Channel tunnel scheme lay principally in the proposal to adopt electric traction in the tunnel, similar to that adopted in the Simplon (from the published reports on the working of which we gather that the results are highly satisfactory). The scheme at present to the fore, however, is no less interesting for the great opening which it offers for almost every kind of electrical plant and machinery.

Railway Electrification.—The issue of the *Street Railway Journal* for Oct. 12 is a special "convention" number, and contains the usual comprehensive survey of electric railway engineering for which this annual issue of our esteemed contemporary is noted. The careful study which has been made of electrical engineering operating practice and the full descriptive and analytical accounts of the operation of such important lines as the New York Central and Hudson River Railroad, the Long Island Railroad, the West Jersey and Seashore Railroad,

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the West Shore Railroad, and the electrified division of the Erie Railroad, as well as the power station of the Interborough Rapid Transit Company, bring together much information respecting the practical operation of lines. The attempt to abstract the great mass of information gathered together in this one issue may be given up as hopeless; but it must be admitted that information is of great interest to electric railway companies (and even to the companies owning steam lines), as our readers who have followed the record of operations in the States which has from time to time appeared in this journal will acknowledge. Of particular importance is an article from the pen of Mr. Philip Dawson, who discusses the progress being made in heavy electric traction in Europe, particularly in the field of single-phase motors. Mr. Dawson's review of the subject shows that European engineers and managers are fully alive to the possibilities of electric power on their steam roads. Probably the most ambitious plans at present being formulated in this direction are those of the Swedish Government, whose extensive trial of electric power receives ample discussion in Mr. Dawson's paper. A careful and thorough study of the subject was undertaken by the chief engineer of the Swedish State Railways, Mr. Robert Dahlander, who has decided upon the adoption of the single-phase system using overhead construction. Germany, Switzerland (which may be looked upon as one of the pioneers of main-line electrification with high-pressure alternating current), Italy, and England, however, are not far in the rear of their Northern neighbours, and are engaged in electric traction work of the greatest importance.

Marseilles Electrical Exhibition.—Yet another international exhibition of the applications of electricity is to be held, this time in Marseilles. This exhibition will be open from April 19 till Oct. 31, 1908, and a circular and covering letter which we have received from the director asks us to bring it to the notice of British manufacturers. From a list of the sections into which the exhibition is to divided, it is evident that the organisers do not propose to overlook any one of the many applications of electricity, and in view of the extent and commercial importance of the district in which the exhibition will be held, it should be a favourable means of impressing French manufacturers with the importance of the British electrical industries. The exhibition will comprise the following principal sections, which will be further subdivided into classes: transmission and distribution of electrical energy; applications of electricity to industries in general; applications of electricity to domestic industries; applications to domestic economy; applications to public and private lighting; applications to heating and ventilation; applications to machinery for lifting; applications to mines and quarries; applications to traction; applications to agriculture; applications to military and naval engineering; electrochemistry—electrometallurgy and the allied sciences; telegraphy and telephony; applications to the medical and surgical sciences; electrical instruments for measurement and calibration; raw materials and manufactures used in electrical industries; practical and theoretical teaching of the science of electricity. The management propose to give the section for electric traction a particularly large space, this being amply justified by the fact that Marseilles, as the pioneer of electric traction in France, is now in possession of a tramway system which includes 155 miles of single track, and of which the generating and sub-stations, as well as the car-building works, will be visited with interest. The particular attention of exhibitors needs be drawn to the increased demand from the neighbourhood of Marseilles for improved means of irrigation in the form of electric pumps and irrigating machinery. Vast areas remain as yet uncultivated for want of water, which now can easily be procured by means of electric appliances, and there is room for thousands of pumps to draw water from the water-bearing strata of the beds and basins of the Rhone and the Durance.

Measurement of Electrolytic Resistance.—A method of measuring electrolytic resistance without using electrodes, as devised by Messrs. W. S. Franklin and L. A. Freudenberger, was described in the October issue of the *American Physical Review*. The method is based upon the use of a transformer, the primary of which is supplied with alternating current, and whose secondary consists of a single "turn" of liquid, the resistance of which is to be measured. The liquid is contained in a glass ring formed of two concentric cylinders with the edges ground plane and covered with two flat glass plates. In one arrangement for measuring the resistance a three-legged transformer core was employed, the electrolytic "turn" being placed around one outer leg and a secondary of wire around the other. The primary coil was wound in two parts, so that when a current was passed through it and the secondary circuits were open there would be no current set up in a test coil placed on the central leg and connected either to a telephone receiver or a special alternating-current galvanometer. Then when the glass vessel is filled with the electrolyte under investigation, the current set up in this upsets the magnetic balance of the system, causing a current to flow in the test coil. By varying the resistance in the wire coil on the other outside leg the system could again be balanced, and at this time the resistance in this circuit was equal to that of the electrolyte. Another arrangement consisted in employing two independent transformer cores with primary coils connected in series; around one the electrolytic conductor was placed, and around the other the wire secondary. With the two secondary circuits open an intermediate connection between the two transformers and the centre of an inductance connected between the supply mains should give rise to no current, but this balance is upset by filling the glass vessel with electrolyte and the balance again restored by means of the wire secondary. In these experiments a disturbing element is the eddy currents set up in the electrolyte. To allow for this the glass vessel was filled about three-quarters full of the electrolyte, and placed so that the circuit was not completed. In this way the disturbing effect of that amount of electrolyte was determined when that due to the total quantity could be computed. The observations made in this way gave results in good agreement with those of Kohlrausch and Holborn.

Brownlow Hill Workhouse Installation.—Some few months ago we published in this journal a description of the electrical installation at Brownlow Hill Workhouse, Liverpool The report of the first year's working has just come to hand, and the results are highly satisfactory. In this report the consulting engineers, Messrs. T. L. Miller, Wilson, and Pegg, state that the results obtained had in the main justified their original anticipations, and that making allowance for the increased price of coal, and allowing also for interest and repayment of capital on the ordinary basis, a saving of about £700 on the year's working was shown over the previous methods. The Liverpool Select Vestry are to be congratulated upon their past year's success, which so amply justifies their belief in the advantages to be derived from the electrical installation. And, apart from the direct economy, there has been (on the admission of Mr. E. Horrigan, chairman of the vestry) an indirect saving from the use of electric lighting both as regards reduction in cost of cleaning and decorating and in the more healthy condition of the wards—a factor of great

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importance. It may be of interest to make a comparison of the actual cost as shown by the first year's working compared with the cost which would have been incurred had the vestry decided, as at one time suggested, to take the whole of their supply from the Liverpool Corporation electricity department. Mr. Horrigan referred to this point at the annual vestry meeting, and presented some interesting figures. Working out the cost of electrical energy from the Liverpool Corporation at the schedule rate quoted, he found that the total bill would have amounted to £2,843. In addition to this, it would have been necessary for the vestry to have incurred a considerable portion of their capital expenditure on the mains, switchboard, motors, and wiring. The total of these items would have amounted to about £4,500, and interest and repayment charges on them would have meant an annual expenditure of £397. Comparing these figures with those in the report, the increased expenditure necessary if the Corporation supply had been taken would have been at least £1,200 per annum. Mr. Horrigan referred to the fact that the consumption of energy for lighting had been very much greater than was anticipated, and that if it had not been for this fact, the actual saving would have been considerably greater than the anticipated one, and he considered that in certain departments there had not been the care exercised in using the current that there might have been. A lesson to be learned from the Brownlow Hill Workhouse experience is that even a small installation such as the one in question, if properly managed, can be very economically run.

Lighting and Telephone Systems.—A recently-issued patent, the holders of which are the British Thomson-Houston Company, describes a dynamo having a uniform bipolar field of constant strength which is intended to be used as a current generator, or as a rotary converter, for supplying current in telephone and like systems. The

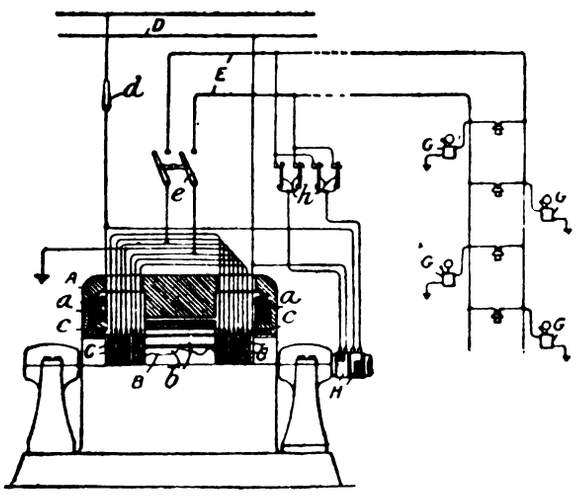

figure shows such a machine used as a converter, receiving high-voltage current from the lighting mains, D, and supplying current to the stations of a party-line telephone system. The field magnet, A, and field coils, *a*, extend circumferentially round the shaft of the armature, B, which carries a plurality of armature conductors, *b*, connected at opposite ends to collector rings, C. By means of brushes, *c*, the conductors, *b*, are all connected in series. The terminals of the armature circuit are connected to the lighting mains, D, while the telephone line wires, E, can be connected by the switch, *e*, across only a portion of the armature conductors. The machine thus acts as a voltage transformer, and is stated to smooth out the small pulsations in the current received from the lighting mains The call bells, G, of the party-line stations are polarised and connected to one or the other line wire. The generator shaft is provided with two make-and-break contact devices, H, connected to opposite ends of the armature circuit, which is grounded at its middle point so that current of the desired polarity may be sent to either line wire by closing the proper switch, *h*. The machine may be disconnected from the lighting circuit by the switch, *d*, and may be driven mechanically so as to act as a generator.

Water Power in Japan.—The possibilities for the development of the enormous water power that exists in Japan, seem to have only been realised since the war by an English engineer. The *Economist* publishes a statement, a forecast of which appeared in these columns some little time ago, that concessions for very important works for the development of water power have been granted to a Kobé syndicate, which is working in co-operation with a Japanese syndicate, and thus avoids the jealousy that would be aroused by the grant of large concessions to foreigners, as the grants are obtained in Japanese names. Thanks to the existence of lofty mountains within a comparatively short distance of the principal industrial centres of Japan, it has been discovered that a large volume of water can be obtained at a high altitude, and in its descent to a lower level can be made to develop an enormous amount of energy. Thus, under the principal grant, which is entitled the Tashirogawa concession, it is proposed to divert a small river, called the Tashirogawa, in such a way as to procure a fall of 3,000ft. into the River Hayakawa, which flows parallel with it at that distance below. By applying the energy thus obtained to the generation of electricity, it is calculated that 66,000 h.p. will be developed. The estimated total to be obtained from the concessions already granted is 100,000 h.p., while applications are being considered for further concessions that would bring the total up to 300,000 h.p. The concessions granted are within 80 miles of Tokyo, 135 of Kioto, and 160 miles of Osaka, which is described as the Manchester of Japan. These distances, of course, offer no serious obstacles to the transmission of electrical energy, when it is remembered that the power generated by the Niagara Falls is carried over distances up to 250 miles. It is said that the project involves no great engineering difficulties, that labour is extremely cheap, and that the power could consequently be produced at a very moderate cost. On the other hand, the steam power, which is its only possible competitor, is costly, as the coal produced in Japan is of indifferent quality, and for naval purposes and other forms of steam production it must be imported at almost prohibitive cost. The concessionaires are very sanguine as to the demand to be anticipated for the power when produced. There has been, it appears, a great development of interurban tramway communication, and this would be stimulated if a supply of cheap electricity were obtainable. There is also scope for the extension of railways, and new construction will, it is thought, be undertaken with a view to operation by electric traction. As matters stand, it is asserted that contracts for from one-half to two-thirds of the power to be generated under the concessions granted can be at once secured, so soon as the supply is available. We await with interest the production of the scheme, which seems to have such bright prospects.

Electric Heating.—Heating by electricity is now not only within practical range, but has gained a decided footing in the typical English home. It was not to be expected that the characteristic conservativeness of the British public would withstand the introduction of so convenient, efficient, clean, and cheap a method as electric heating, which bids fair to occupy as prominent a place in domestic life as does electric lighting. But the potentialities of electric heating are not confined to the kitchen, for in the warming of rooms the electric radiator is looked upon

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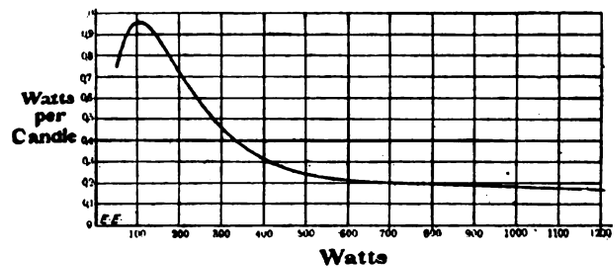
as an instrument which gives as good an efficiency as does a gas stove or coal fire, without the inconvenience and cumbersomeness inseparable from either of the latter. Here, then, is a sphere of industry upon which manufacturing energy should be centred; for, with the production of the right article, the contractor should have little difficulty in persuading his client to adopt it, especially in those districts (which are very common now) where a cheap supply of electrical energy for electric heating is available. It is gratifying to note that the leading electrical manufacturers are not neglecting this branch of business, and when we find such firms as the B.T.H, the G.E.C., the Dowsing Company, and Edison and Swan—whose names are household words—engaging in the manufacture of this class of apparatus, we may rest assured that inherent defects which hinder its sale will not be allowed to remain, and that the companies will supply an article which can be used by the consumer to the best advantage. The principal type of electric radiators at present made is known as the luminous type. In this country the luminous type of heater is being used to great advantage, and there can be no question that the light adds to the selling power of the device. The heat lamps, when used in conjunction with reflectors, produce a considerable current of heated air, besides radiating heat into the room. As an instance of the enormous heating effect of a luminous or semi-luminous source, it may be mentioned that, according to the experiments of Dulong, a substance heated above cherry red—say a clear orange—gives off 500 times the heat by radiation that would be given by contact of air. Then, again, there is the great advantage of the heat being immediately available with this system. A type of radiator, the efficiency of which is also very great, is that which gives off little or no light. What would at first seem a drawback in the case of this type is the fact that the heat is not available immediately. But it possesses the advantage of giving off intense heat at, it is said, a less current consumption. It is erroneously believed by many consumers that electric heating is too expensive. This error can be disposed of by a little energetic publicity work. Standardised radiators of four heat lamps, taking 250 watts each, do not consume more than one unit of electricity per hour, which in many places costs as little as 1d. per unit. Then there is the advantage of having heat absolutely free from any of the defects of gas or fuel, while the radiators are entirely free from the unhealthiness of gas stoves. This is a branch of business, too, which may be profitable to central stations.

Quartz Lamps.—Some interesting developments of the mercury-vapour lamp, which involve the replacing of the glass tube for holding the mercury by a tube of fused quartz, are reported in Germany. The developments were traced by Mr. O. Bussman in a paper which he read before the Berlin Electrical Society, to which our contemporary, the New York *Electrical World*, refers. The new lamp is simply a mercury-vapour lamp, the distingishing feature of which is, as we have already said, that the tube in which the mercury arc plays is made of fused quartz instead of glass, so that it stands a much higher temperature. The following curve of specific power consumption shows that the expected maximum is reached at about one watt per candle, and that afterwards the specific consumption decreases rapidly down to about 0·16 watt per candle. It is instructive to observe what happens after the arc is started. In the new lamp, as in the ordinary mercury-vapour lamp, the tube is exhausted when cold. When the circuit is closed, the arc in the quartz lamp fills the whole tube, just as in the case of the ordinary lamp; but after some time the arc contracts into a thin line, and not only does not increase in candle-power, but changes in colour, the unpleasant greenish-blue light of the mercury arc becoming a more pleasant yellow-white light. By a comparison of the spectra of an ordinary mercury-vapour lamp and the quartz lamp, it is found that the latter shows, in addition to the well-known mercury line spectrum, a continuous spectrum, and the intensity of the latter increases with the watts. Moreover, the intensity of the different lines in this spectrum increases in a different degree. The yellow and red rays increase much more in intensity than the green and blue rays, and the lamp emits distinctly red rays. In the ordinary mercury-vapour lamp the vapour pressure increases to about 2mm. On the other hand, in the quartz lamp, when it is operated to its best advantage in practice, the pressure has gone up to about one atmosphere. For this reason the new lamp may be called a "high-pressure mercury-vapour lamp." The commercial lamp is operated at about one atmosphere pressure, or slightly less. For a vapour pressure of about one atmosphere the specific consumption is 0·2 to 0·25 watt per Hefner candle-power, if the electrical power is measured at the terminals of the lamp and the candle-power in a direction perpendicular to the axis of the tube. The third feature which strongly distinguishes the quartz lamp from the ordinary mercury-vapour lamp is that the arc is very much shorter. The price quoted for the three to four ampere lamps for 220 volts, which in energy consumption correspond to 12 to 16 ampere arc lamps, is about £10 (including one quartz tube). The high cost is due to the expense of the quartz tube. The new lamp is thought to be



specially suitable for lighting extended railroad stations on account of the high voltage and the small attendance, and also for lighting workshops, parks, and streets However, it lacks sufficient red rays to be useful for interior lighting. The Germans now make it a practice to compare arc lamps on the basis of the mean lower hemispherical candle-power. But it would seem that for the comparison of different types of lamps the only true criterion is the mean spherical candle-power. The *Electrical World* compares this new German lamp with the ordinary arc lamps in this respect. "The maximum candle-power of the open 'full arc' is only about 1,200 instead of 2,000 as popularly believed, its mean spherical candle-power being 400 to 450, or about 1 c.p. per watt; while the usual 6·6-ampere enclosed arc gives only 150 mean spherical candle-power, corresponding to three watts per candle-power." According to the Reichsanstalt tests, the 4·20-ampere quartz tube lamp gave 2,680 and 3,110 mean spherical Hefner candle-power, the voltage at the terminals of the quartz tube being 174 and 197 respectively. If we add 40 volts as lost in the series resistance, the voltage at the terminals of the lamp becomes 214 and 237 respectively, hence the watts 899 and 995. Since one spherical Hefner candle-power equals 0·88 spherical British candle-power (if we use the older official ratio), the corresponding British candle-powers of the quartz lamp are 2,358 and 2,737. We, therefore, get for the specific consumption the figures 0·38 and 0·36 watt per mean spherical (British) candle-power measured without outer globe.

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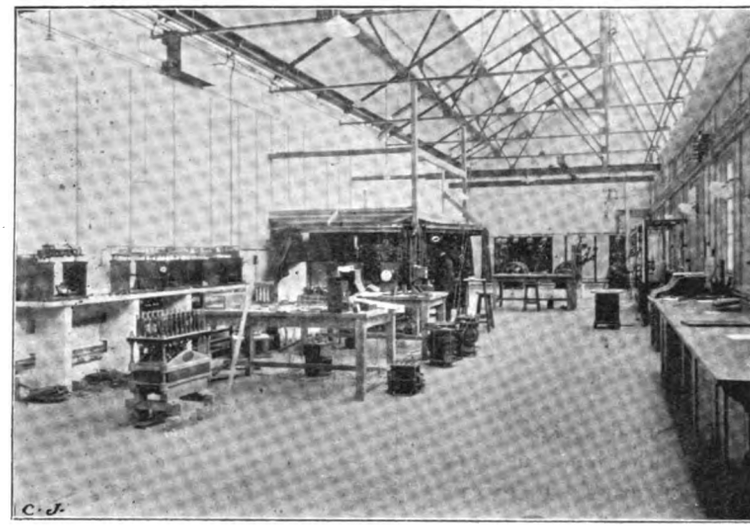
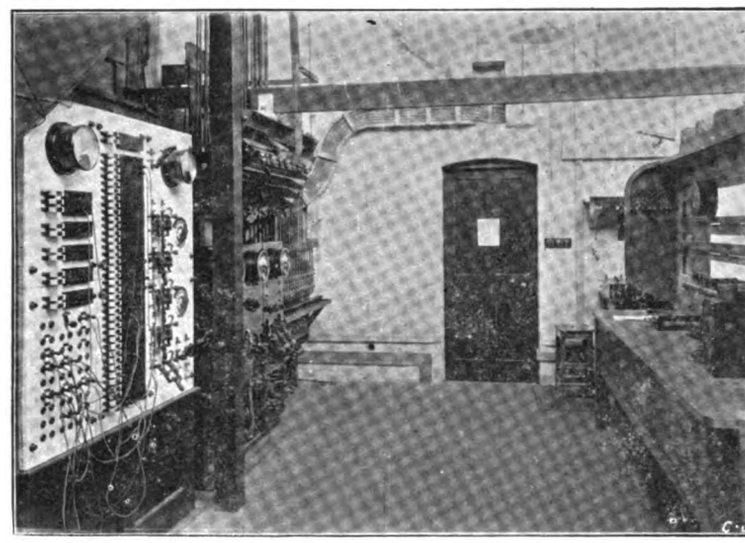
THE NATIONAL PHYSICAL LABORATORY.

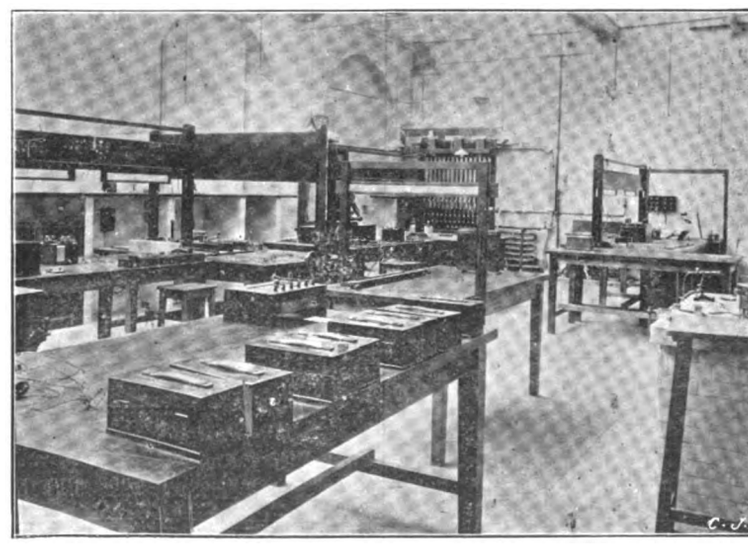
We are indebted to the *Contract Journal* for the following account of the National Physical Laboratory which was prepared for the recent visit of the Incorporated Association of Municipal and County Engineers to this national institution at Bushy House:



General View of Large Test Room—Alternating-Current Section—looking west. Electro-Technical Building.



East End of Large Test Room, showing Arrangements for Direct-Current Instrument Testing. Electro-Technical Building.



General View of Resistance and Primary Battery Testing Room, looking east. Electro-Technical Building.

The younger among scientific men cannot realise the difficulties of exact measurement met with by the older and previous generations of workers. Thanks largely to the persistence of committees of the British Association and to the powerful advocacy of such men as Lord Kelvin, the late Prof. Clerk Maxwell, the late Latimer Clark, Lord Rayleigh, Sir Oliver Lodge, etc., among physical investigators, not to mention chemists and engineers, the necessity for exact measurement was gradually forced upon the public mind. The construction of instruments and the carrying out of experiments, however, was left to the enterprise

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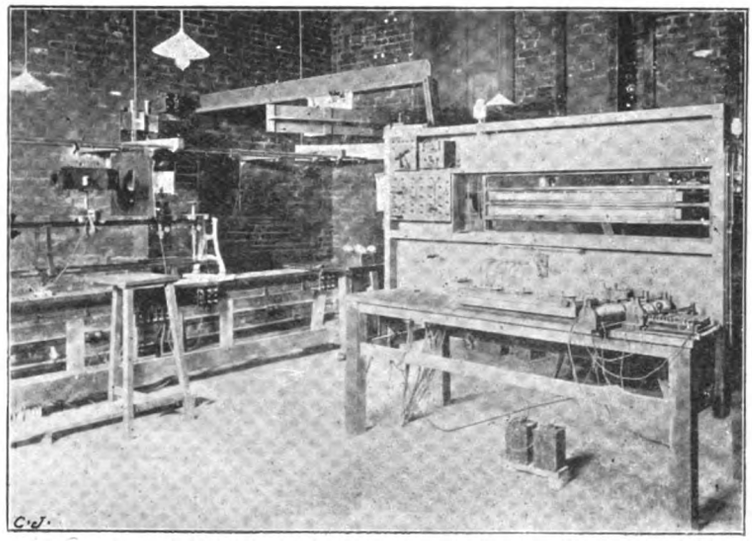
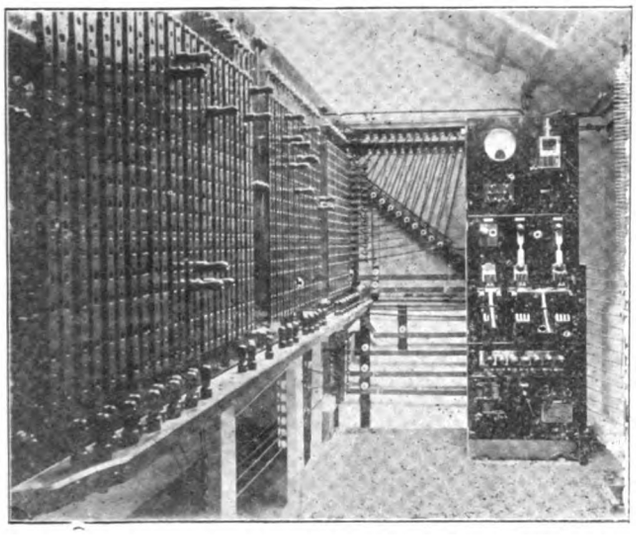
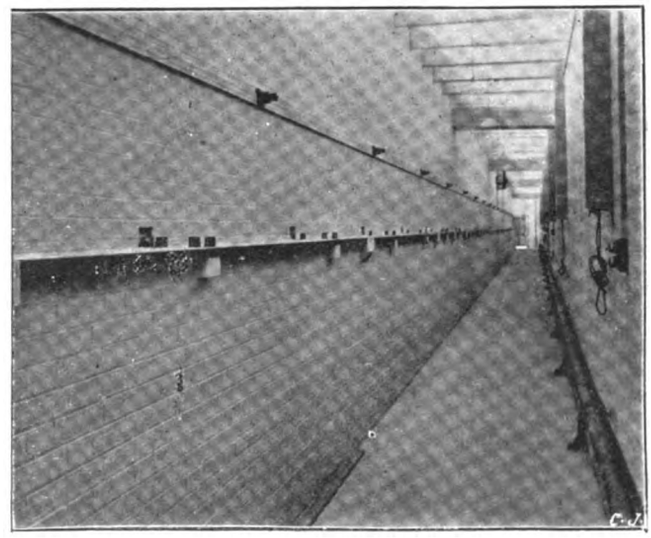
of individuals till Germany founded the Physikalisch-Technische Reichsanstalt in Berlin, 1883-87. This institution appealed to Sir Oliver Lodge, who in 1891 before the British Association suggested something similar for this country. Later on Sir Douglas Galton took the matter up, and in the end Lord Salisbury appointed a committee which unanimously reported, "That a public institution should be founded for standardising and verifying instruments, for testing materials, and for the determination of physical constants." The Treasury accepted this report, the carrying out of which was placed in the hands of the Royal Society. Certain work had long been carried on at the Kew Observatory in the Old Deer Park, but after careful investigation it was decided not to extend the observatory, but a home was found for the new institution at Bushy House, Teddington, while retaining Kew as one of the divisions.



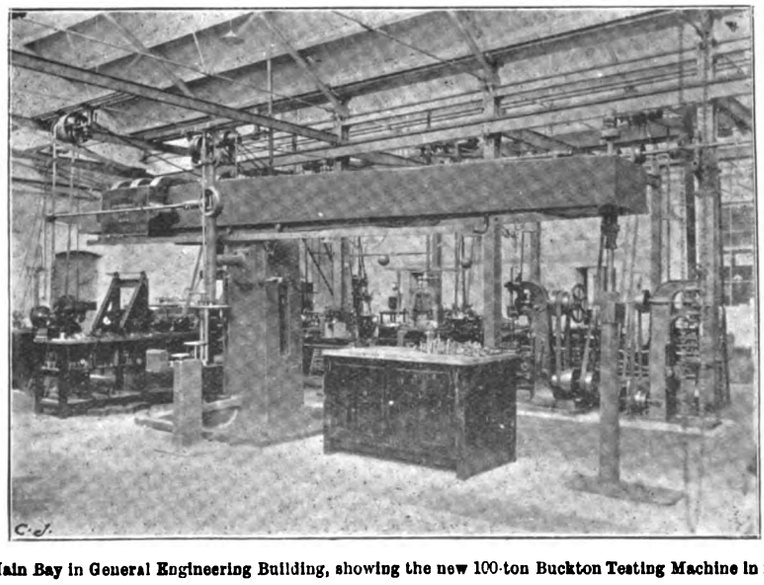
Photometric Standards Room. Electro-Technical Building.



Main Distribution Plug Board and Main Switch.



Corridor in New Metrological Building, with Arrangement for Measuring Surveying Tapes



View of Main Bay in General Engineering Building, showing the new 100-ton Buckton Testing Machine in foreground.

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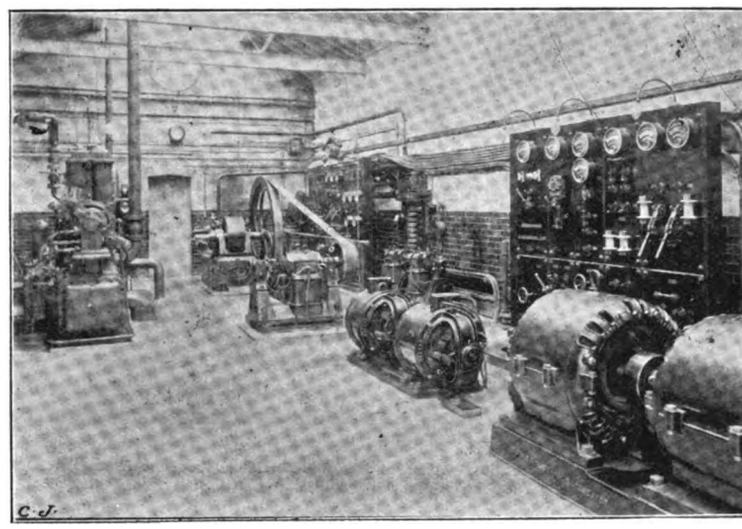
The electro-technical building, of which several interior views are given herewith, has been recently added, the work of this department having grown to such an extent as to necessitate special provision. Entering through a room at present unequipped, but which is intended for taximeter and heavy machine testing generally, we reach the principal room, wherein is carried on test work in connection with electrical instruments, transformers, and the materials used for the construction of all kinds of alternating-current electrical apparatus. Its equipment

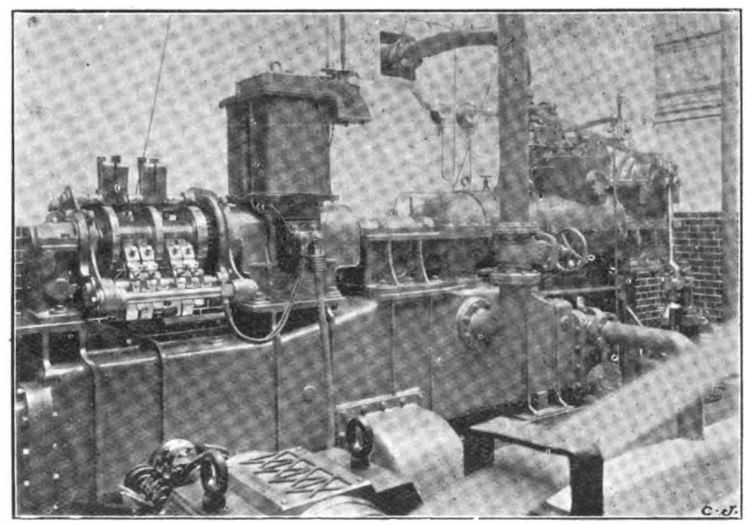


Power House, with Motor-Generators (extension plant) in foreground.

comprises several motor-generators receiving their direct-current supply from an outside source, high and low tension switchgear, and the necessary standard measuring instruments. The transformers which supply extra high tension for the purposes of the various tests are housed in an adjoining sub-station, and controlled from a special switchboard in the room. A very large scale giving the standard of alternating-current voltage is noteworthy. The east end of this main test bay is equipped for testing direct-current instruments, as shown in one of the accompanying illustrations. A feature of the switchgear in this section is the liberal amount of copper used in its construction, for currents up to 8,000 amperes are required in the work undertaken, being obtained from a battery of accumulators. Passing through this section we enter a room equipped for testing resistances, primary batteries, etc. Insulation testing sets figure very largely in the work which comes under the attention of this sub-section. Retracing our steps across the east end of the main bay, we pass into a room where life tests on incandescent electric lamps are being made, and notice as the principal item of its equipment a Tirril voltage regulator supplied by the British Thomson-Houston Company, Limited. This room belongs to the photometric department, which has an elaborate and expensive equipment upstairs for testing arc and incandescent electric lamps.

We may now proceed to the general engineering building, which has recently undergone considerable extension. Much valuable research work is here conducted. Especially noteworthy among the many interesting items of its equipment is a machine for ascertaining the effect of alternating stress on different materials. A Buckton 100-ton testing machine, just added, also claims attention. Then there is an interesting apparatus for making wind-pressure tests, and in a corner of an extension bay an arrangement for measuring the specific heat of superheated steam and enabling steam research work generally.

Leaving the engineering department, we next give our attention to a new building wherein an expert staff is busy with the intricacies of metallurgical chemistry in all its branches, and then visit a building which is being prepared for the reception of the metrological equipment and staff now housed in the main building, with important additions. These additions include the elaborate provision illustrated herewith for testing surveying tapes for length, either on the flat or suspended, up to 150ft. In a series of rooms sandwiched between the two side corridors length measurements of all kinds will be undertaken, and the expansion or contraction of materials under different temperatures exactly observed. The care taken to safeguard the rooms from external fluctuations of temperature, even to the provision of double-glazed ceilings within the main roof, is to be noticed.



Turbo-Generator, Busby House.

At present housed in the main building, but belonging really to the metallurgical department, is an interesting apparatus for taking photographs by ultra-violet light,

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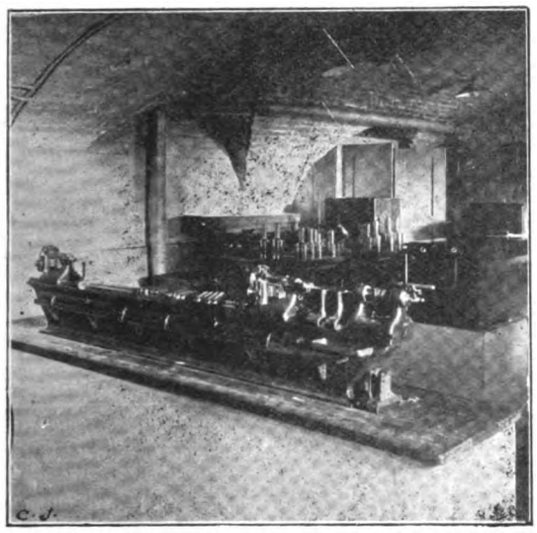
the object being to obtain a higher magnification than is possible with ordinary light. It is used chiefly for organic substances in connection with metallurgical research. The tide-predicting machine, a creation of Lord Kelvin's mathematical brain, is also to be seen in the main building, being a wonderful piece of mechanism.

The work of the laboratory is under the directorship of Dr. Glazebrook, who is assisted by a staff of efficient assistants. The history of its working years is short, but eminently satisfactory.

At the conclusion of the visit,

The PRESIDENT remarked that before leaving he would like to move a vote of thanks to Dr. Glazebrook. The laboratory they had seen had been erected in a rather unusual position for works of that description—in the neighbourhood of a historic building. They would all agree that a building of that sort could not be put to a better use than the purpose for which it was being employed at the present time. The machines and apparatus they had seen were of the very greatest advantage to the engineering profession, probably more to mechanical and electrical engineers than to municipal, but as belonging to a profession which depended almost entirely upon accuracy of measurement, they were pleased to have had the opportunity of visiting the place, and they were much indebted to Dr. Glazebrook and his assistants for taking



View in Present Metrological Department, showing in the foreground a Pratt and Witney Machine, having an accuracy of .0001 of an inch, for standardising end measures, and to the right a Hartmann Automatic Machine for measuring spherically-ended end standards to one 10,000th of a millimetre.

them round and showing them everything in connection with the place. If their visit had only been to the laboratory, it would have been sufficient repayment to them for the trouble of attending the Hampton meeting.

The vote of thanks having been carried, Dr. GLAZEBROOK thanked the president for the way in which he had proposed the vote of thanks. It had been a real pleasure to himself and his staff to see them there. He was particularly grateful for them to have recognised that the work was for the good of the engineering profession. The whole of their work was intended to bring benefit to the country through engineering work. Accuracy and standardisation were what was wanted to enable them to cope with the many difficulties they had. What they were doing there was for that purpose.

THE RETAIL ELECTRICAL TRADE.

BY J. A. K.

There has been a good deal of excited discussion in certain hardware and electrical contemporaries on the advisability or otherwise of the ironmonger handling electrical contracting work, and while the point may or may not be open to discussion it is clear that such a discussion tends to estrange the sympathies of a large body of men who can and ought to be of the greatest possible use to the electrical cause. While there is no doubt whatever that electricity suffered somewhat severely in its early days from the fact that numerous people (whether ironmongers, plumbers, or gasfitters) rushed into electrical contracting work with the smallest or no technical qualifications, yet there can equally be no doubt that nothing but good can result from the handling of the retail "goods" trade by what should be the proper men—*i.e.*, the ironmongers. The public is accustomed to deal with them for all replacements and requirements for gas fittings and gas apparatus, just as for the older petroleum lamps and stoves, and the public will be best served if the same men can supply similar wants in electrical matters.

Let us say what we will, the day is still far distant when electricity will hold the field entirely for illuminating, heating, and cooking, though that day *is* coming; but until it is here it is absurd to try and keep the sale of electrical goods in the hands of one special set of men—viz, the contractors. Let the contractor by all means attend to the technical part of the work, even as now the plumber and gasfitter attend to their respective departments; but, just as no man in his senses goes to his plumber for a watering pot or his gasfitter for a new grill pan for his gas stove, so there is no reason why he should go to his contractor for an electric lamp or kettle. It will be only to the general advantage of the industry to "popularise" the retail trade instead of trying to surround it with a semi-mysterious halo, which only tends to keep people away from a more extended use of the great facilities offered them by electricity.

While advocating the handling of these goods by the hardware trade, it must not be taken that the writer is in favour of the general taking up of wiring work by ironmongers; for, though it may be well for large firms to have a wiring department, just as they have expert plumbers and gasfitters in their employ, yet, each to his trade, and the ironmonger, let him monger many of the electrical goods of which as yet he handles very very few. Electricity is advancing by leaps and bounds in such domestic uses as heating and cooking, and there is plenty of room in the selling line for both the ironmonger and the contractor as yet, and only good can result from a large increase of sales in such goods as stoves, cooking apparatus, etc.

The analogy of the gas and water industries (though possibly obnoxious to the electrical trade, which hitherto has tried to assume a sort of "aristocratic" attitude towards all other trades) must in time hold good in electrical matters, and just as in these trades the selling of the goods and the "engineering" of the services have been practically entirely severed the one from the other, so it will eventuate in the electrical industry, as by that means the public will most easily be educated and supplied, and the efficient service of the public is absolutely essential to any industry that is to flourish.

In the large body of hardwaremen and ironmongers there exists ready made an enormous selling organisation which has its finger on the pulse of public wants in matters very akin to electrical goods, and it is simply utterly foolish to ignore such valuable channels of distribution for such goods, or, what is worse, try and prevent their reaching such channels. Let us realise that the more people there are selling current-consuming devices the more current will there be consumed and (this for the contractors) the more circuits to run.

FITTINGS FOR ELECTRIC LIGHTING.

Some Season's Specialities.—III.

The artistic requirements of artificial illumination become ever more exacting, and thus impose upon the manufacturer of accessories for this purpose the burden of steadily modifying and adapting his products to the varying tastes of the day. The task of the illuminating engineer (who in this country is a person of the future) is, therefore, not only to supply so many candle-feet of light over a given area, but also to provide fittings which shall be gratifying to the æsthetic senses We do not pretend to know what particular type of architecture for house decoration is in

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vogue at the present day, but it is evident, from a visit to the showrooms of the leading manufacturers of electrical

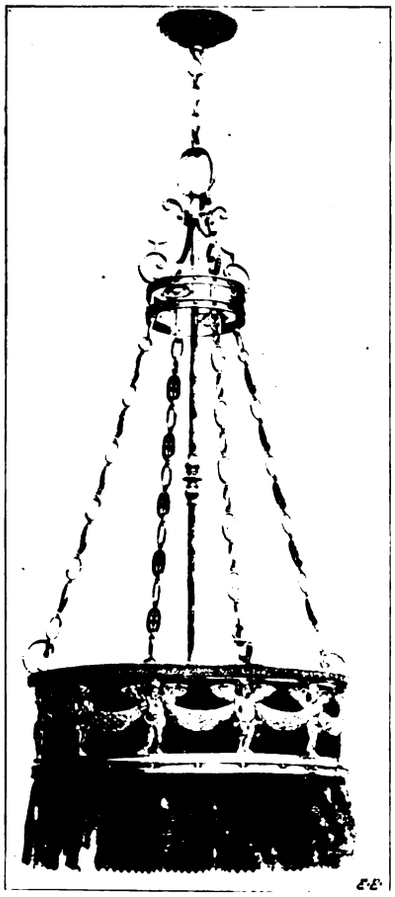

FIG. 1.—Renaissance Shade Lamp (Best and Lloyd).

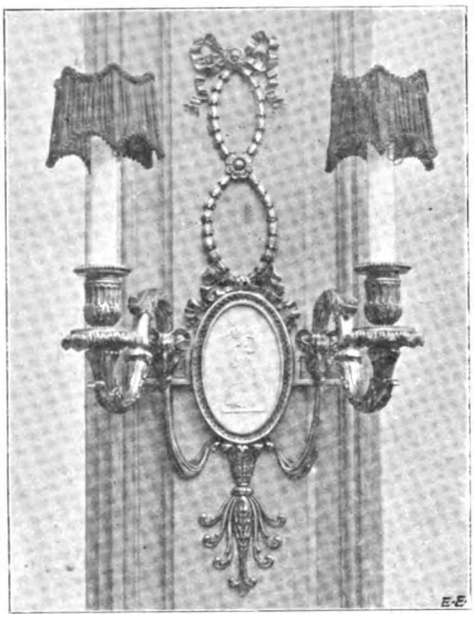

FIG. 2.—"Adam" Bracket (Best and Lloyd).

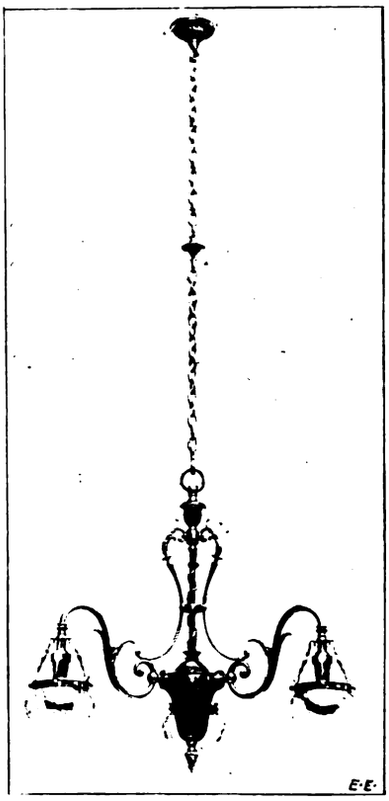

FIG. 3.—"Adam" Electrolier (Best and Lloyd)

fittings, that the "Adam" and "Georgian" types of fitting are prevalent. Among those who are making a prominent show in these lines are Messrs. Best and Lloyd, of Birmingham and London. At their chief showrooms in London,

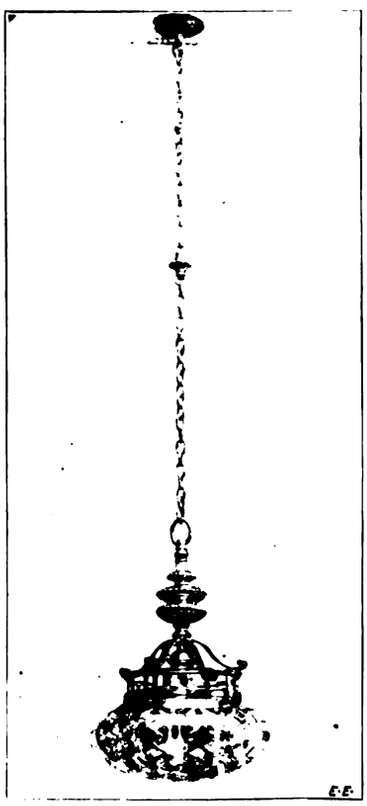

FIG. 5.—"Georgian" Pendant (Best and Lloyd).

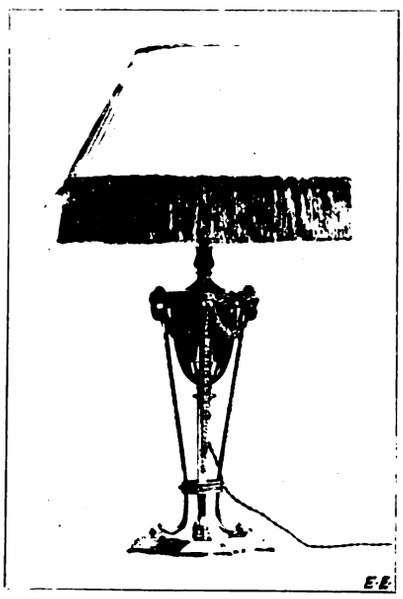

FIG. 4.—"Adam" Table Lamp (Best and Lloyd)

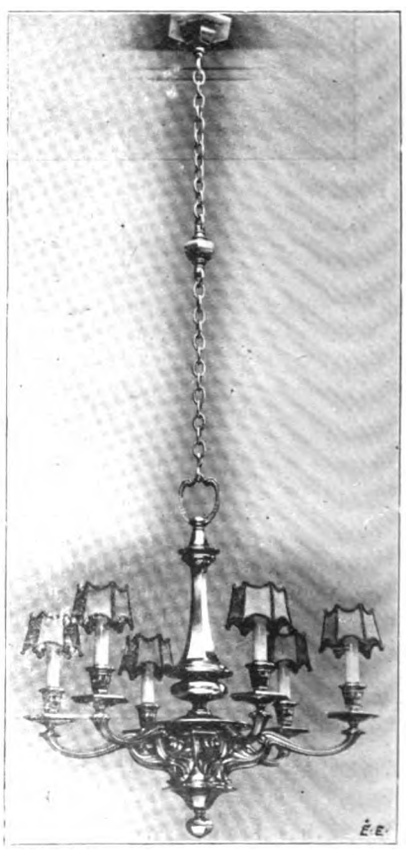

FIG. 6.—Electrolier (Best and Lloyd).

which are situated at 11, Bartlett's-buildings, Holborn-circus, E.C., there is to be seen an elegant display of really high-class fittings, some types of which we illustrate. A word should be said about the premises, round which much history has been made. It is an old Queen Anne house, dating from 1685, and presents many points of interest. In one of the upper rooms the original "Adam" ceiling remains the same as of old, except, of course, that it has been cleaned. As much as possible of the old main staircase has been retained, and the fine doorway, as well as the original panelling on the walls, has not been interfered with. It is singularly appropriate that such an ancient, historical building should be used as showrooms for artistic electric light fittings. Meanwhile, by converting some of the old disused rooms, Messrs. Best and Lloyd

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have been able to extend their display, and to classify their fittings in various styles. Mention should be made of the fact that Messrs. Best and Lloyd manufacture all the fittings which they sell at their extensive works in Birmingham. New designs are introduced by them almost

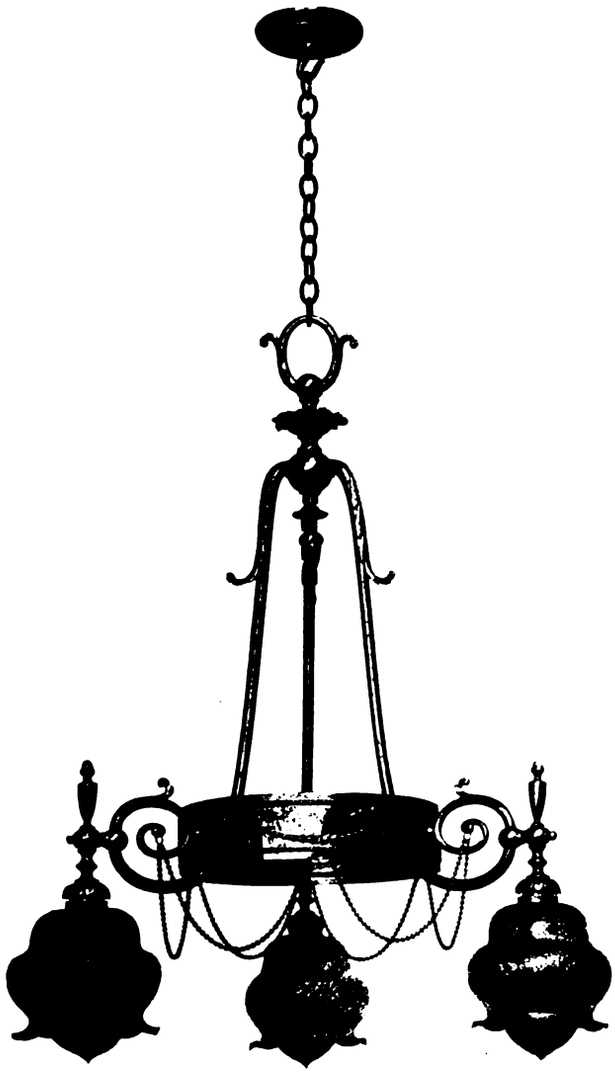

Fig 7.—Three-Light Electrolier (Evered and Co).

weekly, and they produce fittings suitable for any style of decoration which may be adopted.

Another firm which is introducing a number of important specialities is that of Messrs. Evered and Co., Limited, of Surrey Works, Smethwick, Birmingham. A beautifully

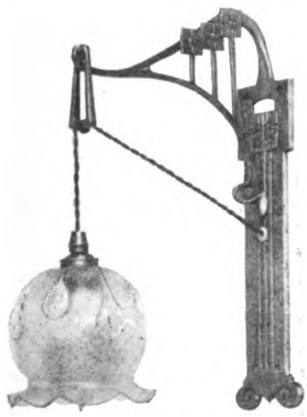

Fig. 8.—One-Light Bracket (Evered and Co.).

designed electrolier, of the most improved pattern, is shown in Fig. 7. One and two light brackets are illustrated in Figs. 8 and 9. These illustrations can in no way indicate the wide range over which the new lines being brought out by Messrs. Evered, for this season, extend; but they may serve to convey some idea of the artistic design of their productions.

Messrs. Charles Joyner and Co., Limited, of Icknield-square, Birmingham, are finding an increasing demand this season for their patent cord absorbers. The advantage of raising and lowering pendants has long been recognised,

Fig. 9 —Two-Light Bracket (Evered and Co.).

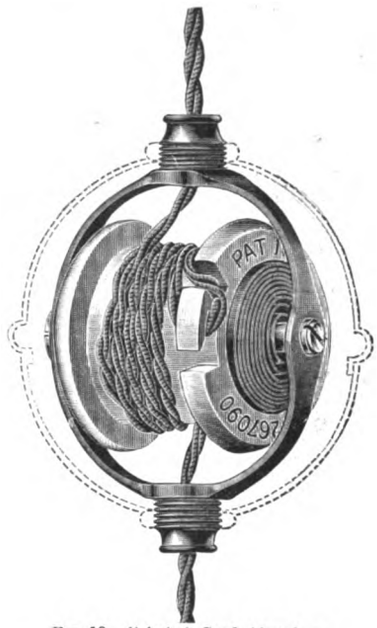

Fig. 10.—"Auto" Cord Absorber (Joyner and Co).

Fig. 11.—Pendant with Absorber (Joyner and Co.).

but the time-honoured method of effecting this adjustment, by means of pulleys and counterweights loaded with shot, has serious drawbacks. Besides being unsightly and troublesome, the system throws undue strain upon ceiling fixtures, as the counterweight has to be twice the weight of the fitting itself. The cord absorber is free from these defects. It consists of a porcelain spring, actuated by a clock spring, mounted in a light framework. The whole is surrounded by a spherical cover, which may be plain or ornamental in character. The device is made up in a large number of styles and sizes to suit different requirements. The larger sizes will support electroliers weighing nearly 10lb. Fig. 11 shows one of the most popular patterns for single lights.

SOME NOTES ON A VISIT TO THE "MAURETANIA."

BY NOTA BENE.

The writer recently had the opportunity of looking over that mammoth liner, the "Mauretania," and was not only impressed by its enormous size and general luxuriousness, but also by the remarkable completeness and evidence of careful planning which the electrical equipment indicated. Everybody knows nearly everything worth knowing about the "Mauretania"—how she is the biggest boat afloat, exceeding her sister ship, the "Lusitania," by one or two feet in length—and everybody feels properly proud that the Germans have for the present thrown up the sponge and are not going to emulate this great achievement. Not so many, perhaps, have been privileged to look into the way in which the work has been put together.

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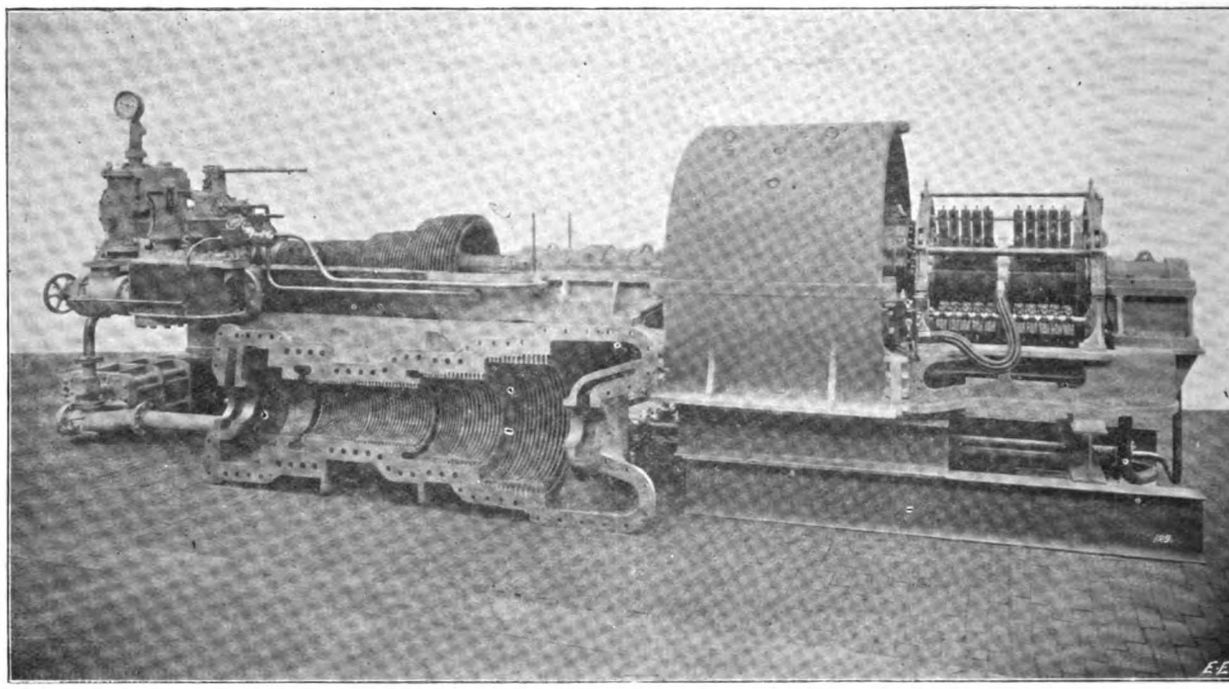
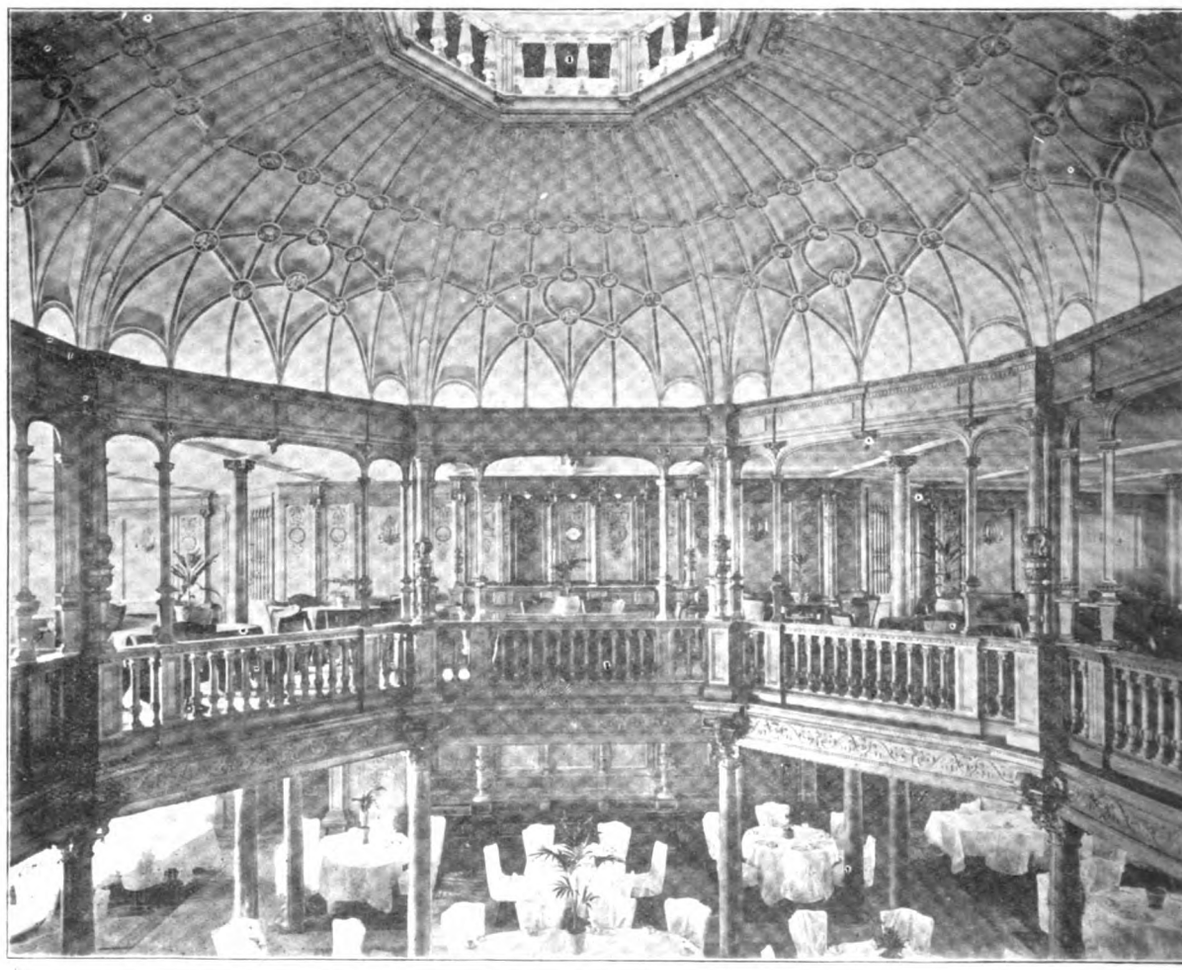
I was told that the electric installation was the largest afloat, and after I had seen the set of four Parsons turbo-dynamos, each easily capable of giving 440 kw. at a pressure of 110 volts, I began to believe it. The photo of a typical engine and dynamo gives an idea of the generating plant used, and it may be noted that the speed of the turbines is 1,200 r.p.m. Marine engineers accustomed to the little reciprocatory engines, which are the usual pieces of plant installed for the electric light in a boat, would find themselves confronted by certain new experiences when put in charge of these "whirligiging things," but I understand that no trouble is experienced in the running of these sets. The dynamos feed to two switchboards, or, rather, two sections of one switchboard, placed one in each engine-room. Each dynamo has a circuit breaker of 4,000 amperes capacity, and there are 12 main circuits each with breakers of 1,000-ampere capacity on each board. To meet the sudden loads thrown on the system by motors starting, time-limit devices are fitted to each circuit breaker. The entire arrangement of



One of the four Parsons 440-k.w. Turbo-Dynamos for Lighting the "Mauretania."



One end of the Dining Saloon of the "Mauretania."

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the board approximates much more closely to the provisions found in a central station on land than the usual devices on board ship. After all, the "Mauretania" is a small floating city, and the generating and transmitting arrangements have to be as complete as anything to be found in a corporation-owned undertaking.

Every Cunarder is liable to go under fire in war time, so the Admiralty insist that electric wiring shall as far as possible be carried out under the waterline. This, in the case of the "Mauretania," involves some particularly awkward runs, and the method is adopted of putting the cables on porcelain cleats, these being protected by channel iron. The cables in parts where they are subjected to intense heat, as in the places adjacent to the stokehold, are asbestos covered.

There are about 6,000 lights distributed over various parts of the ship, and, as is to be expected, there is a considerable difference between the types of fittings to be found in the "business" parts of the boat and those in the luxurious suites, state-rooms, dining saloons, library, ladies' boudoir, etc., occupied by the passengers. In the engine-room and stokehold the fittings are simple and strong, and the total candle-power in this region is over 11,000. In the passengers' quarters the utmost luxury prevails. The fittings are everywhere of the most handsome and tasteful construction, and there has evidently been someone belonging to that new school of scientist, the "illuminating engineer," at work. Perhaps one of the most beautiful lighting effects is that seen in the first-class dining saloon, where the dome, which is painted in white and gold, is entirely lit by concealed lights. The effect by night is magical, as not a lamp is seen, but a brilliant glow is thrown down on the tables beneath. The accompanying illustration gives but a faint idea of the beautiful effect produced. Electric radiators, portable reading lamps, and such luxuries as curling tong heaters, cigar lighters, and fans are to be found in the state-rooms, and anyone travelling first-class will be reasonably discontented after a return to ordinary life from this electric fairyland.

Electric power is almost universally employed in this ship. Down in the place that would in any ordinary boat be called the galley there are such refinements as motor-driven potato peelers, dish-washers, and other up-to-date luxuries. There are 16 forced-draught fans on the boat, each driven by a 50-h.p. motor. In the engine-room electric motors open the steam admission valves to the turbines; others operate the barring gear for the main turbine shafts—one motor to each of the four shafts. Motors are even installed for such occasional work as lifting the covers off the turbines. Breakdown engineering (if there is any) on board the "Mauretania" must be a luxury. Motors drive bilge pumps, refrigerating machinery, hoists, passenger elevators, jib cranes, and boat hoists. There are 90 motors alone to do the work of ventilating the ship.

Some land engineers who are situated in central stations complain of the modern tendency to multiply signalling devices therein. If they were on this boat they would be scared. Electric fire alarms, three separate telephone systems, electric clocks, indicators for the sidelights, make a fairly brave display. One interesting feature is the first-class passengers' telephone system, which runs to a regular telephone exchange, which can be connected to the shore immediately on arrival in port. Altogether, the installation, which was carried out by Messrs. W. C. Martin and Co. and their sub-contractors, indicates pretty clearly that marine engineering in the future is going to entail a fairly special knowledge of electrical engineering, and a berth on the "Mauretania" would not be a bad training ground.

This ship, which from her speed trials has proved to be the fastest afloat, was built by Messrs. Swan, Hunter, and Wigham Richardson, Limited.

Rosario (River Plate).—The electric tramway company has sent another note to the Provincial Government repeating the application made some time since—to which they have received no reply—for permission to extend their lines to Alberdi. To attend to the extra lines which they hope shortly to put in service the electric tramway company is adding to their shops in Calle La Plata two 1,000-h.p. engines and four tubulars, which they expect to receive from Europe this month.

ON THE INDICATED POWER AND MECHANICAL EFFICIENCY OF THE GAS-ENGINE.*

BY PROF. BERTRAM HOPKINSON.

(Concluded from page 629.)

A large number of tests were made with the object of determining the mechanical losses by finding the difference between indicated power and brake power, and of comparing the result with that obtained from running the engine light under the same conditions. It will be well to describe one of these tests in detail, and to summarise the results of the others. The engine was run with a fairly full load, missing about one explosion in five cycles. The load was applied by means of rope brakes, and, as the test only lasted a short time, it was unnecessary to employ any water cooling. While careful observations were taken of the brake load (the difference between a dead weight and a spring balance) three photographs of indicator diagrams were taken, each photograph covering about a dozen explosions. At the same time the misses occurring in about a couple of hundred cycles were counted, so that the ratio of missed ignitions to cycles was accurately known. These observations gave all the data for the mechanical efficiency, no observation of speed being necessary; the speed was, however, kept approximately constant by the governor at 180 r.p.m., and in what follows brake power and indicated power are both calculated on the assumption that that was in fact the speed of the engine. The following are the results of measuring the three photographs together, with the observations taken at the same time as the photographs:

TABLE II.

Jacket: Exit temperature.	Explosions. Cycles.	M.E.P. from diagram.	Gas per suction.	I.H.P.	B.H.P.
150° F. (65° C.)	0·084	100·3	0·1196	39·7	34·0
—	0·82	99·4	0·1182	40·2	34·6
160° F. (71° C.)	0·825	99·0	0·1164	40·2	34·9

The gas charge was measured, as described above, by means of a standard holder, and is correct to within one part in 200. It will be seen that the mean pressures from the three diagrams show very good agreement, being all within 1 per cent. of the mean value after allowing for the small change in gas charge. The mean of the three observations of brake horse-power is 34·5. The mean indicated power is 40·0, giving a mechanical efficiency of 86·2 per cent. The difference between brake and indicated horse-power ranges from 5·7 h.p. to 5·3 h.p., the mean being 5·5 h.p. In the course of the test the jacket temperature rose slightly, and, as will shortly appear, this is sufficient to account for the small diminution in mechanical losses observed in the course of the test. Immediately after the completion of the above full-load tests the brakes were taken off and the engine run without load, the jacket water being throttled so as to prevent the engine from cooling down rapidly. Photographs were at once taken of the indicator diagram, the gas consumption was measured, and the ratio of explosions to total cycles was ascertained to be 0·141. The mean pressure was found to be 105·5lb. per square inch, the gas consumption 0·1252, giving 7·35 i.h.p., or about 1·85 h.p. more than the difference between the indicated horse-power and the brake horse-power in the full-load tests. Had the engine in the latter case been firing every time instead of four times out of five, this difference would have been increased in the ratio 5/4, becoming 2·3 h.p.

This result—that is, that the power taken to turn the engine round at light load is rather over 2 h.p. more than the mechanical losses at full load, which was verified on many occasions—is due almost wholly to the difference in power absorbed by the pumping strokes of the engine at light load and at full load. This difference appears in Fig. 2, which shows the suction loop in the two cases. The full line is the diagram of a cycle in which no gas is taken, the dotted line shows the negative part of a diagram of a cycle in which gas is taken. It will be seen that, as usual in these engines, the exhaust line after an explosion is considerably lower than when the engine is simply exhausting a charge of air. Moreover, when the engine takes gas the pressure at the middle of the suction stroke is about a pound higher than when the engine is taking air only — no doubt because of the less restricted opening in the latter case. The mean pressure of the full-load suction loop is 2·9lb. per square inch, corresponding to 1·4 h.p. at 180 revolutions, whereas in the other case the pressure is 5·0lb. per square inch, giving 2·5 h.p. In addition to this, a certain amount of work is done in the compression and expansion of the charge of air which occurs when no gas is admitted, the compression line being rather higher than the expansion line. It is difficult to show the whole of this work area on a diagram, because if the spring of the indicator is sufficiently stiff to take the maximum compression pressure of 170lb. per square inch it is hardly sufficiently sensitive to record the small difference of pressure

* Paper read before the Institution of Mechanical Engineers.

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between the expansion and compression strokes. From a good many observations of diagrams with different strengths of spring, however, and also from calculations based on the loss of heat during compression, it would appear that the mean pressure of this part of the diagram is certainly between 1·5lb. and 2·5lb. per square inch. On this account, therefore, 1·0 h.p. must be added to the negative work done in each cycle in which no gas is taken, making approximately 3·5 h.p. at 180 r.p.m. This is 2·1 h.p. more than the power represented by the negative loop when the engine is firing every time, and is, therefore, just about sufficient to account for the difference between the full-load mechanical loss and the light-load indicated power.

An independent estimate of the power lost in pumping was made by belting the engine to the dynamo and motoring it round without allowing it to take gas. Two measurements were made, one immediately after the other; in one the engine was closed up as usual, in the other the exhaust-valve cover was removed so that there was no pressure in the cylinder. Assuming that the belt losses and friction losses are the same in the two cases, the difference between the powers absorbed by the dynamo (after deducting dynamo losses) should be equal to the power absorbed in pumping. Two tests gave the following results, the jacket temperature in both cases being 180deg. F. (82deg. C.):

	Aug. 24.	Aug. 25.
Engine closed	7·72	7·1
Engine opened	4·14	3·77
Difference	3·58	3·33

The mean is 3·45 h.p. against 3·5 h.p., estimated from indicator diagrams. In comparing the mechanical loss with the light-load indicated power, care was taken that the conditions of the engine as regards lubrication and cylinder temperature were as nearly as possible the same. It was found that these factors make a very great difference to the engine friction, and it is important to allow for this in basing any estimate of indicated power upon the power absorbed by the engine at light load. This point is strikingly illustrated

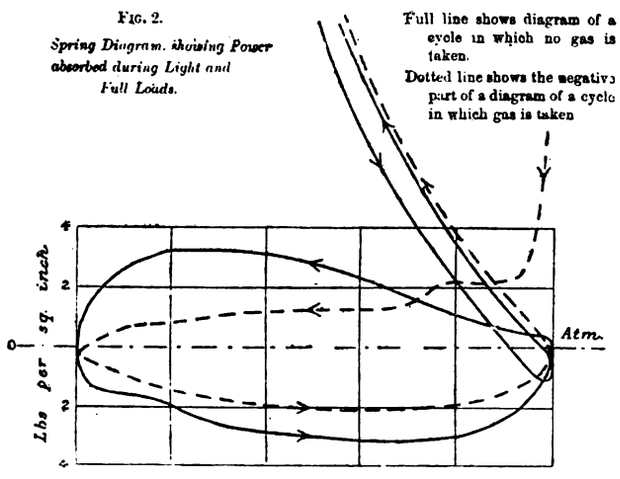
Full line shows diagram of a cycle in which no gas is taken.
Dotted line shows the negative part of a diagram of a cycle in which gas is taken
Atm.
Lbs per sq. inch
4
2
0
2
4

FIG. 2.
Spring Diagram, showing Power absorbed during Light and Full Loads.

by an experiment which was made immediately after one of the tests for mechanical efficiency. At the end of that test the jacket temperature was 179deg. F. (81deg. C.), the engine was absorbing about 7 h.p., exploding once in seven cycles, and the ordinary normal lubrication was going on. The gas consumption was 0·1159 cubic foot per suction. With the engine running under these conditions and without stopping it or altering the conditions in any other way, the jacket water, which had previously been shut off, was turned fully on, so that in a few minutes the jacket temperature had fallen to 61deg. F. (16deg. C.). The gas consumption was then found to have risen to 0·1205 cubic foot per suction, or by about 3 per cent., and the engine was taking gas once in 4·85 cycles. Thus the power absorbed had increased, in consequence of the reduced cylinder temperature, to 10·0, or by about 40 per cent. on its value with the hot cylinder. A considerable quantity of water was then injected into the cylinder through the small suction valve which is fitted for the purpose of preventing pre-ignitions. The result of this was an immediate drop in the power absorbed to about 6 h.p., or rather less than the engine was using with the hot jacket and with the normal lubrication. This very great variation in the power absorbed by the engine in friction must, of course, be within the experience of many people who have worked practically with gas-engines, and it is referred to here mainly because it is so important a factor in the testing of these engines for mechanical efficiency. In the full-load test immediately preceding this experiment the brake power was 36·2, and if the indicated power had been calculated by adding to the brake power the horse-power absorbed at no load, the result might have been anywhere between 43·2 and 46·2, according as the light-load tests were done with a cold or with a hot jacket. The indicated horse-power was determined by measurement of the diagram to be in fact 41·2.

Confirmation of the great variation of power absorbed with the condition of the cylinder was obtained by motoring the engine round. The exhaust-valve cover was taken off the engine so that the cylinder was open to the air and there was no loss from pumping. The power taken to drive the dynamo was measured electrically, and the dynamo losses were deducted, so that the results given below are the total frictional losses in the engine plus the loss in the belt (probably about 0·5 h.p.).

Engine hot (about 180° F., 82° C.): Normal lubrication, power absorbed 4 h.p.
Engine cold (70° F., 21° C.): Normal lubrication, power absorbed 6·5 h.p.
Engine cold (70° F.): Excess of oil, power absorbed 4·7 h.p.
Engine cold (70° F.): Water injected, power absorbed 2·7 h.p.

A separate determination of the power required to drive the engine round with the piston removed was made, and it was found to be 1·4 h.p. This includes the main bearing friction, valve-lifting and belt losses. If this be deducted from the figures given above, the result is the piston friction, which, of course, is alone affected by the changes in cylinder temperature and lubrication. It will be seen that the piston friction varies according to conditions between 1·3 h.p. and 5·1 h.p., the normal value with jacket at 180deg. F. being about 2·5 h.p. In normal working at nearly full load (41·0 i.h.p.) with the jacket at 180deg. F., the mechanical losses in this engine may be allocated as follows:

TABLE III.

	H.P.	Per cent. of I.H.P.
Suction	1·4	3·4
Piston friction	2·5	6·1
Other friction (valve lifting, etc.)	1·1	2·7
Total	5·0	12·2

The apportionment between piston friction and other friction is somewhat uncertain, as it may be to some extent affected by the existence of pressures in the cylinder, the estimate of piston friction being based upon running the engine with the cylinder open to the air.

The effect of using water as a lubricant when the cylinder is cold is, of course, easy to understand, though the author hardly expected to find that it was so great in amount. It is not quite so marked, though still quite perceptible, when the engine is running fully loaded. In one test, in which the engine was fully loaded and the jacket water at a temperature of about 180deg. F. (82deg. C.) at exit, it was found that injection of water in considerable quantity diminished the number of explosions per minute by about 3 per cent. with the same brake load and speed. This difference is due entirely to the change of lubrication, the water having no effect whatever upon the indicator diagram. The following table gives the mechanical loss in this engine observed under different conditions. The lubrication is in each case normal, and the loss is the difference between the observed brake power and the indicated power. The engine was nearly fully loaded in every case, the proportion of idle cycles varying from 0·17 to 0·20.

TABLE IV.

Date.	Jacket temperature.	Loss (H.P.).
Aug. 16, 1906	150–160deg. F. (65–71deg. C.)	6·0
Aug. 22, 1906	185deg. F. (85deg. C.)	5·0
Aug. 22, 1906	185deg. F. (85deg. C.)	4·9
Jan. 31, 1907	69deg. F. (20deg. C.)	7·1
Jan. 31, 1907	150–160deg. F. (65–71deg. C.)	5·5
Jan. 31, 1907	203deg. F. (95deg. C.)	4·5

The results show the effect of jacket temperature. The slight reduction in loss as between the August and January experiments is to be expected because the engine was run a good deal in the interval. The following is a summary of the various efficiency figures relating to this engine:

TABLE V.

Thermal efficiency	35½ per cent. to 37 per cent., according to strength of mixture.*
Mechanical efficiency for medium charge	85 per cent. to 90 per cent., according to jacket temperature.
Air-cycle efficiency	52 2 per cent.
Efficiency relative to air cycle	0·64 to 0·71.

* The weaker mixtures give the higher efficiency. Full details of the tests establishing this fact will be given in a further communication.

It may be interesting in this connection to give the results of a series of tests for mechanical efficiency which were made upon a gas-engine of a very different type—that is, a four-cylinder petrol motor running up to 1,200 r.p.m. The engine was kindly lent to the author by the manufacturers, the Daimler Company, Limited, and has cylinders 3·56in. diameter with a stroke of 5·11in. The mechanical losses were determined by the method described by the author in a paper in *Engineering* (Feb. 8, 1907). The method consists in running one cylinder only of the engine and of indicating that cylinder, there being no load

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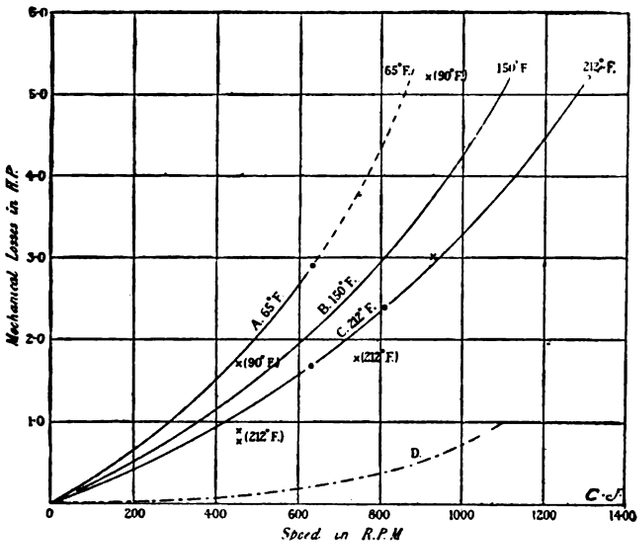
on the engine. The indicated power of the single cylinder is then equal to the mechanical friction of the engine plus the negative work shown on the diagrams of all the four cylinders. When the engine is running fully loaded at the same speed the loss by mechanical friction will be substantially unaltered, but the suction losses will not be quite the same, owing to the same causes that operate in the case of the large gas-engine. The suction loops in the three idle cylinders are different from that in the firing cylinder, and there is, moreover, the negative work done in the compression and expansion. The pumping losses, however, in the Daimler engine bear a very much smaller proportion to the whole than in the large gas-engine, owing to the relatively great size of the ports, so that no serious error is involved in neglecting the difference in these losses as between firing and not firing. Fig. 3 shows the relation between the power indicated by the single cylinder and the speed for three different temperatures. In Curve A the outlet temperature of the jacket water was 65deg. F. (18deg. C.), in Curve B about 150deg. F. (65deg. C.), and in Curve C the water was just boiling. The dotted curve, D, shows the power absorbed in pumping, estimated from light spring indicator diagrams, so that the difference between this curve and any one of the others gives an approximation to the loss by mechanical friction. These curves show that the frictional losses at a temperature of 65deg. F. are nearly double those when the jacket water is boiling. They also show that the losses increase very much more rapidly than in proportion to the speed, as is to be expected from the fact that they are due to fluid friction. These experiments were done for the author by Mr. L. G. E. Morse, of King's College, Cambridge.

Fig 3.

Mechanical Efficiency of Daimler Engine with varying Temperatures of Water-Jacket



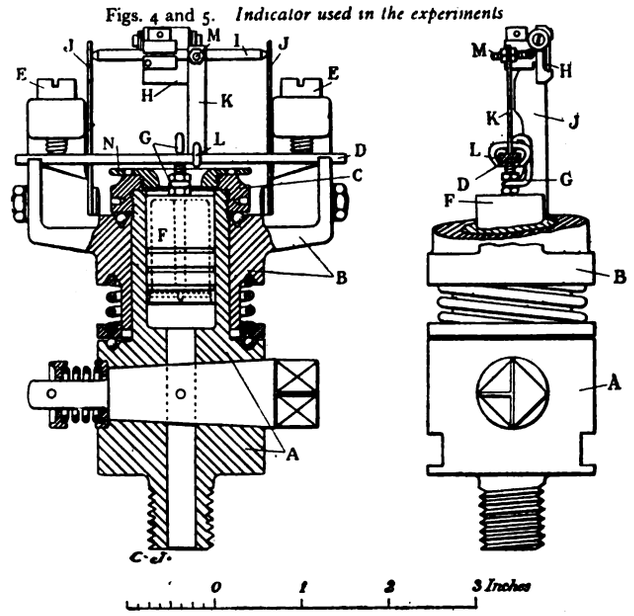
Mr. Morse devised another method of getting the mechanical efficiency of a multi-cylinder motor, which, as it is very simple and appears to be quite accurate, is worth giving here. It consists in running the engine loaded with all the cylinders working. The load is put on by means of a Prony brake clamped to the flywheel, carrying a dead weight which is partially supported by a spring balance having an open scale. The spring balance reads the excess of the dead weight over the brake load in the usual manner, and small changes in the brake load may be very accurately read. In making a test one cylinder is stopped from firing by cutting off the current, and the pressure on the brake blocks is reduced until the speed has come up to its old value. The reduction in brake load is then read off, and is approximately that corresponding to the indicated power of the cylinder which has been cut out. The four cylinders are treated in succession in this way, and by adding the results the indicated power of the engine is determined. Points obtained by this method with the corresponding jacket temperatures are shown by crosses (×) on Fig. 3, and it will be seen that they agree very well with those obtained by indicating only one cylinder. The mechanical efficiency of this engine is remarkably high for its size. With boiling jacket water the mechanical efficiency is 90 per cent. at a speed of 400 r.p.m. It falls off to 75 per cent. at a speed of about 1,300 r.p.m. The thermal efficiency is also high, reaching over 26 per cent. under the most favourable conditions. The air-cycle efficiency corresponding to the compression ratio, 3·85, is 41·5 per cent., so that the relative efficiency is 0·625.

Appendix I.

Description of Indicator.

Fig. 4 is a full-size drawing of the instrument, partly in section. The block, A, is screwed into the ordinary indicator hole of the engine. The frame, B, fits over the block, sufficient clearance being left to provide for unequal expansion. The frame is held up by a spring into engagement with the lower face of the nut, C (screwed to the top of A), a ball-race being interposed so as to admit of easy rotation of the frame about the axis of A. The spring, D, is a piece of steel strip resting in grooves at the end of the frame, B, and held by the screws, E E. The spring is slightly bowed before insertion in the frame, so that when the screws, E E, are screwed home the spring is held straight with slight pressure on the four points of support. The piston, F, slides in a bore in the block, A. It is made hollow, but a plate closes its lower end. At the top it is provided with a hook, G, the opening of which is slightly larger than the thickness of the spring. The piston is thus free to move laterally, and no binding action is possible between it and the sides of the bore, such as would occur if the piston were rigidly attached to the spring. The mirror, H, is clamped to a steel spindle, I, the ends of which are pivoted in small holes in the vertical spring cheeks, J J. The motion of the spring, D, is communicated to the spindle and mirror by means of the piece of vertical spring, K. The lower end of this piece of spring is held firmly on the face of the main spring, D, by means of the jaws, L; the upper end is firmly clamped to the arm, M, which projects at right angles from the mirror spindle. (See Fig. 5, which is a section in a plane at right angles to Fig. 4.) The spring K, while sufficiently rigid to transmit the motion of the main spring to the end of the arm, M, without buckling is flexible enough to allow for the angular motion of that arm. The mirror is thus turned about the axis of the spindle by an amount which is proportional to the displacement of the

Figs. 4 and 5. *Indicator used in the experiments*



main spring, D, and, therefore, to the pressure under the piston. In order to give the other motion to the mirror the frame, B, is positively connected by linkage to a reciprocating part of the engine, and is thus caused to rock as a whole about the axis of the block, A. The motion thus given to the frame, B, must be in phase with and proportional to the piston motion. In consequence of the smallness of the angular motion (about one sixteenth of a radian) of the frame, B, it is easy to secure this result with simple gearing, the effect of the curvature of the paths of the joints in the linkage being negligible. A convenient arrangement is that shown diagrammatically in Fig. 6, in which S is an eccentric fixed to the crankshaft, and such that the diameter is to the throw as the crank radius is to the length of the connecting rod. The lever, W, is jointed at one end to the rod, V, which takes its motion from one end of a lever pivoted at the other end, T, and engaging with the eccentric by a roller, J. At the other end W is fixed to a clamping ring, X, which fits over the turned portion of the frame of the indicator (Fig. 4).

The manner in which the diagrams are made visible is apparent from the diagram, Fig. 7. The source of light is a fine hole, P, illuminated by an ordinary four-volt incandescent lamp. The rays from this, after reflection from the plane mirror of the indicator, Q, fall upon the convex lens, R_1, which is placed about 18in. from the mirror, and is 4in. in diameter. The focal length of this lens is about equal to its distance from the mirror, and the beam of reflected light is therefore refracted to a direction about parallel with the axis of the lens. The beam comes to a focus in the plane, R_2, and traces out in that plane the indicator diagram of the engine, the vertical displacements of the spot (corresponding to the tilting of the mirror about the spindle) being proportional to the pressure, and the horizontal displacements (corresponding to the rocking of the indicator frame) to the piston motion. With a sufficiently

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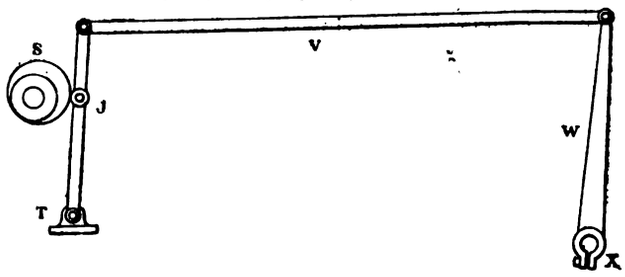
powerful source of light this diagram could be made visible by a ground-glass screen placed in the plane, R_2, but in order to render it visible with a small lamp a transparent screen is used, and a second lens, R_3, is interposed about 10in. from R_2. This lens is of equal diameter with R_1, and refracts the beam of light (which before striking it is parallel to the axis) to its principal focus, R_4, where the eye is placed. The beam is at the same time converted into a parallel beam, and the spot is seen sharply defined on the screen. The diagram traced by the spot is seen as a bright line of light. The screen is engraved with horizontal and vertical lines, on which the diagram is projected. The pressure at any point can thus be easily read off, or the diagram can be plotted down on squared paper. Three pistons are used, the areas being in the ratio of 1, 2, and 4. There are two springs, which are ground so that the stiffnesses are in the ratio of 1 to 5. A wide range of sensibility is thus obtained. The smaller pistons fit inside liners which are inserted in the bore of the block, A (Fig. 4). The spring is

FIG. 6

Diagram of Levers for operating the Indicator Mirror



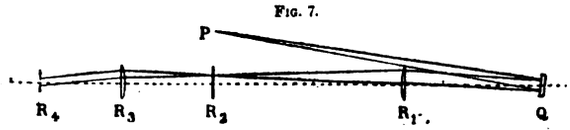
very easily changed by slacking the screws, E E, and slipping the springs out together with the spindle and mirror, the spring cheeks, J J, being slightly separated to allow of the spindle being taken out. When the spring has been removed, the piston can also easily be taken out by removing the cap, N (Fig. 4), which serves also as a stop to prevent excessive bending of the spring. The indicator is very easily calibrated by dead weights. The calibration is found to remain constant within 1 or 2 per cent. when the spring is removed and replaced. Suction pressures are registered on the same scale as those above atmosphere, on account of the slight initial set in the spring.

APPENDIX II.

Conditions Determining the Gas and Air taken per Suction.

The total quantity of mixture drawn into the engine per suction is determined mainly by the temperature of the cylinder walls and piston, and is not affected much by the temperature of the gas left in the compression space from the previous stroke. This is most easily seen by supposing the incoming charge to be kept adiabatically separate from the residual gas. The total charge then drawn in will obviously be independent of the temperature of that gas. If now at the end of the suction stroke, when all valves are closed, the incoming charge and the residual gas are mixed, the pressure will not change. For the internal energy of a given volume of gas having constant specific heat is a function of its pressure, and is independent of its temperature or of the distribution of temperature in it. It can make little difference whether the mixing takes

FIG. 7.



place at the end of the stroke, as supposed, or during the stroke, as, in fact, it does. In either case the quantity of gas drawn in is nearly independent of the temperature of that with which it mixes. The author believes that this was first pointed out by Mr. Dugald Clerk, in the appendix to his paper on the "Limits of Thermal Efficiency in Internal-Combustion Engines." It follows that in an engine governing by hit-and-miss, the amount of gas and air drawn in will be substantially the same after a miss as after an explosion. The ratio of gas to air in the charge taken in, and the quantity of gas, will also be much the same, provided that the opening of the gas-cock and the pressure outside be the same. Since, however, the incoming charge mixes with cold air instead of hot products, the weight of the total charge present in the cylinder at the end of suction will be greater, its temperature will be lower, and the percentage of gas present in it will be less. The diagram should, therefore, be unaffected except in so far as the weakening of the mixture improves the efficiency, and so enlarges the area. This should cause an enlargement of from 4 to 5 per cent., or considerably more than has usually been observed in the engine used for the tests described in this paper. The inference is that the gas supply is, in fact, rather less after a miss than after an explosion. Fuller investigation of the matter shows that this must be so.

Let v = quantity of gas left in compression space ;
t = temperature of gas left in compression space ;
V = quantity of gas and air taken in ;
T = temperature of gas and air taken in before entering ;
v_o = volume of cylinder contents at completion of suction ;
t_o = temperature of cylinder contents at completion of suction ;

the quantities of gas being expressed in standard cubic feet—that is, cubic feet reckoned under the standard pressure of 760mm. of mercury (14·7lb. per square inch), and the standard temperature of 0deg. C.—and the temperature on the absolute Centigrade scale. Then at the commencement of suction we have V standard cubic feet of air and gas outside the engine at temperature T and v inside at temperature t, all at atmospheric pressure, p_o. Thus the stuff which is ultimately to form the total charge has at this point the energy $k(\mathrm{V}\,\mathrm{T} + v\,t)$, where k is the thermal capacity at constant volume, or 19 foot-pounds. When suction is finished the stuff is all inside the engine, and it then has the energy $k(\mathrm{V}+v)\,t_o$. During suction work is done by the engine to an amount, W, which can be calculated from the light-spring diagram. Some heat, H, is also received from the cylinder walls. Some of this work goes to increasing the internal energy, and some is done against the atmospheric pressure. The latter item is equal to the pressure multiplied by the increase of volume of the stuff, that is to

$$\left\{\frac{\mathrm{V}\,(t_o - \mathrm{T})}{273} + \frac{v\,(t_o - t)}{273}\right\} p_o\,,$$

p_o being the atmospheric pressure in pounds per square feet. Equating the network done on the stuff plus the gain of heat to the increase of energy, we get

$$\mathrm{W} - \left\{\frac{\mathrm{V}\,(t_o - \mathrm{T})}{273} + \frac{v\,(t_o - t)}{273}\right\} p_o + \mathrm{H}.$$
$$= k\,(\mathrm{V}+v)\,t_o - k\,(\mathrm{V}\,\mathrm{T} + v\,t).$$

Or, since $k + \frac{p_o}{273} = k_p$, the specific heat at constant pressure :

$$\mathrm{W} + \mathrm{H} = k_p\,\{\mathrm{V}\,(t_o - \mathrm{T}) + v\,(t_o - t)\}.$$

Now,
$$\frac{(\mathrm{V} + v)\,t_o}{273} = v_o$$

whence, substituting for t_o

$$\mathrm{V}\,\mathrm{T} = -\frac{\mathrm{W} + \mathrm{H}}{k_p} + 273\,v_o - v\,t.$$

If V′ be the actual volume (before entering) of the gas and air taken in, so that $\mathrm{V}' = \frac{\mathrm{T}}{273}\,\mathrm{V}$, and if v_s be the stroke volume $\left(= v_o - \frac{t\,v}{273}\right)$, the last equation may be written :

$$\mathrm{V}' = v_s - \frac{\mathrm{W} + \mathrm{H}}{k_p \times 273}$$

or the actual volume taken is less than the stroke volume by the quantity $\frac{\mathrm{W} + \mathrm{H}}{k_p \times 273}$. The hotter the contents of the compression space the less heat will be taken in from the cylinder walls during suction. The charge taken in after an explosion will, therefore, exceed that taken in after a scavenging stroke, the cylinder and piston temperatures being the same. It is assumed in this calculation that the pressure is atmospheric at the beginning and end of the suction stroke. With good valve action this is sufficiently nearly the case, and when it is not so it is easy to make the necessary correction. A further assumption is that the whole entering charge comes in from the air and gas pipes. This is not quite true, since in most engines the exhaust valve remains open for some time after the suction stroke has begun, and some stuff may back in from the exhaust pipe.

In the engine on which these experiments were made the mean pressure in the suction stroke when taking both gas and air is 2lb. per square inch. Thus $\frac{\mathrm{W}}{t_p \times 273}$ is $\frac{2 \times 144 \times v_s}{26{\cdot}75 \times 273} = 0{\cdot}04\,v_s$. The volume drawn in is, therefore, reduced to 4 per cent. below the stroke volume on account of the work done on the charge in drawing it in. The substantial correctness of this result has been verified by actual measurement of the cylinder contents at the beginning and end of the suction stroke, the engine being motored round and sucking air only, so that there was but little exchange of heat between the gas and the cylinder walls. The temperature of the charge at each end of the suction stroke was measured by a platinum thermometer. The value of H cannot, of course, be calculated, but it is not difficult to measure the actual volume of air taken by means of an anemometer. Tests of this kind under various conditions were made on the Crossley

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engine, of which the following are the most important. In each case λ is the ratio of the total volume of gas and air taken in per suction, V′, to the stroke volume, v_s. The stroke volume is 1·26 cubic feet: (1) Engine motored round without firing, gas-cock shut, λ = 0·87. (2) Engine motored round without firing, gas-cock open, λ=0·90. (3) Engine firing 80 per 100 cycles. Jacket 62deg.-69deg. F. (16deg.-20deg. C.), λ=0·87. (4) Engine firing 87 per 100 cycles. Jacket 173deg.-200deg. F. (78deg.-93deg. C.), λ=0·825. In No. 2 H cannot have amounted to much, as the jacket and piston were both cold. About half of the 10 per cent. loss of volume is to be ascribed to the work done, W, as already explained; the other half is due to gas coming in from the exhaust pipe during the first portion of the suction stroke. In No. 3 the piston was hot because of the continual firing; it would have a temperature of at least 350deg. C. (662deg. F.). Thus H is considerable, and the result is seen in a reduced charge as compared with (2). In (4) H is further increased, and the charge is further reduced, by the hot jacket. It was found in these tests that the ratio of gas to air taken in varied somewhat though the opening of the gas-valve and the gas pressure were always the same. The range of variation amounted to about 5 per cent. on the ratio, and it could not be correlated definitely with any change in conditions. It takes place slowly, however, and does not affect the conclusion stated above as to the effect of a missed ignition on the charge of gas taken. It is probably due to changes in the temperature distribution in the engine, which would alter the relative amount by which the gas and air streams are warmed in coming in.

The anemometer was calibrated by motoring the engine round, the setting of the exhaust valve being altered so that it opened at the out-centre and closed a little before the in-centre. The overlap of the exhaust and inlet valves was thus reduced to about 7deg. only, and the error due to air coming in from the exhaust pipe was practically eliminated. Measurements of temperature (by platinum thermometer) and of pressure were made at the opening and closing of the inlet valve, and the cylinder contents at these poinnts were thus determined. The calibration so made was accurate within 2 or 3 per cent. A somewhat similar method was used by the Institution of Civil Engineers' Committee, but they did not make any measurement of temperature. On this account their calibration was probably somewhat too high, perhaps as much as 5 per cent. For their purpose this was near enough, since they only required the total volume of air passed through the engine for the purpose of estimating the amount of a small correction in their heat quantities.

Appendix III.

On the Loss of Heat in Compression.

In this engine the pressure reached at the end of the compression stroke, when compressing air only, is 173lb. per square inch absolute, with a normal barometer. The pressure at the closing of the inlet valve under the same circumstances is 0·15lb. per square inch above atmosphere, or 14·85lb. per square inch absolute. The ratio in which the volume is reduced between the closing of the inlet valve and the completion of compression is 6·17. Assuming that there is no leakage, it follows that the absolute temperature is increased by the compression in the ratio $\frac{173}{14{\cdot}85 \times 6{\cdot}17}$, or 1·89. The rise of temperature is, therefore, 0·89 θ_0, where θ_0 is the temperature at the beginning of compression. Assuming that the compression curve is of the form $p v^n$ = constant, the index n has the value 1·35. As a matter of fact, n is less at the beginning of compression than at the end. The work done in compressing air according to the law $p v^{1{\cdot}35}$ = constant, so that the volume changes in the ratio 6·17 would be sufficient (if there were no loss of heat) to raise its temperature in the ratio 2·14. This is most easily seen by noting that the curve $p v^{1{\cdot}35}$ = constant is the adiabatic compression curve of a gas whose specific heat is $\frac{7{\cdot}75}{0{\cdot}35}$ = 22·2 foot-pounds per standard cubic foot. The temperature rise corresponding to compression in the ratio 6·17 is, as already seen, 0·89 θ_0; and this is the rise of temperature produced in a gas of specific heat 22·2 by the work under the compression curve. The same amount of work applied to heating air would, therefore, raise its temperature by $\frac{22{\cdot}2}{19} \times 0{\cdot}89$ = 1·04 times θ_0, since the specific heat of air is 19 foot-pounds. Since the actual rise of temperature of the air is 0·89 θ_0, it follows that the heat lost in compression is such as would raise the temperature of the air by 1·04 − 0·89 = 0·15 times θ_0. Thus about 14 per cent. of the work done in compression in this engine is lost to the cylinder walls. This result depends on the assumption that the compression curve has the form $p v^n$ = constant, but the result will not be greatly different if n varies somewhat during the compression stroke, provided that the pressure and volume at the beginning and end of compression are the same. The mean absolute pressure of the compression curve (still assumed to be $p v^{1{\cdot}35}$ = constant) is 3·03 times the initial pressure, or 45lb. per square inch. We have now to consider the expansion curve. If the expansion be assumed to be adiabatic, the pressure after expanding 6·17 times will be $\frac{173}{(6{\cdot}17)^{1{\cdot}41}}$, or 13·5lb. per square inch. This is not far from the value actually observed by the indicator, and it is probable that very little heat is lost in the expansion. The mean pressure under the assumed adiabatic expansion curve is, starting at 173lb. per square inch and finishing at 13·5lb., just over 43lb. per square inch. The mean pressure in the loop formed by the compression and expansion curves is, therefore, about 2lb. per square inch.

FORTHCOMING EVENTS.

FRIDAY, NOV. 8.

Electro-Harmonic Society.—At 8 p.m., ladies' night, at the King's Hall, Holborn Restaurant.

Physical Society.—At 8 p.m., in the Physics Laboratory, Royal College of Science, Imperial Institute-road, South Kensington, discussion on Mr. Campbell's paper, "On the Use of Variable Mutual Inductances"; "A Graphic Method for Stream-Lines and Equipotential Surfaces," by Mr. L. F. Richardson; "On the Lateral Vibrations of Bars supported at Two Points with one end overhanging," by Dr. J. Morrow.

Northampton Institute Engineering Society.—At 5.30 p.m., debate on "The Relative Merit of College and Workshop Training for the Engineer." Dr. R. M. Walmsley in the chair.

Institution of Civil Engineers (Yorkshire Students' Section).—At 7.30 p.m., at Philosophical Hall, Leeds, "Archæological Engineering," by Mr. E. Kitson Clark.

SATURDAY, NOV. 9.

Institution of Electrical Engineers.—At 10 a.m., students' visit to Bow works of North London Railway Co.

MONDAY, NOV. 11.

Institution of Mechanical Engineers (Graduates' Section).—At 8 p.m., "Railway Signalling," by Mr. Herbert E. Morgan.

TUESDAY, NOV. 12.

Institution of Civil Engineers.—At 8 p.m., "The Extension, Widening, and Strengthening of Folkestone Pier," by Mr. T. H. Ker.

Manchester Local Section.—At 7.30 p.m., chairman's address, Mr. M. B. Field.

WEDNESDAY, NOV. 13.

Association of Engineers-in-Charge.—At 8 p.m., at St. Bride's Institute, Bride-lane, Fleet-street, E.C., "Economic Considerations on the Management of Plant," by Mr. W. H. Patchell.

THURSDAY, NOV. 14.

Institution of Electrical Engineers.—At 8 p.m., at Great George-street, "The Dielectric Strength of Insulating Materials and the Grading of Cables," by Mr. Alexander Russell, M.A.

I.E.E. Dublin Local Section.—At 8 p.m., at the Royal College of Science, opening meeting.

Birmingham and District Electric Club.—At 7.30 p.m., at the Colonnade Hotel, New-street, "Recent Developments in Single-Phase Motors for Power and Traction," by Mr. Vincent E. Walters.

FRIDAY, NOV. 15.

Institution of Mechanical Engineers.—At 8 p.m., at Storey's-gate, "Labour-Saving Appliances at the Mines of the New Kleinfontein Co., Transvaal," by Mr. Edward J. Way, of Johannesburg.

I.E.E. Manchester Students' Section.—Tuesday, Nov. 19, at 7.30 p.m., at Municipal School of Technology, "Power for Works and Factories, with Costs," by Mr. L. J. Lepine.

I.E.E. Glasgow Local Section.—Tuesday, Nov. 12, at 8 p.m., meeting at 207, Bath-street; Friday, Nov. 15, at 8 p.m., students' meeting at Glasgow Technical College; Wednesday, Nov. 20, at 6.30 p.m., annual dinner at Grosvenor Hotel.

APPOINTMENTS VACANT.

Overhead Linesmen for tramway system in the North of England. Applications to Box E T 7, office of this paper. See advertisement in last issue.

Lecturer at the Glasgow and West of Scotland Technical College. Salary, £150-£200 per annum. Applications to be addressed to Prof. Magnus Maclean, D.Sc., by Nov. 12. See advertisement in last issue.

Professor to Chair of Electrical Technology, Indian Institute of Science, Bangalore, India. The salary attached to the chair will be £1.000 per annum at the commencement, and the professor will be provided with a residence. See advertisement in last issue.

Assistant to Borough Electrical Engineer, Eccles Corporation Electricity Department. Salary, £120 per annum. Applications to Mr. Edwin Parkes, town clerk, by Nov. 11.

Travellers (two) required by an electrical firm. Salary, £300 per annum and liberal commission. Applications to Thermo, office of this paper. See advertisement in last issue.

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TO CORRESPONDENTS.

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THE RAILWAY CRISIS.

We make no apology for reference to a crisis that for the moment seems to be ended, and we think ended in the right fashion. The subject of labour *versus* capital is woefully misunderstood by the very men who ought to use every endeavour to understand it best. As we read the late agitation, it was that a union of practically a minority of the men should be recognised by the various companies as a kind of parliament which should stand in the place of the workers in case of disputes. We have never yet recognised the validity of the claims of outsiders to interfere in questions arising between masters and men, but we have long recognised that men with troubles or fancied troubles ought to be able to put those troubles before and for the consideration of the masters without fear of ulterior detriment. Thus, if the employés select of their own number men to state their case, it would be recognised that these selected men were merely mouthpieces and acting impersonally—an action for which there would be no legitimate cause for grievance; nor could they be looked upon as agitators, paid to agitate, hence probably antagonistic to the interests of the employer. The dogmatism is true that the interests of masters and men are identical, but there are masters and masters, men and men; and to tar the whole with one brush because of the black sheep is wrong. Labour is not the source of wealth, and the mistake of Adam Smith in not more rigidly defining his terminology has led many a man into error. Labour is of the same character as the fork used to convey food to the mouth. The fork is not food, but the one-pronged fork is not so efficient as the two, three, or four pronged forks, hence the better results by using the latter. It is the efficiency of labour that determines results. For the best results it must be applied continuously (practice makes perfect); it must be applied with skill (necessitating brains, knowledge, and organisation); it must be aided by mechanical appliances, power machinery, etc. (again brains and knowledge). Far too little credit is given to anything but brawn, and yet mere brawn is the least of the properties leading to the greatest efficiency. This, however, is a digression. The recent agitation in the railway world is not singular. It has followed a long series of agitations in other industries, and we have no hope that the end has come yet. The precedent solution interests us. It may well be adopted by all and sundry, and if so adopted would probably lead to a better understanding on both sides. We repudiate utterly the doctrine that most employers think no more of their employés than that they are mere pawns on a chess-board to be used merely for the making of money. There is as close a sympathy between many masters and men now as there was in the olden days when all lived and moved, worked and played under one roof tree.

MANUFACTURERS' POLICY.

In our last week's leader on large German gas-engines we concluded with the opinion that "the English maker of modern gas-engines has every reason to be proud of the engineering and commercial success which has resulted from his pioneering work." We had expected to have received this week more replies from our large gas-engine manufacturers, expressing their opinions on the subject in the same free way that Messrs. Crossley Bros., Messrs. Richardsons, Westgarth, and Co., and the British Westinghouse Company did in our article last week. These replies have not come to hand, and from personal interviews with the firms who do not wish to express any opinion at

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present, we regret to find that they are quite satisfied with "their present engineering and commercial success." The history of the world shows that when a nation becomes rich and satisfied it is a sign that decay has commenced, and that the nation is on the down grade. The same thing applies to an industry and to a commercial firm. At one time the cloth industry of England was centred in and around Gloucester, where to-day hardly a cloth mill is to be found. On the streams through the countryside there are to be seen a large number of ruins of factories and disused dams. From one manufacturer in the district who has built up a new industry in three of these disused mills, we learned that the cloth trade left the district because the manufacturers were rich and lethargic. They continued making cloth by the old processes until it no longer paid, and the industry moved itself to Yorkshire. One of the largest gas-engine makers in this country now assures us that they are making large profits with the present engines, and that it does not pay them to build very large engines, for which they think there is no demand. Instead of devoting these large profits to pioneering work in the manufacture of new types of large engines, they are evidently spending them on personal luxuries. Without wishing to prophesy evil, we feel sure that such a policy means trouble ahead. It only requires a radical reduction in the price of electrical energy for the electric motor to oust the gas-engine of a small size from all districts where such a supply is given. This will reduce the demand for such engines, and the manufacturer's standing charges will then have to be borne by a smaller output, which will make serious inroads into his profits. If he continues to wait on the fence, he will find that those English firms who are pioneering in very large gas-engine construction will have secured the market, and from their experience will be able to hold the same. There is no need to quote names of firms who in the past ten years have been through the exact experience above referred to. One firm in particular has had to abandon a most successful and profitable steam-engine, but, fortunately, in this case it has recouped itself by turbine manufacture We trust that more of our gas-engine manufacturers will realise that a fair proportion of their profits should now be devoted to developing the demand for larger gas-engines to be used on blast-furnace and coke-oven gas. The value of such prime movers to our iron industries is great, and the long-hour load which blowing engines and rolling-mills provide well warrants the expenditure of large sums for a gas-engine, which is so much more economical with this class of fuel than is a boiler and steam-engine.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

STEAM-TURBINES v. GAS-ENGINES.

SIR,—As Mr. Fox in his letter criticising my statements showing the comparative capital and running costs of steam-turbines and gas-engines does not give any figures indicating his own views, it is somewhat difficult to deal with so general a criticism as he makes. If, however, Mr. Fox will prepare and submit a counter statement based upon actual experience, I shall be glad to submit a more detailed statement showing upon what foundation each item of my estimate is based. We should then each be in a better position to criticise the other, and those of your readers who are interested in the subject would be able to form their own conclusions as to what extent either of us had exaggerated. Mr. Fox apparently considers that I have overestimated the capital cost of a 16,000-kw. steam plant. I can only say that all the figures I have before me giving the cost of actual steam-turbine installations that have been carried out are appreciably higher than those given in my estimate.

Mr. Highfield, in his recent paper before the Institution of Electrical Engineers, estimates the total cost of a 14,000-kw. installation at £201,130, or £14·4 per kilowatt, whereas in the estimate Mr. Fox criticises as being too high includes only £210,262 for a 16,000-kw. installation, or £13·1 per kilowatt. My own view is that I have underestimated the cost of the steam plant and over-estimated that of the gas plant. The proper allowance to make for depreciation is a matter upon which there exists a very great difference of opinion. Actual experience with large gas-engines has extended for nearly, if not quite, as long a period as that of large steam-turbines, and there appears to be nothing to indicate that it will be necessary to allow a higher rate of depreciation for gas-engines than for steam-turbines. It will probably be found that the life of a steam-turbine generator, running at very high speeds, will be considerably shorter than that of slow-speed gas-engines. An all-round allowance of 10 per cent. for interest and depreciation on generating plant, buildings, boilers, etc., is a very usual figure to include in estimates, though the actual amount set aside in practice is generally very much less.

Mr. Fox's reference to gas-engine installations that have not been altogether successful up to the present time reminds one of the adverse reports *re* steam-turbines that were so freely circulated a few years ago. As recently as the year 1900, when contemplating some extensions at Hastings, I discussed with several other engineers the question of the advisability of using steam-turbines, but found that the general opinion at that time was that they were not reliable, and were most extravagant as regards steam consumption. The Manchester-square installation, where the turbines exhausted to atmosphere, was more freely quoted then than Johannesburg at the present time. I remember that one engineer, who has since become one of the largest users and strongest advocates of steam-turbines, then told me that nothing would induce him to use them. He jocularly remarked that it was commonly reported that at one installation a turbine was carried into the station by means of a 20-ton crane and was carried out a few weeks later in bucketfuls. As, however, these adverse reports were all based upon rumour I determined, before coming to a decision, to inspect the few turbine installations running in the country, which at that time could have been counted on the fingers of one hand. The actual facts obtained from these installations were so entirely contrary to the alarming reports then in circulation that I had no hesitation in placing an order for a 500-kw. turbo-alternator, the performance of which, I may add, fully justified all the makers' guarantees.

May I suggest that engineers interested in the question should themselves visit some of the large gas-engine installations in this country and abroad, many of which have been running for years not only on blast-furnace and coke-oven gas, but on by-product recovery producer gas. I venture to prophecy that they will obtain information both as to reliability and low working costs that will surprise them.—Yours, etc., LEONARD ANDREWS.

London, E.C., Nov. 5, 1907.

THE TELEPHONE QUESTION.

SIR,—The wave of discontent with the telephone service which is passing through the country and finding voice in the Press almost everywhere, thoroughly justifies the demand for a stringent parliamentary inquiry which I made in your columns a few months ago. Wherever installed the common-battery system gives rise to complaints, while the increased tariffs introduced under Post Office control and the apparently systematic overcharging of calls are exciting discontent from London to Aberdeen. In the Metropolis it is the overcharges which are receiving most attention. This is not surprising, seeing that the amounts payable are determined by the operator's recording apparatus, which is very fallible as a register of passing calls. It is completely under the control of the operator, who can, if she chooses, pass the calls of any subscriber

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or subscribers free, or, conversely, add as many calls to any subscriber or subscribers as may appear good unto her. The registering device is only automatic up to a certain point, and remains absolutely ineffective without a certain action of the operator, which she can either omit altogether at discretion or repeat several times. In the former case the call passes free, in the latter case the register bears false witness against the subscriber whose line is so treated. It is a pity that the meter is not more effective; but, to my mind, the really serious part of the matter is the attitude assumed by the Post Office. In its defence the Department asserts that the overcharges must be imaginary, because the recording instrument is automatic, and cannot err, or (rather inconsistently), that if it errs, it can only do so in favour of the subscriber. Such an attitude, in face of the facts, is the reverse of honourable. One can understand a peddling trader of obscure moral perception so endeavouring to conceal defects, but on the part of the Department of the British Government conduct of this kind is unworthy and reprehensible.—Yours, etc.,

A. R. BENNETT.

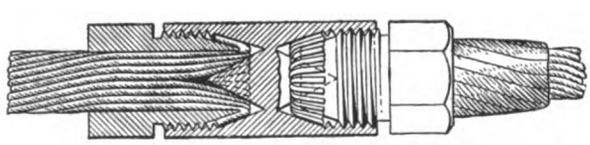
110-VOLT LAMPS ON VARIOUS VOLTAGES.

SIR,—Referring to your request for some information in connection with a letter from "S F. F." in your last issue, the best plan will be to have two circuits with an equal number of lamps on each, so that series or parallel running can be easily used as required. As regards the resistance required to regulate the voltage on mains other than 110 or 220 volts supply, the best way will be to get a round piece of wood about 2ft. long by 3in. in diameter, and if it is hollow, so much the better. On to this wood is wound a few hundred turns of iron wire, No. 20 S.W.G. being very suitable, and suitable means in the shape of cable connectors for varying the number of turns in circuit is now all that is necessary to complete the article. When required for use it is placed in a wooden tub filled with fresh water, and, as it is only wanted for a very short time generally, it will be found thoroughly practicable and satisfactory. It is very easily carried—a fact we have no doubt the travelling engineer will appreciate—and a wooden tub can generally be found at most places. If "S. F. F." has any difficulty in following this method, we shall be glad to supply further information on hearing from him, our address being given in the advertising columns of this paper.—Yours, etc.,

S. W. MARTYN AND CO.

CABLE CLAMPS.

With reference to Mr. Webb's letter in our last issue, asking for the address of the makers of the above articles, we believe, from the rough sketch shown, he is referring to a "Martyn's patent cable connector," which has been on the market for the last few months. The illustration



shows the method of attaching the cables by this connector very clearly, and, if this is the article Mr. Webb is seeking, further particulars will no doubt be supplied by Messrs. S. W. Martyn and Co., 11, Pratt-street, Camden Town, London, N.W.

WINDMILLS FOR ELECTRIC DRIVE.

SIR,—Would you or some of your readers kindly tell me if I could get a book dealing with the design and construction of windmills, and, if so, where?—Yours, etc.,

R. B. DUNLOP.

5, St. James's-street, Antrim-road, Belfast,
Nov. 2, 1907.

LEAD WIPED JOINTS.

SIR,—I read in your issue of Oct. 25 an account of the Ascot and District Gas and Electricity Company, in which on p. 586, first column, third line from bottom, the following appeared: "All services and straight-through joints are lead wiped joints, and wiped joints are made on to all three and four way disconnecting boxes." Am I to understand the boxes are of lead, and the lead sheathing of cables are wiped on to it? Also, in the case of a concentric lead-covered cable, is it possible to make a T-joint and wiped?

I shall be very pleased if you or your readers will kindly answer the above question, giving, if possible, a sketch to the latter question; also how it's done.—Yours, etc.,

JOINT.

[The lead wiped joint is made on to a brass coupling, which in turn is clamped on to the cast-iron joint box. We hope next week to publish the sketches asked for.—ED., *E. E.*]

CONFERENCE ON SCREW THREADS.

A conference was convened by the Engineering Standards Committee on Oct. 24, at the Institution of Civil Engineers, to which were invited representatives from the Royal Automobile Club, the Institution of Automobile Engineers, the Commercial Motor Users' Association, the Agricultural Engineers' Association, and the Society of Motor Manufacturers and Traders. The conference was held with a view of ascertaining how far the series of fine threads laid down by the committee (full particulars of which have been issued in their report No. 20) were adapted to the special conditions of design existing in motorcar construction. The chair was taken by Mr. H. F. Donaldson, chief superintendent of the Royal Ordnance Factories and chairman of the Sectional Committee on Screw Threads and Limit Gauges.

It might be of advantage if we recalled the fact that three series of threads have been standardised by the committee: (1) British standard Whitworth; (2) British standard fine threads; (3) British Association. Some very interesting evidence, amongst others, was given by Mr. Lanchester, Mr. O'Gorman, Mr. Orcutt, and Mr. Godfrey Brewer, and it transpired that for most purposes the existing standard fine threads were deemed suitable for employment in car construction. Mr. Lanchester pointed out that, whereas the gradation in the series of fine threads in sizes relating to the strength of the bolts was satisfactory in sizes $\frac{3}{8}$in. and above, the jump from a $\frac{5}{16}$in. to a $\frac{1}{4}$in. bolt was proportionally too great, and did not allow of sufficient latitude in design. He suggested for the committee's consideration the insertion of an intermediate size. He stated that the screw threads adopted by his firm changed from English to metric pitches at a diameter of $\frac{5}{16}$in, where a convenient relationship existed between these two systems of pitches, based on the fact that 8mm. closely approximated to a diameter of $\frac{5}{16}$in., and he suggested a similar step in the committee's tables. It would appear, therefore, that instead of carrying down the standards to $\frac{1}{4}$in. before adopting the British Association metric pitches it would be desirable, at any rate for motorcar work, to make the change at $\frac{5}{16}$in., and to consider the adaptability of this to general engineering work. Attention was called to the necessity of standardising the thread commonly used on sparking plugs, and which has a 1 5mm. pitch, since several firms were manufacturing a thread which, though closely resembling this, did not interchange with it.

Mr. Orcutt spoke in favour of the limits down by the committee, by the aid of which it was hoped to secure interchangeable work, and referred to the present unsatisfactory state of much of the work turned out by the majority of the bolt and nut manufacturers. To his knowledge, so difficult had one prominent engineering firm found it to secure anything like reasonable accuracy in the bolts and nuts supplied from manufacturers' stock that they were about to institute a nut and bolt department of their own. The difficulty of obtaining reasonably accurate bolts and nuts was confirmed by others present, one member of the committee stating that his firm had already been forced to adopt a similar course to that referred to.

The results of the conference may be summarised as

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follows: (1) an expression of approval on behalf of the automobile industry of the work already carried out by the committee and the suitability of the British standard fine threads for employment in car construction; (2) the advantage of lightening the existing Whitworth standard nuts by reducing their width across the flats when employed in motorcar construction; (3) the desirability of adding certain special standard threads to those already standardised by the committee.

SOME NOTES ON INSULATION AND INSULATION TESTING.*

BY S. M. HILLS AND T. GERMANN.

A substance insulates because it is possessed of three distinct properties: firstly, the ability to stand mechanical and electrical stresses due to the voltage used; secondly, a conductivity such that but a negligibly small current can flow through it and leak away; thirdly, the power to resist chemical action that may be set up by application of the voltage. There is no direct relation between the breakdown E.M.F. and the ohmic resistance of an insulator. A low ohmic resistance usually means a low breakdown test, but the converse is not always true.

A good insulator should fulfil the following general requirements: (1) high disruptive strength; (2) good ohmic resistance; (3) physical properties should remain permanent over a wide range of temperature; (4) must be non-volatile and non-hygroscopic; (5) resist the action of water, acids, and alkalies; (6) fireproof.

No single substance fulfils all these requirements, and various mixtures have been devised in an attempt to produce an insulator possessing the required properties. The density, and, therefore, the molecular composition of the various components, of the mixture is different, and the particles or cells of which they may be conceived as being built up of can move more freely in some than in others. Since the electrical displacement varies directly with the density, the effect of a mixture is to cause an unequal distribution of pressure in the dielectric. A large number of insulation troubles may be attributed to this phenomenon

Line Insulation.—In high-voltage distribution, the insulation of the line is a very important matter. There are two substances to choose from—namely, porcelain and glass. Good samples of either will give excellent results up to 5,000 volts, but beyond this figure considerable leakage occurs. Glass often permits of leakage when new, and ages very badly; the surface becomes roughened, moisture and dirt collect until the surface is found to be a tolerably good conductor. Cheap porcelain is often extremely hygroscopic, some makes absorbing 1 to 2 per cent. of moisture. Porcelain for insulating purposes should absorb no moisture and show a brilliant vitreous fracture, which will give no flowing stain with ink. Glass is homogeneous throughout its thickness, but with porcelain it is often found that once the glaze is damaged a porous and practically non-insulating porcelain is revealed. The best substance to use is a thoroughly vitrified porcelain, in which the ordinary glaze is replaced by an actual fusing of the material itself. It is strong, tough, and non-hygroscopic, has very high insulating properties, the surface does not weather, and the insulation is practically permanent. The insulator should be so designed that the extent of surface is as long and narrow as is practicable; also the surface must be initially and continuously highly insulating.

Oils.—With the increased use of high-voltage distribution a larger number of oil-cooled transformers and oil switches are required, and, therefore, the question of insulating oils has received more attention. Each manufacturer has his own pet specification, but the following contains the conditions required in an average specification: (1) the oil should be a pure mineral oil, obtained by the fractional distillation of petroleum, unmixed with any other substance, and without subsequent chemical treatment; (2) flash test must not be less than 180deg.; (3) evaporation not greater than 2 per cent. after heating for eight hours at 100deg. C.; (4) must not contain moisture, acid, alkali, or sulphur; (5) must be as clear as possible, fluid, and free from particles of metallic nature. There are two main methods employed in testing the dielectric strength of the oil—namely: (1) between two spheres submerged in the oil and placed ½in. apart; (2) between two needle points placed ½in. apart. The latter method gives a lower value than the former, and since in a transformer or switch many sharp edges, if not points, are met with, the authors favour the use of method 2.

Varnishes, when used in the preparation of insulation, are usually impregnated on cloth, paper, etc. This forms an insulator, the density and electrical displacement of which is not the same in all parts—a very undesirable state of affairs. It is advisable to test the dielectric strength of the varnish when impregnated on paper, at various densities, in order to endeavour to obtain an insulator of somewhat uniform density. The highest dielectric strength will not be obtained by using the highest density varnish, unless the density of the neat varnish happens to be best suited for passing into the pores of the paper.

Ageing and Heating —Insulation often rapidly deteriorates with age, and it is necessary to store samples of insulation and test them after they have been stored for two or three months. The deterioration is probably due to atmospheric and drying effects, also to the mechanical stresses produced by the rapid alternation of the voltaic stress. Insulation is a bad conductor of electricity, and, therefore, as would be expected, it is a bad conductor of heat—a property which accounts to a large extent for its deterioration with age. The higher the temperature of the insulation the lower the dielectric strength.

Marble.—Marble is largely used for switchboards, and though preferable to slate on account of its absence from metallic veins, it is not an ideal switchboard material. Marble is one of that class of substances which are always cold, consequently it rapidly condenses moisture, which on a switchboard causes surface leakage. The mechanical properties vary inversely with the electrical properties. The specific gravity has a considerable effect on the properties—*e.g.*: (1) the greater the specific gravity the lower the absorption of moisture; (2) the greater the specific gravity the greater the crushing stress; (3) the greater the specific gravity the lower the breakdown voltage.

Conclusion.—Practically speaking, there is no piece of electrical machinery in which some insulation is not used, yet but little is known about the subject, nor is the requisite amount of importance assigned to it. Doubtless many of the large firms have a considerable amount of knowledge on the subject, but it is so jealously guarded that the average electrical engineer stands but little chance of obtaining it. Insulation is affected by so many things that testing is a matter of great difficulty, and widely different results are obtained, the reason or reasons for this not being definitely known. It is, therefore, imperative that great care should be taken to make tests, which are to be used for comparative purposes, under precisely similar conditions. The study and improvement of insulation demands the attention of the scientific electrician and chemist, not the practical engineer, who considers insulation to be fulfilled by wrapping tape round a conductor.

* Abstract of paper read before the Northampton Institute Engineering Society on Friday, Oct. 25, 1907.

THE ACTION OF ROLLER LIGHTNING ARRESTERS.

The two types of lightning arrester at present in common use are the Siemens horn arrester and the Wurts roller arrester. The method of operation of the horn arrester has been understood from the start, but in the case of the roller type some doubt has existed. The breaking of the arc in this type was usually explained as due to the material of the rollers, but the fact that experiment has proved that the greater the number of rollers (the greater the sub-division of the gap) the more certain is the action is not accounted for by this explanation. Steinmetz first drew attention to the effect of the capacity of the rollers towards one another and towards earth, and this point is further investigated in a paper by Herr J. Liska in *Elektrotechnik und Maschinenbau.*

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Consider a row of air-gaps as shown in Fig. 1 with the middle point, o, at zero potential and the ends connected to an alternating supply of voltage, $+V_1$ and $-V_1$ respectively. Let l indicate the distance of a roller from the zero point, being marked + if measured to the right and − if to the left. At a point $\pm l$ let the potential be $\pm V$, the maximum instantaneous values being used in all cases so as to eliminate time. Let the unit of length used be the distance between two spark-gaps so that l will also represent the number of spark-gap or rollers counted from the zero point. Assume, first, that there is only capacity between the rollers. If the resistance and the self-induction of the circuit are neglected, a wattless capacity current will flow across the gaps. If C = capacity per unit of length, the reactance per unit of length = $X = \frac{1}{2\pi \sim C}$ the current = $J = \frac{V_1}{l_1} 2\pi \sim C$, and the potential of the point l is $V = J X l = \frac{V_1}{l_1} l$—*i.e.*, the potential follows a straight line law and the voltage between rollers is the same all along, as shown by Curve I. (Fig. 1). The potential gradient = $\frac{dV}{dl} = \frac{V_1}{l_1}$, and since the frequency is eliminated it is clear that the result applies to direct as well as alternating currents. Assuming, next, that the rollers also possess capacity towards earth, the current will no longer be the same at all points, but will diminish on both sides as the zero point is reached.

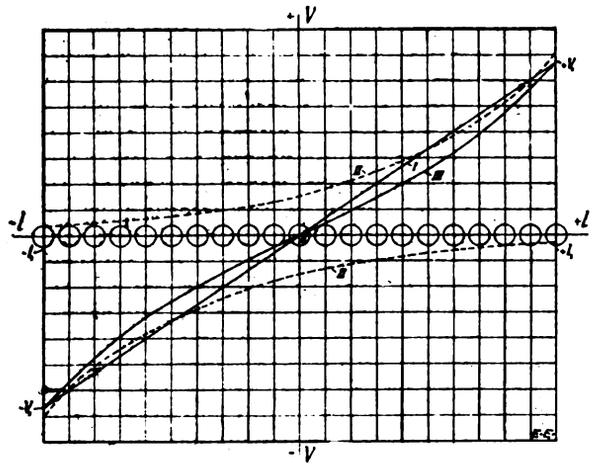

FIG. 1.

Let C_o = capacity to earth per unit of length, B = the corresponding susceptance, and neglect the conductance of the circuit. The current flow to earth along dl is then $dJ = V \cdot B \cdot dl$, and if J_o = current at point o, the current at the point l will = $J = J_o + B\int_o^l V \cdot dl$. The fall of potential along dl is $dV = J \cdot X \cdot dl$, or

$$\frac{dV}{dl} = J X = J_o X + B X \int_o^l V \cdot dl.$$

The solution of this equation is

$$\frac{dV}{dl} = \frac{V_1}{\epsilon^{a l_1} - \epsilon^{-a l_1}} \times a (\epsilon^{a l} + \epsilon^{-a l}), \text{ where } a = \frac{C_o}{C}.$$

This indicates that the potential gradient line is no longer straight, but is the difference between the height of two exponential curves (Curves III. in Fig. 1), as shown by Curve II. (Fig. 1). The maximum voltage difference between rollers gets greater the greater l_1 is, and the curve becomes more and more bent the greater $\frac{C_o}{C}$ is. In this case, too, contrary to Steinmetz's statement, the result is independent of the frequency, and applies equally to direct and alternating supply.

The effect of the presence of capacity to earth as well as between rollers will be somewhat as follows. If the potential of the lines rises relatively to the earth from any cause, the voltage between the first two rollers will increase until the sparking value is reached, and sparks will then pass these. This sparking proceeds from the same cause from gap to gap until either all the gaps have been bridged, or—with a smaller voltage or smaller frequency—a point is reached where the voltage between rollers is less than the sparking voltage for the gap. In the former case the voltage gradient line will be straight, because the capacity current to earth will be negligible compared with the short-circuit current across the gaps. This straight line gradient will, however, be insufficient to maintain the arc, and an automatic extinction of the arc results independently of the material of the rollers, although with suitable "non-arcing" metals the certainty of action will be improved.

In the second case the working current never has an opportunity of following the discharge spark. Since an increase in the number of rollers and an increase in the value of a both tend to increase the steepness of the voltage gradient at the ends, and so improve the action, it would seem worth while not only to use a large number of rollers, as is already the practice, but also to increase $a = \frac{C_o}{C}$ by adding earthed metal side frames (with an insulating coating if necessary), as shown diagrammatically in Fig. 2. The writer works out a numerical example, assuming V_1 = 15,000 volts, l_1 = 150, and obtains the following striking results for various values of a:

Value of a.	Voltage between rollers at the end.	Voltage between rollers at the centre.
0	100	100
·01	170	72·2
·02	300	30·1
·03	450	10·1
·04	600	3·0
·05	750	·74

In the design of such arresters, C would be a constant depending on the size of the rollers employed; l_1, half the number of rollers required, would be decided by the fact that with a uniform voltage gradient the normal supply

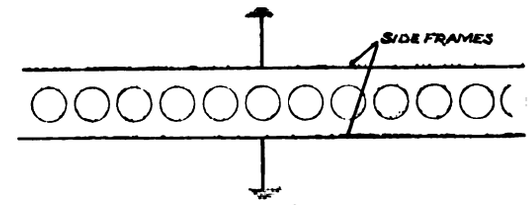

FIG. 2.

volts must not be able to maintain an arc across the gaps—*i.e.*, $\frac{V_1}{l_1} = \frac{V'}{\mu}$, where V′ is the voltage which can maintain an arc across the gap used and μ is a constant greater than 1. V′ and C and μ must be determined experimentally. The position of the earthed side frames must be arranged so that the maximum voltage between two rollers at the end is insufficient to bridge the gap between roller and side frame.

AN IMPROVED ELECTRICAL SPEED GEAR.

In a paper recently read before the Verband Deutscher Elektrotechniker, Herr Heyland described an improved combination of motors and generators by means of which a wide speed variation can be efficiently obtained with any form of alternating supply, single-phase or multiphase. The arrangement is shown in Fig. 1. The principal motor is a single, two, or three phase induction motor. If such a machine is to be run at speeds differing widely from synchronism, it is essential that the secondary member of the motor shall take up a large portion of the energy entering the primary portion. This energy will be wasted if it is absorbed in the secondary windings or in resistances inserted into the secondary by means of slip-rings. If, however, it is taken up by a second motor, as is the case with the cascade connection, it can be made use of again, although somewhat inefficiently. If now the auxiliary motor, instead of driving the same shaft as the principal motor (as with the cascade connection), is arranged on a separate shaft, it can be used as a speed regulator for the principal motor, because the slip of the latter will depend on the load put on to the auxiliary motor. If, for instance,

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a brake is put on the auxiliary motor its load will increase, so that the secondary of the principal motor is called upon for an increased supply, and it can only furnish this by an increased slip. In this way a wide speed adjustment is attainable, but the secondary load is still wasted. Instead of the brake, Heyland employs a direct-current dynamo (called the "regenerator"), and so obtains the greater part of the secondary energy in the form of direct current, which is employed to drive a direct-current "additional motor" mounted on the same shaft as the principal motor. The above is the Heyland combination, and it lends itself to considerable modification according as an induction motor, a synchronous motor, or an alternating-current commutator motor is used for the auxiliary machine. The use of a synchronous motor has the advantage of allowing the power factor of the alternating-current supply to be made simply by means of variations in the synchronous motor excitation. After the excitation has been set for one load it is unnecessary to adjust it, since the frequency and the voltage supplied to the auxiliary motor vary together. By suitably fixing the excitation so as to allow small variations for $\cos \phi = 1$, it is even possible to compensate for drop in supply voltage, as in the case of rotary converters. Since this compensation for power factor is present immediately on starting it is a distinct advance on the ordinary alternating-current commutator motors, which throw a heavy inductive load on the circuit at starting. The possibility

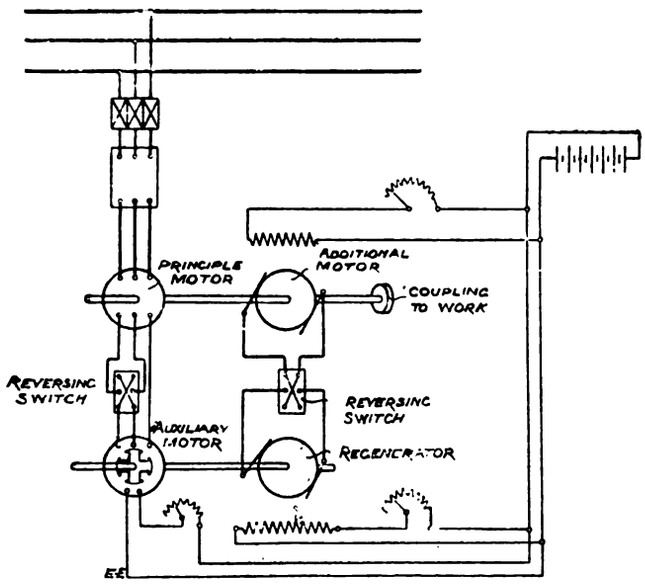

FIG. 1.

of compensating for phase displacement also enables the principal motor to be used as an asynchronous generator for braking purposes when desired. An objection to the use of a synchronous auxiliary motor lies in the fact that it has to be synchronised at starting, but some experiments carried out at Dresden by Herr Kübler showed that this gave very little trouble. In starting up, the auxiliary motor is first put in motion either from the direct-current side or by means of a starting motor, or, if specially designed, as an induction motor. Next, the main switch (of the principal motor) is closed, the auxiliary motor is synchronised with the principal motor's secondary and the switch between these two is then closed. The principal motor now exerts a small torque, since the driving power for the auxiliary motor passes through it, but this torque will usually be insufficient to start the principal motor. To start the latter, the circuit between the "regenerator" dynamo and the "additional motor" is closed—the latter being fully excited, whilst the regenerator is slightly excited, so as to produce the necessary torque in the principal motor. The main supply will at this stage just cover the losses in the machines, so that the designer can readily arrange matters so as to give a large starting torque with small power consumption. Theoretically, the attainable starting torque is unlimited. As soon as the principal motor starts the frequency of its secondary currents falls, and with it the speed of the auxiliary motor. If the load on the principal motor is kept constant, either automatically or by regulation, the torque of the additional motor will drop with the speed, thus giving a series characteristic to the driving shaft; it is, however, also possible to arrange for constant acceleration with rising load. If it is considered advantageous to work with the principal motor alone after full speed has been attained (for instance, in the case of long-distance railways), it would only be necessary to arrange the direct-current machines so that at slightly below the synchronous speed of the principal motor the E.M.F.'s of regenerator and additional motor are equal. The principal motor would then rise in speed until the auxiliary motor practically came to rest and could be short-circuited. The phase compensation is, of course, lost then. If the additional motor E.M.F. exceeds the E.M.F. of the regenerator at well below synchronous speed, this lower speed will be the approximate limit reached. In this case the auxiliary motor will not slow down sufficiently to introduce any liability to fall out of step. By arranging the torque of the additional motor to oppose that of the principal motor, it is possible to cause reversal of direction of the principal shaft by increasing the excitation of the additional motor sufficiently. The auxiliary motor then runs above synchronism, since the slip of the principal motor is over 100 per cent. This possibility might be advantageous in the case of haulage gear for fine adjustments. The arrangement lends itself to widespread modifications, and, with or without the addition of flywheels, can be used to deal with sudden momentary overloads in the same way as the Ilgner system.

PHYSICAL SOCIETY.

At the meeting of this society on Oct. 25, Prof. J. Perry, F.R.S., president, in the chair,

A paper by Dr. J. A. FLEMING, F.R.S., on "*Magnetic Oscillators as Radiators in Wireless Telegraphy*" was read by the author. An open or Hertzian oscillator is called an electric oscillator because the effects produced in space are due in part to the potential of the free charges at the ends. A closed-circuit oscillator is called a magnetic oscillator because the effects it produces are wholly due to current. Hertz showed that the energy radiated per period from an open oscillator could be expressed by the formula $E = 16 \pi^4 \phi^2 / 3 \lambda^3$, where λ is the wave length and ϕ the electric moment. The author has shown that a similar formula $E = 16 \pi^4 M^2 / 3 \lambda^3$, where M is the magnetic moment, holds good for the closed-circuit oscillator. Assuming persistent or undamped oscillations to be used, these formulæ were transformed by the author into two others—viz.: $W = 87 \times 10^{-20} l^2 a^2 N^2$ for the open oscillator, and $W = 4 \times 10^{-38} S^2 a^2 N^4$ for the closed oscillator, where a is the R.M.S. value of the current in the oscillator and N is the frequency. Hence the radiation from the open oscillator varies as the square of the frequency and that from the closed one as the fourth power. The paper describes experiments made with flat square coils of various sizes used as magnetic oscillators in the quadrangle of University College, London. In one circuit undamped oscillations were set up by means of a Poulsen arc, and the induced oscillations created in the other circuit at a distance were detected and measured by means of the author's oscillation valve or incandescent-lamp detector. The distance separating the two circuits was varied from about 50ft. to 250ft. Curves were obtained showing how the secondary current varied with the distance of the circuits apart and with their relative position. It was shown that the inductive effect was greatest when the flat coils were in a horizontal position and at a certain distance above the earth. The law of variation with distance proved to be something between the inverse cube and the inverse square of the distance. It was then shown that increase in size of the coils had a very marked action in increasing the inductive effect, and also that for equal power the use of the spark method creating intermittent oscillations in the primary gave better effects than the use of the arc or undamped oscillations. It was also shown that for the coils used the true radiation of energy was very small, and, therefore, that the distance effects obtained were almost entirely due to magnetic or Faradaic induction. Suggestions were then made for increasing the efficacy of the ordinary inductive type of wireless telegraphy by the use of high-frequency oscillations in the primary circuit, and a suitable detector such as the author's oscillation valve combined with a telephone as a receiver in the secondary circuit. Such a method would have a far greater reach than the ordinary low-frequency alternating-current inductive telegraphy and not be open to the objection of disturbing commercial telephonic circuits.

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Mr. A. RUSSELL thanked the author for his clear exposition of the theory of electric oscillators and for the valuable formulæ he gave for magnetic oscillators. The experiments described were exceedingly interesting and instructive. It was, however, difficult to interpret some of the results obtained. He asked whether the author had been able to find a position for the secondary coil in which no current was induced in it. Possibly buried pipes or metallic conductors, iron girders in adjacent buildings or iron railings in the neighbourhood, might have had some influence in modifying the inductive effects between the coils.

Mr. TAYLOR said that the Post Office had tried arrangements similar to those described for magnetic space telegraphy, and had found that the closed-circuit method was inferior to that in which earth-connected vertical coils were used. The ratio between the received currents when using an earth-connected and a closed circuit was often as great as 80 to 1, and he thought the improvements in the closed-circuit method would have to be very great to make it equivalent to the earthed-circuit method.

A paper "*On the Use of Variable Mutual Inductances*" was read by Mr. A. CAMPBELL. In connection with wireless telegraphy the measurement of small inductances and capacities is of importance. One of the methods described has special reference to small self-inductances. Mutual inductances can be more easily dealt with than self-inductances, for the former can be (1) more accurately calculated from dimensions, (2) are less affected by change of frequency, and (3) when variable can be made to pass through zero value. A convenient form of variable mutual inductance consists of a continuously variable part and a series of steps. The first consists of two equal parallel coils with a third coil moving parallel to their planes round an axis eccentric to the fixed coils. The scale thus obtained is very open near zero (which is an advantage) and the graduation is done by experiment, a theoretical discussion being given in an appendix. The steps are obtained by means of another fixed coil of stranded wire, each strand giving an equal sub-division. The model shown had two ranges, from 0·01 up to 200 and 2,000 microhenries. A variable mutual inductance of this type has a number of applications. It is obviously convenient for calibrating ballistic galvanometers. By means of it mutual inductances of all values can be readily measured. By several methods it can be used to measure capacities, and the formulæ required are mostly very simple. Its most important application, however, appears to be the measurement of small self-inductances as follows. Let the variable mutual inductance be called W. With a source of intermittent or alternating current and any convenient detector (vibration galvanometer, telephone, etc.) a bridge with corners, A, B, C, D, is formed, in which B D and D C are equal non-inductive arms, A B is the fixed secondary of W, and A C has resistance and self-inductance equal to those in A B. The detector is across B D, while the source is applied at D and also through the primary of W connected to A. When W is set to zero reading a balance is obtained. An unknown small self-inductance, N, is now inserted in A C, and the balance restored by adding resistance in A B and adjusting the mutual inductance, W. The reading of W when doubled gives directly the value of the unknown N. The method is really a differential one, and can also be used to give very accurate measurements of the difference between two nearly equal large self-inductances.

The discussion of Mr. Campbell's paper was postponed until the next meeting.

PERSONAL.

Mr. T. Jenkins, of Portsmouth, has been appointed shift engineer at the Bridlington electricity works.

Sir William Matthews, K.C.M.G., has been unanimously elected an honorary member of the Society of Engineers, of 17, Victoria-street, S.W.

Mr. H. M. Hobart has taken into partnership Mr. A. G. Ellis, who has been associated with him for several years, and his consulting engineering practice will be carried on under the name of Hobart and Ellis.

Mr. Benjamin D. Williams, Guaun Adda House, Dinas, Rhondda Valley, has been appointed by the Bibiani Goldfields chief engineer in their mines at Dunkwa, West Africa. He has held his present position as chief electrician to the Ocean Steam Coal Co. for the past 24 years.

Mr. E. S. Woollard Moore, A.M.I.C.E., associated with the Electric Construction Co. for many years as chief engineer and as joint manager, has taken offices at Central House, New-street, Birmingham, where he is carrying on business as a consulting engineer.

Mr. T. A. Nunwick, who has for many years represented Messrs. Dorman and Smith, of Ordsal Electrical Works, Manchester, has now, in addition to this work, taken up an agency for Messrs. C. J. Thursfield and Co., electric fittings manufacturers, of Cecil Works, Birmingham, and has opened showrooms at Onward-buildings, 207, Deansgate, Manchester, for the convenience of Messrs. Thursfield's customers in the North.

Mr. William Paterson, foreman electrician at the Railway Locomotive Works, Inverurie, has been appointed foreman electrician on the Bengal and Nagpur Railway, India, and leaves early this month for Khargpur, where he is to be located. He has been the recipient of several tangible tokens of esteem and regard, including a beautifully-framed photographic group of the men in that department, and also a writing-case, both of which were subscribed for by the staff of the electrical department under the recipient's charge.

LEGAL INTELLIGENCE.

SMOKE NUISANCE PROSECUTION.

After many long hearings since July last, Mr. Curtis Bennett gave judgment at the Westminster Court on Monday in the case of the Chelsea Borough Council *v.* the Underground Electric Railways of London. The latter were summoned for permitting black smoke to issue from the chimneys of their large generating station at Lots-road, Chelsea.

Mr. CURTIS BENNETT said in his opinion the prosecution ought not to have been instituted on such slender and unsatisfactory evidence as the Borough Council produced. London owed a great debt of gratitude to a company which had caused underground traffic to be worked by electrical power. Such a prosecution ought not to have been begun without the Council being able to produce scientific witnesses to contradict the great mass of scientific evidence called by the defendant company. He felt that it was a case in which substantial costs should be allowed. He dismissed the summons with 300 guineas costs against the Council.

LIABILITY OF MACHINERY TO DISTRAINT.

Mr. Justice Phillimore and Mr. Justice Walton, sitting as a Divisional Court, gave judgment last week in a case of some importance. Messrs. Crossley Bros., the well-known engineers, let a gas-engine on the hire system to a manufacturer, and the hirer having got into financial difficulties, the engine was seized for rent. His Honour Judge Smyly, who first heard the case at the County Court, held that as the engine was fixed to the floor it was subject to distress by reason of a High Court decision given in 1850.

After a hearing lasting nearly two days the Divisional Court decided that the gas-engine was absolutely exempt from distress by reason of it being a fixture.

Their lordships granted leave to appeal.

GRIFFITHS v. MANCHESTER CORPORATION.

This case was heard at the Manchester Assizes on the 31st ult. before Mr. Justice Pickford and a special jury. The plaintiff, Edward Charles Griffiths, claimed damages for having been run down and injured by an electric car while cycling to town on Saturday, July 13. The defence was a denial of negligence, and the Corporation pleaded that the plaintiff alone was responsible for his injuries.

PLAINTIFF said he was riding along Plymouth-grove between 8 and 9 o'clock on the morning named. He had passed the end of High-street and was approaching the loop, riding cautiously. There was a large covered bogie car standing on the line, and he was within a yard of this, on the tram track, when the driver, without sounding his gong or giving the slightest warning, put on power and ran into him. He was struck on the head by the brass rail of the car, knocked off his machine, and badly injured.

Medical evidence having been given as to the extent of the plaintiff's injuries, the jury found for the plaintiff, damages £110, and his Lordship gave judgment for that amount.

COMPANIES' MEETINGS AND REPORTS.

HOVE ELECTRIC LIGHTING.

An extraordinary general meeting of the Hove Electric Lighting Co. was held on the 31st ult., Colonel A. J. Filgate, R.E. (the chairman), presiding.

The CHAIRMAN stated that for a considerable time the capital expenditure of the Company had been largely in excess of its issued capital, and at the end of last year amounted to £159,620, while its issued capital was £75,000 in shares and £44,600 in debentures and debenture stock. They had utilised the premiums received on their issues on capital account, and had employed the reserve account to meet capital expenditure. This had been of considerable advantage to them in establishing their position, but the term of their concession from the Hove Corporation was running on, and they considered it necessary that this procedure should cease, and that they should make ample provision for contingencies which might arise at the end of the concession. It appeared to the directors that the best way of doing this would be to issue further capital to replace the money they had expended out of their reserve account, and to invest the reserve in good securities outside the business. After much consideration, they had come to the conclusion that the best way of doing this was to issue preference shares. The Company's present authorised share capital was £100,000, and out of that they had issued £75,000, and had still £25,000 available for issue. Under the resolution increasing the capital to £100,000 it was provided that the whole of the shares should rank in all respects *pari passu* with the existing shares, and consequently, as matters now stood, they could not issue preference shares. They did not desire to increase the total capital of the Company, and they, therefore, decided to ask the authority of that meeting to issue the remaining £25,000 as 5 per cent. preference shares, which they proposed to offer for subscription to their share and

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debenture holders. With the assets of the reserve fund invested and added to each year they hoped to place the Company in a position to deal with the situation which might arise when their concession came to an end in 1934. He then proposed a formal resolution to give effect to the scheme outlined in his speech.

Mr. C. F. TUFNELL seconded the motion, which was carried.

ELECTROLYTIC ALKALI.

The annual meeting of the Electrolytic Alkali Co. was held in Liverpool last week, Colonel W. L. Pilkington presiding.

The CHAIRMAN, in moving the adoption of the report (*Electrical Engineer*, Nov. 1), said as a result of experience the directors were of opinion that the Company had suffered materially in consequence of too much information being made public, and that it was not to the interests of the Company to present the accounts in such detail as hitherto. The directors had no object in withholding details except that of protecting the Company's interests. The Board was naturally disappointed that it was not in a position to present an account showing a net trading result at least equal to that of last year. It was hoped it was only a postponement of the time when the Company would be able to make a return to all the shareholders on their investments. The directors' great regret was that they were not sharing in the present trade boom, more especially as some portions of the chemical trade were benefiting. Two and a half years' dividend had now accrued on the preference capital, but in view of the unsettled state in that portion of the chemical trade in which they were engaged, the Board thought the wisest course was to pay only one half-year's dividend upon such shares.

The report was adopted.

NORWICH ELECTRIC TRAMWAYS.

The eleventh annual meeting of the Norwich Electric Tramways Co. was held on the 30th ult., Mr. Francis Fitzgerald presiding.

The annual report for the year ended June 30, 1907, presented at the meeting stated that the balance of profit as shown by the revenue account for the year was £7,843. 8s.; to this sum had to be added £203. 13s., interest and transfer fees received, bringing the gross profit for the year up to £8,047. 1s. Taking into account the sum of £372. 12s. 5d., being the balance brought forward from the previous year after paying the dividend and providing for the reserve, the amount credited to profit and loss account amounted to £8,419. 13s. 5d. Deducting from this amount the sum of £2,640, 4 per cent. interest on the Company's mortgage bonds for the year, left a sum of £5,779. 13s. 5d. to be dealt with. The directors recommended that out of this sum £1,000 be placed to reserve fund account, that a dividend of 1¾ per cent., amounting to £4,620, be paid on the shares of the Company for the year ended June 30, 1907, and that the balance of £159. 13s. 5d. be carried forward. Comparing the accounts with those for the year ended June 30, 1906, the revenue had increased by £73. 17s. 1d., and the expenses after making allowance for difference in stores in hand showed an increase of £2,041. 1s. 9d., which included £800 for unusual legal expenses, therefore showing a decrease of £1,967. 4s. 8d. in the profits of the year. As in former years, considerable sums had been spent out of revenue in order to maintain the permanent way, rolling-stock, and power station in an efficient condition. The number of passengers carried was 7,220,714, a decrease of 80,439 on the previous year, and the number of car miles run was 1,081,221, as against 1,085 055.

The CHAIRMAN noted with regret that there had been a decrease in the profits of the year of a sum amounting to over £1,900, and also there had been a decrease in the number of passengers carried of over 80,000 on the previous year. This decrease had followed upon a decrease shown in 1906, and also in the two or three preceding years. The directors had taken in hand this matter, and with a view of trying to stop this rather unhappy trend of affairs, had carefully gone into the question, and had decided to make certain alterations with regard to the service. These they hoped would result in a minimum of inconvenience to the inhabitants of Norwich, and at the same time save this very considerable financial loss. The new plans had now been put into execution, and the directors were carefully watching developments. He only hoped that when they met again a year hence he should be able to show a more satisfactory working than had been shown during the last year.

Mr. E. A. HOPKINS seconded the adoption of the report, which was agreed to.

RICHARDSONS-WESTGARTH.

At the annual meeting of Messrs. Richardsons, Westgarth, and Co., the CHAIRMAN (Sir Christopher Furness, M.P.) said that progress was being made at the turbine works at Hartlepool. They were just completing an entire generating plant at Spennymoor for the Durham Electric Power Supply Co., consisting of four turbines with Contraflo condensers, cooling towers, Nesdrum boilers. The station adjoins the Weardale Co.'s works, and will utilise the gas produced from that company's coke ovens, which are now being erected. These ovens are capable of producing some 3,000 to 4,000 tons of coke per week, and the entire plant represents the latest developments in coke production. Amongst the turbines in progress are those for the Corporations of Dublin and Glasgow, and one of 12,000 h.p. for the Dunston power station of the County of Durham Electric Power Supply Co., this turbine being the most powerful yet made for any electric power station in the kingdom. With regard to the future, it was impossible to forecast what would happen, but he (the chairman) was confident that they would not only get their full share of orders, but that their profits would be at least as favourable as the average prevailing in their range of manufactures.

Mr. S. W. FURNESS moved that a dividend on the ordinary shares for the year ended Aug. 25, 1907, at 4 per cent. be declared, and that warrants for same be posted forthwith.

Mr. ALFRED HARRISON seconded the motion, which was carried.

FRASER AND CHALMERS.

The report of Fraser and Chalmers for the year ended June 30 last, to be submitted at the meeting on the 14th inst., states that there has been a marked falling off in business from South Africa during the year, but an increase of orders from other parts of the world has largely made up for this, so that the profit, before allowances for depreciation, is only £4 068 less than that of the preceding year. The absence of extensive new construction work in South Africa and the severe competition for the reduced number of orders placed by the mines has made the year a bad one in that field for all machinery makers. Outside of South Africa trade in large engine work for hoisting, air compressing, and pumping has been very good, and the Erith shops have been well filled and are still fully occupied. The addition made to the machine shop for the purpose of starting the manufacture of steam-turbines has been found inadequate for the purpose, and as this class of work requires special tools and special facilities for trial running it was decided to build a large new shop. Work on this was begun in the spring, and the building is now nearly completed, so that the tools from the temporary shop and the necessary new ones will shortly be placed in the new building. Most of the expenditure on this will appear in next year's accounts, as the work was not far advanced at June 30 last. The financial position of the Company enables the directors to meet this outlay without issuing fresh capital, and it is not probable that there will be occasion for any serious additional capital expenditure for several years to come, as the works will have reached a suitable size and capacity in relation to the capital and nature of business of the Company. The trade of the Company is not confined to Erith manufactures, but many agencies are held and worked to advantage in connection with special machinery and supplies of other makers. There has been no change in the holding of Allis-Chalmers shares during the year, and no dividend has been received from these. The directors recommend a final dividend of 6 per cent. on the ordinary shares making 10 per cent. for the year, leaving a balance on the year's profits of £638 to be carried forward, and making a total balance to the credit of profit and loss account of £88,740.

WESTERN UNION TELEGRAPH.

The report of the president of the Western Union Telegraph Co. for the year ended June 30 last states that the business of the year, compared with that of last year, is as follows: revenues, 32,856,406dol., showing an increase of 2,180,751dol.; expenses, 26,532,196dol., an increase of 2,927,124dol.; net revenue, 6,324,210dol., a decrease of 746,372dol.; interest on bonds, 1,420,061dol., an increase of 92,086dol.; profit, 4,901,140dol., a decrease of 838,458dol.; appropriated for dividends, 4,869,095dol., an increase of 7dol.; surplus, 36,052dol., a decrease of 838,465dol. The amount brought forward from last year was 16,848,728dol., which, with the surplus of 36,052dol. mentioned above, makes 16,881,781dol. The net growth of the plant was: in poles and cable, 2,687 miles; in wire, 65,052 miles; in offices, 437. The number of messages increased 3,317,469. The increase in operating and general expenses was due to the necessary outlay to care for the larger number of messages handled, to the increase of 10 per cent. in the salaries of all the operators, which went into effect March 1, 1907, and to the continued high prices for all materials used in the maintenance of the lines. The improvements in the property of the Company referred to in the last report were continued during the year, making large expenditures necessary and increasing the outlay for reconstruction of poles and wires 758,354dol. Much of this work has been completed since the close of the fiscal year, and a material reduction of demands for reconstruction has followed the improved condition of the lines due to the liberal outlay of the past three years. The automatic printing telegraph owned by the Company has been extended, and is now applied to the business exchanged between New York City on the one hand and Buffalo, Boston, Pittsburg, Chicago, Philadelphia, Atalanta, and St. Louis on the other, also to that between Chicago and St. Louis, between Philadelphia and Pittsburg, and between Buffalo and Chicago. The cost of construction was 2,872,950dol., which was 420,030dol. less than last year.

DRAKE AND GORHAM.

The report of Drake and Gorham for the year ended June 30 last, to be submitted at the meeting on the 11th inst., states that, after payment of all charges, including bonuses, due to staff, there remains a net profit of £343, which, with £1,055 brought forward, makes £1,398, which it is proposed to carry forward. The directors regret that the result of the year's working will not justify the payment of a dividend, which must be attributed to general stagnation in electrical business, high cost of materials, and low prices obtainable, especially in the South of England. Owing to the condition of the financial markets there has been a general desire on the part of those on whom the Company relies for country house lighting to defer outlay on luxuries, and a reduction in turnover and profits in this department has resulted. The expense involved in the transfer of stock to the new stores has been written off, obsolete apparatus has been depreciated, and provision has been made for a difference in the stock, which has no doubt been occasioned by the change of premises, both for fittings and works. The building and electrical equipment of the lace mill mentioned in the last report has been completed, and the results obtained have fully answered expectations. Other mills are in hand, also a woollen factory, and the electric driving of a portion of a

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weaving mill is nearly completed. The Company has extended its business as purchasing agents and experts for motorcars, and a number of letters have been received showing appreciation of the services rendered.

CAPE ELECTRIC TRAMWAYS.

The report of the Cape Electric Tramways for the year to June 30 last, to be presented at the meeting on 20th inst., states that the profit and loss account shows, after providing for debenture interest and redemption of debentures, a net balance to credit of £14,714, which, added to the £1,751 brought forward, gives a total of £16,466. From this sum the reserve fund has been credited with the amount of £4,000 and the balance (£12,466) has been carried forward. The business of the Company has fallen off in nearly all sections owing to the continued depression, which has had the effect of decreasing the commerce and population of Cape Town; the necessity for reducing the fares on certain sections of the system has also contributed to the diminution of the revenue. The arbitration between the Cape Government and this Company, referred to in last year's report, in regard to the amount to be paid by that Government to this Company as compensation for the expropriation of the Sea Point Railway, took place during the year, and the amount of the award (£41,200) has been duly paid to this Company by the Government. The competition of the Sea Point Railway with the tramways, alluded to by the chairman in his speech at the last annual meeting, has continued during the year, and has become more acute as the railway rates have been still further lowered, and in self-defence the Company has had to do likewise. The most marked decrease in receipts is on the Sea Point section of the Cape tramway system, and is, of course, directly owing to the unfair competition instituted under the ægis of the Cape Government. Every effort has been made by the directors to bring about a settlement, and the Cape Ministry were appealed to, to induce the Sea Point Municipality to agree to a reasonable compromise. Unfortunately, the concessions which the Company was willing to make (which were acknowledged as reasonable by the Prime Minister and Commissioner of Crown Lands and Public Works of the Cape Colony) were rejected by the Sea Point Municipality. In face, however, of the adverse conditions prevalent during the year, the general manager at Cape Town continued to make further retrenchments in every department compatible with retaining efficiency, and as a result the working expenses for the year ended June 30 last show a reduction on the previous year of over £16,000 for the Cape Town system. In Port Elizabeth, also, the general manager there has decreased the working expenditure of that system by £1,600 for the past year as compared with the previous year. The directors have every reason to be satisfied with the excellence of the local administration, and especially with the general managers at Cape Town and Port Elizabeth, who have done their utmost to protect the interests of the Company under great difficulties.

EASTERN TELEGRAPH.

The report of the Eastern Telegraph Co. for the half-year ended June 30 states that the revenue amounted to £593,432, from which are deducted £202,702 for the ordinary expenses, and £40,853 for expenditure relating to maintenance of cables, depreciation of spare cable, sundry differences in exchange, and income tax payable abroad, leaving £349,876, to which is added £1,252 brought from the preceding account, making a total available balance of £351,128. After providing for income tax payable in England, interest on mortgage debenture stock, and for two quarterly dividends on the preference stock, there remains £268,651, out of which the directors have placed £7,000 to the reserve fund for maintenance ships, £120,000 to the general reserve fund, and have allocated £100,000 to meet the two interim dividends of 1½ per cent. each on the ordinary stock, the balance of £41,651 being carried forward. The general reserve fund has been debited with £130,000 as a provision on account of investment fluctuations, and this sum has been deducted from the cost of investments. The directors have appointed Mr. John Cuthbert Denison-Pender to a seat at the Board.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH.

The report of the Eastern Extension, Australasia, and China Telegraph Co. for the half-year ended June 30, 1907, states that the gross receipts amounted to £304,367, against £303,791 for the corresponding half-year of 1906. The working expenses, including £25,704 for maintenance of cables, absorb £155 930, against £141,246 for the corresponding period of 1906, leaving £148,437. From this is deducted £713 for income tax payable in England, £73 for donation to Chinese hospital and £15,048 for interest on debenture stock, leaving £132,603 as the net profit for the half-year. After adding £17,344 brought forward there is an available balance of £149,947. Two quarterly interim dividends of 1½ per cent. each have been paid for the half-year, leaving £74,947 to be carried forward. The general reserve fund has been debited with £120,000 as a provision on account of investment fluctuations, and this sum has been deducted from the cost of investments.

NEW COMPANIES REGISTERED.

Anajas Rubber Syndicate, Limited. — Registered Oct. 24. Capital, £3,750 in 1s. shares. Objects: to carry on the business of planters, growers, curers, importers and exporters of, and dealers in rubber, cacao, mandioca, coffee, tobacco, and other products, etc. No initial public issue.

Bradford Electrical Engineering Co.—This company has been registered with a nominal capital of £3,000 for the purpose of acquiring the business of electrical engineers carried on by C. J. Cassé and Son at 3, Royal-arcade, Bradford, and to carry on the business of electricians, mechanical engineers, and manufacturers, etc.

Posoltega Rubber Estates, Limited.—Registered Sept. 30. Capital, £30,000 in £1 shares. Objects: to acquire the rubber estate known as the Chiquimulapa Rubber Plantation, situate on the west coast of the Republic of Nicaragua, Central America, to adopt an agreement with the Lothbury Syndicate, and to plant, prepare for market, and deal in indiarubber, guttapercha, and other gums and natural products. Registered office: Blomfield House, 85, London-wall, E.C.

London Asiatic Rubber and Produce Co., Limited. — Registered Oct. 26 by Munns and Longden, 8, Old Jewry, E.C. Capital, £140,000 in £1 shares. Objects: to acquire the business of the Asiatic Rubber and Produce Co., the registered office of which is in Colombo, with a view thereto to enter into an agreement with the said company, to acquire any lands or interest therein, or any other property or rights in the Federated Malay States, the Straits Settlements, or elsewhere, and to carry on the business of planters and manufacturers of and dealers in rubber, tea, coffee, and other natural products, etc. Registered office: 11, Idol-lane, E.C.

Liens Registered.

Electrolytic Alkali Co., Limited.—Issue on Oct. 16 of £400 4½ per cent. first mortgage debentures, part of series created July 9, 1904, to secure £50,000. Charged on the company's undertaking and property, including uncalled capital. Trustees: Liverpool Mortgage Insurance Co. Total amount previously issued of same series, £32,700.

Britannia Engineering Co., Limited (Colchester).—Issue on Sept. 26 of £1,000 6 per cent. second mortgage debentures, part of series created July 20, 1907, to secure £15,000. Charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £13,000.

OPENINGS FOR CONTRACTORS.

ABERDEEN—Six houses, north side of Osborne-place, Messrs. Sutherland and George, architects; polishing mill and stone-dressing sheds, Pittodrie-place, Mr. D. Hodge, architect; fish-curing premises, South Esplanade, Messrs. Brown and Watt, architects; house and shops, Desswood-place, Mr. W. E. Gould, architect; additions to St. Margaret's Episcopal Church, Gallowgate, Mr. G. Irving, architect; additions to school, Great Queen's Cross, Mr. J. Graigin, architect.

AINSDALE—Eight houses in Mill-lane, Mr. J. Gibson, architect.

ANDOVER—Post office, Commissioners of Works.

ASHTON—Improvement of Orrell School, renovation of Hallgate School, and new school, Education Committee.

ASHTON-IN-MAKERFIELD — Public baths. Mr. J. C. Prestwich, architect.

BAKEWELL—Isolation hospital, Derbyshire County Council (£3,657).

BARNARD—Alterations to Council school, Herts County Council.

BILSTON—Schools for Holy Trinity parish. Mr. J. P. Baker, architect.

BIRKDALE—Office, Liverpool-road, Messrs. J. Ward and Sons; house in Stanley-avenue, Mr. J. I. Chambers; house in Sandringham-road, Messrs. Rimmer and Lewis; house in Carlisle-road, Mr. W. C. Lewis.

BIRR—Alterations to Hibernian Bank, Limited, premises. Mr. W. Byrne, architect.

BLACKWELL—Alterations at Durham Council School. Mr. A. J. Dawson, architect.

BOLTON—Anglican church (£1,900).

BOURNEMOUTH—Six houses, Edghill-road, Mr. S. Harris; six terrace houses, Stourvale-road, Mr. Butler; two houses and shops, corner Southbourne-grove and Cheshunt-avenue, Mr. A. Ives; spire for St. Alban's Church, Rev. S. C. Lowry; house, Charminster-road, Mr. C. T. Newlyn; two houses, Stourcliff-avenue, Mrs. S. Gower; two houses, Lowther-road, Mr. W. A. Clapcott; three houses, Malvern-road, Messrs. Jeans and Miles; two houses, Oswald-road, Mr. A. Vine; 15 houses, Chatsworth-road, Mr. G. Dolman; house, Charminster-road, Mr J. Welstead; house, Acland-road, Mr. C. Stephens; two houses and shop, Alma-road, Mr. C. H. Belbin; house, Pine Cliff-avenue, Mr. A. E. Hoare; five houses, Bryanstone-road, Messrs. Jones and Seward; house, Lowther-road, Mr. S. M. Davis; two houses, Edgehill-road, Mr. F. Burton; house, Edgehill-road, Mr. E. Simmonds; house, Irving-road, Mr. W. C. Hayter; two houses, Arnewood-road, Mr. F. Elcock; house, Guildhill-road, Mr. W. Bullen; house, Calthorpe-road, Mr. W. J. Kidman; house, Frederica-road, Mr. E J. Smith; two houses, Pine Cliff-avenue, Messrs. Davis and Lambert; house, Dalmeny-avenue, Southbourne, Mr. C. R. Welch; rebuilding Railway Hotel, Holdenhurst-road, Mr. H C. Cartwright; house, Burtley-road, Southbourne, Mr. J. Edwards; house, Hengistbury-road, Southbourne, Messrs. Betteridge and Co.; house, Southern-road, Mr. G. A. Drake; house, Grantham-road, Mr. G. A. Drake; house, Lowther-road, Mr. G. E. Lambert.

BOW—Renovation of relief offices, Board of Guardians.

BRENCHLEY—Council school, Education Committee.

BRISLEY—Enlargement of Church of England Schools.

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BRISTOL—Extension of asylum buildings, City Council.
BRITON FERRY—Dwellings (£12,347), Town Council.
BROMLEY—Elementary school, Kent Education Committee.
BUCKIE—Dwelling-house, Mr. J. Hutchinson.
CAMBERLEY—Extension to Council schools, Surrey Education Committee.
CAMBERWELL, S.E. — Block of flats, Camberwell Green, Mr. H. Woodroffe.
CARDIFF—Alterations and additions to the House of Nazareth. Mr. E. Corbett, architect.
CARLETON—Alteration to Council schools, West Riding Education Authority.
CARLIN HOW—Elementary school (£2,463), North Riding County Council.
CASTLERAHAN — Workmen's dwellings, Rural District Council (£85,980).
CASTLEREAGH — Workmen's dwellings (£3,946), Rural District Council.
CHALFORD HILL—Council school, Gloucester Education Committee (£1,500).
CHANDLERSFORD—Elementary school, Hants Education Committee.
CHELMSFORD—Offices, Essex Education Committee (£1,000).
CHERITON—New railway station, South-Eastern and Chatham Railway.
CLAPHAM, S.W.—Elementary school, London County Council.
CLAPTON, N.E.—Renovation of Clapton-park Congregational Church (£4,000).
COLWYN BAY—Extensions to electric lighting undertaking (£3,000), Town Council.
COMRIE—Elementary school, School Board.
CORK—120 workmen's dwellings, Rural District Council.
CORWEN—Minister's house. Mr. G. D. Lewis, architect.
COVENTRY—Court-room (£4,000), Warwickshire County Council.
CRAIGCEFNPARC—Council school, Glamorgan County Council.
CROYDON—Swimming bath, Council; alterations to Waingate School (£525), Guardians.
CWMGWILI—Elementary school, Carnarvonshire County Committee. Mr. W. Morgan, architect.
DARLINGTON—Extensions to technical college (£1,300), Town Council.
DARTMOUTH—Dwelling house. Mr. W. Marr, architect.
DARWEN—Extension of school, accommodation 600, County Education Committee.
DEPTFORD, S.E.—Elementary school, London County Council.
DORCHESTER—Alterations to Council school. Mr. J. Feacey, architect.
DROGHEDA—Extension to National School House. Mr. F. H. Tallan, architect.
DULWICH, S.E.—House in High-road. Messrs. Muir and McIlwraith, architects.
EASTBOURNE—Addition to parish-room, Wellesley-road, Mr. F.G. Cooke, architect; two houses, Brightland-road, Mr. C. Crisford, architect; two houses, Watts-lane, Messrs. Mitchell and Ford, architects; two houses, Victoria-drive, Mr. A. E. Lacey, architect; nine houses, Sidley-road, Mr. R. W. H. Hamblyn.
EAST STONEHOUSE—Electric installation, municipal buildings. Mr. C. H. Trounce, surveyor.
EBBW VALE—Presbyterian schoolroom. Mr. H. Batten, architect.
ECCLES—Storage tanks and two temporary buildings to be used as filling sheds at their works, Silk-street, British Petroleum Co.; extension of Berkeley-street and erection of 12 houses, Mr. T. Fletcher; additions and alterations to schools, trustees of the Trinity Wesleyan Schools; storeshed at the rear of 20, Church street, Mr. Damp.
ENNISCORTHY—Reconstruction of market house building. Mr. P. J. Shaw, architect.
EPSOM—Rebuilding St. Martin's Church. Messrs. Nicholson and Corlette.
EVESHAM—Enlargement of public library and institute buildings (£8,000), Town Council.
FAILSWORTH—Council school, Ashton Education Committee.
FAWBERT—Alterations to Council school, Herts County Council.
FINSBURY, W.C.—Elementary school, London County Council; buildings in City-road, Mr. G. Weymouth.
FULHAM, S.W.—Extensions to Corporation electric light undertaking (£7,307).
GIRLINGTON—Parish room in connection with St. Phillip's Church. Messrs. J. Young and Co., architects.
GLASSHOUGHTON—Alteration to Council schools, West Riding Education Authority.
GODALMING—Municipal buildings (£4,000). Mr. J. H. Norris, borough surveyor.
GREENOCK—Chalet for consumptive patients (£808), Parish Council.
GREENWICH, S.E.—Buildings in Blackwell-lane, Mr. D. Iles.
GLYNCORRWG—Additions and alterations to Council school, Glamorgan County Council.
GUILDFORD—Workshops, labourers' sheds, married quarters, and casual wards (£665), Guardians.
HACKNEY, N.E.—Elementary school, London County Council.
HENDON, N.W.—School to accommodate 1,000 scholars, Education Committee.
HOMERTON N.E.—Infirmary, City of London Guardians.
HORTON REGIS—Store, Mr. Barber.
HUDDERSFIELD — Dwelling-house, Allison-drive. Mr. A. Shaw, architect.
HULL—Electric lighting (£46,527), Corporation.
HUNSTANTON—Enlargement of New Hunstanton School, Norfolk Education Committee.
HURSLEY—Elementary school, Rural District Council.
HYTHE—House, Earlsfield-road, Mr. S. Wise; house, Hill Crest-road, Mr. P. Hoskin.
ILFORD—Cecil Hall in connection with Anglican Church.
INCE—Spinning mill (£100,000), Empress Spinning Co.
IPSWICH—Secondary school (£4,350), Education Committee.
ISLE OF MAN—Hospital and nursing home (£10,000).
JUMP—Alterations and additions to Council school, West Riding Education Committee.
KENNINGTON, S.E.—Installation of electric light, Lawn-lane School, London County Council.
KENSINGTON, W.—Elementary school, London County Council.
KIDSGROVE—Stables and buildings (£300), Urban District Council.
KINTBURY—Wesleyan Sunday school.
KNARESBOROUGH—Laundry buildings at workhouse (£1,100).
LANGLEY MILL—Council school, Derbyshire Education Committee.
LANGSETT—Alteration to Council schools, West Riding Education Authority.
LARNE—Residence, Main-street. Mr. J. P. Irving, architect.
LEAGRAVE—House in Cumberland-road, Mr. Smith.
LEEDS—Congregational church, Shaftsbury-avenue (£6,500), Mr. F. W. Beevers, architect.
LEE-ON-SOLENT — Elementary school (£2,246), Hants Education Committee.
LEIGH—Theatre and hippodrome, Leigh-road.
LEIGHTON—Public offices (£744), Urban District Council.
LIVERPOOL — Extensions to Corporation electricity undertaking (£200,000).
LLANAFAN—Restoration of school building (£1,000), Cardigan Education Committee.
LONDON, E.—Enlargement of Berners-street Council School, London County Council.
LONGTON—Additions to Sunday school and institute at SS. Mary and Chad, Handford Hill, Rev. T. L. Murray; boiler-house at the baths, Markets and Baths Committee; casting shed at Clifton Works, Stafford-street, Mr. Jos. Aynsley; warehouse at Falcon Pottery, Waterloo-street, Mr. T. Lawrence.
LOUGHBOROUGH — Additions to Markfield Church school. Messrs. Barrow, Cliffe, and Alcock, architects.
LYDNEY—Cottage hospital, Town Council.
MACCLESFIELD—Laboratory for Council. Mr. J. Wright, architect.
MAGDALEN—Renovation of parish church (£2,620).
MAIDSTONE - Council school, Education Committee.
MANCHESTER—New sorting office, Commissioners of Works.
MARGATE—Concert Hall, Corporation.
MAUD—United Free church.
MERTHYR TYDFIL—Dwelling-houses, Newfoundland-terrace. Messrs. F. James and Sons, architects.
MEXBOROUGH—Extension to market, Urban District Council. Mr G. F. Carter, surveyor.
NEW BROMPTON—Anglican church, St. Luke's parish.
NEWLAND—Cemetery chapel, Hull Corporation.
NEW SHERWOOD—Elementary school (£6,600), Notts Education Committee.
NEWTON—Council school, Derbyshire Education Committee.
NORMANTON—United Methodist chapel. Mr. J. Tomlinson, architect.
NORTHALLERTON—Police station, North Riding County Council.
NORTH SHIELDS—Elementary school (£21,155), Education Committee.
NORTHWOOD—Extensions to the Wesleyan church (£1,000).
NORWOOD, S.E.—Elementary school, London County Council.
NOTTINGHAM—Renovation of St. Mary's Church (£6,500).
PADDINGTON, W.—Elementary school, London County Council.
PADDINGTON, W.—Dwelling-houses, Harrow-road, Messrs. Joseph and Smithem.
PARTICK—Telephonic exchange (£20,000), National Telephone Co.
PATRICROFT—Engine-house at Leigh-street and storeshed and card-room in George-street, Messrs. H. Leigh and Sons.
PENTYRCH—Caretaker's house, Glamorgan County Council.
PLUMSTEAD—Enlargement of St. Nicholas Church; erection of church, St. Michael's parish.
PONDARDULAIS — Additions and alterations to Council school, Glamorgan County Council.
PONTARDAWE—Public institute (£3,500.)
POPPLETON—Parish hall and Sunday school.
PORTSMOUTH—Additions to tramway office. Mr. A. Hellard, town clerk.
RAMSGATE—Hospital, Corporation (£11,641).
REDRUTH—Police station. Mr. J. Caudwell, architect.
RETFORD—Extension of Corporation electric light (£1,700).
RICHMOND—Secondary chool (£5,500).

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ST. ATHAN—Additions and alterations to Council school, Glamorgan County Council.
ST. MARYLEBONE, W.—Elementary school, London County Council.
ST. PANCRAS, N.W.—Elementary school, London County Council.
SALISBURY PLAIN—Wesleyan soldiers' home (£6,000).
SAWBRIDGEWORTH—Alterations to Council school, Herts County Council.
SEDGEFIELD—Installation of electric light at workhouse, Guardians.
SHEFFIELD—Alterations at union office (£4,700), Guardians.
SHEFFIELD—Soldiers' home at Hillsborough. Mr. G. Wilson, architect.
SHIPTON—Elementary school, Hants Education Committee.
SILCOATES—Congregational school (£10,000).
SLIGO—Workmen's dwellings, Rural District Council (£88,873).
STALLING BUSK—Anglican church (£650).
STALYBRIDGE—Council school (£1,500).
STANTON HILL—United Methodist Free Church.
STILLINGTON—Elementary school (£14,700), North Riding County Council.
STOKE-ON-TRENT.—Receiving home, cottage, and laundry (£1,200), Guardians.
STOKESLEY—Elementary school (£3,296), North Riding County Council.
STOPSLEY—Additions to Clark's engineering works.
STYAL—Additions to schools, Chorlton Guardians. Mr. J. W. Beaumont, architect.
SUNDERLAND—Elementary school at St. Benets, Education Committee.
SURBITON — Extension of Corporation electricity undertaking (£20,000).
SWANAGE—Shelters on the esplanade, Urban District Council.
SWANSEA—Technical school (£7,500), Board of Education.
THORPE SELVIN—Alteration to Council schools, West Riding Education Authority.
THRAPSTON—Elementary school. Mr. J. T. Blackwell, architect.
TONGWYNLAIS—Council school, Glamorgan County Council.
TONYREFAIL—Caretaker's house, Glamorgan County Council.
TREETON—Alterations and additions to Council school, West Riding Education Committee.
TRILLICK—Twenty-nine cottages, Rural District Council (£1,075).
TULLA—Labourers' dwellings (£32,278), Rural District Council.
URLINGFORD—Labourers' dwellings (£14,927), Rural District Council.
UXBRIDGE—Two houses, Derby-road, Mr. J. J. Ward, jun.
WALSOKEN—Houses, Mr. R. T. Tash.
WANDSWORTH, S.W.—Elementary school, London County Council.
WELLINGBOROUGH—Additions to factory, Vivian-road, Mr. Haines; alterations to London and North-Western Station.
WEYMOUTH—Secondary school, Town Council.
WHITLEY—Dairy, Estates and Finance Committee of Coventry Corporation.
WIGAN—Shops in King-street. Mr. R. Pennington, architect.
WINLATON—Alterations of Durham County Council school. Mr. A. J. Dawson, architect.
WITHERNSEA—Four houses, Princes-avenue, Mr. Tasker.
WOLSTANTON—Alteration at Ellison-street School (£600), Town Council.
WOLVERHAMPTON—Spring Vale Steel Mill (£100,000).
WOLVERTON — New business premises, Industrial and Provident Society. Mr. J. W. Wilson, architect.
WOODBRIDGE—Extension to waterworks buildings (£1,000), Woodbridge Water Co.
WOOLWICH—Elementary school, London County Council.
YIEWSLEY—Eight houses and shops, Providence-road, Mr. R. Smith.
YORK—House, Alma-terrace, Mr. Caffrey; house and shop, Queen Victoria-terrace, South Bank, John J. Hunt, Limited; two houses, Lawrence-street, Mr. J. Voakes; two houses, Norfolk-street and Bishopthorpe-road, Mr. Webster; additions to St. Mary's Convent, Blossom-street, Sisters of St. Mary's Convent; temporary shed, Cemetery-road, York Equitable Industrial Society; two houses, East-parade, Mr. J. Tinson; house, Norfolk-street, Bishopthorpe-road, Mr. Sellers; two cottages, Trinity-lane, Mr. J. Birch.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Melbourne.—The Municipality invite tenders for 80 alternating-current flame arc lamps. Tenders by Nov. 15.

Perth (Australia).—The Postmaster-General invites tenders for 80 accumulators for telegraph purposes. Tenders by Dec. 11.

Melbourne. — The Postmaster-General invites tenders for 30 metallic iron telephone switchboards. Tenders by Dec. 31.

Paris. - The Post and Telegraph Department invite tenders for commutator tablets for central telephone station. Tenders by Nov. 16.

London, N.E.—The London County Council invite tenders for the erection of a tramways car-shed at Mare-street, Hackney. Tenders by Nov. 12.

Sheffield.—The Tramways Committee invite tenders for the supply of clothing. Particulars from the Tramways General Manager. Tenders by Nov. 18.

New South Wales. — The Postmaster-General, Sydney, invites tenders for one branching metallic multiple magneto switchboard. Tenders by Jan. 8, 1908.

Edinburgh.—Tenders are invited for well-boring at McDonald-road electricity generating station. Particulars from the Engineer's Office, Dewar-place, Edinburgh. Tenders by Nov. 11.

Newcastle-on-Tyne.—The Tramways Committee invite tenders for the supply of uniforms for 12 months ending March 31, 1909. Tenders to the Chairman of the Tramways Committee by Nov. 16.

Bootle.—The Corporation invite alternative tenders for supply of coal for use at the electric light station for six months ending June 30. Tenders to Mr. J. Henry Farmer, town clerk, by Nov. 16.

Melbourne.—The Postmaster-General's Department invite tenders for 11 sets and a common-battery switchboard, and 3,000 subscribers telephones, etc., for the Windsor exchange. Tenders by Jan. 7.

Peterborough.—The Electricity Committee invite tenders for supplying about 2,200 yards of feeder cables. Tenders to Mr. J. C. Gill, city electrical engineer, by Nov. 21. See advertisement.

Wigan.—Tenders are invited for the supply of 500 tons of best washed slack for quick-firing purposes to the electric works, Chapel-lane, Wigan. Tenders to Mr. Harold Jevons, town clerk, by Nov. 11.

Dublin.—The Dublin United Tramways Co. invite tenders for stores, including electric supplies, for the year ending Dec. 31, 1908. Tenders to Chairman, 9, Upper Sackville-street, Dublin, by Nov. 11.

London.—The London General Omnibus Co., of 6, Finsbury-square, E.C., invite, among other things, tenders for electrical appliances and tools, and leather machine belting. Tenders by Nov. 18.

Sydney.—The Postmaster-General invites tenders for 1,000 common-battery wall telephones and 100 portable telephones. Particulars from the Commonwealth Offices, 72, Victoria-street, Westminster. Tenders by Dec. 11.

Brisbane.—Tenders are invited for insulators, iron spindlers, and copper wire for the Postmaster-General's Department. Particulars from Captain Muirhead Collins, 72, Victoria-street, Westminster. Tenders by Dec. 16.

Buenos Ayres.—Tenders are invited for the construction of underground electric tramways. Particulars from the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London. Tenders by June 1, 1908.

Stoke-upon-Trent.—Tenders are invited for mains and services, balancer and booster, and switching apparatus. Tenders to Chairman of Electricity Committee, Electricity Works, Stoke-upon-Trent, by Nov. 23. See advertisement.

Helsingborg (Scandinavia). — Tenders are invited by the Municipality for two three-phase current generators and one air-compressor. Particulars from the Commercial Intelligence Branch of the Board of Trade. Tenders by Nov. 12.

Stepney.—The Electric Light Committee invite tenders for work in connection with the Council's projected new generating station at the riverside at Blyth's Wharf, Limehouse, and sub-station at Osborn-street, Whitechapel. Tenders by Nov. 11.

London, S.W.—The London County Council invite tenders for the supply of stores for one year from Jan. 1, 1908, including electric fittings, lamps, cables, etc., and tramway car fittings. Tenders to the Clerk, County Hall, Spring-gardens, by Nov. 11.

Buenos Ayres.—Tenders are invited for (1) the construction of and (2) the concession to work the two principal sections of the underground electric railway. Particulars from the Argentine Legation, 12, Rue van Moer, Brussels. Tenders by May 1, 1908.

Adelaide.—The Deputy Postmaster-General for Queensland invites tenders for a common battery switchboard and 3,000 subscribers' telephones. Specification No. 166. Particulars may be obtained from the Commonwealth Offices, 72, Victoria-street, London, S.W. Tenders by Jan. 8, 1908.

Warrington.—The Cheshire Lines Committee invite tenders for the supply of stores during the year 1908, including telegraph materials, permanent-way materials, and steel fishplates. Tenders to Mr. Glegge Thomas, secretary, Cheshire Lines Stores Department, Warrington, by Nov. 22.

Victoria.—The Deputy Postmaster-General at Melbourne invites tenders for the supply and delivery at Melbourne of 11 sections of a common-battery switchboard and 3,000 subscribers' telephones and other apparatus for telephone exchange, Windsor, in accordance with Victorian specification No. 148. Tenders by Jan. 7.

Manchester.—The Electricity Committee invite tenders for the supply and erection of the following: (Specification No. 18) high and low tension switchgear; (19) transforming plant; (20) motor converters. Particulars from Mr. F. E. Hughes, Electricity Department, Town Hall, Manchester. Tenders to the Chairman of the Electricity Committee by Nov. 12.

RESULTS OF TENDERS.

Hull.—The Electric Lighting Committee have accepted the tender of Bannister and Co. for the supply of coal to the power station.

Bridlington.—The Borough Council have accepted the tender of Mr. T. Gray for the erection of a coal-shed at the electricity works for £20. 10s.

Sheffield.—The tender of Morrison and Roebuck, 4, Birley-street, Blackpool, has been accepted for electric installation and ventilating fans at the Royal Hippodrome.

Warrington.—The Electricity and Tramways Committee have accepted the tender of the St. Helens Cable Co. for the supply of cables for 12 months according to specification and schedule of prices.

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London.—The London County Council have received the following tenders for the wiring and fitting, for electric lighting, of the Holloway tramways car-shed and the Holloway, Hackney, and Clapton tramways sub-stations:

Pinching and Walton, Cannon-street, E.C.*	£2,374	13	1
W. G. Cannon and Sons, Southwark	2,741	2	11
Revy, Phillips, and Co., Queen Victoria-street, E.C.	2,754	13	4
Lacy and Co., Buckingham Palace-road, S.W.	3,992	17	9

* Recommended for acceptance.

St. Marylebone.—The following tenders have been received for the supply of 440 yards 1 square inch cable required for additions to the distributing network:

W. T. Henley's Telegraph Works Co. (accepted)	£377	17	0
Siemens Bros. and Co.	282	12	0
W. T. Glover and Co.	282	12	0
St. Helens Cable and Rubber Co.	322	0	0
Callender's Cable Co.	338	0	0

Croydon.—The Lighting and Electricity Committee have received the following tenders for the runway at the power station:

Vaughan and Sons	£423	14	0
Hale and Willett	414	4	0
C. A. Cass	366	10	0
R. Priest	296	6	0
H. Morris and Bastert	292	14	0
Brockley Ironworks	278	5	0
Morley Electrical Engineering Co.	270	10	0
S. A. Heywood and Son (accepted)	234	0	0

Japanese Steelworks.—The Lancashire Dynamo and Motor Co. have recently secured a contract for the equipment of the generating station for the Kabushika Kwaisha Mihon Seiko Sho. This contract was placed by Baron Yamanouchi, of the Imperial Japanese navy, and the value is considerably over £50,000. The equipment consists of three 1,000-kw. generating sets, consisting of Belliss triple-expansion engines and Lancashire compound interpole generators with slip-rings and static balancers for giving a three-wire supply at 440 volts across the outers. The contract also includes for pipework, condensers, floor plating, switchboards, cables, etc., for a complete power station equipment. Nearly 300 motors of the Lancashire Dynamo Co.'s make, most of which are of large size for variable speed of 3-1, will be used for driving machine tools, gun-boring lathes, cranes, etc.

Recent Contracts.—Messrs. Royce, Limited, Trafford Park, Manchester, have recently received the following orders: from Messrs. Richardson and Cruddas, engineers, of Bombay, four overhead electrically-driven cranes; from Messrs. E. H. Hunter and Co., of London, four electrically-driven cranes for use in the additions which the Osaka Engineering Co., of Japan, are making to their already extensive engineering works; three electrically-driven cranes for Messrs. Kerr, Stuart, and Co., engineers, of Stoke, Staffordshire; from Messrs. Galloways, Limited, an electrically-driven crane for their new boiler works at Ardwick; from the Churchill Machine Tool Co., of Pendleton, an electrically-driven crane for use in their new extension; from Messrs. Selig, Sonnenthal, and Co., of London and Coventry, cranes for their new works; and a repeat order for an electrically-driven crane from Messrs. Jos. Buckton and Co., of Leeds.

BUSINESS NOTES.

TRACTION.

Sheffield.—The Corporation Tramways Committee are offering £500 towards the £2,000 which is the estimated cost of the improvement of Lady's Bridge.

Widnes.—The Town Council have decided to apply for a Bill in Parliament to obtain powers for the working and running of motor 'buses by the Corporation.

Santiago.—Owing to the Government's delay in considering the tenders of Messrs. S. Pearson and Son and of a German firm for the Arica-La Paz Railway, the English firm has withdrawn its tender.

Brisbane Electric Tramways Investment Co.—Traffic receipts of the Brisbane Tramways for the month of October, amounted to £13,537. Corresponding month last year £11,721, increase £1,816.

City of Buenos Ayres Tramways Co.—The directors of the City of Buenos Ayres Tramways Co. (1904) have declared a dividend of 1s. 3d. per share, less income tax, for the three months ended Sept. 30 last.

Madras Electric Tramways.—The receipts for the fortnight ending Oct. 31 totalled Rs.17,721, against a total of Rs.14,961 for the corresponding period of 1906. The gross receipts from Jan. 1 were Rs.344,483, against Rs.286,564 for 1906.

Reading.—The Town Council have adopted a recommendation from the Tramways Committee that, until further orders, cars be not run on Sundays in the Bath-road section, and only on the Erleigh-road to post office section after 5.30 p.m., and at intervals of 10 minutes.

Barry.—A special meeting of the Barry District Council has been held for the purpose of conferring with Mr. Robert Hammond, M.I.C.E., of Victoria-street, Westminster, with reference to the proposed electric lighting and tramways for the town. The discussion was conducted in private.

Buenos Ayres and Belgrano Electric Tramways Co.—The receipts for the week ending Nov. 4, 1907, converted to gold, were £4,262; corresponding period 1906, £4,173—increase, £89. Aggregates from Jan. 1, 1907, £169,123; aggregates from Jan. 1, 1906, £159,841—increase, £9,282.

British Columbia Electric Railway Co.—The directors' report as at June 30 recommends the following dividends: ½ per cent. on preferred ordinary and 4 per cent. on deferred ordinary, making for year 5½ per cent. and 7½ per cent. respectively.

Gourock.—In a letter to the Town Council the manager of the tramways company states his directors cannot see their way to make any reduction in the present fares, which were recently raised. Increased expenditure, due to the payment of better wages to tramway men, is the reason given by the company for this decision.

Brighton.—A resolution has been passed by the Preston Park Ward Ratepayers' Association, requesting the Tramways Committee to consider the desirability of giving at least a 7½-minute service in the Dyke-road during the winter, but after consideration the committee are unable to recommend the Council to run a 7½-minute service as suggested.

Stratford (Essex).—The East Ham and the West Ham tramway systems at Plashet grove and Green-street, Upton Park, have been linked up, and a joint service of cars has commenced running between Stratford Town Hall and East Ham Town Hall. Direct access is now to be had to Barking, and through Barking to Ilford from Stratford, as well as from Canning Town.

Newport.—The Tramways Committee of the Newport Town Council have decided not to take steps in the next session of Parliament to obtain a provisional order for extending the line to the eastern end of the transporter bridge. This work, together with the construction of a siding for the cars in Rodney-road and the doubling of the line on Stow-hill from the Westgate to Charles-street, was estimated to cost £19,140.

Mansfield.—An order made by the Light Railway Commissioners, modified and confirmed by the Board of Trade, authorising the construction of light railways in the borough of Mansfield and the urban districts of Mansfield Woodhouse and of Sutton-in-Ashfield, and the rural district of Skegby, in extension of the light railways authorised by the Mansfield and District Light Railways Order, 1901, has just been issued.

Leith.—At a meeting of the Leith Tramways Committee on the 31st ult., a letter from the Edinburgh Town Council with regard to the proposed extension of the Leith electric tramway system to Granton was under consideration, and a sub-committee was appointed to confer further with representatives of Edinburgh on the subject. The burgh engineer was instructed to prepare alternative plans showing the single line as had been proposed and also a double line.

Bournemouth.—At the last meeting of the Council the town clerk reported the results of the action brought by the Corporation against the Poole Electric Tramway Co., and announced that the company had given notice of appeal against the decision of the Court with reference to certain sums which had been awarded to the Corporation. The town clerk was instructed by the Tramways Committee to give notice of appeal also in so far as the judgment was in favour of the company.

Middlesex.—At the last meeting of the County Council an application was received from the borough of Richmond for permission to construct tramways over King Edward VII. Bridge in connection with the proposed tramways along Sandycombe-road and Lower Mortlake-road, Richmond, to a point in the centre of the town, and the Highway Committee, after consideration, held the opinion that the County Council should not assent to the application at present. The Council decided that the request be not acceded to at present.

Whalley and Padiham Light Railway.—Although the promoters of the Blackburn, Whalley, and Padiham light railway have had six years in which to construct the line, they have not even raised their capital, much less have they commenced the construction of the works. Four extensions of time have been granted by the Board of Trade, and now the promoters of the scheme have applied for a further extension of time for 18 months. At the forthcoming meeting of the Lancashire County Council this body will be asked to oppose the application.

Luton.—At the last meeting of the Council the town clerk reported that it would be necessary for application to be made to the Board of Trade for its consent to the proposed lease to Messrs. J. G. White and Co. of the tramways, and to the provisions of such lease; that notice of the intention of the making of the lease must be published by the Corporation by advertisement in the manner provided by the regulations contained in the schedule of the Tramways Act, 1870. The Council authorised the town clerk to take whatever steps may be necessary.

Tipton.—At the meeting of the District Council the chairman referred to the stoppage of reduced fares for children on the local and district tramways. The excuse of the tramway authorities was that the special tickets issued for children had been used by pupil teachers and other persons over age. He thought that even if the school tickets were withdrawn the public ought not to be deprived of the privilege of taking children on the cars at half price. He moved that representations on those lines be made to the tramway company, and this was agreed to.

A Tube Express.—So successful was an experimental express train run on the Piccadilly Tube that it has been decided to continue it daily. The train will in future leave Holborn at 11.16 p.m. nightly, and, calling only at King's Cross and Holloway, arrive at Finsbury Park at 11.26 p.m., in time to catch several suburban services over the Great Northern line. This train is expected to be particularly useful to theatre-goers. This is the first fast train to be run on any of the tube railways. It should be mentioned that, owing to a careful arrangement of the time-table, the ordinary service is not interfered with.

Nottingham.—At the next meeting of the City Council a motion will be considered that, as the tramway service of the Sherwood cars from Trent Bridge to Station-street is being run at considerable loss, the cars be discontinued, and that the circular cars from the market,

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via Station-street and Sneinton, be run as formerly; the suggested fare to be 1d. between any parts of the circle, and that transfer tickets be granted from the cars running from Colwick-road to Station-street to the Wilford cars running to the Trent Bridge; also that two children be allowed to travel for one fare on these or any other tramway routes in the city.

Royton.—A tramway mishap occurred in Oldham-road on Sunday night. Shortly after 10 o'clock a tramcar belonging to the Oldham Corporation jumped the points near Crompton-street. Although the driver and conductor promptly applied the brakes, they were unable to stop the car, which dashed into the front of the house, No. 68, of which Mr. John Robert Hadfield is the tenant. The brickwork below the window was staved in, but the damage done was not as serious as at one time seemed likely. The car was filled with passengers at the time of the accident, but fortunately no one was injured, and the vehicle was not much damaged.

Swansea.—An exciting incident happened on Tuesday week to a Sketty to Swansea Docks electric tramcar. As the car was running down the gradient of Mansel-street the brakes seemed not to act, and as the car gained in impetus as it went on the greatest alarm was felt by the passengers, because at the bottom of the incline the car would have to turn a corner into Cradock-street in following its course to the docks. Consequently several passengers proceeded to jump off as the corner was neared. Fortunately, however, the pointsman at the four cross roads kept the points open, with the result that, instead of turning the corner to the docks, the car went straight on and soon came to a standstill.

Ilford.—The Ilford Urban Council has held a special meeting to consider a new situation which has arisen with regard to the proposed extension of the tramways along Cranbrook-road. An intimation has been received from several of the contractors that they would be prepared to extend the tramways on the surface-contact system for the same price as they had originally offered to do it on the overhead system. The Council were informed, however, that there would not be time to complete this arrangement so as to enable the Bill to be placed before Parliament this session. Under the circumstances it was considered advisable to temporarily abandon the Bill which it had been proposed to bring forward, rather than proceed with it and be compelled to undertake the overhead system. This course was adopted.

Leeds.—The Leeds Corporation have affixed notices to the public street lamps all along the route declaring their intention to apply for parliamentary powers to enable them to construct tramways from the present terminus at Horsforth to Guiseley. The project is undertaken at the request of the District Councils of Guiseley, Yeadon, and Rawdon, who have agreed to jointly give the Leeds Corporation £400 per annum for a period of 11 years. Powers are to be asked for to carry the line as far as the White Cross Inn at Guiseley, but at the outset the trams will not be taken beyond the Station Hotel in the township named. The fare from Guiseley to Leeds is to be 5d. and that from Henshaw (Yeadon) and Rawdon 4d, the charge from Horsforth remaining as at present. Provision is also made in the agreement for the running of workmen's cars.

Halesowen.—Messrs. J. W. Willis Bund (chairman of the Worcestershire County Council) and E. J. Bigwood (chairman of the Highways and Bridges Committee) held an inquiry at Blackheath on the 30th ult. respecting the scheme for the widening of Long-lane, Halesowen, in connection with the proposed tramways to be laid down in the Halesowen district. The clerk explained that the scheme was for the raising, widening, and making into a new street a portion of Long-lane from the Nimmings to New England. The County Council were willing to carry out the improvement for a sum of £2,200, exclusive of any fencing, on condition that all land for widening was given up free of cost. The District Council asked the property owners fronting this portion of the road to contribute £381, the fencing and land for widening towards the improvement.

Sowerby Bridge.—Another mishap was reported from the Pye Nest tramway route on Wednesday week which caused a good deal of apprehension amongst the travelling public of Sowerby Bridge. It appears that the car leaving Cow Green at 5.35 a.m. reached a sharp turn just above which the other car ran back, when it is stated that the trolley came off, and the car rushed away at an increasing speed for a distance of 100 yards or so. The car was plunged in darkness, and the inside, being full of passengers, presented a scene of much confusion. Several men, despite the efforts of the conductor, jumped off. The car went round the first bend below Edwards-road and on to the straight gradient below. Here, according to one of the passengers, it was still gaining speed, but the men in charge gradually regained control, and after a run of about 150 yards brought it to a standstill.

Burnley.—The Council have authorised the erection of cash and parcels offices in connection with the tramways on a site adjacent to the new theatre. The following student fares have been adopted: Towneley terminus to Scott Park-road, and Park-lane to Manchester-road summit, three months 12s. 6d., six months 25s. 12 months 45s. The following ordinary transfer fare was also adopted: Cog-lane to Park-lane, 1d. The Tramways Committee at one of their meetings had under consideration an application from the tram conductors for an increase in their rate of pay. The tramways manager submitted a printed return showing the wages, hours of duty, etc., of conductors on Corporation tramways, principally in Lancashire and Yorkshire. The committee also considered an application from the drivers and conductors for one week's holiday per annum with pay, and from the overhead linesman for an extension of his holiday from seven to fourteen days per annum with pay. It was resolved that the tramways manager arrange for a special meeting of the committee to be held at an early date to consider the wages of conductors and the question of allowing holidays with pay to employés of the department.

West Bromwich.—In a report issued on the 4th inst. the Highway Committee of the West Bromwich Corporation state that the South Staffordshire Tramways (Lessee) Co. have written to the effect that, after having given children's ½d. fares a long and exhaustive trial, they regret to say the experiment has resulted in a loss to the company. Though anxious to give cheap locomotion, they must ask the public to pay a reasonable rate for the facilities given. In abolishing half fares for children they are only conforming to the general practice of Birmingham and other large corporations. They have no knowledge of tickets available until 1910 having been issued to scholars. They have heretofore sanctioned the issue of passes to older scholars when attending public schools to enable them to use the ½d. tickets for children under 12 years of age, but not for any specified time, and the fee paid for such a pass was nominal to cover the cost of printing. The company submit that they have acted fairly, and cannot see their way to reinstate the children's ½d. fares or to extend the ½d. stages.

Bury.—The subject of the extensions of the tramways have for some period been under the consideration of the Bury Tradesmen's Association, and on Thursday week a deputation consisting of the chairman and one or two members of the executive of the association waited upon the chairman of the Tramways Committee and the manager, and laid before them various schemes for the extension of the tramway system. These were mainly as follows: from Limefield to Bass-lane and on to Shuttleworth and Edenfield; from Jericho to Simpson Clough and on to Heywood; from Stopes (Radcliffe) to Little Lever, where, it is urged, there is a large population and no tramways. The chairman and manager met the deputation very favourably, and promised to bring the matter before the Tramways Committee, more especially in regard to the suggested extension to Little Lever. The deputation are hopeful that sufficient particulars were given to the chairman of the committee to convince him that the scheme was a good one. Another suggestion made by the deputation was that the tramways should be continued to Holcome Brook and Ramsbottom, and on to Stubbins and Edenfield. The proposals, it is anticipated, will be laid before the Tramways Committee.

Darlington.—The general manager of the Darlington tramways, Mr. J. R. P. Lunn, has issued a report to the members of the Darlington Corporation, in which he contrasts the working of the ½d. and 1d. fares. The receipts for 12 months of ½d. fares average 6·88d. per car mile, and for 12 months of 1d. fares 6·97d. per car mile. He sets out that with ½d. fares there are more stoppages of the cars, and estimates that one extra stop on each route increases the working expenses by £52 a year. Again, the heavy loads carried with ½d. fares, to produce the same revenue as with 1d. fares, causes a greater consumption of electricity, and from test runs he found that it required 7 per cent. more current to carry 30cwt. from car-sheds to Harrowgate-hill than it did to carry 15cwt. A car stopping at every stopping place between the Market-place and Harrowgate-hill consumed 40 per cent more current than with a non-stop run. From inquiries made from motormen, he finds that they undoubtedly had more stops when ½d. fares were in force. He estimates that the decrease in cost of electricity, owing to the lighter loads and fewer stops, would be about £75 per annum under the 1d. fares, and there is also a saving in repairs, etc., of about £16 per annum, or £92 in all, which is in addition to the increased revenue of £64 odd during the year of 1d. fares.

Belfast.—At the last meeting of the Council the Tramway Committee's minutes showed that the general manager (Mr. Andrew Nance) had submitted a lengthy report on the question of the Ligoniel extension, which stated that the cost of construction and equipment as far as Wolfhill would be about £9,500, and that the annual expenditure would amount to £1,750. The additional revenue, in his opinion, would not amount to more than £5. A deputation had been received on the same subject, and the committee had finally passed the following resolution: "That, in the opinion of the present committee, the Ligoniel tramway system should be completed within the two years." A further lengthy report from the general manager dealing with the half-year ending Sept. 30 showed that it had been an exceedingly prosperous one. The report continued: "The receipts show an increase of £6,460, whereas the working expenses are practically the same. The result is that the whole of the increased receipts is retained as increase of gross profits. Over a quarter of million of additional car miles have been run during the half-year without adding anything to the working expenses. The working expenses come out at 4·29d., and compare with 4·70d. per car mile run for the corresponding half-year." The committee having discussed the report and statement, congratulated the general manager on the satisfactory and successful working of the undertaking.

Erdington.—At the last meeting of the Council the Tramways and Electric Lighting Committee reported that they had received the draft agreement proposed to be entered into with the Birmingham Corporation as to the running of trams in Erdington. The clerk had had several interviews with Mr. Baker, the manager of the Corporation tramways, and by arrangement with him had made certain modifications and alterations, but, owing to the absence from town of Mr. Pritchard, the deputy town clerk, who was attending to the matter, these alterations had not yet received the formal approval of the town clerk's department. It was resolved that the agreement be approved, and that the clerk be authorised to affix the seal of the Council thereto. The clerk was authorised to affix the seal of the Council to a mortgage for securing to the trustees of the Wesleyan Assurance Society the sum of £35,800, being the cost of construction and equipment of tramway No. 1, together with interest thereon at the rate of £3. 17s. 6d. per cent. per annum, repayable by equal half-yearly instalments of principal and interest combined, extending over a period of 40 years. It was further resolved that the bill of costs of the clerk in relation to tramway matters, amounting with payments for parliamentary agents' charges, counsels' fees, etc., to £150. 11s. 6d., be

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referred to the clerk of the peace for taxation, and that an order be drawn on the treasurer for the amount of such costs when taxed.

LIGHTING AND GENERAL

West Derby.—The Guardians have been able to generate electricity for use at the workhouse at a cost of 3d. per unit.

Barrow.—The Electricity Committee have decided to appoint a canvasser for a period of six months at a wage of 30s. per week and commission.

London Platino-Brazilian Telegraph Co.—The directors of this company have declared an interim dividend of 1¾ per cent. on account of the year to Dec. 31.

Worksop.—The Urban District Council have instructed their clerk to acquire a loan of £1,700 for electric lighting purposes, the terms at present offered being 3¾ per cent.

Luton.—The Higher Education Sub-Committee of the Bedfordshire County Council have decided to provide electric light fittings at a cost of £143 at the Luton Secondary School.

Hull.—The Local Government Board will hold an inquiry on Nov. 12 into the Council's application for sanction to the borrowing of £46,527 for electric lighting purposes.

Pembrokeshire.—The County Council have decided to provide the county offices, etc., with the telephone and have also decided that the education offices should be connected.

Eastbourne.—The Electricity and Street Lighting Committee intend to appeal against the proposed increase of the assessment of the electricity undertaking from £1,420 to £5,076.

Liverpool.—An inquiry is to be held by the Local Government Board on Nov. 26 into the application by the Corporation for sanction to borrow £200,000 for the electricity undertaking.

Callan.—At a public meeting of residents a resolution was carried agreeing to co-operate with the Town Commissioners in endeavouring to obtain power to install electric lighting throughout the town.

Leyton.—The Urban District Council have decided to open showrooms at Lea Bridge-road and Leytonstone-road in order to demonstrate the advantages of the use of electricity by the inhabitants.

Salford.—The Town Council have decided to make application to the Local Government Board for sanction to the borrowing of £3,000 for the purpose of extending the electric lighting system to Prestwich.

Notice of Dividend.—The *London Gazette* states that a first and final dividend of 1s. 4d. in the £ has been declared in the estate of K. C. Moran, electrical engineer and contractor, 80A, Teddesley-street, Walsall, Staffs.

Windermere.—The Urban District Council have granted permission to the Windermere and District Electricity Supply Co. to lay a service cable in Rayrigg-road from Queen's-square to the Canon Stock Memorial Hall.

Longton.—Owing to the great difference in the quarterly charges for gaslighting St. John's Church clock, the Council have asked the Electricity Committee to undertake the lighting of the clock for a fixed annual sum.

Market Drayton.—At a special meeting of the Parish Council a petition for the lighting of Alexandra-road and Longslow-road was received from ratepayers, and it was decided to arrange for the public lighting area to be extended to these roads.

Bispham-with-Norbreck.—The Urban District Council intend to apply to the Board of Trade for a provisional order under the Electric Lighting Acts to secure power to generate, store, and supply electric energy for lighting, heating, power, and other purposes public and private.

Dundee.—The Town Council of Dundee are giving notice of their intention to apply to the Board of Trade for powers to extend the area of supply, and to sell electricity for all public and private purposes, etc. A list of the roads and streets in which electric lines are to be laid down is given.

Kendal.—The Town Council have decided to engage Mr. Hansom, of Fleetwood, to prepare specifications and estimates, and attend the Local Government Board inquiry on the application to borrow further capital, and to pay him a fee of 10 guineas for such services, in addition to the fee of 20 guineas for the report upon the undertaking.

Wembley.—The Fregnal Estates have written to the Council stating that they are forming a company for the purpose of supplying electric light at Wembley Park, and would prefer to acquire through the Council the provisional order for their own roads and as much of the Council's roads as have not already been dealt with. The matter is under consideration.

Bridgend.—The District Council have decided to extend the cable to the junction of Merthyrmawr-road with Grove-road; also to write the Board of Guardians asking if they would be prepared to adopt electric light for the cottage homes. On the recommendation of the Lighting Committee the Council have decided to experiment with Osram lamps for public lighting.

York.—At a recent meeting of the Streets and Buildings Committee of the Corporation a letter was read from the city electrical engineer stating that the Electricity Committee desired to extend the electric arc lighting along the Fulford-road as far as the infantry barracks, and, after consideration, the committee gave instructions for additional electric lamps to be fixed, as requested.

Durham.—The Finance Committee of the Board of Guardians have considered a letter from the County of Durham Electrical Distribution Co. regarding the lighting of the workhouse, and recommended that the company be asked to furnish the Guardians with a scheme for lighting the workhouse with electric light, and also with an estimate of the cost. This has been agreed to by the Board.

Llandaff.—The Llandaff and Dinas Powis Council have decided to apply to the Board of Trade for an order amending the Llandaff and Dinas Powis electric order of 1901 in order that the Council might transfer the Radyr portion of the undertaking to a private company. The Council have further asked for an extension of two years in the time allowed for the compulsory carrying out of the work.

St. Annes.—At the last meeting of the Council the electrical engineer reported that 74,726 units were sold during September. He had in hand applications from 12 consumers for the equivalent of 294 8 c.p. lamps. The work of the department has been progressing satisfactorily. There has again been a small decrease on units to the tramway company, but this has been more than counterbalanced by increase in private consumption.

Aberdeen.—At the last meeting of the Parish Council a letter was read from the District Committee of the Aberdeen County Council stating that there had been some informal suggestions that Summerfield Hospital might be provided with electric light from the installation at Oldmill, and asking the Council if light could be supplied from that institution, and on what terms. The communication was remitted to the Poorhouse Committee for a report.

Grimsby.—On the morning of the 7th a youth named John Precious was using the new electric capstan on the Great Central Railway on the west side of the Royal Dock at Grimsby for the purpose of pulling a wagon into position to unload a barley boat, when suddenly his feet were caught and he was thrown down and whirled round several times before somebody could stop the current. The unfortunate lad received several terrible blows in the face, and died while being conveyed to the hospital.

Chagford.—At the last meeting of the Parish Council a communication was received from the Devon Gas Association offering to undertake the public street-lighting with incandescent gas-lights at a cost lower than the Council were now paying. They would be prepared to enter into an agreement for five years. After discussion it was decided to reply that the Council were satisfied that they had in the electric light not only a satisfactory light, but a cheap illuminant, and at present they did not contemplate making any alteration.

Bargoed.—Mr. W. B. Lloyd presided over a meeting of the Rhymney Valley and General Electric Supply Co. held at the Junction Hotel, Bargoed, on Wednesday of last week, when the details of a scheme for the supply of electric light to the town were discussed. Nothing was definitely settled, but another meeting is to be held. The provisional order has already been secured for Gelligaer, Bedwellty, and Mynyddislwyn parishes, and we understand that the shares will be issued to the public after the next meeting.

Rochdale.—The Corporation Electricity Committee have referred to the Works Sub-Committee correspondence with the Rochdale Canal Co. with reference to a supply of electricity for power purposes. In reply to a letter from the Education Committee with reference to a supply of electricity at Spotland, Oakenrod, and Castlemere Council Schools, the committee intimated that they would favourably consider a definite application for the lighting of Spotland School, and they have ordered that the necessary cable be obtained and laid to supply Oakenrod School.

Metropolitan Asylums Board.—At the last meeting of the Board the Hospitals Committee recommended that electricity should be substituted for gas at the South-Western Hospital. The arguments advanced in favour of the change were that electricity would be cheaper, that the cost of painting and cleaning works would be lessened; and that it was more convenient, and attended with less risk of fire. It was estimated that the cost of the installation of electric light would be about £4,000. The recommendation of the committee was approved.

Stone.—At the last Guardians' meeting a letter was read from the Electricity Committee of the Urban District Council of Leek, stating that application had been received for a supply of electricity in Russell-street, and the committee would at their next meeting consider the advisability of extending their mains from Haywood-street to Derby-street, and would be glad to hear from the Guardians whether, in the event of the cable being laid, they would be prepared to take a supply to their offices. The matter was referred to the General Purposes Committee.

Marseilles.—His Majesty's Consul-General at Marseilles reports that it has been decided to hold an international electrical exhibition at Marseilles next year, from April to October. He does not consider that the exhibition will have other than local importance, but he is of opinion that it will be properly conducted and successfully organised, and that it would be worth the while of British manufacturers desiring an opening for trade with the industrial region of the South of France, and especially manufacturers of electrical mining appliances, to consider the advisability of exhibiting.

Liquidations.—The *London Gazette* announces that a general meeting of the members of the English Electric Carbon Co. will be held at 41, Regent-street, Wrexham, on Dec. 5, at 11 a.m., for the purpose of receiving the liquidator's report. The creditors of the Totnes Electric Lighting Co. are required to send all particulars of their claims to Messrs. Simpson and Bowen, Princes-street-chambers, 2, Princes-street, Bank, E.C., by Dec. 14. The creditors of the Chelmsford Electric Lighting Co. are required to send all particulars of their claims to Messrs. Simpson and Bowen by Dec. 14.

Huge Electric Crane.—To accommodate what is believed to be the largest floating electric crane in the world, which Messrs. Harland and Wolff have purchased, an immense pontoon built at Greenock arrived at Belfast on Saturday last, towed by three tugs. The hulk, which is 150ft. long by 85ft. broad, filled the entire waterway between the twin islands, but was safely navigated through and berthed at the Victoria Wharf. The crane to be erected on it is guaranteed to lift

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150 tons and will be chiefly used for putting machinery on board the mammoth liners which the Queen's Island firm are building.

Stock Exchange.—Applications have been made to the Stock Exchange Committtee to appoint a special settling day in and to grant a quotation to Victoria Falls Power Co.'s 8,000 preference shares of £1 each, fully paid, 800,001 to 808,000. The committee has also been asked to appoint a special settling day in African Rubber Co.'s 5,000 5 per cent. cumulative preference shares of £1 each, fully paid, Nos. 1 to 5,000; and Nigeria Bitumen Corporation's further issue of 700 shares of £1 each, fully paid, Nos. 182,703 to 183,407. The committee has further been asked to allow Victoria Falls Power Co.'s 800,000 preference shares of £1 each, fully paid, Nos. 1 to 800,000, to be quoted in the official list.

Hastings.—In response to an application from the National Telephone Co. for permission to construct a manhole, 5ft. 6in. by 4ft. 6in., in connection with the company's underground cables at the east end of York-buildings, the Council have given the required permission. The Electricity Committee have reported having had before them a report from the borough electrical engineer stating that the transformers in the sub-station at the East Sussex Hospital were all fully loaded, and suggesting that a 40-kw. single-phase transformer, which could be purchased for the sum of £54, should be obtained and installed in the sub-station as a spare. The committee recommended that the transformer be purchased and installed as suggested, and the Council have agreed.

Belfast.—At the last Council meeting the electrical engineer submitted the following report: "The summary of rental for the quarter ended Sept. 30, 1907, shows an output for lighting and power purposes, excluding tramways supply, of 652,041 units, being an increase of 19·3 per cent. over the output for the corresponding period last year. This increase is equally divided between lighting and power, being 19·4 per cent. respectively. The energy supplied to the tramways during the quarter amounts to 1,797,744 units, or an increase of 18 per cent. The lamp connections at the end of the quarter were equivalent to 171,119 8-c.p. lamps, being an increase during the year of 20·047. The motors connected represent 3,846 h.p., being an increase during the year of 563 h.p." The committee considered the statement very satisfactory, and it was entered upon the minutes.

Aston.—The Council Electricity Committee have received a report from the engineer to the effect that in order to deal with present and anticipated applications in the Chester-road and Grange-road districts of Erdington it will be necessary to extend the low-tension mains by running from sub-station No. 3 (Silver Birch-road) a ·12 square inch four-core cable, *via* Orphange-road to Chester-road, and a ·06 square inch cable along Chester-road in an easterly direction as far as Lyndoch, containing a ·03 square inch four-core cable to Grange-road as far as the western gateway of The Cedars, the estimated cost being £630, which sum is included in the Erdington lighting loan. The committee have instructed the engineer to carry out this work. The committee report the electricity department is still making good progress in the supply of current, as will be seen from the following figures: September, 1906, 155,834; September, 1907, 219,276.

Huddersfield.—A lecture on motor-driven machinery was given on Wednesday evening of last week in connection with the Huddersfield Technical College Engineering Society. Mr. W. R. Bower, A.R.C.S., presided over a fair attendance, and briefly introduced the lecturer Mr. Brooke confined his remarks chiefly to electrically-driven motors, and explained the Huddersfield system of single and three phase current. He attacked the present method used in the town, and condemned the American method which was adopted some 14 years ago. Had the British system been adopted it would long ago have prevented the running back of tramcars and the like, and to a great extent done away with the fear of bad brakes. He also effectively touched upon mill driving by electricity, showing the price of the present system compared with that of steam to the advantage of the former. At the close of a very instructive and interesting exposition of the value of electrically-driven machinery, Mr. Brooke was accorded a hearty vote of thanks.

Portadown.—At the monthly meeting of the Town Council, Mr. H. V. Pegg, consulting engineer of the Belfast and North-East of Ireland Power Gas Co., waited on the Council and put before them details of a scheme for lighting the town with electricity. He assured the Council that his company meant business, and that they had decided to erect the first station in Ireland in Portadown or neighbourhood at a cost of between £60,000 and £100,000, and that from this station they would supply other towns. There were some financial details yet to be arranged, and the station would be completed within 10 months from the commencement of the work. He suggested that the Council should consider the advisability of adopting a scheme for lighting the town by electricity, and should apply for a provisional order for that purpose. The whole Council was constituted a committee to consider the improved lighting of the town, and they were empowered to expend a sum of £50 in procuring professional information and advice on the subject.

South Staffordshire.—Sir Alfred Hickman is laying down a complete new steel plant at his Spring Vale Works, near Wolverhampton, at an estimated cost of nearly £100,000. The new mill is being built on the latest American principles, and will be worked entirely by electricity, being the first mill in England worked on this principle. It will be capable of turning out every class of heavy steel bars, plates, and girders, and will have a capacity largely exceeding that of any mill in this country. The metal ore will now be run direct from the furnaces into a patent mixer, and being converted into ingots will be conveyed in a malleable state to the mill, where it will be rolled down into bars or plates as required. The new system will accelerate the production of steel, and also secure more uniform and better results. It is expected that the mill will be completed early in the New Year, and the Staffordshire Steel and Ingot Works will then be the best equipped works in England, and capable of meeting the severest competition from America or Germany.

Llanelly.—At a special meeting of the Urban District Council the electric light and traction question was again considered. Mr. D. James Davies moved that, without prejudice to the position of the Council under their contract with the South Wales Power Co., the Council offer to enter into an agreement with Mr. Holland and his syndicate upon the basis of the terms of option B of the said contract, and that, failing a settlement of satisfactory terms as to price of current and general conditions, the Council should then offer an arrangement equivalent to option A in the said contract. This was agreed to. Mr. D. J. Davies proposed that the Council should inform Mr. Holland that unless Railway No. 1 authorised by the Llanelly and District Light Railways Order, 1907, be constructed and completed ready for use on or before March 1, 1908, the whole facts of the case relative to the existing conditions of the railway track and tram service generally should be laid before the Board of Trade. This was also carried.

Greenock.—The new electricity generating station erected by Greenock Corporation in Dellingburn-street was opened on the 30th ult. by Treasurer Brown, convener of the Electricity Committee. Some time ago the municipal authorities decided to build a refuse destructor, and as the existing electricity establishment in Hunter-place has been producing its full capacity of current for several years, it was further resolved that the heat available from the burning of the refuse should be utilised for raising steam for the production of electricity. Although the destructor is not yet completed, the latter part of the scheme has now been inaugurated, and the Corporation will thereby be enabled to meet the growing demand for electricity, both for lighting and traction purposes. The total cost of the destructor and electric power station is estimated at about £41,700. The proceedings were attended by a large company, including members of the Corporation and representatives of the contracting firms, and after the ceremony of setting the machinery in motion had been performed by Treasurer Brown a toast-list was gone through.

Eccles.—At the last meeting of the Council the Electric Light Works Sub-Committee recommended that the necessary cable be laid for the purpose of giving a supply of electrical energy for motor-driving purposes to the works of the Eccles Tool Manufacturing Co., subject to the company undertaking to pay a minimum sum of £15. 8s. per annum for the supply of energy for the ensuing three years; that a lamp be fixed in the footway opposite to the post office in Lewis-street; that a lamp be fixed in Highfield-drive, Monton, subject to the street being kerbed and channelled; that the following appointments be made—an assistant to the electrical engineer at a commencing salary of £120 per annum, an additional switchboard attendant at a wage of 24s. per week; that tenders be invited for the supply of the following additional electrical plant—one 50-kw. transformer at an estimated cost of £76, and three spare armatures at an estimated cost of £100. It was resolved that an additional lamp of a distinguishable pattern and suitably inscribed so as to indicate the location of the post office in Lewis street be fixed at the corner of Lewis-street and Liverpool-road.

Bournemouth.—The report of the borough electrical engineer on the working of the generating station for the half-year ended Sept. 30, 1907, has been before the Council. During the half-year 926,904 Board of Trade units have been generated and distributed, being a decreased output of 18,431 Board of Trade units on the corresponding period of last year. The sale of 50,443 units to the Lighting Committee for street arc lighting has yielded a revenue of £420. 7s. 2d. for the half-year, and this amount will still further reduce the cost per unit for traction purposes. Notwithstanding the fact that for over three months of the present half-year the price of coal has been over 20s. per ton and the output of current less, the total cost per unit, irrespective of interest and sinking funds, has been under 1d.—viz., ·9966d.—due to the utmost care and economy being exercised. In regard to the price paid to the Bournemouth and Poole Electricity Supply Co. for current for traction purposes as amended from Jan. 1, 1907—viz., 1⅜d. for the first 400,000 units, 1⅛d. for the second 400,000 units, and 1½d. for all amounts above 800,000—it must be taken into account that this price did not include the capital cost of ducts, feeders, cables, switchboard, and meters, which amounts to a capital charge of over £30,000. Therefore, in making a comparison this capital amount should be deducted from the capital cost, which would leave the total cost of the half-year's output of 926,904 units at some £5,160. If a similar amount of current had been obtained from the company the cost would have been some £6,148, showing a saving of some £1,250 for the half-year by the Corporation in running their own station, the total saving per annum being some £2,500.

PROVISIONAL PATENTS, 1907.

OCT. 28.

23756. Electric fans. Frederick Diehl and Adolf F. Becker, 65, Chancery-lane, London. (Date applied for under Patents Act, 1901, April 22, 1907, being date of application in United States.) (Complete specification.)

23768. Improvements in electrically-controlled compasses. Siemens Bros. and Co., Limited, and George Sylvester Grimston, Queen Anne's-chambers, Broadway, Westminster.

23772. Improvements in electrically-propelled tramcars. John Smith Raworth, Queen Anne's-chambers, Broadway, Westminster.

23774. Improvements in or relating to electrical connection devices. Otto Gractzer, Chancery-lane Station-chambers, London. (Complete specification.)

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23778. Improvements in electric resistances. Charles Aubrey Day, 321, High Holborn, London. (Fabrik Elektrischer, Zunder, G. m. b. H., Germany.) (Complete specification.)

23780. Improved reversible and collapsible trolley pole for electric vehicles. John Lindsay and Robert Lindsay, 56, Ludgate-hill, London. (Complete specification.)

23781. Method of renewing the carbon rods in arc lamps having electrodes supported from below. Deutsche Beck-Bogenlampen-Ges. m. b. H., 27, Chancery-lane, London. (Date applied for under Patents Act, 1901, Oct. 26, 1906, being date of application in Germany.) (Complete specification.)

23786. Improvements in the manufacture of electric incandescence lamps. Edward Alfred Gimingham, Birkbeck Bank-chambers, Southampton-buildings, London.

23801. Improvements in electrical water heaters. Edward Joseph Condon, 55, Chancery-lane, London. (Date applied for under Patents Act, 1901, Nov. 1, 1906, being date of application in United States.) (Complete specification.)

23805. Improvements in wire-stringing devices applicable for use in the insulation of wire and for other purposes. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

Oct. 29.

23816. Improved means for controlling brake power on electrical tramway and railway vehicles. Mark Cummins, 4, St. Ann's-square, Manchester.

23818. Improvements pertaining to optical lanterns and the regulation and control of light-producing agents, electric arcs, limelights, or the like, used in connection therewith, and apparatus therefor. George Robson, 21, Rochdale-road, Leyton, Essex.

23857. Improved means for attachment to the trolley boom of an electric tram, for the purpose of guiding the trolley wheel to the live overhead wire. Arthur Say Chapman, 14, Beresford-road, Hornsey, London.

23877. Improvements in and relating to electromagnetic sound producers. Jörgen Flood Sandberg Barth and Ole Lökken, 7, Southampton-buildings, London. (Complete specification.)

23880. Means for generating direct current of limited strength. Felten und Guilleaume-Lahmeyerwerke Act.-Ges., 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Oct. 31, 1906, being date of application in Germany.) (Complete specification.)

23881. Improvements in connection with electrical installations. Felten und Guilleaume-Lahmeyerwerke Act.-Ges., 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Oct. 31, 1906, being date of application in Germany.) (Complete specification.)

23894. Improved electric condenser. Ignacy Moscicki and Jean de Modzelewski, 40, Chancery-lane, London. (Date applied for under Patents Act, 1901, Oct. 30, 1906, being date of application in Switzerland.) (Complete specification.)

23903. Improvements in carbon electrodes. Joseph Theodor Szek, Broad-sanctuary-chambers, Westminster.

23907. Improvements in electrolytes for the electro-deposition of copper and other metals. Henry Winder Brownsdon and Richard Alfred Ernest Payne, 35, Temple-row, Birmingham.

23908. Improvements in synchronised high-tension ignition systems for electrically firing internal explosion engines and the like. Joseph Howard Chambers and Peter Frederick Blaker Bennett, Arden Works, Heneage-street, Birmingham.

Oct. 30.

23914. Improvements in electric controlling devices. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

23915. Improvements in and relating to electric motor controllers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

23916. Improvements in and relating to alternating-current machines. Marius C. A. Latour, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Oct. 31, 1906, being date of application in France.) (Complete specification.)

23921. Improvements in alternating-current induction motors. Arthur Henry Kemp and Philip Kemp, 144, Stockport-road, Ardwick, Manchester.

23949. Improved method of and ingredients for the manufacture of a substance suitable for electrical insulation. Charles Hess, 173, Fleet-street, London.

23950. Improvements in or applicable to electroliers and in ceiling roses therefor. Grace Flora Woods, 4, St. Ann's-square, Manchester.

23956. Improvements in electric signs. Percy Good, 11, Southwark-street, London.

23957. Improvements in or relating to electrical contact breakers for use on internal-combustion engines. Sydney Slater Guy, 18, Hertford-street, Coventry.

23977. Improvements in or relating to electric telegraph apparatus. Sidney George Brown, 7, Southampton-buildings, London.

23983. Insulating end post for rail joints. William Elliott Karns, 165, Queen Victoria-street, London. (Complete specification.)

23991. Improved joint for parts which are required to be detachably connected together, especially applicable to electric incandescent lamps and holders therefor. Herbert Edward Theobald, 52, Chancery-lane, London.

24002. Improvements in or relating to electric motor controlling apparatus. Eugene Chaudoir, 173, Fleet-street, London.

24006. Improvements in and relating to electromagnetic relays. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

24017. Improvements in and relating to the measurement of electrical power. Vittorio Arcioni, 18, Southampton-buildings, London. (Complete specification.)

24023. Electro-medical apparatus. Reuben Swinburne Clymer and Thomas Mortimer Woodhouse, Norfolk House, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Nov. 7, 1906, being date of application in United States.) (Complete specification.)

24027. Improvements in and relating to arc lamps. Dagobert Timar and Karl von Dreger, 7, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Sept. 7, 1907, being date of application in Germany.) (Complete specification.)

24028. Process for decarbonising tungsten filaments containing carbon or carbide. Wolfram-Lampen Akt.-Ges., 7, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Oct. 31, 1906, being date of application in Germany.) (Complete specification.)

Oct. 31.

24074. Improvements in and relating to the measurement of electrical power. Vittorio Arcioni, 18, Southampton-buildings, London. (Complete specification.)

24079. Improvements in insulating conduit tubes for electric lines and cables. Thomas Taylor, Electric-avenue, Wilton, Birmingham. (Complete specification.)

24103. Improvements in electrical indicators. William Edward Lake, 7, Southampton-buildings, London. (The Auto Pump Company, United States. (Complete specification.)

24135. Improvements in alternating-current electric machines. Allgemeine Elektricitäts-Ges., 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Nov. 1, 1906, being date of application in Germany.) (Complete specification.)

Nov. 1.

24138. Improvements in electric arc lamps. Adrian Denman Jones, Hartham Works, Hartham road, Holloway.

24152. Improvements in the method of and means for fixing rose blocks of electric lamps to ceilings and walls. Thomas Charles William Tucker, 4, Corporation-street, Manchester.

24154. Improvements in or relating to magneto-electric machines. Vaughan Wickenden Robinson and Hermanus Willem Van Raden, High-street-chambers, Coventry.

24165. Electric enumerator for telephone calls. Samuel Dickinson Williams, 8, Faulkner-road, Newport, Mon.

24189. Improvements in cathodes for electro-deposition of metals. Alexander Hill, Birkbeck Bank-chambers, Southampton-buildings, London. (Douglas Lay, British Columbia.)

24197. Improvements in and relating to apparatus for the automatic distribution of telegraphic messages. Alphonse Lemoine, 7, Southampton-buildings, London. (Complete specification.)

24200. Improvements in or relating to electric and other switches or switch-operating devices. Giovanni Gaglio and Luigi Villani, 111, Hatton-garden, London. (Complete specification.)

24212. Improvements in electrical indicating or recording targets. James Yate Johnson, 47, Lincoln's-inn-fields, London. (Felten und Guilleaume-Lahmeyerwerke Act.-Ges., Germany.) (Complete specification.)

24231. Improvements in and relating to systems of electric distribution. The British Thomson-Houston Company, Limited, 83 Cannon-street, London. (General Electric Company, United States.)

24234. Improvements in and relating to magneto and dynamo-electric generators. Frederick Treeby Reid, 27, Chancery-lane, London.

Nov. 2.

24257. Improvements relating to rectifiers for alternating current. Samuel Wells Cuttris, Prudential-buildings, Park-row, Leeds.

24260. Improved means for operating from a distance electrical or fluid-pressure-driven organ-blowing apparatus. James Page, Sunny Hurst, Tempest-street, Lincoln. (Complete specification.)

24267. Improvements in or relating to apparatus for electrically lighting miners' safety lamps. Henry Mostyn Darrah and Frederick Perrins, 55, Market-street, Manchester.

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24288. Improvements in contact breakers for electrical ignition in internal-combustion engines. Robert Bosch, trading as the Firm Robert Bosch, Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Jan. 2, 1907, being date of application in Germany.) (Complete specification.)

24294. Improvements in and relating to electric bells. George William Mascord and Thomas Arthur Eyre Blake, 27, Chancery-lane, London.

24299. Process for obtaining cold electric light by means of high-tension electricity. Dagobert Timar and Karl von Dreger, 7, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Nov. 3, 1905, being date of application in Germany.) (Complete specification.)

24307. Improvements in and relating to galvanic cells having rotating electrodes. Adolf Steiner von Eltenberg and Heinrich Lach, 18, Southampton-buildings, London.

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Nov. 21.)

1906.

17086. Telephonic transmitters. Graham.

19378. Electric signalling apparatus for use on and in connection with railway locomotive engines and the like. Bonnevialle.

23896. Electric motor control systems. British Thomson-Houston Company. (General Electric Company.)

24336. Electric current converting dynamo-electric machines. British Thomson-Houston Company. (General Electric Company.)

24361. Multiple holder for electric incandescent lamps. Wallace.

24472. Underground boxes or chambers used in connection with underground electrical cables and for other purposes. Chambers.

24959. Gravity-fed arc lamp. Blanckensee, Mc'Mullen, and Mosey.

24968. Rotors for dynamo-electric machines. British Thomson-Houston Company and Dawson.

24973. Electric incandescent lamps. Lederer.

24986. Electrolytic deposition of metals. Cowper-Coles.

25204. Electric transformers. British Thomson-Houston Company. (General Electric Company.)

26033. Magnetic brakes for vehicles running on rails. Simpson.

23112. Electrically-driven machines for vacuum dust extracting, said machines being applicable for cleaning carpets, hangings, clothes, and the like. Higgins and Light Electric Motor Company.

26144. Electrolytic deposition of metals. Taylor.

27570. Magneto-electric generators for ignition in internal-combustion motors. Albion Motorcar Company and Murray.

27694. Brush gear of dynamo-electric machines and motors. Marshall.

29692. Commutators for dynamo-electric machines. Loring.

29757. Electroliers. Dafforn.

1907.

517. Electric accumulator and other cells. Leitner.

2121. Electrical fuse-boxes. W. T. Henley's Telegraph Works Company and Nichols.

3850. Trolley wheels as used in the trolley heads of electric tramcars worked on the overhead trolley system. Birkby and Birkby.

5223. Manufacture of electrodes for electrolytic purposes. Johnson. (Chemische Fabrik Griesheim Elektron.)

7177. Electric arc lamps. Mermod, Mermod, and Mermod. (Date applied for under International Convention, April 5, 1906.)

7519. Dynamo-electric machines having ring-wound armatures. Tingley. (Date applied for under International Convention, April 4, 1906.)

8913. Electric switches or circuit breakers. Bumpstead and Gover.

9483. Incandescent electric lamps. Triquet and Barrollier.

12552. Measurement of electrical energy. Conrad and Bradshaw. (Date applied for under International Convention, June 4, 1906.)

14087. Arc lamps for changing the luminous intensity in any given direction. Fortuny. (Date applied for under International Convention, June 19, 1906.)

14629. Regulation of electric circuits and means therefor. Siemens-Schuckertwerke Ges. (Date applied for under International Convention, June 26, 1906.)

14797. Boxed electric switches, fuses, and the like. Veritys, Limited, and Gott.

15594. Armature for magneto induction machines. Dymond. (Eisemann and Co.)

17360. Methods of manufacturing conductive filaments for use in electric lamps or other apparatus. Coolidge. (Date applied for under International Convention, Aug. 1, 1906.)

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £	Last price. £
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-⅝
—— Ord., 1,125 000	1 ..	⅛-¼
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 ..	⅜-½
—— Ordinary. Nos. 1 125,000	1 ..	3/16 5/16
British Aluminium Co., Ordinary, 2,001-40 000	5 ..	4-5 xd
—— 7 per cent. Cum. Pref., 1-40,000	5 ..	4⅞ 5¼ xd
—— "A" 6 per cent. Cum. Pref., 1-20 000	5 ..	4½-5
—— 4 per cent. Funding Certificates, 1-20 000	5 ..	3⅞ 4¼ xd
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	100 103
—— 5 per cent Loch Leven Deb. (Reg.) Red., 1-3 000	100 ..	96 99
British Insulated and Helsby Cables, Ord., 1-100,000	5 ..	6¼-7
—— 6 per cent. Cum. Pref., 1-100 000	5 ..	5⅞-6⅛
—— 4½ per cent. Mortgage Debentures	100 ..	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	85-89
British Westinghouse Elec. and Manuf. 6 per cent Pref., 275,001-375 000	3 ..	⅞-1⅛
—— 4 per cent. Mortgage Debenture Stock	100 ..	55 65
Brush Electrical Engineering, Ordinary, Nos. 1-105,751	2 ..	⅛-¼
—— Non. Cum., 6 per cent., Pref.	2 ..	⅜-1⅛
—— 4½ per cent 1st Debenture Stock	100 ..	83-86
—— 4½ per cent. 2nd Debenture Stock	100 ..	67-70
Callender's Cable, Debentures	100 ..	105¼-107½
—— Ordinary	5 ..	9½-10¼ xd
—— 5 per cent. Pref.	5 ..	5¼-5⅝
Consolidated Electrical Co., Ordinary, 1-110,000	1 ..	7/16-9/16
Crompton and Co.	3 ..	1⅞-2
—— 5 per cent Debentures	100 ..	86-93
Dick, Kerr and Co., Ordinary, 1 260 000	1 ..	1⅛-1½
—— 6 per cent. Cum. Pref., 1-305,000	1 ..	1-1⅛
—— 4½ per cent. Debenture Stock, Red.	100 ..	101-104
Edison and Swan United, "A" Shares, 1-99 261	5 ..	1-1¼ xd
—— "A" Shares, 01-017,139	5 ..	2-2¼
—— 5 per cent. Debentures	100 ..	87-90
—— 4 per cent. Deb. Stock, Red.	100 ..	83-85
Electric Construction, Nos. 1 to 112 100	2 ..	⅛-⅜
—— 7 per cent. Cumulative Pref.	2 ..	¾-1
—— 4 per cent. Perp. 1st Mort. Deb	100 ..	77-81
Electrolytic Alkali Co., Ordinary, 1-202,218	1 ..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock Red	100 ..	—
General Electric Company (1900) 5 per cent. Cum. Pref.	10 ..	8-8½
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	89-92
W. T. Henley's Telegraph Works, Ordinary	5 ..	10½-11½
—— 4½ per cent. Preference	5 ..	5- ½
—— 4½ per cent. Debentures	100 ..	105½-107½
India Rubber, Gutta Percha, and Telegraph Works	10 ..	14½-15½
—— 4 per cent. Debentures	100 ..	86-88
National Electric Construction Co., 1-170,000	1 ..	13/16-15/16
Parker, Thos., Limited, Ordinary	10 ..	10-10½
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-30,000	5 ..	—
Telegraph Construction and Maintenance	12 ..	27-30
—— 5 per cent. Bonds	100 ..	99½-102½
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10 ..	8¾-9¼

Electric Lighting and Supply.—

Name.	Amount paid. £	Last price. £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5 ..	4½-5
Bournemouth and Poole, Ordinary	10 ..	9⅞-10⅜
—— 4½ per cent. Cum. Pref., 7 501-15 000	10 ..	9⅜-10½
—— 6 per cent. Cum Second Pref., 15 001-22,500	10 ..	9½ 10⅜
—— 4½ per cent. Debenture Stock, Red	100 ..	99-102
Bromley (Kent) Electric Light and Power Co	5 ..	4⅜-5⅛
—— 4½ per cent. 1st Debenture Stock, Red.	100 ..	99-99 xd
Brompton and Kensington, Ordinary	5 ..	7-8
—— 7 per cent. Preference	5 ..	7¼-½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5 ..	6-7
—— Nos. 80,000-100,000	4 ..	5⅜ 6⅜
Cambridge Electric Supply Company, £10 Ord.	8 ..	12½-13½
Canadian General Electric Co., Common Shares	$100 ..	102-106
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100 ..	98-101
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5 ..	3⅜-4¼
—— 4½ per cent. Cum Pref., 1-80,000	5 ..	3⅜-3⅝
—— 4 per cent. Debenture Stock, Red.	100 ..	97-100
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5 ..	3⅜-3¾
—— ditto (1903) 40,001-80,000	5 ..	3¼-4¼
Chelsea Electricity Supply	5 ..	3¼-4¼
—— 4½ per cent. Debentures	100 ..	102-106
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000 ..	—
City of London, Ordinary	10 ..	8⅜-9⅜
—— 6 per cent. Cumulative Pref.	10 ..	1 1-11¼
—— 5 per cent. Debenture Stock	100 ..	122-125
—— 4½ per cent. 2nd Deb Stk. Prov. Certs. (all pd.)	100 ..	97-100
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1 630	£0 ..	50-53
Cor Jubilee Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100 ..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5 ..	3⅛-4⅛
—— 5 per cent Preference, 1-50,000	5 ..	4⅛-4⅜
County of London Elec. Supply, Ordinary	10 ..	6¼-7
—— 6 per cent. Cum Pref.	10 ..	10-10⅜
—— 4½ per cent. Debentures Prov. Certs. All pd., Red.	100 ..	107-110
—— 4½ per cent. 2nd Debentures Prov Certs	100 ..	97-98 xd
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5 ..	⅛-1
—— 6 per cent. Cum Pref.	5 ..	1-1⅛
—— 4½ per cent. First Mort. Deb	100 ..	76-81
Electrical Development Co. of Ontario 5 per cent. 1st Mort. 20-year Gold Bonds, 10 751-15 750	— ..	76-79 p.c.
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5 ..	2⅛-2⅜
—— 5 per cent Debenture Stock, Red	100 ..	85⅛-89
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red	100 ..	94-96
Folkestone Electric Supply, Ord., Nos. 1-10 000	5 ..	4⅜-4⅞
—— 5 per cent. Cum. Pref., Nos. 1-10 000	5 ..	4⅞-5⅛
—— 4½ per cent. First Deb Stock, Red.	100 ..	96-99
Hove Electric Lighting, Ord., 1-13 000	5 ..	6½-7
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red	100 ..	101-103
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Deb. Stk., Red	100 ..	92-95 xd
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1 ..	—
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000	5 ..	8¼-8½
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red	100 ..	98-102
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9⅜-10½

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Name.	Amount paid.	Last price.
	£	£
London Electric, Ordinary	3 ..	1¼-1⅝
—— 6 per cent. Pref.	5 ..	5-4½
—— 4 per cent 1st Mortgage Debenture Stock, Red....	100 ..	89-92
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red (Prov. Certs) all paid	100 ..	92-95 xd
Metropolitan Ordinary, 100 001- 00,000	5 ..	5¼-5⅜
—— 4½ per cent. First Mortgage Debenture Stock.....	100 ..	103-107
—— 4½ per cent. Cum. Pref.	5 ..	4⅜-5⅛
—— 2½ per cent. Mortgage Debenture, Red.	100 ..	87 92
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds. 1935, C 1-1,000 ($100), D 1-3,000 ($500), M 1 4,400 ($1 000)	— ..	72-74 p.c.
Mexican Light and Power Co., Capital Stock	$100 ..	38-40
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14 000 ($1,000)	— ..	82-84
Midland Electric Power Dis., 4½ p.c 1st Mort. Deb.	— ..	95-98
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009 ..	5 ..	6½-6⅜
—— do., 57,010-75 000	5 ..	6¼-6⅜
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid	5 ..	6¼-6⅜
—— 5 per cent., Pref., 1-57,009	5 ..	5-5⅛
—— do., 75,001-87,500 (issued at 10s. prem., 4s paid)....	5 ..	5-5⅛
Notting Hill Electric Lighting	10 ..	11 12
—— 4 per cent. First Mort. Debs. Nos. 1 500 (Reg.)	100 ..	95-97
Oxford Electric, Ordinary, 1-96 and 40 14,310	5 ..	5½ 6
—— 4 per cent. Debenture Stock	100 ..	96-97
River Plate Electricity Co, Ord., 1 119 687 & 120,501-120 507	1 ..	⅞-1
—— 6 per cent. Non-Cum. Pref., 1-100,000	1 ..	⅞-1
—— 5 per cent. Debenture Stock, Red	100 ..	95 98
Rosario Electric Co., 6 per cent Cum Pref., 1-20 000	5 ..	4⅞ 5⅜
—— 6 per cent. Cum 2nd Pref., 1-15,000	5 ..	4⅞ 5⅜
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	96 98
Shawinigan Water and Power Co., 5 p.c. Cons 1st Mt. Bds.	— ..	89-101 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5 ..	½ 1⅛
—— 4 per cent. Debenture Stock	100 ..	71-75
South London Ordinary	5 ..	2¼-2⅜
South Metropolitan Electric Light and Power, Ord.	1 ..	⅞-1
—— 7 per cent Cum Pref.	1 ..	15/16-1 1/16
—— 4½ per cent. 1st Mort. Deb.	100 ..	99 102
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	7¼ 8¼
—— 7 per cent. Pref.	5 ..	6-7
—— 3½ per cent. Deb.	100 ..	86-91
Urban Electric Supply Co., Ordinary, 8-30,007	5 ..	1⅜ 2⅛
—— 5 per cent. Cumulative Preference, 50 001 80,000....	5 ..	1⅝-2⅜
Westminster, Ordinary	5 ..	8¼-9¼
—— 4½ per cent. Cum. Pref., 110,101-138,251	5 ..	4⅜-5⅛

Electric Tramways.—

Name.	Amount paid.	Last price.
	£	£
Anglo-Argentine, 5½ per cent. Cum Pref., 1-250,007	5 ..	5⅞ 6⅛
—— Ord.	5 ..	7⅜-⅞
—— Permanent 6 per cent Debenture Stock, 1888	100 ..	131-134
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk, Red.	100 ..	102-105
Barcelona Tramways, Ord., 1-20 000	10 ..	—
—— 5 per cent. Cum. Pref. Shares, 1 10 000	10 ..	—
—— 5 per cent Deb., Red., 1 000	100 ..	—
—— 4½ per cent. Red. Deb Stock	100 ..	—
Bath Elec Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1 ..	11/16 13/16
—— 5 per cent. Cum. Pref. Shares, 1-75 000	1 ..	27/32-31/32
Birmingham and Midland Trams., 4½ p.c 1st Db. Stk, Red.	100 ..	94-97
Blackpool and Fleetwood Tramroad	10 ..	13⅜ 1⅞
Bombay Elec Supply and Trams. Co, 6 per cent Cum. Pref.	8 ..	7⅛ 8
—— 4½ per cent. Deb. Stock, Red.	100 ..	94-96
Brisbane Tramway Invest., Ord., 1-75 000	5 ..	3-3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4⅜ 4⅝ xd
—— 4½ per cent. Deb. Stk, Red., Prov. Certs. all pd ..	100 ..	98-100
British Columbia Electric Railway Co., Ord Def.	100 ..	128-133
—— Ord. Pref.	100 ..	113 116
—— 5 per cent. Cum. Perpetual Pref. Stock	100 ..	101 105
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	98-101
—— 4½ per cent. Vancouver Power Deb.	100 ..	102-104
British Electric Traction, Ord. 1-300,000 & 60,001-90 000	10 ..	1⅛ 2¼
—— 6 per cent. Cm Pf., 30,001-60 000	10 ..	4⅜ 5⅛
—— 5 per cent. Perpetual Debenture Stock	100 ..	94-97
—— 4½ per cent 2nd Deb. Stock	100 ..	74-78 xd
Bueno Ayres and Belgrano Trams	5 ..	4 7/16 4 11/16
—— "A" 6 per cent. Cm. Pf., 1-4 .000	5 ..	4⅛-5¼
—— "B" 6 per cent Cm. Pf., 1 27 500	5 ..	4⅜ 5¼
—— 5 per cent. Deb Stock, Red.	100 ..	105-115
—— Prov. Cert., all paid	100 ..	103-105
Buenos Ayres Electric Trams, 5 p.c Deb Stk., Red.	100 ..	92-97
Buenos Ayres Gd Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100 ..	99-103
—— 6 per cent. Deb. Bonds, Red., 1-2,675	100 ..	98-103
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	91 94
Calcutta Tramways, 1-105,000	5 ..	6⅛-7⅛
—— 105,001-137,610	5 ..	5 5¼
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	100 103
Cape Electric Tramways, Nos. 1-480,000	1 ..	⅛-⅜
City of Birmingham Tramways, 5 per cent. Cum Pref.	5 ..	4¼-4⅜ xd
—— 4 per cent 1st Mortgage Deb, 1-3 000 (1917)	100 ..	95-99
City of Buenos Ayres Trams. Co. (1 04), 1-248 000	5 ..	5¼-5⅜
—— 4 per cent. Deb. Stock, Red 1 85	100 ..	98-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	93-97 x l
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	1⅜-1⅝
—— 6 per cent. Cum Pref.	10 ..	12⅜-13⅜
—— 4 per cent. Debentures	100 ..	80-95
Dublin United Tramways (1896), Ord., Nos 1-60 000	10 ..	13-13⅝
—— 6 per cent. Pref., Nos. within 1-60 000	10 ..	12⅜-13⅜
—— 2½ per cent. Mort Debs., 1-3 000 Red	100 ..	90-95
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk, Red..	100 ..	97-100
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1,000 ..	85 90
Imperial Tramways, Ordinary	all ..	18-19
—— 6 per cent. Cum. Pref.	all ..	14-14½
—— 4½ per cent. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 20 001-60 000	5 ..	⅞-1⅛
—— 4 per cent. 1st. Mt. Db Stock, Red.	100 ..	66-71
Kalgoorlie Electric Tramways, 1-250,000	1 ..	3/32-5/32
—— 5 per cent "A" Deb. Stock	100 ..	89-93
—— 6 per cent "B" Deb. Stock	100 ..	74-78
Kidderminster and District Lighting and Traction, Pref.	5 ..	10- 0½
Lancashire United Tramways, Limited, 5 per cent Prior Lien Deb. Stock, Red.	100	94-97
—— £296 500 2nd Mort. Deb. Stock	— ..	—
—— £83,'30 Deferred Deb. Stock (all fully paid)	— ..	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-593,188	1 ..	1-1⅛
—— 6 per cent. Cum. Pref., Nos 1-425 553	1 ..	1-1⅛
—— 5 per cent. Mort Deb., 1-5 000 Red.	100 ..	92-97
London United Trys. (1901), 5 per cent. Cum. Pref.	10 ..	7⅜-8⅜
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100 ..	82-86
Madras Elec Trams. (1904) 5 per cent. Deb. Stk., Red.	100	96-99
Manila Elec. R.R. and Lightg. Corp., 5 p.c 1st Lien and Coll Tr. Sinkg. Fund Gold Bonds of 1953, Red. 1-16,635	$1,000 ..	90 92
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 201-21 635 and 23,436 25 000	— ..	4½ 5
—— 4½ per cent 1st Mort. Deb Stock, Red.	100 ..	96-99
Metropolitan Elec Trams., Defd., 1 000,001-1 314 016	1 ..	1/16 3/16
—— 5 per cent. Cum Pref. 500,001 1 000 000	1 ..	27/32-3 /32
—— 4½ per cent. Deb. Stock, Red.	100 ..	93-96
Mexico Trams. Co, Gen. Cons 1st Mort 50-year 5 per cent. Gold Bonds	— ..	80-82 p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con. Mort Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000 ..	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 201-2 000 1922	100 ..	101-103
New General Traction, 6 per cent. Cum. Pref., 1-10 000 and 24 001-74 000	5 ..	⅜-1⅛
Oldham, Ashton, and Hyde Tramway, Ordinary	10 ..	2
—— 5 per cent. Cum. Pref.	10 ..	8⅜-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100 ..	101-105
Potteries Electric Traction, Ordinary, 1-245.000	1 ..	5 15-9/16
—— 5 per cent Cum Pref., 300 001-545 000	1 ..	⅛-⅜
—— 4½ per cent Debenture Stock	100 ..	95-98
Provincial Tramways Co., Ordinary, 1-24 918	10 ..	4⅜-5¼
—— 6 per cent. Cum. Pref., 1-10 000	10 ..	10¼-11¼
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-20,000	5 ..	5 5⅛
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100 ..	97-99
Sao Paulo Tramway, Light, and Power Co.	£100 ..	108-109
—— 5 per cent. 1st Mort Deb., Red. 1929, 1-11,000	$500 ..	93-95 p.c.
South Metropolitan Electric Tramways and Lighting Co, 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1 ..	⅛-1
—— 4 per cent. Deb St ck, Red. 1-40	100 ..	80-84
Sunderland District Electric Tramways, 5 p.c 1st Mort. Debs, Red., 1-1 600	100 ..	84-88
Yorkshire (West Riding) Elec Tram. Co, Ord, 70 001-110,000	5 ..	1-1⅛
—— 6 per cent. Cum Pref., 1-46,261	5 ..	3¼-3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	87-90

Electric Railways.—

Name.	Amount paid	Last price.
	£	£
Central London, Ordinary	100 ..	54-57
—— 4 per cent. Pref.	100 ..	85-87
—— " deferred	100 ..	4 -43
—— 4 p c Deb. Stock (Prov. Script Certs, fully paid) ..	100 ..	10 -10⅜
City and South London, Consolidated Ordinary	100 ..	43-45
—— 4 per cent Debenture Stock	100 ..	101-103 xd
—— 5 per cent. Pref. Stock '91	100 ..	116-119
—— " " " '96	100 ..	115-116
—— " " " '01	100 ..	113 116
—— " " " '05	100 ..	108-111
Liverpool Overhead, 5 per cent. Pref	10 ..	10-10½
—— Ordinary, 1-50,000	10 ..	2¾-3⅛
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	— ..	44-49

Telegraphs and Telephones.—

Name.	Amount paid.	Last price.
	£	£
Amazon Telegraph Co., 1-25,000	10 ..	3-3½
—— 5 per cent. Debs., Red., within 1-1,069	100 ..	85-88
American Telephone and Telegraph Coll. Tr. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78 000	$1 000 ..	89 91
Anglo-American Telegraph Co., Ordinary	100 ..	51-54
—— 6 per cent. Preferred Ordinary	100 ..	91-94
—— Deferred Ordinary	100 ..	13¼-13⅜
Anglo-Portuguese Telephone Co, 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	99-102
Chili Telephone Co., 1-44,000	5 ..	6⅜ 7⅛
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red..	100 ..	85-89
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10 ..	6 7
—— 10 per cent Preference, 1-6 000	10 ..	15⅜-16⅜
Direct Spanish Telegraph Co., Ordinary	5 ..	3¼-3⅜
—— 10 per cent. Cum. Preference	5 ..	9-9½
—— 4½ per cent. Debs, 1-500	50 ..	98-101
Direct United States Cable Co.	20 ..	12½-13½
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1 1 200, Red.	100 ..	100-102
Eastern and South African, 4 per cent. Mort. Debs, within 1-3,000, 1909	100 ..	97½-100¼
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8 000, 1913	25 ..	98-100
Eastern Extension, Australasia and China, 1 300 000	10 ..	11-12 xd
—— 4 per cent. Mort. Deb Stock, Perp	100 ..	99-102
Eastern Telegraph Co., Ordinary Stock	100 ..	121-126
—— 3½ per cent. Preference Stock	100 ..	84-85
—— 4 per cent. Mortgage Debenture Stock	100 ..	99-102
Great Northern Telegraph Co. (of Copenhagen)	10 ..	30-33
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort Debs, within 1-1,200, Red.	100 ..	99-101
Indo-European Telegraph Co.	25 ..	52-55 xd
Marconi's Wireless Telegraph Co, Nos 25,128- 84,190	1 ..	¾-1
Monte Video Telephone Co., Ordinary 1-72,680	1	15/16-1 1/16 xd
—— 5 per cent. Preference, 1-86,492	— ..	⅞-1
National Telephone, Preferred	100 ..	106-108
—— Deferred Stock	100 ..	106-108
—— 6 per cent. Cum. First Pref.	10 ..	10¾-12⅛
—— 6 per cent Cum. Second Pref.	10 ..	10-12
—— 5 per cent Non. Cum. Third Pref.	5 ..	5¼-5⅝
—— 3½ per cent. Deb. Stock, Red.	100 ..	96-98
—— 4 per cent Deb. Stock, Red.	100 ..	100-102
Oriental Telephone and Electric Company	1 ..	1¼-1⅜ xd
—— 6 per cent. Cum. Pref	1 ..	1⅛-1⅜ xd
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1 000	100 ..	97-100
United River Plate Tele. Co., Ordinary, 1-100,000	5 ..	7-8 xd
—— 5 per cent. Cum. Pref., 1-40,000	5 ..	6⅞-7⅛
—— 5 per cent. Debenture Stock, Red.	100 ..	—
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100 ..	99-102
West African Telegraph Co.	10 ..	10-10¼
West Coast of America, 1-30 000 and 53 001-53,008	2½ ..	1-1⅛
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph ..	100 ..	97 100
West India and Panama Telegraph Co., Ordinary	10 ..	7/16-9/16
—— 6 per cent. Cum. 1st Preference	10 ..	7-8
—— 6 per cent. Cum 2nd Preference	10 ..	6⅞-7⅜
—— 5 per cent. Debs., Red., 1-800	100 ..	98-102
Western Telegraph Co., 1-207,930	10 ..	12½-13¼
—— 4 per cent. Debenture Stock, Red.	100 ..	98½-101⅛

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.							Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1907.	1906.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Oct. 30	1,230	1,231	- 4	— h	25½	25	May 31	64,071	15,530,351	1,379,723	0 98	11·14	2,512	6·45
Ayr Corporation	,, 19	213	196	+ 17	—	8	8	,, 15	14,528	3,316,380	353,945	1	9·71	1,830	5·16
Baker Street and Waterloo Ry.	Nov. 2	2 705	1,940	+ 765	+16,090	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 3	1 151	881	+ 17i	- 260	23 53	21·53	March 31	55,025	11,145,531	1,309,903	1·18	10·08	2,338b	6·03
Birmingham Corporation	,, 2	5 423	—	—	—	56½	—	,, 31	17,133	4,709,798	266,526	86	14·5	8,866	—
Blackburn Corporation	Oct 30	1,011	940	+ 101	+ 2 235	24	21	,, 25	48,875	8,661,720	986 953	1·35	11·69	2,036	7·44
Blackpool Corporation	,, 31	435	377	+ 63	- 1,401	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	,, 26	311	279	+ 32	- 1,139	16½	16½	Dec. 31	31,846	2,325,677	579,264	3·28	13 19	—	7·27
Bolton Corporation	Nov. 3	2 2 9	1,985	+ 263	+ 4,300	42	40	March 31	95 766	20,205,196	2,161,130	1·13	10·63	2,394	6·14
Bournemouth Corporation	Oct. 30	1,362	1,359	- 7	+ 907	17·41	16·82	,, 31	55,276	10,058,288	1,121,623	1·32	11 83	3,226	7·19
Bradford Corporation	Nov. 2	4,482	4 023	+ 459	+ 2,579	95	95	,, 31	230,085	47,108,000	5,053,392	1·172	10 927	2,396	—
Brighton Corporation	,, 3	763	750	+ 13	- 2,8 2	9½	9½	,, 31	50,339	11,321,160	1,152,82	1·06	10·48	,914·8	8·014
Bristol Tramway Company	,, 1	4 867	4,770	+ 97	—	51½	51½	Dec. 31	259,799	45,312,373	6 127,135	—	—	—	—
Burnley Corporation	,, 2	1,438	1,·18	+ 125	—	40	40	March 31	57,932	11,092,704	1,197,772	1·31	11·61	5,388	8 17
Burton Corporation	,, 2	270	—	- 1	- 424	8½	8½	,, 31	17,950	3,878,269	454,082	1·07	9·21	2,0 8	6·76
Cardiff Corporation	—	—	—	—	—	32 62	†32·26	,, 31	112,209	24,134,363	2,770,049	1·12	9·72	3,782	9·44
Carlisle Tramways Company	,, 2	168	181	- 13	—	8·5	8·5	Dec. 31	10,713	2,935 002	359,756	—	7·14	—	5.18
Central London Railway	,, 2	5,637	6,601	- 964	- 14,275	6	6	,, 31	347,588	4,875,547	1,261,214	1·86	65·10	57,931	5·80
Charing X, Euston, & Hamp. Ry.	,, 2	2 760	—	—	—	8	—	—	—	—	—	—	—	—	
City and South London Railway	,, 3	3,08.	2.830	+ 251	+ 8,320	6½	6½	,, 31	—	—	—	—	—		
Colchester Corporation	Oct. 25	20i	218	- 13	—	8	8	March 31	10,588	2,457,553	220,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	,, 31	4.0	427	- 17	- 523	15½	15½	Dec 31	24,895	5,814,376	882,256	1·01	6·64	—	4·69
Croydon Corporation	Nov. 1	1,3·6	—	- 45	—	12c	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 1	25i	243	+ 8	- 19	7 23	7·23	March 3	—	—	—	—	—	—	
Dover Corporation	,, 2	195	211	- 18	- 1 035	4½	4½	,, 31	11,250	2 853,200	284,343	·94	9·49	2,500	
Dublin and Lucan Electric Ry.	,, 1	113	102	+ 11	+ 231h	6¾	6¾	Dec 31	6,358	402,511	110,738	3·79	13·78	942	7 33
Dublin U.T.	,, 1	5 950	4,645	+1 305	+ 2) 149	48½	48½	,, 31	267,489	50,050,949	7,077,372	1·28	9 07	691	5 55
Dundee City Tramways	Oct. 30	1,114	1,044	+ 70	+ 719	22	22	May 1[illegible]	50,154	13 086 396	1,005 911	·906	11·36	2,180	7·42
East Ham Corporation	Nov. 2	868	80i	+ 62	- 20i	14	14	March 31	56,652	3,689,658	863,816	·64	10 18	2,934	6 79
Glasgow Corporation	Oct 26	17,947	17,0·7	+ 860	+ 9,579h	79½	79½	May 31	756,480	195,767,519	17,945,595	—	,0 12	—	—
Gloucester Corporation	,, 20	247	235	+ 12	- 183	15	15	March 31	15,465	3,902,077	563,595	·80	6·68	999	5·32
G.N., Piccadilly, and Brompton	Nov. 2	4,660	—	—	—	9	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	37	37	,, 31	74.019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 2	1.586	1,383	+ 203	+ 2,381	35	35	,, 31	69,938	12,838,150	1,665,262	1·24	9·71	1,923	—
Hull Corporation	,, 2	2,558	2,352	+ 205	+ 3,941	26	26	,, 31	112,651	27,102,921	2,910,698	1	9·29		—
Ilford Corporation	—	—	—	—	—	10½	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	Oct. 31	130	117	+ 13	+ 249	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	11,586	3,626,656	419,800	·737	6 62	1,480	5 22
Lancashire United Tramways	,, 30	1,2·9	1,052	+ 157	+ 13,22)	38½	28	—	—	—	—	—	—	—	—
Leeds Corporation	,, 31	6,314	6,214	+ 100	+ 8,300	89½	89½	March 25	298,233	64,223,666	7,121,038	1 10	10 02	351	—
Leicester Corporation	Nov. 2	2,119	2 090	+ 28	—	42	42	Dec. 31	26,011	12 039,252	1,229,507	1	9·79	—	4 82
Liverpool Corporation	Oct. 26	10,6·8	10.814	- 196	+ 7.429	104	104	,, 31	547 625	116,642 663	12,166 419	—	—	—	—
Liverpool Overhead Railway	Nov. 3	1,538	1,425	+ 113	+ 1,728h	6·65	6 65	June 30	81,302	11,171,865	1,024,275	—	—	—	—
London County Council	Oct. 26	31,700	25,967	+4,733	+155,813	98	98	—	—	—	—	—	—	—	—
Lowestoft Corporation	Nov. 2	183	177	+ 6	—	6	6	Sept. 30	14,511	3,128,867	359,435	1 08	9·68	2,630	6·48
Maidstone Corporation	—	—	—	—	—	2	2	March 31	4,740	850,121	112,227	1 33	10 13	2,370	
Manchester Corporation	,, 2	15,044	13 545	+1,499	+33 8 4	149	149	,, 31	631,956	126,900,875	14,123,124	1·19	10·73	4,299	6·39
Metropolitan District Railway	,, 2	8,145	8,325	- 180	- 641	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 3	15,449	15.4.7	+ 32	+ 5,774	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 2	129	127	+ 2	- 24	2¾	2¾	,, 31	6,159	1,992,647	206,358	82	7 14	2,239	—
Newcastle-on-Tyne Corporation	,, 2	4,02i	4,0·6	- 11	+ 587	50	50	,, 31	197,849	43,063,934	4,326,152	1 07	10·98	3,957	7·0
Newport (Mon.) Corporation	,, 2	631	536	+ 35	+ 1,709	15½	15½	,, 31	30,356	7,252,535	783 435	—	9 29	—	6·4
Oldham Corporation	—	—	—	—	—	34	34	,, 25	65.553	13,466,245	1,504,740	1 16	10·45	1,886	—
Portsmouth Corporation	May 25	2,330	1 578	+ 752	+ 632	28½	28½	,, 31	95,702	19,625,329	197,499	1·17	11 63	—	—
Reading Corporation	Oct. 31	610	583	+ 27	- 728	33½	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	11·29	21·29	,, 31	14,881	2,837,110	386,547	1·24	9·24	1,102	7 92
Rotherham Corporation	—	—	—	—	—	9½	9½	,, 31	23.569	5,251,472	593,054	1 07	9·53	2,612	7·49
Salford Corporation	Nov. 4	4,605	4,378	+ 227	+ 4,033	70¾	70¾	,, 31	214,111	39,213,560	4,894,590	1·28	10·29	—	—
Scarborough Tramways Co.	—	—	—	—	—	4½	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 3	5,590	5,018	+ 572	+ 8 301	35¾	35¾	,, 25	240,565	63,952,283	,049,899	903	9 543	3,653	5·94
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,365	9 294,771	1,108,369	1·27	11·02	—	7·83
Southend-on-Sea Corporation	Oct. 30	304	273	+ 31	- 86	9	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	,, 31	39,550	6,766,031	1,027,730	—	9 23	—	4 75
Sunderland Corporation	,, 20	1,347	1,345	+ 2	- 557	20	20	,, 31	64,858	15,364,463	1,495,785	1·004	10·36	—	6·37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	4,937	1,315,757	102,751	0·87	11 53	1,371	—
Torquay Tramways	Oct 31	171	—	—	—	5·16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	Nov. 2	763	706	+ 57	+ 725	12 68	12·43	,, 31	43,607	7,995,451	862,12	9·27	12·14	3,132	7·50
Warrington Corporation	—	—	—	—	—	9	9	,, 31	17,057	4,418 225	403 363	—	9 85	—	6·33
West Ham Corporation	Oct. 31	2,162	2,075	+ 87	+ 1,211	14·7	14·7	,, 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	,, 30	332	816	+ 16	+ 242	20	20	,, 31	41,905	8,847,066	950,338	—	10 583	2,062	6·1o

† And 98 miles of interlacing track. a Train mile. b Per mile of single track. c Miles of route. h Half-year's figure k Double track.

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NOTES.

Royal Institution.—A Christmas course of illustrated lectures, adapted to a juvenile auditory, will be delivered at the Royal Institution by Sir David Gill on "Astronomy Old and New." The dates of the lectures are Dec. 28 (Saturday) and 31, 1907, and Jan. 2, 4, 7, and 9, 1908, at 3 o'clock.

Nernst Incandescence Lamps.—Mr. W. Nernst has been at work on the production of a conductive incandescence body, the result of which is to be found in a recently issued patent. For the production of such bodies a tungstate of thorium, zirconium, yttrium, or the like is heated in hydrogen or other reducing gas so as to give an intimate mixture of tungsten and rare earth. The tungstate is obtained by the chemical action between the rare earth and a compound or alloy of tungstate, such as oxide, chloride, or nitride; for example, oxide of thorium or of zirconium may be melted in an iridium crucible by means of an oxy-hydrogen blowpipe, together with tungsten acid, in the proportions required by the formula ThW_2O_8 or ZrW_2O_8. The bodies produced may be used in a vacuum or indifferent atmosphere, preferably with alternating current, and in series with a resistance, which may be of iron.

Bavarian Railway Electrification.—It is calulated that by the electrification of the State railways in the Bavarian highlands there will be a yearly average saving of 16s. to 19s. per horse-power to start with, and from £2 17s. to £5. 9s. when the traffic has increased by 50 per cent., which may be in 15 to 20 years from the time of introducing electric power. The trunk line from Munich to Lindau, 137 miles long, and all the lines south of it will be the first to be electrified; for that purpose 92,000 h.p. will be necessary, and in this particular case the annual average economy would amount to £3. 15s. per horse-power, or about £345,000 in all.—With regard to the Bavarian telegraphs and telephones, the British consul reports that experiments have lately been made between Berlin and Munich (distance 322 miles) to test Prof. Korn's well-known invention of transmitting pictures by electrical appliances connected with telegraph wires. Other experiments have also been made to use the direct cable between Munich and Zurich (distance about 210 miles) for the simultaneous transmission of telephonic and telegraphic messages. The cable is overhead except the short subaqueous portion of it which connects the Bavarian with the Swiss shores through the Lake of Constance.

Blackfriars Bridge Widening Works.—A visit of the Junior Institution of Engineers was recently paid to the Blackfriars Bridge widening works, through facilities kindly extended by the engineer, Mr. Basil Mott, M.I.C.E. The members, about 100 in number, were received by the resident engineer, Mr. D. Anderson, and Mr. H. Cunningham, engineer to the contractors (Messrs. Sir William Arrol and Co.). Divided into groups, they were first shown the working drawings, and a description of the operations being carried out was given. The existing fascia and parapet on the up-river side are being removed for the insertion of three additional ribs at 10ft. centres, increasing the width by 30ft, and making the distance between parapets 105ft., the roadway to be 73ft. wide and each footpath 16ft. The London County Council tramway will be laid on the western side. The members in the course of the inspection saw the last one of the pier caissons to be sunk, on the staging preparatory to being let down from overhead girders by means of hydraulic jacks. The air-compressor, cranes, hoists, etc., are worked electrically by current supplied from the public mains, so that the smoke nuisance may be entirely avoided. Altogether a most enjoyable afternoon was spent in the examination of the numerous features of engineering interest, and before dispersing the members' acknowledgments were conveyed by the chairman of the institution, Mr. Frank R. Durham.

Society of Arts.—A programme of the arrangements for the forthcoming session of the Society of Arts has come to hand, giving a list of the various lectures which have been fixed. The session (which is the one hundred and fifty-fourth session) will open on Wednesday, Nov. 20, when Sir Stewart Colvin Bayley, vice-president and chairman of the council, will deliver an address. The ordinary meetings of the society will be held on subsequent Wednesday evenings, but of those arranged to take place before Christmas we are chiefly interested in that one fixed for Dec. 11, when Sir William Ramsay will deliver the Aldred lecture, entitled "Radioactive Phenomena." Among the other meetings arranged we note that Sir E. W. Brabrook will deliver an address on "Old-Age Pensions," while a discourse will be presented from Prof. H. S. Hele-Shaw and Mr. Douglas Mackenzie on "The Problem of Road Construction, with a view to Present and Future Requirements." One of the Shaw lectures on industrial hygiene will be delivered by Dr. J. S. Haldane on the subject of "The Removal of Dust and Fumes in Factories." The Howard lectures will be delivered by Prof. Hele-Shaw on "The Navigation of the Air." These will be given in March and April next year. Altogether the arrangements are of an excellent character, and go far towards the realisation of the aim of the society, which includes that of assisting in "the advancement, development, and practical application of every department or science in connection with the arts, manufactures, and commerce of this country."

Turbine Generating Stations.—A paper outlining recent developments in steam turbine generating stations, with special reference to the Spy Run station of the Fort Wayne and Wabash Valley Traction Company, was presented by Mr. J. R. Bibbins at the recent annual convention of the American Street and Interurban Railway Association. It was shown that a Westinghouse-Parsons turbo-generator of large size requires only $\frac{1}{20}$ square foot of floor area per generator horse-power, which is less than one-fourth of that required by a horizontal Corliss, and less than one-third of that occupied by a vertical Corliss. In a few very large stations (above 10,000 kw.) the investment cost has been somewhat less than £20 per kilowatt. In the Spy Run 8,500-kw. station the total cost was £13. 5s. per kilowatt of total generating rating. This cost was distributed as follows: building, £2. 5s.; generating plant complete, £6. 3s.; boiler plant, £2. 15s.; condenser plant, 16s.; coal-handling plant, 2s.; erection superintendence, engineering, and miscellaneous, £1. 2s. It is interesting to note that a positive pressure fan has been installed to ensure ventilation of the generators. This system of ventilation has the advantage of maintaining low generator temperature throughout the whole year. Moreover, a large excess of air can be supplied to any of the units that may for any reason be overloaded abnormally. Thus the fan blast in a generator auxiliary allows greater overload to be carried without damage. A report of the paper appeared in our esteemed contemporary, the *Electrical World* of New York.

Australia.—The scheme for the electrification of the Victorian railways, which was so much talked about by Mr. Bent, the Premier, while in London this summer, continues to absorb public attention in the colony. Mr. Charles H. Merz, who is being consulted on the matter, should have reached his destination by now, and his report

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will be awaited with interest. But, according to a statement recently made by the chairman of the Railway Commissioners, it appears that the scope of Mr. Merz's inquiries is limited to specific instructions given by Mr. Tait. He appears to be limited to expressing opinions as to the best means of conversion, if determined upon by others, and the financial results. The recommendation as to whether the conversion in whole or in part is actually to take place is left apparently to the Commissioners. It is doubtful, however, if the railway conversion scheme will take place for some time, for, apart from other considerations, the fares are low and the service very good under steam. Notwithstanding the fact that the recently-instituted protected tariff is designed to encourage electrical manufacturing in the colony, foreign rivals are straining every nerve to gain an entry into Australia. A friend of ours writes that they have had visits recently from several Continental firms' representatives. In fact, he says, Germany, Austria, and Belgium are pushing their trade in Australia, especially the first-mentioned country, and, he adds, some very poor lines are now getting on the market. The people, he says, do not know better, and he mentions that several installations have had to be taken down. Here, surely, is a chance for British manufacturers, to whom the Commonwealth Parliament have granted a preference in tariff rates.

Loch Loven Water-Power Scheme.—Good progress has been made this summer with the contracts for the development of the vast water-power resources at Loch Leven in Argyllshire. It is now calculated that fully 35,000 e.h.p. will be obtained. To get this power a huge dam is now being constructed at a point inland about 5½ miles from the head of Loch Leven. Three separate lochs are to be united, giving a total length of water reservoir of nine miles. This great body of water will be utilised to drive turbines and work a factory for the manufacture of aluminium. This factory is under erection at Kinlochleven, near the sea, and the water will be conveyed to the power-house by a conduit four miles long, and thereafter by a pipe line a mile and a quarter long. The wall of the dam is in length fully three-quarters of a mile. At the base the width is 63ft. It rises to a height of 80ft., and the width at the top is to be 10ft. A foundation is had in the rock, the minimum depth being 5½ft. The conduit is covered in, and is of concrete strengthened with expanded metal sheets. It is 8ft. square, and it is computed that as the average inclination is 1ft. in 1,000, the water will flow at the rate of 8ft. per second. In order to get an early start at the manufacture of aluminium, a temporary factory will be at work early next year. A wooden conduit 3½ft. square will bring a supply of water from a river nearer at hand than the huge reservoir, and this temporary installation will be used until the great works are ready. Sir John Jackson, Limited, hold the contract for the dam and hydraulic works. The British Aluminium Company, who, along with the Loch Leven Water Power Company, are the promoters of this costly undertaking, have already a factory at Foyers, in Inverness-shire.

Experience with Gas-Engines.—Some particulars respecting experience with the gas-engine generating plant at the Somerville Park station of the Boston Elevated Railway Company are of interest at the present moment, when the question of gas-driven plant is well to the fore. The information was given at a meeting of the American Street and Interurban Railway Association by Mr. Paul Winsor, chief engineer of motive power of the Boston Company, and is reproduced in the *Electrical World*. The Somerville station is equipped with two 600-h.p. Crossley gas-engines supplied by a pair of Loomis-Pettibone gas producers, the engines being direct connected with 350-h.p. Crocker-Wheeler generators. The plant was started in May, 1906, and since then there have been no shutdowns, accidents, or failures. Ignition current is supplied by 14-volt generators in connection with floating storage batteries. The igniters originally had platinum tips, which were expensive and gave considerable trouble, but during the past four months they have been operated without platinum and with less trouble. The average coal consumption during the period from January to August of this year was 2·034lb. per kilowatt-hour, or 1·404lb. per brake horse-power hour. This showing is larger than that of last year, when 1·45lb. per kilowatt-hour was reported. The paper states that the smallness of this figure was due to errors in weighing and checking coal. During the same period of seven months the coal consumption of the steam plants average 3·477lb. per kilowatt-hour, thus showing a superior efficiency of 41·5 per cent. for the gas-engine plant. In conclusion, Mr. Winsor said he believed that a gas-engine plant making its own producer gas will operate at least as reliably as a steam plant, and will use from 30 to 60 per cent. less fuel, depending somewhat upon the size of the steam plant with which it is compared. The drawbacks of the gas plant are, first, cost, which approximates £40 per kilowatt when rated so as to have a 33⅓ per cent. overload capacity; and, second, the small size of units, the statement being made that the largest gas-engine now built is only of 3,000 kw. capacity.

Lighting in Schools.—Very few modern schools are erected in which electricity is not employed as the illuminant, while in some of the older schools the lighting is being converted from gas to electricity. In schools of the latter type, the arrangement of the lights is generally of a most haphazard character, many of them having been carried out before illuminating engineering was ever dreamt of as a science in this country. In consequence of this, the results obtained have never been of the most satisfactory character, either from the point of view of efficiency or of economy. While in modern schools, illumination is arranged for on a more scientific basis than hitherto, there still remains much to be done before anything like perfection is reached. This important subject has been discussed at one or two congresses of those interested in school hygiene, which may be taken as a sign that educational reformers are as alive to the necessity for improving the methods of illumination in schools as are engineers and architects. But here there arises the question as to whether gas or electricity is the superior form of illuminant for schools. The hygienic advantages of the former over the latter are admitted on all sides, but there is still much doubt as to the relative economies, notwithstanding the growing use of electricity for lighting schools. In this respect we came across an interesting report which the Education Committee of the London County Council presented at a meeting of the Council on Tuesday. "We have," say the committee, "for some time past considered the relative merits of the systems of gas and electric lighting in Council schools. Gas lighting by means of plain burners has been practically superseded in the Council's schools by the introduction of incandescent mantles, which have been found preferable from the points of view of economy and efficiency. Our principal endeavour has therefore been to obtain an accurate comparison of the merits of incandescent gas and electric lighting. As regards hygiene and general efficiency, electricity possesses many advantages over gas, but from exhaustive comparative tables which we have had before us it would appear that the cost of maintenance is about 50 per cent. higher. We are informed, however, that the present type of incan-

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descent electric lamp is likely to be superseded in the near future by metallic film lamps, which will, it is anticipated, effect a very great saving in the consumption of current, and may even render electricity a cheaper illuminant than gas." The statement as to comparative cost is, of course, very general, and it would have been instructive had the committee afforded us an insight into the method of comparison.

Institution of Civil Engineers.—The presidential address of Sir William Matthews, delivered at the opening meeting of the present session of the institution, touched upon many subjects. But it was quite natural that that branch of the profession which Sir William has made his own should receive particular attention, and it followed that his remarks were confined principally to recent developments in shipbuilding, and in tracing the influence of these developments on harbour and dock accommodation. Lighthouses and signalling coming within those "branches of engineering work which are associated with over-sea traffic" were briefly referred to by the president, who stated that the introduction of incandescent oil burners had effected an improvement in the efficiency of lighthouses. The committee of scientific experts who investigated in 1884-5 the question of the relative merits of electricity, gas, and oil for lighthouse work reported with respect to electricity that, notwithstanding its greater ratio of diminution in intensity as distance increases, its vastly higher initial power renders it visible at a greater distance in hazy weather than the highest powers tried in gas or oil. The committee also reported that oil was the most suitable and economical illuminant for ordinary use, and that electricity should only be adopted for important headlands or landfalls where a very intense light is needed. Since then, however, many improvements in arc lamps have been effected which have immeasurably increased their efficiency for lighthouse work, and Sir William Matthews admitted that at some of the electric lighthouses on the English coast where flame carbons had been introduced, the tinted beam of light produced by the chemical treatment of the carbons rendered it much more penetrative, under favourable atmospheric conditions, than the white electric beam. With reference to the general equipment of docks and wharves, he said that hydraulic power possessed advantages for coal hoists, the actuating of dock gates, for lifting sluices, and not improbably also in manipulating swingbridges. But for the ordinary crane equipment of docks and quays, electric power had demonstrated its equality with hydraulic power, and in some cases its superiority. He regretted, however, that there were as yet so few figures available as to the actual cost of working a dock entirely equipped with electric machinery. If, however, the actual figures showing working costs are not available, it may be assumed that the latter are of a satisfactory nature, otherwise we would not witness such an increase in the installations of electric plant in connection with docks and harbours as is taking place if the experience hitherto obtained with this class of machinery did not warrant the extensions.

The Grounded Neutral.—The controversial question as to whether the neutral of high-tension alternating-current systems should be grounded or not, and if grounded, whether it should be through a resistance or direct, continues to attract discussion without nearing a solution. It formed the subject of discussion at a recent meeting of the American Institute of Electrical Engineers, when three papers expressing different points of view were presented. In one of these Mr. Paul M. Lincoln discussed the matter from the point of view of the operating engineer, arguing to some extent in favour of grounding the neutral, and presenting a number of considerations to be taken into account when the question arises. Mr. Lincoln does not draw any general conclusion from his arguments, but it may be gathered from the evidence which he adduces that the proper action to be taken should depend upon the specific conditions surrounding each individual case. Mr. George J. Rhodes related the experience with a grounded neutral on the high-tension system of the Interborough Rapid Transit Company, particulars of which appeared in this journal on Nov. 2, 1906. The chief circumstance which led to the grounding of the neutral on this company's system was the serious nature of cable burn-outs. As a rule, the detectors gave indication of a ground on one leg of the system from five to thirty minutes before the circuit breaker opened, but, on account of the large number of feeders connected, it was practically impossible to isolate the damaged feeder before the short-circuit occurred. From the data brought forward by Mr. Rhodes it is evident that grounding the neutral of the Interborough system through a series resistance has been quite successful. It seems to have greatly reduced the disturbance from cable burn-outs and the time necessary to restore an injured cable to service. On the other hand, Mr. F. G. Clark, in a paper contributed by him, strongly opposes the grounding of the neutral through a resistance, and gives an account of a high-tension installation where the question of grounding the neutral was investigated, and in connection with which he recommended that the limiting resistance which was proposed should be omitted. Thus, the views brought to light, while being very well as expressions of opinion, cannot be said to point to any general conclusion. They may be aptly summed up in the words of Dr. C. P. Steinmetz—viz., that the system should not be grounded where grounding is not necessary. He expressed this view as opposed to the idea of grounding everything unless there is a special reason to the contrary. It may make a difference, he said, whether the system is an overhead transmission system or an underground cable system in city streets. Resistance in the grounding is used where it is judged unsafe to ground without.

Single-Phase Traction.—In a succinct review of a very comprehensive subject, Mr. Philip Dawson, in the *Street Railway Journal*, presents the case of single-phase and continuous-current traction. His arguments lead to the conclusion that for continuous-current motors to bear comparison with alternating-current motors, motors of at least half the required pressure advantageous for operation and distribution must be commercially produced. Such high-pressure motors would also necessitate the use of rotary conversion, or their equivalent continuous current at 6,000 volts to 10,000 or even 15,000 volts. From this it must not be inferred, however, that nothing is being done to perfect the high-pressure continuous-current motor. Several firms are working in this direction, and there are on the market at present such motors and controlling apparatus which are quite workmanlike and highly satisfactory. What Mr. Dawson attempts to show is that "the single-phase motor as at present constructed possesses great and real advantages which make it admirably suited to the requirements of railways working under all conditions and just as suited to handling heavy suburban traffic as long-distance traffic, to which latter field only many, particularly American, engineers would have it relegated." The operations which are about to be conducted on a large scale should enable us to draw satisfactory conclusions from the three examples of single-phase main-line railways where suburban traffic is electrically handled. The "Victoria - London Bridge" section of the London, Brighton, and South Coast Railway should be completed early next year; the Hamburg-Ohlsdorf-Blankenese is now working experimentally; while the New York, New

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Haven, and Hartford Railway is now being operated regularly. By the end of next year, therefore, some real facts should be available which will be of great assistance to railway authorities in guiding their future actions, and which, at the same time, may have an important bearing upon the electrical industry. It is but natural that Mr. Dawson, who is identified with the most important single-phase equipment to be introduced into this country so far, should be a warm advocate of single-phase traction, and time will show whether the sanguine expectations reach fulfilment in actual practice. Meanwhile, it is noteworthy that single phase is being more widely adopted for railway electrification. The recent decision to electrify the Berlin Stadt and Ring Railway with the single-phase system is a case in point. The complete plan embraces some 366 miles of track. The voltage employed on the trolley will be 10,000, and motorcar trains, probably of the two-car form of the Allgemeine Elektricitäts-Gesellschaft, like those on the Hamburg-Altona line will be used. The first section is to be electrically equipped by 1913 and the entire system by 1920. This decision certainly upholds the view of Mr. Dawson. But a more remarkable feature is the courage of the authorities in adopting the single-phase system on such a large scale, in spite of the dearth of reliable results obtained from actual operation, under working conditions.

Electric Signs.—One has only to walk at night through the busy thoroughfares of our leading cities to find proofs of the great and extending employment of electric illuminated signs. The unattractive, stereotyped sign which has served so long is now being found out of harmony with the requirements of the day, and the most progressive tradesmen, realising that sensible advertising is the essence of modern business, are finding in the electrically-illuminated sign an effective advertising medium. The importance of electric signs lies in the fact that they attain their highest usefulness during the hours when the business thoroughfares are crowded with pedestrians from all parts of a district, who cannot fail to notice an illuminated sign, especially if it displays any novel features. The usefulness of the ordinary sign, on the other hand, is limited to but a few out of the 24 hours, and even during those hours non-electric signs do not possess any striking advantage over electric signs, which serve a very useful purpose during the day. This is a phase of central-station business which is capable of infinite development in this country, where the advantages of electric illuminated signs are not nearly so widely appreciated as in the United States. At present, electric publicity, if it may be so termed, is extensively adopted by a few firms renowned for the production of articles of world-wide use, and in many busy centres electric signs are familiarising the passers-by with the names of these commodities. Places of amusement, especially in London, are likewise adopting this method of advertising, which in their cases is facilitated by the provision of "interchangeable" letters. This form of sign is particularly useful where a permanent electric sign is fitted, requiring frequent change of notice. The constantly changing names of artists announced outside music-halls, the names of plays for theatre porticos, the music played by an orchestra, the names of public speakers, the destination of the next train at a railway station—these are some of the purposes for which interchangeable signs are especially advantageous. Outside these spheres, however, electric illuminated signs seem to be making little headway. It would be a mistake to confine this class of business to too narrow boundaries, since sign advertising in one form or another seems limited to hardly any line of trade or mauufacture. Electrical undertakers should realise that the electrical sign has already proved to be a self-advertising feature of electric lighting service, and that with a little additional energy in "pushing" it among consumers it will become an important phase of central-station business. If, therefore, novelty and originality are imparted in the manufacture of the electric sign, it should eventually replace the old-style non-electric sign, that must perforce quit work at sunset. What is essential is that the electric sign should be put on a definite business footing in this country, and that a complete system of electrically-illuminated advertising should be perfected. Added to these the energies of the central station, there should be little fear of this branch of trade languishing into the realms of chance jobbery.

Free Residence Wiring.—Many ingenious schemes have from time to time been devised with a view to increasing the success of electricity supply undertakings, all of which have, more or less, fulfilled their aim. But a scheme which can hardly be said to have justified itself by results is that whereby electrical undertakers carry out for themselves the wiring work in connection with houses or residences. Free wiring has been tried in a great many towns, but experience has shown that it is more economical, and more conducive to the sale of electricity for lighting and power, for the undertakers to confine themselves to the business which they are empowered to carry on under the Electric Lighting Act—*i.e.*, the distribution of electrical energy over their allotted area—and to leave to the contractors the task of canvassing for and installing installations on premises. That is now the general practice in this country, though there are one or two towns in which the municipality as electrical undertakers have adopted the free-wiring principle. Bearing in mind certain disastrous results that have followed the adoption of this principle in England, it is interesting to compare them with some results that have accrued in the States. Mr. J. F. Vail, general manager of the Pueblo and Suburban Traction and Lighting Company, has furnished the *Electrical World* (New York) with some information respecting the free wiring of 1,200 residences in Pueblo. The condition with which the company was confronted was that in a town with about 5,000 dwellings only 2,000 were electrically lighted. The company wired the houses and installed drop cords free. The customer paid for the lamps and for any fixtures he might want. An extra charge was also made for wiring a porch lamp with a switch. The company employ 25 wiremen, most of whom were boys learning the business, working under competent supervision and earning about £8 per month. The cost of wiring the first 348 houses was £1. 10s. 6d. per house. In these houses there were 2,387 drop lamps, making the cost 4s. 2d. per lamp, and the average number of drop lamps per house about seven. The second set of 116 houses wired under the more rigid requirements cost £2. 4s. per house with 786 drop lamps at 5s. 2d., the number of lamps per house being about seven. The cost for 532 houses was £11. 10s., being about £2. 3s. per house. In this figure is included the time spent by the canvassers on this class of business, which amounted to about 10 per cent. of the total cost, and a further 10 per cent. was added to the cost shown on the books to provide for the use of teams, storeroom expense, etc. The actual cost of wiring came below the company's preliminary estimates, and the revenue which these customers have brought in amounts to more than that estimated. It was thought before the work was begun that it would pay to do it if a revenue of 6s. per month per customer could be secured. There is a minimum bill of 4s. Mr. Vail states that as a matter of fact these 1,200 customers have increased the company's revenue an average of £600 per month, or £7,200 per year. This

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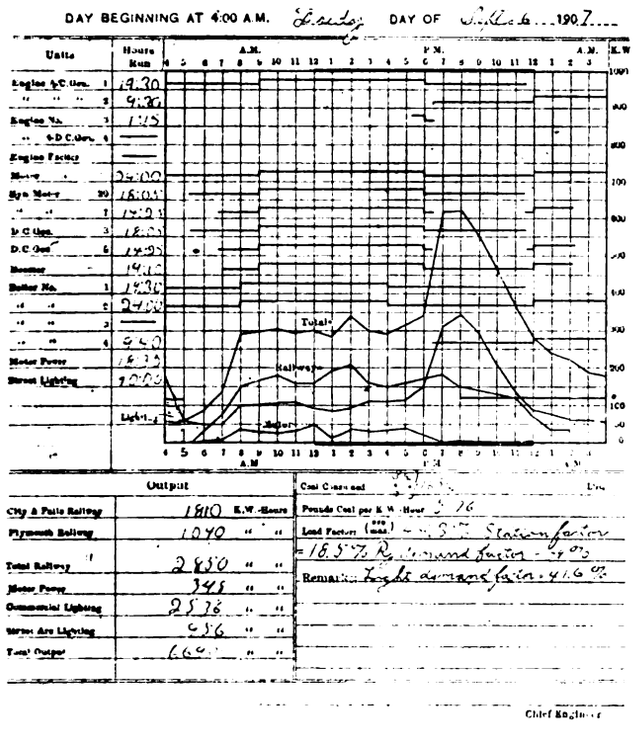
seemed to be a rather high figure for such a class of houses. However, Pueblo is a railroad and manufacturing town, and the class of people who live in small rented houses of the kind wired are inclined to be extravagant users of any commodity as long as they have money. We should think that there are very few places where the conditions are as favourable for this class of enterprise as Pueblo.

A New Power Station Report.—The accompanying form of power station report, for which we are indebted to our New York contemporary, the *Electrical World*, has been in use for the past six months by the Sheboygan Light, Power, and Railway Company, and has also been adopted by the Milwaukee Northern Railway Company. The record is very simple, is easily read, and can be understood at a glance. Possibly the only explanation required is the little break in the straight lines, indicating the runs of the various units. This little break in the straight line is put in to show the time when the men changed shifts.



The amount of apparatus in operation during the hours of peak load can be seen at a glance, and it is very readily observed if any machine has been run too long after the peak was off or if it was started too late. The time of switching on and off the street lamps is also shown by the last straight line at the bottom. The load curves are obtained by reading watt-hour meters in the power station every hour. This has been found very practical, and no extra trouble for the power station force. The method of making up these curves is interesting. All of the charts and curves are made by the engineer in charge of the shift at the power station, and they involve no labour of any kind at the office. The pads are accurately registered, and a carbon copy sheet is put under the first leaf. The power station engineer or his assistant then plots a curve every hour by making pencil points with an ordinary lead pencil. At the end of his shift he connects all the pencil points with a line. The engineer on the next shift does the same thing. In this way the manager has a complete history of the power station in the most complete form available at all times. The load factor given is the percentage which the average load is of the maximum. The station factor is the percentage which the average load is of the total capacity of the station. The railway demand factor is the percentage the maximum railway load is of the station capacity, and the lighting demand factor is the corresponding figure for the lamp load.

Foreign Trade Returns.—The aggregate value of the imports for the month of October, as disclosed in the Board of Trade returns, show a larger increase as compared with last year than in either of the two previous months, while the exports, too, show a striking increase in value. However, it is not our purpose at present to deal with the question of our foreign trade as represented in the latest statistics, but to extract from these statistics figures showing the movements of electrical commodities. We find that during the month of October the import of telegraph cables and apparatus reached an aggregate value of £106,155, which, compared with the corresponding month of the preceding year, marked a decrease of £8,011, or 7·01 per cent. For the 10 months of the present year the value of imports of this class of goods is returned as £1,043,688, an increase of £65,156, or 6·6 per cent., compared with 1906. Under the heading of articles wholly or mainly manufactured, we find that of wire (including telegraph and telephone wire) 3,863 tons, valued at £43,148, were imported during October, compared with 4,875 tons, valued at £52,501, during the corresponding month of 1906. The imports of wire during the first 10 months of 1907 and 1906 amounted respectively to 49,022 tons, valued at £528,524, and 48,987 tons, valued at £503,157. Electrical machinery was imported last month to the extent of 715 tons, valued at £55,531, compared with 868 tons, valued at £53,171, in October, 1906. The value of the 6,297 tons of electrical machinery imported during the 10 months of this year is returned as £502,172, compared with £488,323, the value of the 6,240 tons imported during the first 10 months of last year. It will thus be seen that as far as concerns the import of electrical commodities which are given separately in the returns, the past month has shown an all-round decrease compared with the same period of the preceding year; on the other hand, the aggregate for the first 10 months of the two years in question shows, on comparison, slightly in favour of the present year. Turning now to exports, we find that under the heading of telegraph cables and electrical apparatus there was an increase during the past month (compared with last year) of no less than £401,821, or 317 per cent., the figures being £528,533. The increase for the first 10 weeks is not so startling, however, for the total value of the exports of this class of goods, which amounted to £2,231,563, represents an increase of £168,061, or 8 per cent. Both in quantity and value does the export of wire (including telegraph and telephone wire) show favourable increases for last month, the quantity, 5,431 tons, valued at £93,808, showing a marked increase when compared with 3,899 tons, valued at £67,321. The export of this commodity for the 10 months of the year has thus been brought to an aggregate of 45,747 tons, which bears a value of £827,645, compared with 36,537 tons, valued at £45,747, last year. Under the heading of electrical machinery, too, there are good advances; the export for October being 1,240 tons, valued at £94,830, compared with 864 tons, valued at £58,495. The returns relating to this commodity for the first 10 months are issued as follows: 1907—quantity 11,141 tons, value £828,788; 1906—quantity 9,333 tons, value £670,170. The export of electrical goods (not including machinery, telegraph, and telephone wire) of foreign and Colonial origin last month reached a value of £18,868, compared with £15,301 for October, 1906, thus bringing the total figures for the 10 months up to £142,537, compared with £96,974 last year.

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GAS-ENGINE PECULIARITIES AS COMPARED WITH THOSE OF THE STEAM-ENGINE.

BY HORACE ALLEN.

In the numerous Press notices referring to internal-combustion engines the writers have frequently taken as a basis of comparison, in regard to the design of the machine, the modern practice of steam-driven engines, but few, if any, have dealt with the peculiarities of the application of gaseous fuel when employed to develop power in competition with its much older rival. As in the comparison of the mechanical design, where it is sometimes wrongly assumed that experience with steam-engines has had a very material influence upon the design of modern gas-engines, much more so is there a necessity for the peculiarities of gaseous fuel to be studied and treated on its own special conditions, as differing from steam practice. Especially where gas-engines have been applied for driving electrical generators in power stations have instances occurred of reverting to steam power, even after very considerable extensions of the gas plant and engines have taken place, during periods of time running into years.

In this connection the most recent case of reverting to steam in an established gas-engine driven station is that of the central electricity station at Walthamstow, Essex. This station was opened seven years ago with three 100-h.p. Westinghouse vertical type gas-engines direct coupled to Helios (Suter) dynamos for supplying direct current, and Dowson gas generators, with scrubbers, gasholders, etc., provided the fuel gas. A fourth set of 100 h.p. was soon added, followed by three 250-h.p. sets. In 1904 this was increased to 10 sets by the addition of three 265-h.p. sets. Seven Dowson gas generators were required to supply the gas, and batteries of a discharge capacity of 250 kw. were also included in the installation, the total capacity of the station being 1,350 kw. and the voltage 230 and 460. A reference to this plant in the *Electrical Review*, Feb. 26, 1904, said: "This plant has been most successful, has never had a shutdown, and is furnishing electrical energy for lighting and power with a remarkably small consumption of coal." *Public Works* of Sept. 15, 1904,* gave a description of this installation, from which the following notes are extracted. At the time the article was written this was the only public installation in this country entirely driven by producer gas. The writer referred to previous attempts in this direction, quoting Coatbridge, 1894; Belfast, 1895; Northwich, King's Lynn, Redditch, Saltburn, Leyton, and Galway. With the exception of Northwich, these stations were not very successful, while it was said of the Walthamstow works that they had been remarkably successful in every way. The failure of some of these installations may be attributed to such defects as (1) commencing with too small unit sets, with dynamos belt driven; (2) nuisance due to vibration, noise and vibration of air, due to exhaust discharge; (3) back firing.

In the Walthamstow case none of the above defects were said to exist, as the vertical type of gas-engine employed was free from vibration, noise of exhaust, or back firing, and was situated in close proximity to a number of dwelling-houses; while in regard to the electrical part of the installation the writer states that: "The electrical plant, from the dynamos to the switchgear and cables, remains unmodified by the substitution of gas for steam as the prime mover." The reduction in staff and quantity of fuel required for a given output are mentioned as being important items contributing to the economy of the gas installation over a similar power steam plant. The Dowson producers were of the pressure type, four being situated in the original producer house and an additional three in a new house. The consumption of fuel was less than 1lb. per brake horse-power, while many electricity works driven by steam require from 6lb. to 9lb. for the same power output. By the addition of more sets the total capacity was brought up to 1,900 kw. The smaller engines' speed was 260 r.p.m. and the larger ones 200 r.p.m., and as the cranks were set at 120deg., an impulse was given at every two-thirds of a revolution. Governing was not of the hit-and-miss system, but by controlling the mixture, and electrical ignition was employed. In fact, it was claimed for the installation that the system of gas driving and type of engine were in every way superior to steam driving, and it comes as a surprise to find a correspondent to the *Wednesbury Herald*, Sept. 28, 1907, writing that: "The system had had a good trial at Walthamstow, where there have been 13 gas-engines in the station, and from the moment of their installation four fitters have been kept constantly employed in doing nothing but execute repairs," and also alleges that: breakdowns were continuous; noxious smell arose from the engines; premature ignition caused most of the troubles, due to carbonisation of the lubricating oil in the cylinders; ignition took place in the crank chambers due to leakage of gas mixture past the piston rings; finally, that steam is now being put in to overcome the troubles. The same correspondent refers to Redditch, where, also, steam has been reverted to after experience with gas power. These allegations were replied to by the borough electrical engineer of Walthamstow in a letter, describing them as inaccurate, stating that it is perfectly untrue that "four fitters have been constantly employed in doing nothing but execute repairs." The engines "are not continually breaking down," but goes on to say: "*The newspaper correspondent makes no mention of electrical troubles, thus implying that the engines have been the sole cause of any breakdown that may have occurred, whereas the principal faults have been with the dynamo armatures.*" (The italics are ours.) Trouble from premature ignition was denied, as was also ignition in the crank chamber, except a few times in one engine a year ago, which was not due to leakage of pistons. He further stated that there is no intention of disposing of the gas-engines.

In the case of the Redditch gas installation, in 1906 the engineer stated that: "It is my opinion that gas-engines are all right for continuous-current work where a battery can be used to steady the pressure and take up any little irregularity that may occur in the running of the engines; but in our case, where the engines were used to drive alternators, the results obtained were most unsatisfactory." Writing again in 1907, the same engineer states that "a continuous-current station can be successfully run by up-to-date gas-engines."

We are, therefore, faced with the anomaly that at Walthamstow gas-driven continuous-current sets with associated batteries are to be replaced by steam power because of troubles due to dynamo armatures, according to the station engineer, while according to the Redditch engineer, if the Westinghouse engines employed at Walthamstow are to be considered "up to date"—and the description of these in *Public Works* would indicate this to be the case—the conditions were such that, both from economy of fuel, cost of attendance, etc., with battery power, the installation should have been quite satisfactory; while, if the breakdowns and other faults were due to the electrical generators, how can these be improved by reverting to steam power?

A leader in the *Wednesbury Herald* of Oct. 12, 1907, refers to a writ having been issued on account of noxious smells, but is it probable that this would account for giving up gas power? The correspondent to the same paper allocates this nuisance of noxious smells to the engines themselves, and goes further to allege that these smells were so objectionable that smoking was permitted in the station, and that the glass roof was obscured.

A review of most of the information available to the public as to the reasons for reverting to steam power would indicate that gas-engine plant has certain peculiarities, and the sooner these are acknowledged and overcome the better for the gas-engine with its high economy and other advantages. In this connection it may well be borne in mind that there are thousands of gas-engines being run on illuminating gas, and a large number of large power gas-engines driven by blast-furnace and coke-oven gas, which are not in any way likely to be replaced by steam plant; also, the general conditions of gas-power plants differ greatly from those of steam boilers and engines. In the case of a steam-boiler, any noxious smells due to the combustion of the coal, etc., are carried away by the chimney stack, and there are none emanating from the engine; a gas producer has no chimney

* "A Gas-Driven Electric Light and Traction Plant," by Arthur H. Allen, A.M.I.E.E.

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stack and should be in a well-ventilated position. Gas-engines of all descriptions should be so disposed in well-ventilated buildings, that all leakage of gas and noxious fumes will readily diffuse and pass away. Unlike the steam-engine, the troubles which may arise with a gas-engine have to be anticipated, for in many cases they cannot be rectified without a stoppage of the engines for cleaning valves or adjusting the ignition.

The successful running of a gas-engine is dependent primarily upon the provision of an explosive mixture and means of ignition. In engines fitted with a simple ignition tube or spark gap, any failure of these amounts to a breakdown, the equivalent of which does not exist in steam practice. Methods of ignition have greatly improved, and can be depended upon for long-continued runs, providing that the scrubbing of the gas is maintained at its proper efficiency. In special cases high-power and single-cylinder engines are fitted with two points of ignition or duplicate systems, but this is only necessary where extreme reliability and freedom from stoppage are especially desired. In the matter of lubrication gas-engines differ very greatly from steam-engines, for whereas insufficient lubrication is very detrimental, excess of lubricant is accompanied with much worse results. When the lubricant gets into the combustion chamber and becomes charred two bad results follow. On charring there are fumes given off, which deposit on the walls of the combustion chamber and ignition points, as well as escaping with the exhaust, and accounting for the noxious fumes. Motor 'buses and all other internal-combustion engines give off noxious fumes if there is an excess of lubricant. The charred residue does not become completely gasified, but remains incandescent, and brings about premature ignition and back firing. It will be obvious that when once the combustion chamber and ignition apparatus becomes fouled there is little chance of rectifying the unsatisfactory conditions existing without stopping the engine and cleaning the affected parts, which means the equivalent of a *breakdown* as compared with steam practice.

In some cases, it is difficult to say how many, the attendant is responsible for the troubles. In the experience of the writer, a man in charge of a gas-engine which had been running for some hours found that the impulses were failing, and shortly the engine stopped. Not knowing the cause of the stoppage, he set to work to take the cams off the half-speed shaft, but on the examination of the gas it was found that there was air leaking into the gas-tube, causing combustion, with the result that only burnt gas reached the engine. As a parallel to this may be mentioned the case of a man in charge of a Corliss steam-engine, who knew so much about the mechanism that he had the valve gear to pieces nearly every day; upon the engine being placed in charge of a different man it gave every satisfaction. In some other cases *expert* (?) gas-engine men have been replaced by intelligent labourers with good results.

The springs controlling the valves and other gear of internal-combustion engines are sometimes accountable for stoppages. It is not so much the employment of springs that causes the trouble, as (1) their being frequently too strong, when inertia effects arise; and (2) their being in such inaccessible places, that when breakage occurs they cannot be replaced without dismantling part of the engine, thereby causing stoppage or breakdown. When springs are so arranged as to be accessible, it frequently happens that they can be renewed without interruption of the running of the engine. It is quite a common thing to replace springs connected to the exhaust-valve spindle while the engine is running, and this would be the same if the other springs were accessible. As in the case of motor drivers, who after spending a long time in tinkering with the ignition and other gear and failing to get the motor to start, bethink themselves of the petrol supply and find that it has run out, even so it is frequently the case with other internal-combustion engines. A stoppage occurs—and it is an experience to have a 600-h.p. single-cylinder engine pull up and refuse to move—and owing to uncertainty as to the cause much time may be wasted in working in the wrong direction. Outside the matter of failure through breakage, which is not now being dealt with, it is not always an easy matter to determine the cause of an engine stopping. It might be due to some interruption in the electric ignition gear—some makers provide a "window" through which the attendant can readily see if a spark is produced in the combustion chamber—but it is not wise to dismantle this without due consideration, though in all internal-combustion engine stoppages this point is the first to suspect.

Sufficient has been said to indicate that the internal-combustion engine requires understanding both by the designer and operator to enable it to retain its advantages over steam-driven plants. That faults in the design or management of the gas producer have in some cases contributed to the condemnation of gas-power installations is common knowledge, the most striking recent example being that of the Johannesburg tramways power plant in South Africa. Failure to effectually scrub the gas previous to its entering the gas-engine cylinder not only prevents the proper cooling of the gas to make it as dense as possible, but allows of condensible hydrocarbons entering the combustion chamber. The gas-engine not only then gives out a lower power than it is capable of, but fouling of the cylinder and ignition points results, followed by premature ignition, back firing, and stoppage. When these conditions occur they can only be remedied by a thorough cleansing of the engine and associated apparatus. In one of the plants mentioned as having reverted to steam the engineer told the writer that frequently the producer gas reached the engines in a hot state, and one or more of the engines started back firing, and the only thing they could do was to shut down these engines until cleaning could be effected.

ECONOMIC CONSIDERATIONS ON THE MANAGEMENT OF PLANT.*

BY W. H. PATCHELL.

The functions of your president appear to be practically ephemeral, as he has no place in your council, and so is not able to do much in shaping the course your association is to steer during his year of office. The position is peculiar, but after all "the proof of the pudding is in the eating," and if the committee can show such progress as this association is making in membership, and such a high-class programme of papers for the session as that just issued, surely your president has no reason to complain, but has every right to feel proud of being in the chair. Every autumn presidential addresses fall around us like the leaves, and when your president only has one opportunity of being useful it is incumbent on him to try to do the greatest good to the greatest number rather than to ride some favourite hobby. The secretary reports that an inspection of the roll of members reveals the fact that very nearly every phase of engineering is represented, and that the members are in charge of important installations comprising steam, gas, oil, electric, and various combinations of all systems. The laws of humanity surely prohibit dealing with the whole of these in one presidential address, so in case any individual finds his particular line has been rather lightly dealt with he must please try to feel socialistic for once. As the majority of the members of this association are engaged in the supervision and operation of existing plants, rather than in the design and erection of new work, a few thoughts concerning the economical operation of plant may be more profitable than an academical dissertation on design.

My first point is suggested by the rigid exclusiveness of this association, which has rightly set itself a high ideal of membership, and even more rightly will not lower its standard until experience has proved it to be wrong, which does not seem at all likely under present conditions. The standard required is that a candidate must have served an apprenticeship or its equivalent, and be equipped with a thorough practical experience. In these days of hurry and stress there is a great tendency to cut the time of apprenticeship in the shops too short, but very great importance must be attached to this part of a man's training, not only because it gives a knowledge of the practical side of his duties which can be obtained in no other way, but it gives

* President's address delivered before the Association of Engineers-in-Charge, Nov. 13, 1907

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what is equally important to an engineer—a knowledge of men at the time of life when the student is most likely to benefit by it, and is not too old to have the two sides of the question duly impressed on him. No man can learn to work a machine by reading books, and he is even less able to get the best out of the human machine by academical research.

It is rather surprising to find so few engineers from electric lighting stations on the roll of members. From experience I know full well that their difficulties in getting away to attend meetings are greater than generally obtained Meetings are held during the time of the peak load, when resident foremen are expected to be on duty, but in cases where they can get away they would find the time spent at the meetings of the association both interesting and profitable, while their joining would help to materially strengthen the association. An engineer-in-charge must have indicated some talent for organisation before he was appointed to the post, but how few there are of us who could not with profit further study and develop the talent. The happy knack of getting the best out of a staff comes naturally to a few, but, like every other talent, it may be developed by care and attentive effort. The man who can lead his staff without driving them, and by honourable skill can gain their cordial confidence and support in the most trying circumstances, is working at a high efficiency.

A common fault is manifest by the close attention to the detail of one particular point while the rest of the concern runs wild and, for the time being, unheeded. A skilful leader will know all that is going on, point out to his staff the lines on which they are to work, and help them individually to fill in the detail while leaving them to develop themselves in doing so. Men who have come to the top are neither those who have found it necessary to do every job themselves—this only occurs in those who are unable to impart knowledge to others—nor are they those who sit in an office writing memoranda to their staff. An American Government official lately put the matter in a few words that are well worth quoting: "To attain to the highest success as an engineer you must not be the type of man who knows how to do things but cannot tell others how to do them—the man who gets knowledge abundantly but can apply it only through his own fingers. Instead of directing your energy simply to increasing your own output by 50 or even 100 per cent., it is far better—you make yourself more useful to the world—by using your energy to increase the output of each of 100 men by 10 per cent. The world recognises this by awarding the prizes to the administrators."

In spite of tempting offers from authorised undertakers, either municipal or company, and the well-seasoned allurements of the promoters of bulk supply schemes, the majority of large institutions still generate their own supply. In many cases the amount of steam used for the electric light engines is small as compared with the amount used for heating and other purposes, so that even in the event of electricity being bought outside the domestic demands for steam would prohibit the shutting down of the boiler plant. In several American cities steam is supplied through mains laid in the streets, and in some cases operated as a by-product by electric supply companies. In some cities private plants have been taken over by the electric supply companies who have undertaken the heating business with results satisfactory to both sides, but there are at present no records of such service being undertaken in this country. The present price of coal and the thirst for information displayed by the Local Government Board render economical working of the whole of their plant more than ever important to engineers-in-charge.

Water Supply.—Water is often taken from the mains when it might more profitably be taken from a well on the premises. Twenty years ago the number of tube wells in the London basin was very small. The older class of well-sinkers stoutly maintained the necessity of a costly sunk well, with perhaps a tube or tubes at the bottom of it Gradually, however, the bored well proved its reliability, and the low price and simplicity of the system has led to a popularity which some years ago would have appeared impossible, or at any rate quite improbable. Direct-acting steam well pumps are in many cases looked upon as "steam eaters," and the disadvantage of having to draw the rods and bucket has led to the adoption of geared pumps, or, when the water supply is plentiful, of the air-lift system, which can claim a record for capacity, and couples reliability with the advantage of having all the working parts on the surface, and an economy at any rate well within the range of commercial requirements. When a change from supply from the mains to a well on the premises is contemplated, the class of water obtainable in each case must be considered. Questions of pollution and sand must also be considered, as mentioned in the discussion of Mr. Shenton's paper on "Small Water Supplies," read before this association last year. In many cases an air-lift or a borehole pump may be driven from an existing large engine, and the extra cost of working the pump is hardly perceptible. Even when a special engine is employed the cost of fuel on a well-designed plant is small.

Of course, it is impossible to forecast exactly what supply will be obtained from a tube well, and perhaps the old sunk well was convenient, as it was easy to drive from the bottom of it either for prospecting or increasing the yield, but for moderate supplies the bored well appears to be the cheaper project. An instance of the uncertainty is shown in the case of two 13in. wells within 100 yards of each other. One borehole yields 4,000 gallons for an hour or so, when the yield gradually falls to 2,000 gallons and remains constant at that point. The other borehole yields 27,000 gallons continuously. In this case the air-compressor is high speed driven by an electric motor taking 40 kw. when lifting 27,000 gallons per hour 96ft. to the surface. In one case, where a gas-producer plant and engine drives a compound equipment consisting of an air-lift pump, which raises the water 120ft. to the surface, and of a plunger pump, which drives the water to a reservoir at a head of 180ft., the cost of fuel used when raising 11,500,000 gallons of water has been under £27, or ·55d. per 1,000 gallons. On the same site a three-throw deep-well pump driven by an engine using town gas pumped 17,000,000 gallons at a cost for fuel of 1·26d. per 1,000 gallons pumped. The town gas was charged at 3s. 3d. per 1,000 cubic feet. At another place an air-lift pump driven by a motor taking 68·5 kw. is lifting 17,300 gallons per hour 262ft.

Water softening is much too large a subject to be handled in one paragraph, as the various systems would have to be dealt with in detail. One system was described by Mr. Lassen before this association in 1905, and it is only my desire now to remind members that it is not economical to feed impure water into a boiler. If the water is of a scale-forming nature, the loss in heat is very serious owing to the deposit of scale on the tubes or plates. If only sludge, or a concentrated solution of salts, is formed the loss in blowing down is also great, although in these latter cases the cost of labour in cleaning is less than when hard scale has to be removed. One of the simplest and most efficient forms of purifier is the open heater. Many varieties are on the market, differing rather in the application than in principle. When such a type can be used it is certainly preferable to a system which turns the pump-room into a whitewash factory, with an uncertain outlet for the by products. I believe one of the strongest arguments in favour of our present London water supply is the low death-rate, which is quoted to show its special suitability to our uses. We have only to return home from a visit to districts more favourably situated to realise how hard our lives are, and to wish that more consideration was paid to those who use soap or evaporate the water and less to those who die!

Fuel.—The great rise in the price of coal has necessitated the consideration of the more economical use of it and of the possibility of using cheaper qualities. Many users who previously burned "large" have found relief in the use of "small" or "nuts," not only in connection with mechanical stokers, but also for hand-fired boilers. Where the draught is poor or the grates small, necessitating a large combustion per square foot, a grade of fuel which will permit an ample amount of air to pass through it is essential. There are several forms of firebar designed to burn small coal, but a bar of the usual shape with small air-spaces will serve very well with a normal draught if the stoker can only be per-

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suaded to keep his fires thin. Thin firing is especially important with small Welsh of the drier kinds, as if a mistake is then made and the fire worked too thick, the application of the pricker only results in making matters worse, and the fire is quickly poked out. Steam jets under the grates form a simple, though rather noisy, means of assisting the draught, but unless the nozzles are carefully watched the proportion of steam blown under the grates to that evaporated by the boiler assumes most uneconomical dimensions, 12 to 15 per cent. being by no means unusual. The jets are also apt to cause local heating and damage to the boiler plates and firebars.

Where the draught can be assisted by a fan it will be found much more economical than the steam jet method. Forced draught has an advantage as regards the size of the fan required, as the air blown under the grates alone has to be handled, while an induced-draught fan has to handle the same weight of air, in addition to the gases of combustion, at a higher temperature, and consequently increased volume. The induced-draught system is generally preferred where the chimney draught only has to be assisted occasionally, such as on peak loads, and it has the advantage that the ashpans then need no alteration, but may be left open, and there is no chance of flames being blown out of the firedoor. It has a disadvantage, however, when dry Welsh coal is being burned, as grit is more likely to be ejected from the chimney. The regulation of the draught by the dampers has not received the attention it deserves. Automatic regulators have been placed on the market, but the sale of them must have been small, as they are rarely met with. To get the best results when hand firing, the air admission, and also the chimney dampers, need careful manipulation, and this is a strong point in favour of mechanical stoking, as then the ideal conditions of long runs without opening the doors may be realised.

Gas analysis has of late years received attention, though for many years it was ignored alike by experts when testing steam-boilers and by the users of boilers; it is only of late years that the percentage of CO_2 in the flue gases has been recorded on boiler tests. Thousands of tons of coal are wasted yearly by the neglect of the subject. The average amount of CO_2 in the gases may be taken at about 7 per cent., which means a loss of 26 per cent. in the calorific value of the fuel. Greater care would increase the percentage of CO_2 to, say, 12 per cent., which means a loss of 15 per cent. only, and would represent a saving of 10 per cent., which would quickly pay for the apparatus involved. The benefit of recording the CO_2 in the flue gases was first realised in Germany, whence the earlier types of instruments were developed. Since their introduction into this country many of the faults in the earlier types have been eliminated, and some of those now on the market merit a much larger recognition than has yet been accorded to them. In many German works it has long been the custom to pay the stokers a premium on the amount of CO_2 recorded, with beneficial results. A sight hole to enable a stoker to see the combustion without opening the firedoor is a very useful adjunct to a furnace, as an intelligent stoker soon notes what colour indicates that the boiler is doing its best, and learns how to regulate his operations to obtain that colour. When boilers are set in battery the hole can only be placed in the front, but the best place is at the side behind the bridge.

Purchase of fuel by analysis is very important, but when we consider the ease with which coal merchants can sell their stock, it is not surprising that they do not generally view the system with favour, and resent the incorporation of such clauses in their contracts. More united effort will be needed to get them educated up to this equitable method of buying fuel. Experience gained by several years' trial has proved to me that sampling and analysis may be done quite commercially under a contract which states the amount of volatile hydrocarbons and ash allowable, with a penalty if the amount of ash is exceeded. Air leakage through boiler settings is a common cause of low efficiency, not only in the case of water-tube boilers, but also in shell boilers of every type excepting the wet-back marine. Asbestos rope is a most useful draught stopper when either built in between the brickwork and the boiler, or caulked lightly in afterwards. It is sufficiently elastic to allow the boiler to expand when hot without moving the brickwork. Cracks in walls should be promptly stopped. In some cases where the ashpans are fitted with doors the stokers are apt to regulate the draught by them, and to leave the full chimney suction on the boiler and setting. It is better practice to regulate by the outlet damper.

Mechanical stokers have, unfortunately, too often been recommended like patent medicines, but the purchasers have found that stokers doing excellent service under certain boilers are useless under others. Of late years much more thought and skill has been applied to the problem, with a resultant gain to all concerned. Even now, due to competition, the makers' estimates are apt to be too sanguine, and best results not only in economy of fuel, but particularly as regards repairs, may often be obtained when working the machines below their rated capacity. When selecting a stoker more care than is sometimes displayed should be taken in choosing a type which will burn different classes, and certainly different sizes, of fuel. For instance, if a stoker is arranged to burn only clean nuts, as the market sometimes calls for more nuts than are made, the price is inflated. Smaller grades are tried, but the waste due to riddling through the grates is then excessive, and the lesser evil is to continue burning nuts, as the design of stoker has debarred the use of the cheaper fuel. Where only one or two boilers are in use no saving in labour can be made by the adoption of mechanical stokers, as the man who is necessary to tend the stokers might as well do the firing himself. A saving may, however, sometimes be effected on the class of fuel used, but this saving must be very definite to be commercial, as the upkeep of the stoker has to be provided out of it.

Steam superheating, although increasing rapidly in favour, is still conspicuous by its absence in many plants where it could very readily be adopted with a distinct gain in economy. No matter whether the steam is to be used in an engine or for heating purposes, the gain due to superheating is very marked. The ill-effect of condensation in steam-pipes is cumulative, and the application of steam-traps to remove the water offers a fine field for further waste. I am glad to see that a paper on this important subject forms part of the programme for this session. Pipe covering is frequently only literally applied, all the flanges being left bare. Although gills and flanges are recognised as necessary adjuncts on radiator pipes, it is strange that when an attempt is made to prevent radiation from steam-pipes these are the very parts which are usually left bare. The excuse is sometimes offered that leakage and the necessity for attention to joints prevents the adoption of covers to flanges. If the joints are properly made and the flanges stiff, they may be safely covered up and their existence almost forgotten. The water formed by condensation at a flange will often cause a leakage that would never have occurred if steam only had been present.

Water heating by economisers may be adopted where the draught is good, and the heat in the gases can be spared as in mechanical draught installations. An economiser, as was shown by Mr. Melville last session, is not only a direct source of economy in itself, but the hot feed water increases the evaporative capacity of the boiler, and, what is more important still, it prevents local cooling, and so saves straining the boiler. Internal heating apparatus is again coming to the fore. Several types are now on the market which are, perhaps, more useful than novel. The older types of this apparatus gave trouble from water hammer when the pump was stopped. This fault must be carefully guarded against. The makers of later models deny any trouble of the kind. When economisers are used care should be taken to prevent cold water being pumped into them, as it causes sweating and rapid deterioration.

Water heaters, both of the open and closed type, are most valuable in the case of non-condensing plants. An open heater will raise the temperature of the water to the temperature of the exhaust steam, as there is no loss due to the head necessary to drive the heat through the plates or tubes as occurs in a closed heater. The scale and deposit formed may be quickly removed from the trays upon which

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it settles, access being obtained by doors which only need to be exhaust-steam tight, no pipe joints or pressure joints have to be disturbed. The facility with which the water can give up the air absorbed in it is another point in favour of the open heater, as such air is apt to cause pitting in the boiler. An objection to open heaters is that they must be put in the suction side of the pumps and at some elevation above them, otherwise the hot water vapours under the pump bucket and the pump loses its water. Where the water is hard special care should be taken to catch in a settling tank or filter any small crystals of lime which do not stick on the trays, otherwise the pumps may get badly cut. Closed heaters, whether of the plate or tubular type, very quickly drop in efficiency, due to the deposit of scale on the water side and oil on the steam side of the heating surfaces, and so increase the normal difference in temperature between the steam and water. They are much more difficult and costly to clean than open heaters, and so the evil cleaning day is kept off as long as possible.

Air heating has been tried again and again, but it is very doubtful if it pays. Perhaps the greatest advantage it possesses is in the suppression of smoke, and in that field it certainly has an important place. Smoke prevention has been run hard both by fanatics and by those who are really anxious to see trade carried on upon a commercial basis with the least possible inconvenience either to the traders or their neighbours. All who have considered the matter will admit that, although black smoke means waste, it is not equally true that a smokeless chimney means economy. On a series of tests the lowest efficiency was recorded with a minimum amount of air, and the highest with a moderate amount of air, when some smoke was made. Every effort should be made to prevent the emission of smoke, the underlying principle of which is the admission of the proper quantity of air at the proper time, and the removal of cooling surfaces so far as is possible from the gases until combustion is complete, as if the temperature is lowered below the critical temperature before combustion is effected no amount of care in air regulation will prevent smoke. The Smoke Abatement Society made a step in the right direction when they last year started lectures for firemen, and the question has been handled in a very practical way by the Smoke Prevention Society in Hamburg, where carefully-watched tests have educated the firemen and led to increases in efficiency up to 14 per cent. on hand-fired boilers.

The main causes of waste in the engine-room are steam-pipe condensation and leaky engine valves. The steam pipes in a plant are very often out of all proportion to the actual requirements of the engines, not only in length but in diameter. Duplicate ring mains in the boiler-room and engine-room are common, but a proper arrangement of pipes and well-made joints does not call for such an expensive insurance against a shutdown. The benefit of shortening the path of the steam between the boiler and engine cannot be overestimated. Good lighting is conducive to economy in both engine and boiler rooms, as plant in a badly-lit room never gets properly looked after or cleaned. Why should it? It is no credit to the cleaner if it cannot be seen! Dirt is about the worst disease a plant can suffer from, as it invariably means neglect of small indications and warnings, timely attention to which would prevent the otherwise inevitable breakdown. Not only is the plant better cared for, but men all work better in cheerful surroundings and lose less time through sickness.

Tests.—It is an unfortunate fact that in many cases an engineer-in-charge does not really know what his plant is doing, and all for the want of tests which he could carry out himself with very slight expense or inconvenience. Coal may be weighed without appreciably increasing the cost of handling it. Water may be measured by positive meters, which do not need much attention so long as they are not run at a high speed or cut by grit. An interesting and novel type of water-meter is Lea's notched weir, which is very simple and not likely to be put out of action by the causes that affect other water-meters. It is a very ingenious application of an indicating and recording attachment to measure the flow over a V notch, the value of which was first investigated by Prof. Jas. Thompson about 50 years ago. These two measurements, coal and water, give sufficient data for checking the cost of evaporation, which is the most important factor in the works cost of private plants. I believe that no single factor has contributed more to the economical running of electricity supply plants than the analysis and publication of their figures by the Press, and I am sanguine enough to believe that if one of the members would collect data as to cost of evaporation in the plants under the charge of members of this association, and present them in the form of a paper, the result would be a healthy competitive stimulant to all concerned.

Engine tests appear to have had more fascination for experimenters than boiler tests, but comparison of records goes to show that there is not much difference in the efficiency of different types of boilers which vary largely in design; certainly the figures are not so far apart as are the results of tests of similar boilers worked under different conditions. This puts all the stronger emphasis on the necessity of an engineer-in-charge knowing what his boilers are doing. The more a man knows of his plant the keener will he be to keep its performance up to the highest level obtainable, and nothing shows a staff the capabilities of a plant and secures confidence in it better than a few tests, the educational value of which on all concerned cannot be overestimated. So far as I have been able to find out, there does not appear to be much published on the cost of steam generation over long periods. In an appendix to the late Mr. Bryan Donkin's "Heat Efficiency of Steam-Boilers," some useful figures are given. I would like here to remark how much those of us who are interested in boiler problems miss our late friend, to whom we were repeatedly indebted for useful hints and data. Two factories, Rothwell and Duneberg, were under the same management, and experiments seem to have been prompted by the high cost of evaporation at Rothwell in the previous year, which amounted to 19·4s. per 1,000 gallons. In the following year the cost was reduced to 13·63s. per 1,000 gallons at Rothwell and to 10·81s. at Duneberg. Further experiments were made, and it is stated that the cost of evaporation fell 39 per cent. at Rothwell and 28 per cent. at Duneberg, representing for one year alone a gain of £6,000. In 1905 results of a 10 weeks' test at Sheffield were reported by Mr. Fedden, which, with coal at 5s. 8d. per ton, worked out to 3·57s. per 1,000 gallons for coal only, and for coal, labour, etc., to 9·32s. These results both look excellent, but if they are translated into London figures with the same coal, they would be of the order of 7s. and 13s. 6d. respectively. In one of the works with which I was connected, the cost over a year for coal only was 9·4s. per 1,000 gallons when the average cost of coal was 16s. 10½d. per ton. Allowing for labour and repairs, the cost was 11·75s. per 1,000 gallons. On a month's test with coal at 13s. 3d. per ton the cost was 8·2s. per 1,000 gallons. The best day's test that I have had was with washed nut coal at 13s. per ton and of 13,800 B.Th.U. value, when the cost of evaporation per 1,000 gallons was 6·46s. on the net water, after allowing for the 7½ per cent. of the total water which was used for steam jets in connection with the stoker. The stoker itself was driven by an electric motor. With another type of stoker I have burned smudge coal costing 7s. per ton and of 10,400 B.Th.U. value, when the cost of evaporation was 3·82s. per 1,000 gallons. Various circumstances have combined which will, I believe, render a repetition of this figure impossible.

In carrying out experiments for practical use, care should be taken to ascertain beforehand that the samples and prices can be repeated in bulk, otherwise much time may be wasted. The capital cost, the working cost, and the maintenance of improvements must always be considered in connection with the saving to be effected by the alteration. For instance, I have known cases where condensing was applied under unfavourable conditions to a non-condensing plant, and the power taken in running the auxiliaries in connection with the condenser practically equalled the power saved on the main engines. This is not the reason why condensers have not been mentioned as possibly applicable and likely to effect a saving in existing plants; I have omitted them because generally the consideration of condensers, cooling towers, and the necessary auxiliaries in

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connection with them, would take more space than can be spared here, and their application would necessitate a greater upheaval of the existing conditions than I am contemplating.

Great economies may be effected in illumination by the use of the metallic-filament lamps now available, which also should especially appeal to those who find it necessary to extend the lighting circuits for new buildings, and are hampered by a fully-loaded plant. Approximate figures may be borne in mind indicating the difference between the two types—1 h.p. = 200 c.p. with carbon-filament lamps or 500 c.p. with metal filaments. The two best-known types at present on the market are the "Osram" and "Tantalum," taking 1·25 and 1·75 watts per candle-power respectively. An objection to the lamps which has not yet been overcome is the high price. The "Tantalum" can be fixed in any position, but the "Osram" must be placed vertical, while neither can yet be obtained for pressures above 130 volts. Higher pressure can only be used on these lamps in series, which is objectionable.

I am afraid I have attempted to condense too much into the time and space at our disposal, so for the convenience of those who only read the last chapter of a book, I would state that my object is to incite engineers-in-charge to get the best possible results from their plants and to help others by bringing those results before their fellows for friendly criticism and the common weal. If my object is attained I shall be more than ever proud that you have given me the opportunity of addressing you as your president.

THE TRAMWAY MOTOR QUESTION.*

BY ALEX. R. MCCALLUM, B SC.

When electric traction was first introduced, some few engineers recognised that the shunt motor was as nearly as possible the ideal for tramway and railway work. There were at that time, however, a number of difficulties in the way of a general use of this type of motor, which difficulties lay entirely in the direction of the problem of commutation. It is my purpose in this paper to consider the relative merits of series, shunt, and separately excited motors for ordinary tramcar work.

The conditions under which the traction motor works are very severe. Owing to the nature of the service frequent stops are necessary, and to maintain a decent average speed a high rate of acceleration and retardation is demanded; a high starting torque is, therefore, essential. Hills on tramway lines are frequent, and, in order to surmount these at a reasonable speed, a large power motor must be employed. At the top of the hill the car has an amount of potential energy stored in it, which energy has been drawn from the line. For economical working it is obvious that on the down grade this potential energy should be returned to the line, and not wasted in heating the brake blocks and wheels. Also, when a car is brought to rest comparatively suddenly, its kinetic energy should be usefully employed instead of being wasted in heat. From the foregoing it is seen that, on purely economical grounds, when a car is running downhill or being brought to rest, the energy stored in it, either in virtue of its position or motion, should be returned to the line, and this can only be effected by causing the motors to run as generators supplying current to the line *at the line potential.*

The torque of any motor is proportional to the product of the field strength and the armature current. If T represents the torque, N the field strength, and C the armature current, then

$$T \propto NC \text{ or } T = kNC,$$

where k is a constant. Now, if the saturation of the poles is not carried beyond the straight part of the saturation curve, the field strength, N, in a series motor depends on the armature current, C, because the armature current passes round the field coils. So that for a series motor we can write

$$T \propto C^2 \text{ because } N \propto C.$$

It is at this point that advocates of the series motor sometimes stop. In the shunt-wound motor, on the other hand, still assuming the saturation is not carried into the bend of the curve,

$$T \propto C.$$

When starting, the armature current is practically always at its greatest value, so that, arguing this way, it would follow that the starting torque of the series motor (depending on the square of the current) must necessarily be greater than that of a shunt motor. But the field strength is a factor in the torque, and there is no reason why the field strength at starting of a shunt motor should not be every whit as large as that of a series motor. The large field strength on starting a series motor is obtained by the large armature current flowing round a comparatively small number of turns. The field winding of a shunt motor consists, as you know, of a large number of turns of fine wire carrying a small current. The magnetising force for any given field strength is the product of the number of turns of wire carrying the field current and the field current. This product, the ampere-turns, can be as large for a shunt motor as for a series. So that by proper design it is possible to obtain as large a starting torque from a shunt-wound motor as from a series motor. The high value of the shunt field current cannot be maintained long, however, owing to the heating of the coils. As speed increases a resistance has to be inserted in the shunt circuit, and this means a loss of energy.

In order to make the working of series motors practicable, the series-parallel system of control was devised. In this system the car is started with the two motors in series, in series with resistances. As the car gains speed the resistances are gradually cut out until the two motors are in simple series across the mains. After passing through the transition notches the motors are in parallel, in series with resistances, and, as the controller handle is moved further, these resistances are cut out until the motors are in full parallel and the car is running at full speed. So that in order to get a car up to full speed it is necessary to introduce resistances into the main circuit. If E is the energy absorbed by a resistance and C the current flowing,

$$E \propto C^2,$$

so that the energy absorbed by a resistance varies as the square of the current. When the resistances are used in the main circuit, it can be seen that the energy expended must be very considerable. It would be most uneconomical (and at the same time impossible from the design of the rheostats now in use) to run series motors on the series-parallel system in any other way than either full series or full parallel. So that with this system there are only two economical speeds, and for a level clear road the first is too slow, the second too quick. The result is curious. A motorman, driving ordinarily, has to use his controller handle like a sort of plaything; he runs his motors on full parallel for a short time, then switches off for a time, allowing the car to run by its own momentum. So that the car proceeds in a series of bounds and a lot of destructive arcing takes place at the controller fingers every time the circuit is broken.

In the case of the shunt motor we have a different state of things. The voltage drop across the field winding is constant, so that for any given resistance in the shunt winding circuit there is a fixed field current, and consequently a fixed field strength. So that, for any given field strength, the speed of the motor remains constant over a very wide range of load. The shunt motor is essentially a constant-speed motor. In order to vary the speed it is necessary to alter the field current, and this can only be done by a variable resistances inserted in series with the field winding. But for any given field strength the speed of the motor remains constant. Here we have a most important argument in favour of the shunt motor for tramway work. Instead of propelling a car in a succession of bounds, a constant driving effort is obtained, keeping the car at a constant speed. The resistance in the field circuit is, of course, always in use to a greater or less degree, and consequently there is always a loss of energy here. But when one considers how small the field current need be, the loss is small, indeed, compared with that which occurs in a rheostat in the power circuit. It is, therefore,

* Paper read before the Dick-Kerr Engineering Society.

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seen that a tramcar speed may be varied by field regulation only.

It is at this point that one of the weaknesses of the shunt-wound motor becomes apparent. Although it is very easy to say that the speed of a shunt-wound motor may be varied by field regulation only, it is a very different thing to obtain a motor which will operate sparklessly over a wide range of speed and load. This was the difficulty which caused the abandonment of the shunt motor in favour of the series in the early days of electric traction. In those days it was necessary to shift the brushes for every change of load, otherwise the motor began to resemble a firework display. Things have progressed since then; the theory of commutation is fairly well understood, and by a proper design of the pole-tips it is possible to vary the speed of a shunt motor over a very wide range of speed without altering the position of the brushes. I do not wish to advocate the use of commutating poles on a tramway motor, as their introduction means a very considerable increase in the cost of the motor. But I repeat that it is now possible to design a shunt motor with a very wide range of speed obtained by field regulation only.

So much, then, for the question of speed regulation. We now come to the second part of the question—namely, regeneration. When a car is going up hill, energy is required and is taken from the line to lift it vertically as well as to propel it. The former is stored in the car as potential energy when it reaches the top. On descending the gradient brakes of some kind have to be used, and the most economical form of brake is an electric one which will return energy to the line. A series motor can, of course, be used as a series generator, but then the voltage which it will supply is a very variable quantity. It is impossible for it to return current to the line at the line pressure. Now, a shunt generator run at a particular speed will supply current at an approximately constant voltage, and if a motor is designed for the line voltage, then run as a generator, it will supply current at the line voltage. When running as a motor for any given speed, there is a certain resistance in the field circuit, and, conversely, if that resistance is in circuit when generating, the current generated will be at the line potential, so that a shunt motor can be used regeneratively, and if properly designed, with the brushes in the neutral position, the current can be collected sparklessly. The same thing applies when the car is being stopped, the kinetic energy of the moving car being returned to the line.

We now come to some general considerations. The constant speed, irrespective of load, which is the characteristic of the shunt motor, plays a very useful part when a car is going downhill with the ordinary wheel brakes on. A very frequent cause of accidents on a down grade is the skidding of the wheels by a too forcible application of the hand brake. This becomes nearly impossible with a shunt motor, as the motor will take current from the line to turn the wheels round and so keep up its speed. Advocates of the series motor have many objections to the shunt motor. It is slightly more expensive to wind, which is quite true. The field coils take up more room, because the percentage of cotton covering to copper for a given number of ampere-turns is greater in the shunt motor than in the series. This also is quite true, but it is not necessary to use cotton-covered wire. There is now a varnish on the market whose insulating powers are quite great enough to withstand the potential difference between adjacent wires in a 500-volt shunt field winding, so that the field coils can be kept quite small.

A great objection often advanced against shunt motors is that shunt motors cannot be run in parallel. The more heavily loaded motor will persist in taking all the load, so that for pure shunt motors the series-parallel system of control cannot be used. The answer to that is that, for shunt motors, it is quite unnecessary to run the motors in parallel at all. The series-parallel control system was devised to overcome the inherent defects of the series motor. If the series motors were connected in simple series for the full speed, all lesser speeds would have to be obtained by the most uneconomical method of inserting resistances in the power circuit. So that a system such as the series-parallel had to be devised. There is no such objection to running shunt motors in series, the control resistances being inserted in the field circuit. For simple shunt motors on a 500-volt tramway circuit, each motor need only be designed for 250 volts. This arrangement, however, has several drawbacks. If there are only 250 volts across the field coil, then, in order to get the necessarily large flux on starting up, the cross-section of steel in the poles must be large, as the ampere-turns per field coil are only half of that obtained by using 500 volts per field winding. This would entail the use of a much larger motor. In order to avoid this, the fields can be connected in a parallel-series system, which field system can be connected entirely apart from the armature circuit, straight across the mains. The motor so obtained is what I have called the separately excited motor. In this system the armatures are connected in series and wound for 250 volts. The fields are connected in parallel-series. On starting the car, the fields are put in full parallel across the mains—*i.e.*, between the trolley wire and earth. As speed increases, resistances are put in series with the fields until a point is reached when the fields are put in simple series across the mains. Further increase in speed is obtained by inserting resistances in the field circuit, thus decreasing the field. By this means a more economical method of control is obtained than that in which each field is wound for 500 volts, and regulation effected by inserting resistance in each field.

The parallel-series controller is a very simple affair. The current made and broken is very small, and consequently no blow-out contrivance is necessary, but an arrangement must be made so that the field circuit must never be broken—*i.e.*, one contact must be in before the previous one is out. There is one additional switch needed, however, and that is a field-breaking switch. When a car is brought to a standstill for any length of time, it would be wasteful to keep on the field current, so that the field circuit must be broken by a proper field switch.

I have not mentioned Mr. Raworth's regenerative control system. I have written this paper more with the object of raising an interest in the subject, and of showing that the series motor is not all that can be desired. I have now reached a point when a consideration of Mr. Raworth's system could well be begun. I can refer any desiring to continue the subject to Mr. A. Raworth's paper before the Institution of Electrical Engineers, which was published in the *Journal* for April, 1907.

ELECTROLYSIS SOMEWHAT EXPLAINED.

(*Communicated.*)

There has been during recent years a considerable amount written concerning electrolysis, and having regard to the unusual energy of cablemakers in advancing schemes whereby a cable will remain in operation defying any earth current until the millennium, and, perhaps, even after, it may seem remarkable to the untutored mind why any trouble in this direction should exist. Perhaps a little peep into the inner workings of an actual supply system which the writer encountered may afford a clue to the existence of such troubles. In one system the writer found that the bulk of the mains consisted of single lead-covered cables, laid direct in the earth, supposed to be about 4in apart, but actually at times touching, with the doubtful protection of a plank—the ordinary deal plank about 6in. by ¾in. thick—which was creosoted when convenient, but when stock ran out, as it usually did, plain planks were used. The mains were laid, say, 12 to 17 years ago, and were of all varieties, some of them very startling. The consequence of this most efficient protection was that where the planks were to be found, they could be crumbled with one's fingers.

When the supply authority operating this beautiful system found that there was a fault, it usually burned coal until it dried all the moisture out of that portion of the district, and if the street was wet at the time, the fault was often located by finding the dry place on the pavement. They had a battery installation in connection with the system, and faults of a less serious description were located by finding out which sub-station had its batteries run down

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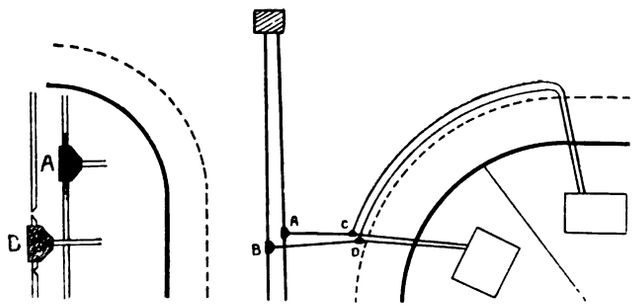
to the greatest extent in the morning. The class of breakdown that used to occur may be illustrated as follows: One night the engineer-in-charge reported an excessive load on one feeder, and in consequence could not shut down and run on the cells, but had to do about three hours' overtime, with the volts jumping about in a most amazing manner, and a short-circuit of about 600 amperes at normal pressure, less drop, falling periodically on a rotary transformer. It was afterwards discovered that all this current went through a single No. 14 S.W.G. copper strand on each pole of the feeder, which in itself was most miraculous. The load went off at about one o'clock in the morning A dead short-circuit was found on the faulty feeder, and minor faults all over the place. Referring to the hand sketch, it was found that the tee box at B would almost lift away from the cable at the edge of the box, which had no proper gland, and which had broken through the lead at each end. The lead of each cable by the box was quite honeycombed with electrolysis. The joint at C had gone in the same way, while the joint at A was considerably eaten away. By cutting out these faults the rest of the network would stand the pressure all right, but it was considered that the best repair that could be effected was to put in new cable throughout. The wonderment concerning electrolysis somewhat disappears from one's mind when one comes against cases of this kind. It may as well be noted that it was not American, but English practice that was responsible for this.



Another case occurring was that of a bad earth on a long length of cable. It was impossible to get at this section, so the earthed wire was made the ordinary earth pole. This went very well for a bit, but in a short time there was a lot of trouble with jumps on that circuit, and after a period a length of cable broke down entirely. On investigation, a length of cable of about 20ft. showed signs of electrolysis, and a gas service was also discovered, put in close under the cable, with one pole of the electric service fused to it. This is another instance of the course of painful instruction which English mains engineers have had to go through It is not good for electric mains to be put in too close to a gas supply. Another little batch of faults which were found was due to the lead covering of the cables making bad contact with iron service joint-boxes, owing to the boxes being used having no provision for bushing, the glands being very small and the leads not being joined across. The current travelling by the lead would travel across the gap through the surrounding earth in its endeavour to follow the easiest path, and the result was that great lumps of sodium and weird-looking masses of indistinguishable stuff was found round the cable at the point of supposed juncture.

There is, no doubt, that the solid system is one of the best to obviate electrolysis, one of the most useful arrangements being that of troughs filled with pitch and covered with bricks. If this is properly done, there is hardly any danger from this cause. Electrolysis is hardly likely to occur if careful attention is given to the insulation of the outer from the start of laying, and if the continuity of the leads is carefully kept up, jointing them metallically at disconnecting boxes and at sub-stations. The writer knows of one armoured low-tension cable with wooden bushed compounded glands at the boxes, where the inner somehow got on to the lead of a piece of cable about 200 yards long. The system stood up in spite of the fact that it was possible to light a lamp by connecting it to the earth from the lead of the cable. The marvellous thing was that it had been in that condition for about two years Perhaps the best way with cables when earth currents are feared is (when it is a drawn-in system) to put earth-plates under the boxes, about 500 yards apart, and to earth all the leads. Every box where branches go out—for example, at street corners—should be treated in this way. A little slack coal or coke placed round such earth-plates improves matters considerably.

GAS-ENGINE PLANT IN AMERICA.

The Chicago *Western Electrician* gives a description of a large electric generating unit with direct-coupled gas-engines to supply current for operating electric cars, which the California Gas and Electric Corporation (now a subsidiary of the Pacific Gas and Electric Company) have had installed at their San Mateo power station, near San Francisco, by the Snow Steam Pump Works, of Buffalo. There are three gas-engine sets, of the horizontal duplex, double-cylinder type, each having a maximum output rated at 5,400 h.p. Each engine has the revolving field of a Crocker-Wheeler three-phase 25-cycle, 13,200-volt generator on its main shaft next to its flywheel. The plant was intended as a relay station to be held in reserve in case of interruption of the current transmitted 140 miles from Blue Lakes to San Francisco for the operation of the electric cars of the united railroads of San Francisco under a 20-year contract, commencing with June 1, 1906. The engines were built about two years ago. The unusual conditions prevailing for some time after the disaster of 1906 had something to do with the delay in the placing of the new gas-engines in commission, although the large gas generating plant with its gasholders was completed and undamaged. On account of shortages in the supply of current available for use in San Francisco, it was found necessary to operate the three gas-engines regularly during the peak load and at other times early in the year 1907, and they have been in almost continuous operation for a number of months. The engines are of the twin-tandem, double acting, four-cylinder, side-crank type, operating on the four-cycle principle. The 5,400 b.h.p. rating of the engine is only on an overload of 35 per cent. The usual overload rating is 15 per cent. for brief periods. The engine delivers 4,600 h.p. at this rating, but normally the engine will deliver 4,000 b.hp. The cylinders are made in two parts, with a circumferential joint in the centre, which is covered by the removable part of the water jacket. The water jackets are cast solid with the ends of the cylinders. The explosion chamber is cast to one side of the cylinder, this making very strong construction. The pistons are made of cast iron and bolted together on a circumferential joint. Six concentric cast-iron piston rings without keepers are used. Both the piston rods are 15in. in diameter and made of two parts—the sleeves, made of nickel steel, and the bolt which extends through the whole length of piston and sleeves. The piston rods are hollow and conduct water to the pistons for cooling purposes. The cylinders are supported on the bed-plate in such a way that they can slide in grooved guides in the longitudinal direction only to allow for expansion or contraction caused by changes in temperature. The bed-plates are held down to the foundation with foundation bolts running clear through to the top of the bed. The weight of the crankshaft is 99,734lb. Its diameter at the rotor fit is 37in., with a journal bearing 30in. in diameter by 4ft. 8in. long. The crank-pin bearing is 19in. by 19in. The wrist-pin is 17in. in diameter and 18in. in length. Two overhung crank-pins are employed, thus avoiding the trouble of keeping more than two main journals on one engine in line. The crank arms are provided with heavy counterweights to partly counterbalance the momentum of the heavy reciprocating parts. The 23ft. flywheel weighs 97,000lb. The weight of the main engine frame is 170,000lb.

For ignition, the electric make-and-break spark is used in connection with a storage battery, discharging at about 10 volts and 1 ampere. Each igniter is supplied with a spark-coil indicator. This indicator will indicate constantly the condition of each circuit. When the indicator swings

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with the igniter, the igniter is in order; when it stays drawn up against the core, the igniter is short-circuited. The engines are started by compressed air, through valves which are operated from the cam-shaft in such a way that the air enters behind the piston, which is starting on its expansion stroke, acting in the same way as steam in a steam-engine. At the end of the stroke the exhaust valve opens and the air escapes. Some of the cylinder ends, during this time, take in a charge, and, when this is ignited, the pressure holds the check valve closed so that the air cannot enter the cylinder. After a few explosions the air is shut off and the engine soon reaches its full speed. The valves, all of which are located on the same side of cylinder, have a positive motion, and are water-cooled. The speed of the engine is regulated by the governor working on the compression and also on the mixture. A Lombard governor regulates indirectly, with the aid of pistons, moved by oil under pressure. Oiling systems facilitate the lubrication of crank bearing, crank, and cross-head. The oil is fed to the bearing through sight feeds. It then runs through filters and is pumped up to the storage tank. The total weight of each twin engine is 600 tons, of which 186 tons represents the weight of the two main frame castings. The frame carries the main bearing block and the slides for the large main cross-head. The floor space occupied by each engine is 35ft. by 74ft. These engines have been started and brought to speed in the short time of from 56 seconds to 2 minutes. This also includes the time required to turn on air, gas, electric current for the igniter, and synchronising at 88 r.p.m. The three engines have been running about eight months, driving three 25-cycle three-phase generators. The fourth unit, which is under construction, will be installed in the same station to generate 60-cycle three-phase current, which is the standard on the California Gas and Electric Corporation's transmission lines. It is the intention to increase the installation, in time, to six units, aggregating over 24,000 kw. in capacity. It has also been planned to install one 4,000-kw., 60-cycle gas-engine generating unit in the company's Oakland power station.

Turning to the generator, the stator frame, which is approximately 26ft. in diameter, is of cast iron, provided with ventilating openings to allow a free circulation of air around the ends of the windings and through the ventilating spaces in the core. It is of the box girder type, designed so as to be strong enough to prevent distortion due to its own weight and the magnetic pull. The laminations of the stator are securely clamped together by end flanges, and provided with a sufficient number of ventilating ducts to ensure a uniform and low temperature throughout the core. Each slot of the stator is lined with a tube of insulating material possessing high dielectric and mechanical strength. The rotor, which is designed for great strength and simplicity, is of cast steel, made in two sections and bolted together. The pole and pole-shoe are cast in one piece and bolted to the rim. There are 34 poles. The rotor coils consist of strip copper wound on edge, each turn being properly insulated from the others, and the whole coil is compressed and baked into a compact unit. The oblong coils have no sharp corners and are held securely in position by the pole-shoes. The exciting current is conducted to the field windings through carbon brushes. The collector rings are supported on a cast-iron hub, from which they are very thoroughly insulated.

The gas plant, which was built especially to supply these gas-engines, produces gas of a quality high enough for illuminating purposes. The surplus gas is turned into mains connected with the city lighting system of San Francisco and used whenever needed. There are two standard gas generating units, each having a capacity of 400,000 cubic feet per day, constructed in accordance with the Lowe crude-oil, water-gas system. The gasholders, which are located within a few hundred feet of the power station, include one with a capacity of 1,000,000 cubic feet, and two holding 200,000 cubic feet each. Mains of ample size furnish connection with the gas-engines. The gas contains from 45 to 55 per cent. of free hydrogen. Its heat value averages about 630 B.Th.U. per cubic foot. In the Lowe crude-oil, water-gas process the crude oil is heated to a temperature of 300deg., being vaporised, and is then mixed with superheated steam. The excess of water is taken out and the vapour and steam pass into a hot-chamber, being superheated to 600deg. F. This high temperature turns the mixture into a fixed oil-and-water gas, which is then purified and passed on to the engines. When the engines were originally designed, the initial pressure of the gas in the main cylinder was estimated at about 150lb. per square inch.

THE DIELECTRIC STRENGTH OF INSULATING MATERIALS AND THE GRADING OF CABLES.*

BY ALEXANDER RUSSELL, M.A., MEMBER.

1 *Introduction.* — In power transmission, whether by direct or alternating current, the saving of copper effected by using very high pressures has directed the attention of manufacturers to the construction of cables which will withstand pressures of 100 kilovolts and upwards. To design cables which will successfully withstand these pressures a knowledge of the electric stresses to which the various insulating materials round the core will be subjected under working conditions is essential, as well as an accurate knowledge of the dielectric coefficients, dielectric strengths, and resistivities of the insulating wrappings. In what follows the author discusses, first, the laws of disruptive discharge; next, the methods of measuring the dielectric strengths of gases, liquids, and solids; and, finally, the electric stresses on the insulating materials of a single-core cable, with special reference to the grading of cables. In Mr. O'Gorman's paper valuable suggestions are made for the scientific grading of cables, and a useful table is given of the values obtained by various experimenters for the physical data of many of the ordinary insulating materials used in practice. Some of the numbers given, however, must be taken only as rough first approximations, as the temperature of the material, the shape of the testing electrodes, etc., are not stated. In the classical paper read by Mr. Jona to the International Congress at St. Louis in 1904 will be found many important theorems in connection with the manufacture of high-tension cables. In his papers also to the Italian Electrotechnical Association (vol. vi., p. 3, and vol. xi, p. 47) he gives very valuable data on the dielectric strengths of oils, etc., and of liquid air. Specimens of Mr. Jona's "graded" cables working at 25 kilovolts were shown by Messrs. Pirelli and Co. at the Paris Exhibition in 1900. Last year also, at the Milan Exhibition, his cables were shown working at 75 kilovolts.

2. *The Stress on the Dielectric.* — The best way of picturing what happens in a dielectric is by means of Faraday's tubes of force. We picture one end of one of these tubes anchored to a unit positive charge on the positive electrode and the other end anchored to a unit negative charge on the other electrode. By the resultant force at a point is meant the force with which a unit positive charge placed at the point would be urged if it could be placed there without disturbing the distribution elsewhere. It follows at once from the definition of potential that the resultant force at a point in a dielectric is equal to the rate at which the potential diminishes as we move along the line of force through the point. It is measured, therefore, by the potential gradient in the direction of the resultant force at the point, and this is the term that electricians customarily employ. It is also equal to 4π times the number of Faraday tubes which pass through unit area of the equipotential surface at the point. When regarded in this way, it is generally called the electric intensity at the point. It has to be remembered when reading the literature of the subject that "the resultant electric force," "the potential gradient," and "the electric intensity" are all used to denote the resultant electric stress at a point.

3. *Dielectric Strength.*—The dielectric strength of an isotropic insulating material in a given physical condition is the maximum value of the electric stress which it can withstand without breaking down.

4. *Faraday's Criterion for Disruptive Discharge.*—In his "Experimental Researches in Electricity," vol. i., p. 436,

* Paper read before the Institution of Electrical Engineers.

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Faraday states that "discharge probably occurs, not when all the particles have attained to a certain degree of tension, but when that particle which has been most affected has been exalted to the subverting or turning point." He considered it probable, therefore, that the disruptive discharge would ensue when the electric intensity at the point subjected to the maximum stress attains a definite value. It is now well known that part of an insulating material can break down without a disruptive discharge necessarily ensuing. For instance, when brush discharges occur from an electrode in air part of the air surrounding the electrode has become a true gaseous electrolyte, and its insulativity has therefore broken down. The air at the boundary of this electrolyte has not broken down because the electric stress to which it is subjected has not reached the "subverting" value. It is not, therefore, safe to conclude that a disruptive discharge ensues the moment the maximum electric stress at any point of the dielectric between the two electrodes attains the breaking-down value for that dielectric. The breaking down of a portion of the dielectric may relieve the electric stress on the remainder. A disruptive discharge ensues only when the breaking down of part of the material leads to the electric stress on the remaining part being greater than it can withstand.

5. *The Maximum Electric Stress between Equal Spherical Electrodes.*—The easiest way of finding the dielectric strength of insulating materials is by finding the disruptive voltage between two equal spherical electrodes embedded in the material. The author has shown that, if the spheres be at a less distance apart than twice the diameter of either, a disruptive discharge will ensue the moment the maximum electric stress between the spheres equals the dielectric strength of the material. In order to calculate the maximum electric stress at the instant of discharge we must know the potential and size of each sphere and the distance between them.

Let a be the radius of each sphere and let x be the minimum distance between them. Let us first suppose that one sphere is at the potential V_1 and that the other is at zero potential. In this case the maximum electric stress, $R_{max.}$, between them is given by:

$$R_{max.} = (V_1/x) f_1,$$

where the values of f_1 can be found from Table II. A proof of this formula is given in the author's paper (*l c. ante*). In the important practical case when $V_1 = -V_2 = V/2$, where V_2 is the potential of the second sphere, we have:

$$R_{max.} = (V/x) f,$$

where f can be found from Table I. In general, if V_1 and V_2 be the potentials of the two spherical electrodes, we have:

$$R_{max.} = \{(V_1 - V_2)/x\} f_1 + 2 (V_2/x) (f_1 - f),$$

where f and f_1 are functions of x/a, the values of which can be found from Tables I. and II. Hence by this formula we can calculate the dielectric strength of the material from the potentials of the electrodes at the instant of the disruptive discharge.

TABLE I.—Values of f.

x/a.	f.	x/a.	f.
0·0	1·000	2	1·770
0·1	1·034	3	2·214
0·2	1·068	4	2·677
0·3	1·102	5	3·151
0·4	1·137	6	3·632
0·5	1·173	7	4·117
0·6	1·208	8	4·604
0·7	1·245	9	5·095
0·8	1·283	10	5·586
0·9	1·321	100	50·51
1·0	1·359	1,000	500 5
1·5	1·559	10,000	5,000·5

TABLE II.—Values of f_1.

x/a.	f_1.	x/a.	f_1.
0·0	1·000	2	2·339
0·1	1·034	3	3·252
0·2	1·068	4	4·201
0·3	1·106	5	5·167
0·4	1·150	6	6·143
0·5	1·199	7	7·125
0·6	1·253	8	8·111
0·7	1·313	9	9·100
0·8	1·378	10	10·091
0·9	1·446	100	100·0
1·0	1·517	1,000	1,000
1·5	1·909	10,000	10,000

6. *The Dielectric Strength of Air.*—In the following table the values of x and V are taken from Dr. Zenneck's work, "Elektromagnetische Schwingungen und Drahtlose Telegraphie," 1905, p. 1,011. They are due to J. Algermissen, and are deduced from the average of the values obtained on different days under varying conditions. It has been assumed that the potentials of the electrodes are + V/2 and − V/2 respectively at the instant of discharge. As the results in the last column are very approximately constant the assumption is justified.

TABLE III.—J. Algermissen. 5cm. spheres (a=2·5). x is measured in centimetres and V in kilovolts.

x.	x/a	f (calc.).	V (obs.).	$R_{max.}$ (calc.).
2·0	0·80	1·283	58·2	37·3
2·2	0·88	1·312	62·6	37·5
2·4	0·96	1·342	67·0	37·5
2·6	1·04	1·374	70·8	37·4
2·8	1·12	1·406	74·4	37·4
3·0	1·20	1·437	78·0	37·4
3·2	1·28	1·469	81·3	37·3
3·4	1·36	1·500	84·7	37·4
3·6	1·44	1·533	88·0	37·5
3·8	1·52	1·566	91·2	37·6
4·0	1·60	1·599	94·2	37·7
4·2	1·68	1·632	97·2	37·5

In the above table $R_{max.}$ has been calculated by means of the formula, $R_{max.} = (V/x) f$.

From the above results, and from many other experimental results obtained with both alternating and direct pressures, the author concludes that the dielectric strength of air under normal conditions is about 3·8 kilovolts per millimetre. The practical constancy of the dielectric strength of air under ordinary atmospheric conditions is recognised in the standardisation rules (1907) of the A.I.E.E. For instance, in § 243, when discussing the value of the spark-gap safety valve, it is stated that "a given setting of the spark-gap is a measure of one definite voltage, and, as its operation depends upon the maximum value of the voltage wave, it is independent of wave-form, and is a limit on the maximum stress to which the insulation is subjected. The spark-gap is not conveniently adapted for comparatively low voltages." The reason for the limitation given in the last sentence of the above quotation will be discussed in the next section. In Appendix D of the American rules a table of the sparking distances in air between "opposed sharp needle-points" for sine-shaped voltage waves is given. It is stated, for example, that when they are 7·5cm. apart the disruptive pressure is 45 kilovolts. It is interesting to notice that if we have two spherical electrodes, each 2cm. in diameter, and if the distance between their centres be 7·5cm., so that the minimum distance between the spheres is 5·5cm., the disruptive voltage is 44 kilovolts, which is practically the same as that between two needle-points 7·5cm. apart. As brush discharges from the needle-points occur at pressures much less than the disruptive voltage, it will be seen that the ionised air round the points at the instant of the disruptive discharge is probably roughly spherical in shape and 1cm. in radius. This is a good illustration of the following sentence in Faraday's "Experimental Researches," § 1,499: "But as has long been recognised, the small body is only a blunt end, and, electrically speaking, a point only a small ball; so that when a point or blunt end is throwing out its brushes into the air it is acting exactly as the small balls have acted in the experiments already described, and by virtue of the same properties and relations."

7. *Failing Cases in Practice.*—The above formulæ cannot be applied in practice when the electrodes are at microscopic distances apart. G. M. Hobbs has shown that when x is less than 3 μ (where $\mu = 10^{-6}$ metres) the sparking potentials are practically independent of the nature of the gas between the electrodes. They depend, however, on the metal of which the electrodes are made. When the electrodes are very close together, it has to be remembered that our assumption of an isotropic medium bounded by smooth rigid equipotential services is no longer permissible. If the surfaces were magnified sufficiently they would be seen to be rough, and the dielectric surrounding the microscopic projections would probably be ionised. In these circumstances, therefore, accurate calculations would be difficult. Hence, in determining dielectric strengths, it is necessary to have the electrodes at appreciable distances

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apart, and, therefore, high voltages must be used. It is not safe to calculate dielectric strengths from the observed disruptive voltages when the electrodes are less than a millimetre apart. When a maximum inaccuracy of more than 1 per cent. is not permissible, they should be at least half a centimetre apart. It has also to be remembered that the formulæ for the maximum value of the electric stress on the medium between spherical electrodes has been obtained on the assumption that the Faraday tubes are in statical equilibrium. In the case of impulsive rushes of electricity, or with alternating pressures at exceedingly high frequencies, the disruptive voltages seem to be independent of the shape of the electrode.

8. *Measuring the Dielectric Strength of Gases.* — The dielectric strength of a gas may be deduced from experiments on the sparking voltages between spherical electrodes. The containing vessel for the gas should be large with the spherical electrodes near the centre. The diameter of the supporting rods should be small compared with the diameter of the electrodes, and care should be taken that no conducting materials or insulating materials having dielectric coefficients different from the gas are in the immediate vicinity of the electrodes, otherwise the distribution of the Faraday tubes between the electrodes will be altered and our formulæ will not apply. It is usually best to earth the middle point of the secondary coil of the transformer, or the middle point of the batteries used, so as to make the potentials of the electrodes equal and opposite at the instant of discharge. If E/2 and $-E/2$ be the potentials of the electrodes, at the instant of discharge, when direct voltages are used, we have

$$R_{max.} = (E/x)\,f,$$

where $R_{max.}$ is the dielectric strength of the gas, x the minimum distance between the electrodes, and f a number which can be obtained from Table I. The nearest points on the electrodes should not be closer than about ½cm., and their diameter should be about 5cm. With air at atmospheric pressure a voltage slightly less than 20 kilovolts would be required when x was 0·5cm. When alternating pressures are used it is absolutely necessary to know the ratio of the maximum voltage, E, to the effective voltage, V. Let this ratio, which is sometimes called the amplitude factor, be denoted by k, then our formula is

$$R_{max.} = (k\,V/x)\,f.$$

Steinmetz's method of putting the electrodes into nitrate of mercury and rubbing them with a clean cloth before and during the experiments is to be commended. This is especially necessary when the electrodes are only a small distance apart. The pressure, temperature, and humidity of the gas must be given. J. N. Collie and W. Ramsay (*Proc. Roy. Soc.*, vol. lix., p. 257, 1896) give interesting comparative values of the sparking potentials for various gases contained in glass tubes. The electrodes were of platinum with slightly rounded ends. Owing to the dielectric coefficient of the glass tube being different from that of the gas, and owing to the great electric stress at the electrodes causing excessive ionisation, absolute values cannot be found from their results, but the following table shows that the dielectric strengths of the gases differ considerably :

Gas	Sparking distances in mm.
Oxygen	23
Air	33
Hydrogen	39
Argon	45·5
Helium	greater than 250

The dielectric strength of helium, therefore, is extraordinarily high compared with that of other gases.

9. *Dielectric Strength of Liquids.*—The liquid to be tested is generally placed in a vertical glass cylinder about 2in. in diameter. Spherical electrodes about ½in. in diameter are immersed in the liquid, and the distance between them is varied by means of a micrometer screw. The formulæ for deducing the dielectric strength from the disruptive voltage are the same as for a gas. The electrodes should not be less than 0·3cm. apart, and at this distance 40 or 50 kilovolts will be required to break down good insulating oils. In some cases when moisture is present much smaller voltages suffice. In order to find the true dielectric strength of an oil, it is necessary to thoroughly dry it before the test. This can be done by letting hot air bubble up through it. It is inadvisable, however, to heat the oil above 100deg. C. as considerable discoloration often results, and its physical state alters. When oils are dried in this way perfectly consistent results can be obtained. As a numerical example, let us suppose that the disruptive voltage for an oil between 1cm. spherical electrodes, 0·3cm. apart, is 28 kilovolts—V_1 being equal to $-V_2$—and the amplitude factor being 1·5. By Table I. we get

$$R_{max.} = (1{\cdot}5 \times 28/0{\cdot}3) \times 1{\cdot}21$$
$$= 168 \text{ kilovolts per centimetre.}$$

10. *Dielectric Strength of Isotropic Solids.*—If the spherical electrodes can be entirely embedded in the insulating material then we can proceed as for liquids and gases, the same formulæ being employed. The method frequently adopted of putting thin sheets of the insulating material between metal electrodes in air is of doubtful value. As the voltage is increased the air surrounding the electrodes is broken down long before the disruptive voltage is reached. The insulating material heats excessively, and the maximum electric stress to which it is subjected cannot be calculated, as the temperature is rarely uniform throughout, and the resistivity of the medium and the dielectric coefficient vary with the temperature. Results obtained by neglecting the variations of the electric stress due to temperature are useful only when all the conditions of the experiment are mentioned.

11. *Dielectric Strength of Æolotropic Solids.*—When the insulating material is æolotropic the calculation of the electric stresses is very difficult. They vary with the dielectric coefficients and the resistivities of the various constituents, and, as we have just mentioned, these quantities vary rapidly with the temperature. Accurate measurements of the mean dielectric strength are, therefore, in many cases almost impossible. It is the opinion of many of the engineers connected with manufacturing companies that the testing pressures sometimes specified by consulting engineers are too high, and that the times for which they are to be applied are too long. Most insulating materials are composed of organic matters, and are, therefore, not quite isotropic, and so the effect of applying an excessive pressure to a cable or a piece of electrical apparatus for a considerable time is often to carbonise part of the dielectric. This permanently weakens it mechanically, and may shorten its life considerably. Mr. J. F. Watson, of Callender's Cable Company, has informed me that he has often noticed when repairing extra high-pressure cables that a partial destruction of the wall of insulation has occurred at places quite remote from the fault. This has probably been caused in some instances by "extravagant testing pressures applied for excessive periods" F. Jona (*l.c. ante*) has also noticed similar phenomena. G. E. Skinner states that "long-continued tests are liable to produce incipient burning at points within the insulation," and so he considers them very inadvisable for dynamos, etc.

(To be continued.)

MANCHESTER SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

That virile offspring of the parent institution—namely, the Manchester Section—opened their 1907-1908 session with a meeting held at the Midland Hotel on Tuesday, the 12th inst. The gathering, as usual, was exceedingly successful, and was characterised by an enthusiasm which gives promise of making the forthcoming session a most important and interesting one.

Mr. M. B. Field, the new chairman, was supported by the secretary (Mr. H. W. Wilson), the members of the council, the majority of the more prominent electrical engineers (both municipal and manufacturing) in the district, with a goodly proportion of students, etc, making a representative gathering of close on 300 The proceedings opened with the chairman's (Mr. Field) address. The address (which we hope to touch on in these columns more fully at

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a later date) was, unfortunately, owing to the low tone in which it was delivered, not heard very clearly by members who happened to be sitting some distance away from the chairman, much to their regret. Mr. Field in his original and interesting theme drew analogies between electrical, magnetic, mechanical, optical, etc., phenomena. The various phenomena were described very fully in the speaker's usual lucid manner, and were made the more interesting by reason of the exhibition of clear diagrams and lantern slides.

A vote of thanks to the chairman for his very interesting address was proposed by Mr. Miles Walker and seconded by Mr. Pearce, to which Mr. Field briefly responded. A hope was expressed that Mr. Field would allow his address to be printed in the *Transactions* of the society.

Mr. H. W. Wilson, the secretary, in a few remarks, drew attention to the new regulation of the parent council in regard to papers for the provincial sections. By this regulation *all* papers are to be submitted to London before being read. London can then insist on the papers being read *there before* Manchester or, say, any other respective centre if they so wish. They can also veto them altogether, or just pass them for reading before the respective local sections. That, in effect, was the meaning of the special note sent out to the members with the notice of the session's proceedings. Mr. Wilson, in a few further remarks, appealed to the members to show their interest in the work done by the Manchester branch by sending their subscriptions in for the printed *Proceedings* of the session.

The serious side of the meeting being then finished with, the members present gave themselves up to the enjoyment of a very pleasant, interesting, and amusing smoking concert. Mr. J. Gibson and Mr. C. E. Crowther in serious song rendered their items admirably, while Mr. T. S. Greenwood in his very humorous turns was highly successful. As usual, however, the feature of the performance was the "Electrical Topical Song." This time there were two—first, a new rendering of last year's song "Under the Circumstances"; second, a song called "The Lost Circumference," a vision of Stuart-street Station in the year 1909. Both of these songs, which we print below, were ably rendered by Mr. P. C. Pope, the successful organiser of the concert. The author of the songs, who in public "hides his light under a bushel," is Mr. E. L. Hill, of Messrs. Siemens's Manchester branch, and we congratulate him on his clever and amusing skits.

Mr. J. S. Peck and Mr. C. H. K. Chamen in proposing a vote of thanks to the artists, and Mr. P. C. Pope in returning thanks for same, finished off a successful evening in a highly satisfactory manner by each of them illustrating that beautiful maxim, "Brevity is the soul of wit." Would this always happened!

"Under the Circumstances."

The title of my song once more
Is "Under the Circumstances."
And I hope it will not greatly bore
Under the circumstances.
Remember, if it's far from neat
And twaddles on uneven feet,
That parallels can never meet
Under any circumstances.

Last year we all were glad to grind
In floury circumstances.
Our Miller sat tight—and firm tho' kind
As kneaded the circumstances.
The flour gave so rich a yield
To-night we plant another Field,
In "Frantic" haste. It's sure to wield
Great good for our circumstances.

At Dickinson Street just now there rise
Inevitable circumstances.
When an Engineer says, "Was I wise
In those old time circumstances
To order turbines and forget
How a reciprocating set
Will scarcely ever need the vet,
Oh, bother the circumstances."

The electrical driving of textiles is,
What ho! for the circumstances.
Quite sure to grow, and stay good biz.
Under the circumstances.
They buy your motors by the ounce,
You take your order book amounts
And add them up, they are fine counts.
She bumps in the circumstances.

Our dance last year was a great success,
Quite usual circumstances.
And so 'twill be again I guess
In December circumstances.
But when the couples thread the maze
One thing must fill you with amaze—
D. C.'s rotating with Polly Fays
And converting the circumstances.

Municipal figures are rather rotten
In certain circumstances.
Depreciation is oft' forgotten
Under these circumstances.
And sinking funds and loans as well
Would be often told to go to heaven
If the L.G.B. weren't there to smell
Into such circumstances.

The output of a turbine set
In usual circumstances
Is fixed by the stop valve—that you get
To suit the circumstances.
If 4,000 kw. have to do eight,
To the maker's just write and the case plainly state.
A new stop valve they'll send and another nameplate
Correct in the circumstances.

The Lancashire Power were very lucky,
Under the circumstances,
To get as Tête a man so plucky
Under all circumstances.
He fought at Salford, and he won.
And let us hope the rising sun
Will gild the job this year begun.
Here's luck to his circumstances.

The Institution meetings are,
In usual circumstances,
Quite like some makes of motorcar
In their usual circumstances.
They start—and off they gaily rip
Till S(-)atan has a bad side slip,
Then all we others get the pip—
Regrettable circumstances.

P.S.—Written after Mr. Field's address by Mr. E. L. Hill.

Magnetic sense, says Mr. Field,
In mundane circumstances,
The human mind can never wield.
He's wrong in the circumstances.
This strong magnetic Field we saw
Proving to-night a first-class draw—
The analogy's without a flaw.
What say you in the circumstances?

"The Lost Circumference."

A Vision of Stuart-street Station in the Year 1909.

Standing one day by a turbine,
I was wrathful and hard to please,
For the governor hunted badly
And the driver was on his knees.
I know not why he was praying
Or what I was doing then,
For the turbine stripped and busted
With a sound like a great Amen.

It covered the central station
With the close of a turbine set,
Part lay on my fevered stomach,
And I found it hot and wet.
But in spite of pain and sorrow,
I thought of my chicks and wife,
And I ran till I heard but the echo—
I ran like Heav'n for life.

It gave poor old McKenzie
Eight months of perfect peace.
He trembled away into silence
And wrote for a big increase.
He did not seek it vainly,
That last huge rise in 'oof;
For he rose with the rest of the turbine
Right through the blooming roof.

It may be poor old McKenzie,
When he comes through the roof again,
Will order another turbine,
But he won't unless he's insane.
He'll return to reciprocating,
And let S(-)atan talk in vain.

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THE

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

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THE RAILWAY CRISIS.—II.

The letter from our correspondent at Stafford is most interesting, but it has the one great fault of those who do not really understand the subject, in that it imagines the saying of "you're another" is valid argument. It is not, and only weakens a case. In our article of last week there was no intention of defining the terms capital and labour as applied to railway or similar work. Our intention was to commend the solution of the problem how to enable masters and men to discuss differences of opinion, etc., without endangering the position of a man or bringing into the dispute outsiders who had no personal connection with the dispute. Our correspondent has really propounded the pretty problem of when is a capitalist not a capitalist? He restricts the term to one where the "manager of a small concern is also the owner," and seems to hold the opinion that a manager or director delegated to act in the place of the capitalist must not be termed the capitalist. It is needless to say we do not agree to such a definition. What is the size of "small"? Assume two or ten capitalists combining to find the capital for a particular concern, and one or nine of them delegating to the other one the organisation and management of the concern; surely we must also assume that all he does is done for the whole and represents the action of capital. He becomes, for argument's sake, the capitalist, the unit "to get return for his expenditure." He is, in fact, the capitalist. The railway managers and directors act as this unit "to charge its customers as much as possible for the services rendered," hence represent the capitalist—though again, as a matter of fact, the organisation of a railway must be on restricted, lines in that the Legislature limits the organisers in various directions as to charges, etc. For all practical purposes, however, the railway management is the management of the capitalist, and represents in all phases of the labour problem the capital, the master, the unit which works for dividends for shareholders, and not merely for wages for the individual. Our correspondent is altogether at sea in this part of his argument. Capital does something besides merely construct and equip, and the men whose concern is to organise so as to make the undertaking pay represent capital, in contradistinction to the men who carry out the orders given them and receive more or less wages for so doing. We are not now concerned whether wages are too low or too high—that is a bone of continual contention. Further, we said, "The dogmatism is true that the interests of masters and men are identical." Our correspondent, on the other hand, holds that "the interests of the workers and the capitalists are fundamentally opposed." Again, we are recalcitrant and withhold adhesion to this doctrine. The capitalist naturally wants to employ his money to the best advantage. If he cannot so employ it, what is the position of the worker? Simply the capitalist declines to employ his capital in providing work that does not pay, or does not pay enough; and one of the factors in the paying is labour. Is it to the worker's advantage to so act that investing capital won't pay? He wants work, plenty of work, so that there is a demand for the worker. Neither party can get what he wants without the other. The only suggestion of difference is as to the exact point of compromise, other things remaining the same. Here, then, we have the funny conditions that two parties want the work, both parties want it for what they will get out of it. If, then, their interests are not identical, we do not quite know in what identity consists. The question of "how much" each party is to get is not the same, and is decided upon quite other grounds. Factors in the effectiveness of labour are continuity and skill. These cannot be obtained

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without the aid of capital, but as each party desires effectiveness, or should desire it, here again is community of interest. Enough has been said to indicate the truth of the dogmatism that the interests of masters and men are identical. We are distinctly of opinion that almost all economical questions are woefully misunderstood. The one between our correspondent and ourselves is of small moment, he maintaining that strictly only shareholders are capitalists, while we took the position that the shareholders' delegates (the directorate) might for argumentation purposes be dubbed the masters, or the capitalists, in contradistinction to the men workers. To us the man who finds the capital and actually manages it and the man, if any, to whom he delegates his powers are in one and the same position, and are "the capitalist." The capitalists or the delegated representatives are the "masters"; the others are the workers. A far larger question raised is that of the nationalisation of railways. This has been warmly discussed for the last thirty or forty years, but as yet with no result. It is a big question, dealing as it does with a capital amount of some twelve to thirteen hundred million pounds. This can well be left for future discussion. We should be glad if more men took a personal interest in these matters like our correspondent, then we should soon get a better understanding of where interests were identical, and points where divergencies might arise.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE TELEPHONE QUESTION.

SIR,—I imagine Mr. A. R. Bennett's principal reading matter is newspaper clippings relating to telephones, and so he loses sense of proportion. Complaints and criticisms gathered from among a thousand daily newspapers and concentrated by a clipping bureau are calculated to give the unthinking person a quite distorted view. There has been some opposition to the measured-rate telephone tariff by large users who have been getting the service on excessively favourable terms. Also the tariff is a novelty, and therefore objectionable. But no sane business man would dispute the soundness of the principle of the measured-rate tariff—payment in proportion to service rendered. The tariff benefits the large class of small users, but they do not speak at chamber of commerce meetings and are not heard from. There have been a few complaints as to overcounting of calls in London, but such complaints occur in every business. A large proportion of people make a practice of always disputing their bills. Mr. Bennett's remarks about the operators and the call registers would apply to any business, as they simply amount to this: that if employés do not do their duty, things will go wrong. This kind of argument leaves out of account such trifles as supervision, management, organisation.

Now for the truer and saner view of the picture. There are 500,000 telephones in use in the United Kingdom—a far larger number than in any other European country, the German Empire excepted. *Every day* some *three million* telephone messages are exchanged in the United Kingdom. With 500,000 daily users and 3,000,000 daily transactions, it would be strange if there were not a few complaints and a few errors. But these figures of the enormous extent of the service and the vast daily volume of traffic make the complaints appear rather insignificant. And so far from there being any "wave of discontent," it is a fact that the National Telephone Company and the Post Office are adding new subscribers to their respective systems as fast as they can find the plant wherewith to meet the public demand for telephone facilities. The measured-rate tariff, although looked at askance by the big user, is proving most acceptable to the small man, the tradesman, and the private resident. Among these classes there is great scope for telephone development in this country.—Yours, etc.,

HERBERT LAWS WEBB.

THE RAILWAY CRISIS.

SIR,—Your article under the above title in your last issue seems to call for some remarks in the nature of criticism. I agree with the writer that the subject of capital and labour has been woefully misunderstood. If any doubt on this point had been previously possible, his dissertation would have dispelled it, for he himself seems to have misunderstood very thoroughly the meaning of the terms as applied to modern industry.

The division of the people concerned into masters and men—or brains and brawn, as he terms it—may have some accuracy in the cases where the manager of a small concern is also the owner, but it is quite misleading when applied to joint-stock undertakings, and particularly so, as in the present case, to railways.

Capital in this case is the wealth which the shareholders have contributed for the construction and equipment of the system. Labour is the necessary human energy employed to carry on the business and maintenance of the concern. Whether the energy is mental or muscular makes no difference. The fact that a superintendent or designer does much brain and little hand work and the platelayer does more manual and less mental work is of no importance in the present classification; all except the few who hold shares in the company employing them, and so belong to both groups, come under the heading labour. The main concern of the capitalist is to get return for his expenditure—to employ men who will get the maximum profit out of the railway, so that he may receive a large dividend on his shares The worker, on the other hand, wishes to obtain the highest rate of wages for his services.

Now, under the existing competitive system the company endeavours to charge its customers as much as possible for the services rendered. For example, it tries to fix goods rates just so high that it becomes a little more profitable to a trader to send his merchandise by rail than by canal or road. The profit gained in a particular time is a definite quantity, and, clearly, if some of it is used to increase wages there will be less for shareholders' dividends. Consequently the interests of the workers and the capitalists are fundamentally opposed, and your writer's dogmatism about the interests of masters and men being identical is contrary to fact.

It is this conflict of interest which has led to the formation of trade unions. The workers, always at a disadvantage because of the more necessitous unemployed who are always ready to undersell them in the lower grades of labour, have combined to demand similar wages for similar work, and a living wage and fair conditions for all their members and other men doing similar work.

The refusal of the shareholders' representatives to meet the workers' representatives brought on the recent crisis. Whether the recent compromise will effect a long or a short peace it is difficult to estimate; and whether it will hasten or delay the only final solution—that is, railway nationalisation—time alone will show.—Yours, etc.,

STAFFORDIAN.

STEAM-TURBINES v. GAS-ENGINES.

SIR,—Mr. Fedden, in a recent letter, puts forward certain modified figures which seem to me a more equitable comparison between the running costs of steam-turbines and gas-engines. Without the introduction of any further figures, I think the ones Mr. Fedden has put forward for steam-turbines, and the ones which Mr. Andrews has given for gas-engines, speak their own tale.

Put briefly, the arguments against the use of *large* gas-engines are, first, that their high capital cost must necessarily militate against a low selling price of electricity if sufficient allowance is made for capital charges in arriving at the selling price; and, second, that the low costs for fuel which accompany the use of gas-engines are largely discounted by the remaining costs which go to make up the total working expenses being in excess of the corresponding costs prevailing with steam-turbines. By the remaining costs I refer, of course, to labour, repairs, oil, waste, and stores (Mr. Andrews grants that all these items are greater with gas-engines than with steam-turbines, with the exception of repairs; I scarcely think, however, that Mr. Andrews

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can seriously claim that the repairs item on gas-engines is less than on steam-turbines). Mr. Andrews makes a comparison between the running costs when dealing with load factors of 15 per cent. and 100 per cent.

Comparison with Load Factor of 15 per cent.—With a load factor of this description Mr. Andrews's figures show in favour of steam turbines—namely, 0·545d. per unit with steam-turbines as against 0·566d. per unit with gas-engines. Mr. Fedden's figures, however, bring this comparison to 0·442d. per unit with steam-turbines and to 0·66d. per unit with gas-engines. I think Mr. Fedden's comparison is a good deal closer than Mr. Andrews's.

Comparison with Load Factor of 100 per cent.—Mr. Andrews's figures with the high load factor—conditions which suit the gas-engine—tend to show a total cost of 0·204d. per unit with steam-turbines, as against 0·135d. per unit with gas-engines. I think, however, that this comparison is not quite fair. These figures, which tend to speak so much in favour of gas-engines, are based on Mr. Andrews's 16,000 kw. of gas-engines running 24 hours a day and 365 days a year, *without any reserve capacity for repairs*, or in the event of one of the units being laid aside for overhaul purposes. In the case of the steam-turbines, it is true that these are assumed also to be working continuously at their normal load, but here an appreciable reserve capacity is available by virtue of the overloads which can be maintained.

To deal with the load for which Mr. Andrews's comparison is made, it would not be unreasonable to have reserve plant to the extent of 50 per cent.—*i.e.*, plant of a capacity of 16,000 kw.—for continuous operation, but sufficient plant to work up to 24,000 kw. to allow for accidents. The following plant would, therefore, be necessary:

Gas Plant—	
4 units of 4,000 kw.	16,000 kw.
Spare—2 ,, ,, ,,	8,000 kw.
Total	24,000 kw.

Steam-Turbines.—Three units of 5,500 kw. = 16,500 kw. (each of these units to be capable of giving 8,250 kw. continuously in case of emergency). Spare one unit of similar capacity, 5,500 kw.—22,000 kw., with a maximum overload capacity of 33,000 kw.

Note.—In case two of the steam-turbines were out of commission, the remaining two units would still be able to deal with the normal load of 16,000 kw. by virtue of the overload capacity; the steam-turbine plant above, therefore, is on the same basis as the gas-engine plant.

The capital cost to provide for a plant of this description, taking Mr. Andrews's figures for the gas-engines and Mr. Fedden's figures for the steam-turbines, would be as follows:

Capital Cost of 16,000-kw. Plant without Reserve Capacity.

	Steam-turbines		Gas-engine	
	Mr. Andrews.	Mr. Fedden.	Mr. Andrews.	Mr. Fedden.
Engines and generators	£96,000	£60,000	£161,700	£161,700
Boilers, etc.	81,000	56,000	—	—
Producers, etc.	—	—	77,700	77,700
Engine-room, etc.	18,000	18,000	42.000	42,000
Switchgear	5,250	5,250	5,250	5,250
	200,250	139,250	286,650	286,650
5 per cent. contingencies	10,012	6,962	14,332	14,332
	£210,262	£146,212	£300,982	£300,982

Extra Capital Outlay to give 50 per cent. Reserve Plant to Engine-House Plant.

	Steam-turbines. On Mr. Fedden's basis.	Gas-engines. On Mr. Andrews's basis.
Engine and generators	£20,000	£80,850
Additional size of engine-room	6,000	21,000
Total (including extras)	£172,212	£402,832

The above amounts to this, that whereas steam-turbine plant would necessitate a capital expenditure of £172,212, an equivalent gas-engine plant would necessitate a capital expenditure of £402,832.

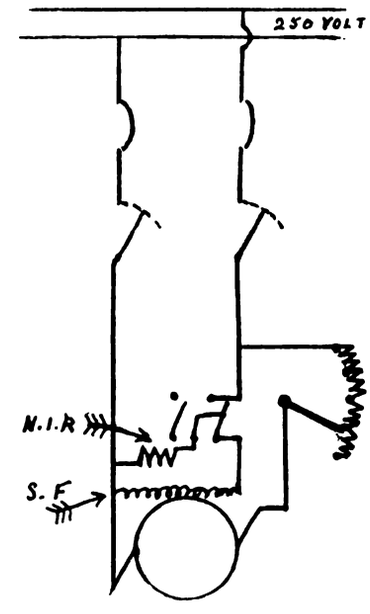
It remains for those installing plant to decide for themselves whether the lower fuel charges accompanying the use of gas-engines—and after making due allowance for the increased cost of running gas-engines in other respects—will justify the big difference in capital expenditure shown above. I think the extreme ease with which overloads can be dealt with on steam-turbines is sometimes overlooked, in view of the fact that this overload capacity is frequently used for dealing with the peaks of loads without a special plant being installed for the purpose, and also obviating the necessity for carrying further reserve plant. If the capital charges are taken properly into account in figuring out the relative costs of running steam-turbines as against gas-engines, I think it will be found that the gas-engine scheme starts very seriously handicapped. It is difficult to imagine, for instance, the amount of gas-engine plant which would be necessary for giving a supply of electricity similar to the supply which Mr. Merz is giving from his Carville station, assuming a similar amount of reserve capacity of plant.

In the case of the steam-turbine plant the reserve capacity is available in the overload capacity of the turbines. Probably even the accommodating German banker would hesitate to find capital for the necessary plant to give the same security of supply as Mr. Merz possesses in his turbine station at Carville.—Yours, etc., E. J. Fox.

Victoria Works, Rugby, Nov. 11, 1907.

RE QUESTION No. 1,008

Sir,—I beg to draw attention to an error in the sketches given by "S. E. T." It will be seen that the starting resistance is in series with the shunt field—hence a very weak field. The motor would consume an excessive current when starting, and it would also tend to race, though when the starting resistance is all cut out the motor would run at the correct speed, as the field would be across 250 volts.



The connections should have been those shown in the accompanying diagram.—Yours, etc., M. Moreton.

Cardiff, Nov. 13, 1907.

SINGLE-PHASE VARIABLE-SPEED MOTOR.

Sir,—We shall esteem it a favour if you will let us know the name of a firm who can supply a single-phase 4-h.p. motor capable of being regulated by a choking coil or a resistance from no speed to full speed, giving full-load torque throughout.—Yours, etc, G. H. W. and Co.

[We are afraid our correspondents are asking rather too much if they require an induction single phase motor to run with constant torque at variable speed. Some of our readers will doubtless inform them through these columns of what the single-phase commutating motor can do under these conditions.—Ed. *E. E.*]

ELECTRIC ALARM BELLS.

Sir,—We should be glad to have the addresses of makers of electric alarm bells actuated by an electric

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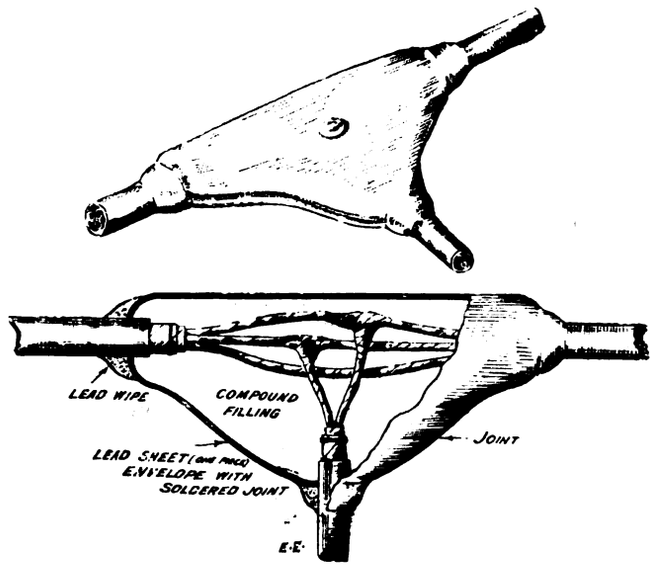
motor from the supply company's service.—Yours, etc.,

ADAMS BROS.

11 and 12, Trafalgar-street, Brighton.

LEAD WIPED JOINTS.

[Messrs. Siemens Bros. have sent us the sketch reproduced herewith of one of the tee joints at Ascot, which is



a further reply to the letter on the subject in our last issue.—ED. *E. E.*]

TRAMWAY ACCIDENTS: THEIR CAUSE AND PREVENTION.

BY SAFETY.

We have from time to time read a great many letters from engineers and other experts setting forth methods of stopping "runaway tramcars." Some of these not only attempt to attribute or attach the blame, but in their own way endeavour to show some measures which would have prevented them. Yet every few days we continue to read of serious or fatal accidents and all with cars which are said to be equipped with the best braking apparatus the market affords, and in nearly every instance failure of the man in charge or of the equipment proves there is yet something lacking. It is not our intention to administer a scathing reprimand to all and sundry tramway people, although there are some to whom the word apathetic could be justly applied. On the other hand, there are, as we intend to show, some who are—to put it plainly—not above being taught and rectifying former errors. In other words, of giving proof of an improving and growing knowledge.

It is the business and duty of the tramway manager to provide for his patrons a punctual and safe service, and to this end they draw up, or cause to be drawn up, in the office, time-bills, headway schedules, etc., or whatever they call them, for the men running the cars to work by, but in most cases it would appear as though this is done by considering the distance only. Now, if tramway managers would go to the trouble of occasionally riding with the motorman to see what he has to encounter in threading his way through the traffic of the town, or of even asking him questions upon the difficulties which he meets with in his daily work, the motorman would probably somewhat enlighten his superior, and win a little of his sympathy; for no one knows better than he the crass stupidity of some men whom we so often see are entrusted with the care of horses and vehicles in the streets—men who know and care little or nothing about the rules or rights of the road, or that they ought, lawfully and morally, to give at least some intimation to the car driver of their intention to cross the track just as he is about to pass—to say nothing of those carters who allow their charges to wander about the streets while they themselves are some distance behind and on the footpath.

Some pedestrians are also just as guilty of this neglect. And these are only a few of the difficulties which the motormen have to contend with, and which are plainly seen by anyone who uses the streets as they are intended to be used. Under such strained circumstances there is little wonder if he becomes either callous or nervous (and I scarce know which is the worst malady), for when the critical moment arrives for prompt action the man generally fails. He cannot think to order nor by touching a spring. It is not so much from incompetence as from having so many little things to do when a life or limb is to be saved or damage avoided. The "little things" are not much in themselves, perhaps, but they are too many to be all done at once or in the short space of time at his disposal. It is often a mere matter of a few feet and seconds, and in many instances he really has not time to think of the various movements which he must go through to stop his car before the damage is done. These results are showing themselves nearly every week. In fact, one would almost think that the tramways were striving with the railways for the superiority—or is it dishonour?—of bad "smashes." If that is not so, then we fail to see why the cars are not equipped with the most up-to-dates brakes and sanding apparatus. The authorities seem to be blind to their own interests.

Can anyone tell exactly what the capsizing of the cars at Swindon, Bradford, and Liverpool cost their various Corporations? Or to what depth Birmingham and Halifax will dip into the towns' pockets ere all their claims are satisfied? To say nothing of the ignominy of the thing. We are all pretty well familiar with the newspaper pictures of these cars as they lay on their sides in the streets of the respective towns which owned them. There was nothing very much in their appearances for any member of the staffs, from the managers downwards, to be proud of, for each and all these accidents could have probably been avoided had the cars been equipped as they ought to have been. The writer ventures to say that the cost of each accident would be sufficient to have equipped a great many cars with proper appliances, particularly one he has just seen in London, and which he understands has been upon the market for the past two years. He came across it quite unexpectedly the other day. He had a front corner seat in a North Metropolitan car, and was reading, but, feeling the car suddenly checked, he looked through the window and there saw an old woman leading a donkey and cart across the track. She, as many people do, had turned short in front of the car without looking to see if the road was clear, and but for the promptitude of the driver, and evidently the efficiency of his braking power, the donkey and cart would have been smashed up and the poor old lady injured or, perhaps, killed. Noticing that the driver was repeatedly sounding the gong, the writer was at a loss to understand how he obtained sand, for the man's foot that should have actuated the sand gear was ringing the gong; but sand was used, and a good stop made. Upon being questioned, the driver replied that in London they frequently "had narrow squeaks like that," and that he was not entitled to all the credit, for the company had equipped all their cars with a patent apparatus which gave a sufficient supply of good dry sand, so that whenever the emergency brake was applied the wheels could not skid. Hence the quick and sure stop, and an accident avoided.

And so we see the management of the North Metropolitan in spending their own money are also taking care of their own property, and wisely, too, which admits of a greater public safety, and also of the fact that they mean to be right up-to-date, for this stop proves it. The London United, I find, have also adopted this safe appliance. These companies evidently do not intend to have their exchequers reduced in paying compensation to people whom they may injure, or to run the risk of having to pay others who say they are, and, perhaps, are not. And where is the manager who, if he does not really know, fully believes that at some time or other he has had to pay many pounds to persons who morally had no right to it, but who have, with a nice plausible tale and a doctor's certificate, been able to convince some county court judge that they are by law entitled to it? Seeing that this up-to-date apparatus has been in use for two years proves in

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that it is past its experimental stage, and not having been known to fail, proves that there is little or no risk. Both of which are good and sound reasons why all managers should equip all their cars with it, for it must more than save its first cost in a very short time in preventing accidents which—even if minor ones—are occurring every day.

OIL-ENGINE INSTALLATION FOR ENGINEERING WORK.

An interesting installation, which involves a considerable amount of trust in the capability of the oil-engine to respond to sudden and unexpected calls, has just been put into commission with a certain amount of pomp and ceremony at South Shields. It consists of a searchlight, the dynamo for which is driven by a high-speed Gardiner oil-engine. This equipment, the contractors for which are Messrs. Crompton and Co., was supplied by the proprietors of the *Shields Daily Gazette* to meet a need keenly felt by the local life brigade. It must be remembered that the Tyne is the only port of call on a wide stretch of rocky coast, and frequently in heavy weather vessels in distress make for this port. Unfortunately, the haven is hedged by many dangerous reefs, and in spite of two extensive stone piers which were erected to choke the sweep of the waves into the harbour mouth many vessels have come to grief, even when actually within the port, on the "Black Middens." The searchlight, which is somewhat similar in type to the Admiralty pattern, is 24in. in diameter, and provided with lenticular diverging strips to increase the width of the beam, if necessary. It is erected in the tower of the South Shields Volunteer Life Brigade house, and commands a complete sweep of the rocks both inside and outside the mouth of the river. It is found useful in examining the sweep of the harbour piers, and the coast line adjacent. On the floor below the tower are placed the engine and dynamo, this situation not being too far away for the attendant in charge. The engine can be started from cold in about eight minutes—that is to say, this is the duration of time required from the instant the alarm is given to the time when the light is in operation. In stormy weather the lamps of the oil-engine are kept constantly burning, so that the searchlight is ready for work in a much shorter time than the above. We must compliment South Shields not only on the public spirit displayed by the proprietors of its newspaper, but also on the possession of a most useful piece of life-saving apparatus.

THE PROTECTION OF BUILDINGS FROM LIGHTNING.*

BY ALFRED HANDS, F.R.MET.S.

The privilege that has been accorded me of addressing you on the protection of buildings from lightning is particularly appreciated, because I believe it is the first time an independent expert has had the honour of addressing your corps on the subject. In 1861 Sir Wm. Snow Harris arranged to deliver a course of lectures at Chatham, but a painful malady, that resulted in almost total blindness, prevented his delivering them. This was a loss, not alone to the Royal Engineers, but to the whole world, for Snow Harris was a master of the subject. He owed his grasp of it to the fact that he was not only an experimenter, but had investigated a great number of cases in which damage had been caused by lightning, and he drew his deductions largely from the experiments that nature had carried out. It is only because I, too, have devoted considerable time to inspecting cases of lightning damage, and especially those in which lightning conductors have failed, that I have ventured to bring the subject before you. In the course of this investigation I have come across many cases that, I think, throw considerable light on this intricate subject, and I shall try and bring some of these before you to explain the conclusions at which I have arrived and the methods I have found advisable to adopt in protecting buildings.

Frequency of Damage by Lightning.—It is scarcely necessary to insist on the fact that a very great amount of damage is caused by lightning in this country every year, but it may be of interest to call your attention to a chart of England and Wales on which I have for some years been marking the positions and nature of objects damaged by lightning by differently coloured spots. I have collected particulars of such occurrences for the past 17 years, and, when all are located, I hope it will give some indication as to the relative frequency of lightning strokes on different soils. At present I have only completed a little over nine years, but even at this stage two facts are shown that are contrary to popular opinion. Firstly, damage occurs more frequently in towns and densely populated districts than in the open country; with a few exceptions, wherever there is a collection of spots a town is situated, and in this way nearly all towns of importance, and especially the large manufacturing centres, are indicated. Secondly, the cases also occur more often along valleys and on comparatively low lands than on the heights, doubtless because storms are liable to follow the courses of valleys. I may mention that there are on this chart 5,767 spots, representing 2,485 buildings (of which 148 are churches); 929 trees; 196 ricks and stacks; 172 persons killed and 728 injured; 1,004 cases in which animals were killed, varying from single ones to as many as 45 in a flock; and 253 objects not covered by any of the other classes.

The Lightning Research Committee's Report.—It is impossible to approach the subject of protection from lightning without referring to the present aspect of the matter in the popular mind and the causes that have led to it. There is at the present moment a great deal of scepticism as to the utility of lightning conductors, and this has been caused, directly and indirectly, by the recent so-called Lightning Research Committee and its report published last year. Time will not permit me to point out all the peculiarities of this report; however, I may say that it is not only so contradictory that one cannot say definitely what is or is not recommended, but it contains grave mis-statements that would lead the public to suppose that science had been seriously at fault, and that what I may call orthodox methods of protection are useless. It states that, out of 115 reports of disasters which occurred during the three years the committee were collecting particulars, 40 related to buildings fitted with lightning conductors. These figures were apparently communicated to the Press before the report was published, and they naturally led to comments that, if one out of every three buildings damaged by lightning had conductors, then conductors must not only be useless but might even be a source of added danger. I have since challenged these figures and obtained a public admission that they are incorrect. As a matter of fact, during those three years nearly 1,200 buildings were damaged by lightning in this country, and of these only 24 had conductors. The recommendations of this committee are of no more value than its statistics. They are avowedly founded on reports by observers, most of whom knew nothing of the subject and were incompetent to form a correct estimate of what they saw, and the reports were in many cases remarkable for their inaccuracy. It is curious how reports often distort facts into extraordinary occurrences that one would think a little scientific knowledge would show to be contrary to the laws of nature. In explaining some of the cases, I will give the published descriptions as a contrast and to show how little such reports can be relied upon to govern our views of the matter. I may explain that in the diagrams I have tried to illustrate the structures in the way they appear to me—that is, I have given a sort of Röntgen-ray view, with the idea of relative resistance conveyed by shade. Thus, the air, resisting most, is shown black; buildings, resisting less well than air, are shown grey; and metals, resisting very little, are shown white. The ground is shown grey near the surface but white below to indicate the conducting stratum that may be regarded as good "earth."

The Science of Lightning Protection.—The science of protection from lightning is not an easy one, but why is it difficult? We know that, in accordance with electrical law, a discharge will take the path of low resistance in preference to that with a high one. If we took a piece of stone and placed a line of metal along it from end to end, except for a break in the centre, and then subjected it to a discharge from an electrical machine; or, if we had a real obelisk composed only of the same material, and fitted it with metal in the same way, and it was struck by lightning, the spark would pass along the metal. If damage occurred it would only be at the gap; the discharge would not go through the masonry in preference to the metal. The experiment might be repeated any number of times, either with the model in the laboratory or with a real obelisk and nature, and the result would be the same.

1. A Sussex church that was struck in 1891 illustrates the obelisk I have been explaining. Someone was looking at the clock at the time, and declared he saw the flash strike it obliquely in a certain direction. We will let our spark strike the vane and watch the effect. [*Experiment.*—Spark strikes vane, and another spark appears between clock and nave roof.] The explanation is that the bolt rod of the vane, instead of extending down a few feet only as usual, was

* Lecture delivered at the School of Military Engineering, Chatham.

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carried down the whole length of the spire, about 40ft. or 50ft., and ended just above the works of the clock; a piece of copper wire, passing from near the lower end of the bolt rod to the clock works, formed a connecting link between the two. The course of the discharge, therefore, was from the vane, down the bolt rod, and through the copper wire (which was fused) to the clock works and face, this part of the course being invisible, not only because it was within an enclosed space, but because it formed a conducting system. The discharge then passed as a luminous one through the masonry of the tower, shattering it, and finally to earth by the lead flashing and rain-pipe. What the observer saw was the bright light here and he imagined the rest. I may add that my description is not entirely hypothesis. In all the cases I am showing there were the usual clues that one picks up as one goes along—clues which might appear insignificant individually, but which, taken in conjunction with one another, form convincing chains of evidence. Reverting to the obelisk, if we completed the line of metal so as to form a continuous conductor, the obelisk would be protected. Electrically bad joints and a bad earth connection would not force the discharge to go through the masonry. Bad joints would only cause injury to the conductor, and a bad "earth" would probably result in a barrow load or so of soil being blown up. The concussion due to the explosive force that blew up the ground might possibly crack the masonry slightly on the surface, but this would be the worst that would happen. But if the obelisk, in place of being solid masonry, was built hollow, with stone steps in the interior, and with a gas-pipe carried up inside to afford light at intervals, the problem would be an entirely different one. There would be a rival conductor in the interior—an alternative path of metal—with a perfect earth connection, because the ramifications of the gas-main underground would afford only a nominal resistance to earth.

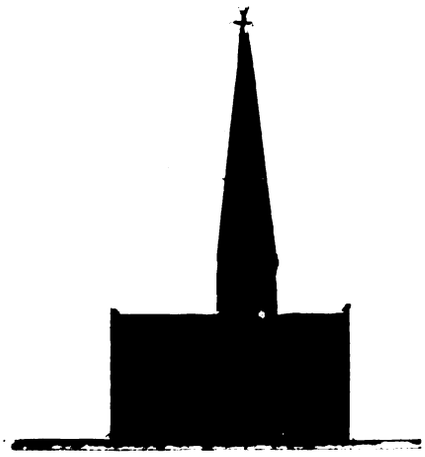

FIG. 1.—German Lutheran Church, Dalston, N.E.

Therefore, if the intended conductor had a high resistance, the bulk of the discharge would spark through the wall and pass to earth by the gas system. The earth resistance of a gas-main is a mere fraction of an ohm, and it is practically impossible to get an appreciably lower one for the conductor; so, even if we gave the latter what is called a "good earth," there would still be the rival in the interior and the danger of division of the discharge between the two paths of metal, for a thickness of a foot or two of masonry is poor insulation to withstand the voltage of a lightning flash. For efficiency it would not only be necessary to have a conductor with a minimum resistance, but it should be fixed on the opposite side of the structure to the gas-pipe, so that there would be a sufficiently thick buffer of insulating material between them and the discharge would not be able to spark through. I consider the safe distance for masonry or brickwork to be a little over 4ft.; less than this is risky, because the question of sparking through the wall would depend on the relative thickness of the masonry and the power of the flash.

2. I will reproduce a case of alternative path that occurred in North London (Fig. 1). The case was described as follows in a list of reports issued by the Lightning Research Committee and exhibited at Earl's Court Exhibition in 1903: "Feb. 26, 1901. London: German Lutheran Church, Ritson-road, Dalston. Flash passed through rose window at north end, leaving stone racery intact but destroying the organ immediately behind it and setting fire to the timbers of organ loft." The evidence that appeared to warrant this peculiar report was the fact that the spire was uninjured; on the other hand, the north window was destroyed, indicating apparently that lightning had passed through it, and a fire was caused at this end of the nave that did, I believe, about £2,000 damage. According to this, lightning ignored the tall spire, about 170ft. in height, that had a ghtning conductor upon it; ignored even the north gable, close to which it was supposed to have passed, that had lead flashing down both sides, which, in conjunction with the rain gutters and down pipes, formed lines of conducting material almost to the ground—it ignored these, because it preferred a path of infinitely greater resistance through the air to curl in through a window about 20ft. or 30ft. from the ground, being attracted, I suppose, by some organ pipes! Yet it was sufficiently satisfactory for the Research Committee to accept and print in its records. We will reproduce the case, letting the discharge do the orthodox thing and strike the vane on the spire. [*Experiment.*—Spark strikes vane and fire occurs at meter, and spreads up staircase to organ loft.] The case is set out in diagrammatic form in the illustration, and it will, perhaps, make my explanation more clear. Attached to the bolt rod of the vane was a lightning conductor carried down inside the spire and out through one of the windows, where it descended the tower and ended in a rain down pipe in this corner, so that there was practically no earth connection. The down pipe was in contact with the lead flashing that passed up round the back of the tower to the other side, where there was another down pipe. Near this was a gas lamp set to light the passage; the gas-pipe passed through the wall to the interior, and along to the meter at the north end. There were, therefore, two lines of metal—one, the lightning conductor continued by the rain-pipe with a bad "earth"; the other, the conductor continued by the lead flashing, rain-pipe, and gas-pipe, to the perfect "earth" afforded by the gas-main; and lightning took the path of least resistance. That a fire was caused at the meter, owing possibly to a bad joint, but more probably to crossed inlet and outlet pipes, was a natural consequence; and it was also a natural consequence, I think, that the fire, having started in a cupboard under some wooden stairs, should have spread up the staircase to the organ loft, burnt the organ, and melted the leaded lights of the window. We have heard a great deal lately about abrupt bends in a conductor causing a discharge to side-flash to neighbouring metals. This opinion has arisen in a rather curious way. Sir Oliver Lodge has written a work on lightning conductors that is a valuable contribution to the subject from a theoretical point of view, though his practical deductions are, I consider, unsound and not warranted. In one part of this book he says that lightning has no time to go round; it will jump across in preference, which in a certain sense might appear correct. In another place he says that self-induction causes side-flash, which statement taken by itself appears true, since we know that by reducing self-induction we can decrease the length of the side-flash. Certain electricians appear to have married one statement to the other, and the issue of this morganatic union is the statement that abrupt bends increase self-induction and so cause side-flash. So much has this been asserted that even many electricians are convinced it is true, although it is contrary to electrical law. A straight wire has a certain amount of self-induction; twist it into a spiral and this is increased enormously. But zigzag it backwards and forwards, giving it, in fact, a number of extremely abrupt bends, and self-induction and consequent side flash are reduced to a minimum.

3. I want to call your attention to the course followed in this case, the discharge going by nine abrupt bends to get to a good earth in preference to a straight course to a bad one. While I have the model here I will show you a variation of the last experiment. I cut away the lead flashing that connects one side of the tower with the other, so that this alternative path is no longer open. We let the spark strike the vane as before. [*Experiment.*—Spark strikes vane, and fire is again caused at the meter, with the same result, because there is now another alternative path open.] When making this model I placed a line of lead foil over the south gable to represent lead flashing, although, if I remember rightly, there was none in the original. Its being here did not affect the first experiment, because I left a break at the back that was afterwards made up with a piece of wire. It now enables me to show you what a roundabout course a discharge will travel, and how necessary it is to guard against alternative paths no matter how circuitous. The course is now down the conductor, along the rain gutter southward, up the roof and down to the east side, along the rain gutter northward, up again over the roof to the west side, along the rain gutter southward, down the rain-pipe, back to the gas lamp, and on by the combination as before. It might be asked: "How is it possible to protect this building, since, however perfect the lightning conductor in that corner, there is always open the alternative path to an earth connection at least as perfect as that of the conductor?" If we followed the Lightning Research Committee's recommendation and put two, or even a dozen, conductors on the spire, the same thing would still happen. Protection is a much more simple matter than this; run the conductor down the south-west corner, and it would then be sufficiently far removed from these dangerous complications. The obelisk I have been explaining is the simplest possible case. If all buildings were as simple as this, protection from lightning would be so ridiculously easy that a council schoolboy could, by means of a few set rules, learn to

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protect them efficiently. The problem one is sometimes confronted with is more like this: metal cowls on chimneys; lead-covered ridges and flashings; metal girders, stoves, and casements; rain-water gutters and pipes, gas and water service pipes, etc.—altogether affording a problem that would require very careful studying. Before going further into the matter, I will show you a few cases of so-called lightning conductor failure in diagrammatic form. I regret that time did not allow of my making models so as to reproduce these experimentally also.

4. On the tower of Stradbroke Church, Suffolk, struck about five years ago, a lightning conductor was fixed to the corner turret, but not connected to the vane; therefore, if the turret had been struck, the masonry between the vane rod and the conductor would have suffered. The point struck, however, was the flagstaff at the opposite corner that had no conductor. The course of the discharge, after shattering the flagstaff, was along the lead roofing up to the metal hinges of the turret door, and then through the masonry to the conductor, by which it passed to earth without further damage, although the resistance to earth was about 900 ohms; there was no possible alternative path in this case. The system I recommended comprised a main conductor from the flagstaff, with branches from the vane and the two other pinnacles, the whole being connected to the lead roof.

5. Fig. 2 shows Needwood Church, Staffordshire, struck about 14 years ago. The system comprised a main conductor from one pinnacle to an earth with a copper plate, 3ft. by 3ft. by ¼in., bedded in clay soil, the resistance being about 12 ohms, and branches from the other three pinnacles. A very bad bend was formed by the conductor being carried down to the lead roof and then up again over the parapet wall. The discharge did not spark through the parapet, but the conductor was ripped loose there. I have on several occasions noticed what I

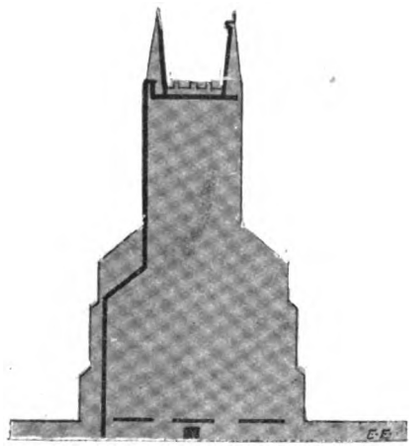

FIG. 2.—Needwood Church, Staffordshire.

take to be a tendency for a conductor to straighten itself when struck by lightning; and, if the fastenings are not very secure, a bad bend like this leads to the conductor being torn loose. On the ground floor, inside the nave, was matting, the ends of which were bound with lead about equal to a 1in. pipe flattened out. There were three lengths of lead binding, the first one being just behind the conductor, and the second just above a large metal stove that rested on a damp floor in a vault. This combination formed an alternative path, and part of the discharge sparked from the conductor through the wall to the first lead binding, on to the next length, and through the floor to the stove. The discharge was undoubtedly exceptionally severe in this case. The course of the conductor was altered so as to do away with the up-and-down bend, and the lead binding was ordered to be removed.

6. In Kea Church, Cornwall, struck about six years ago, the spire was entirely copper covered, but a conductor was carried over it from the vane to the ground. I was told there was an earth-plate, but did not test it, and do not know the resistance. As the church is on a hillside the resistance would probably be rather high. It was reported that lightning had struck the roof of the nave close to the spire, because this was the only place damaged, but I found that the vane had been struck. The discharge had divided between the conductor and a rain down pipe in the corner, both being connected at the top by the metal roof, and both having practically the same earth connection because a piece of copper wire, put up to support some creepers, was stretched across from one to the other a few feet above the ground. The portion of the discharge that passed down the rain-pipe divided again by sparking through the parapet wall to the lead flashing (down the roof of the nave), which, with the rain gutter and down pipe by the porch, formed another line of metal to the ground. I believe the authorities afterwards had the rain-pipes earthed with the idea of letting the electricity escape, which would only make matters worse; what was wanted was a connection of metal across the top of the parapet wall from the rain-pipe to the lead flashing.

7. Fig. 3 shows a very common case, a short elevation rod fixed on a chimney, and near it a much higher mass of metal in the form of a cowl. The discharge passed through the cowl, and shattered the corner of the stack in passing to the conductor. Here the elevation rod should have been fixed on the cowl, or else a connection of metal should have been made from the cowl to the conductor. These cases are all comparatively simple ones. I propose showing next some results due to the surging effect of a discharge; and, as this is often overlooked and is possibly not very generally understood, I will explain it first in case anyone present has not considered the matter. Electricity—or, perhaps, I should say, the movement in the ether that causes electrical effects—has properties that correspond to inertia and momentum in matter, and in scientific terms they are called electromagnetic inertia and electrokinetic momentum. We have to remember that when a conducting system receives a discharge, it is momentarily charged because of inertia having to be overcome, and the consequent sudden rise and fall of potential does not leave outlying parts of the system at a normal level. There is an alternate rise and fall like the water in a bath that has been tipped up suddenly at one end. Although the effect is all over in a fraction of a second, damage might occur which, although slight in itself, might have serious results, so precautions should be taken to guard against it. Although water is not a good analogy, it is the best I can think of to bring the action to mind. Imagine a system of canals. Suppose a main canal, open to the sea, and equivalent to a conductor with a good earth connection. To right and left suppose two branch canals, equal to branch lines of metal from the conductor, the former having only a very weak wall dividing it from a pool of water, while all the other banks are sufficiently high and strong to resist pressure due to the rise and fall of the water-level. The pool represents a piece of metal near the far end of the branch con-

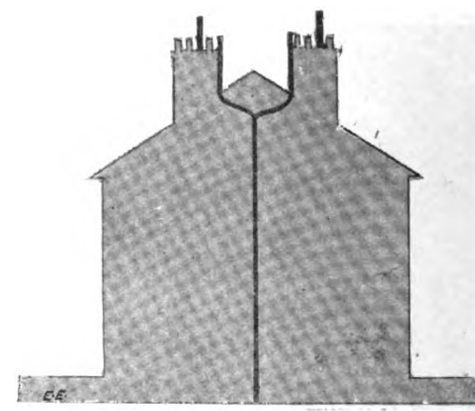

FIG. 3.—Type of Ordinary Small House.

ductor and not connected to it. If the level of the water in the main canal were suddenly raised enormously, there would be a rush along the canal due to the passage of the extra head of water to the sea, but the water in the branch canals would not remain at normal sea-level; there would be a surging effect along them. In the left-hand canal there would be no effect beyond the rise and fall of water; but with the right-hand one, the dividing wall, being very weak, might be broken down. The strength of the wall represents the insulating strength—or, in other words, the distance—between the branch conductor and the adjacent metal, and would determine whether a breakdown, or spark, occurred between the two.

(To be continued.)

APPOINTMENTS VACANT.

Switchboard Attendant, Stirling Corporation. Applications to Mr. J. Papworth, burgh electrical engineer, Stirling, by Nov. 19.

Switchboard Attendant, Clacton Urban District Council. Applications to Mr. H. Everitt, electrical engineer, Clacton-on-Sea, by Nov. 27.

City Electrical Engineer, Sydney, N.S.W. Commencing salary, £900 per annum. Applications to Mr. Thomas H. Nesbitt, town clerk, by Jan. 16, 1908. See advertisement.

Assistant Junior Demonstrator in the electrical engineering laboratories, Northampton Polytechnic Institute. Salary, £80 per annum. Applications by Nov. 26. See advertisement.

Chief Assistant Engineer, Hoylake and West Kirby Urban District Council. Commencing salary, £125 per annum. Applications to Mr. C. J. Turner, Electricity Supply Works, Hoylake, Cheshire, by Nov. 18.

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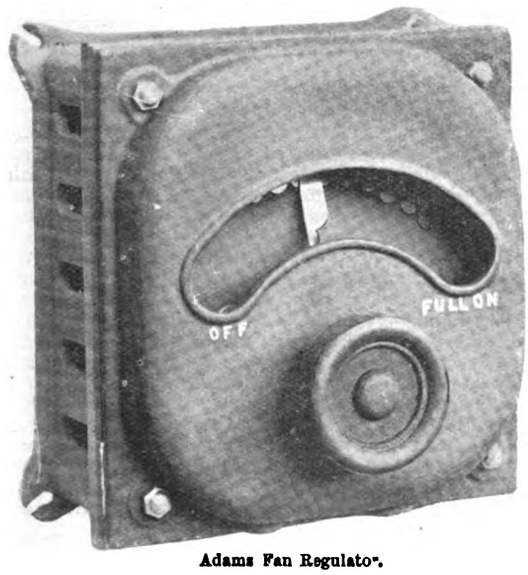
CATALOGUES, PRICE LISTS, ETC.

LAHMEYER ELECTRICAL COMPANY, LIMITED, 109-111, New Oxford-street, London, W.C.—Two new price lists have been issued, No. 10, of large continuous-current dynamos and motors, and, No. 11 F, of three-phase alternators. The lists are most conveniently arranged for showing almost at a glance the prices of the various types and sizes of machines, as well as of resistances and accessories. Both continuous and alternating current machines are made either for belt or rope drive, as well as for direct coupling, in which case they are provided with three bearings. Machines arranged for rope drive are never provided with slide rails, as their use would be of no advantage, for the short ropes that were already sufficiently taut would be still further stretched, while with slack ropes the necessary tightening would not be obtained. Approximate weights of the various types and arrangements are given in the lists, which are of sufficient interest to warrant being widely applied for.

CROMPTON AND CO., LIMITED, Salisbury House, London-wall, London, E.C.—A pocket catalogue has been prepared giving a price list of the various manufactures. The wide range over which these manufactures extend is shown at a glance, and it is, therefore, obvious that detailed treatment of them is impossible within the limited space of a pocket-book. The latter, however, may serve as a means of introduction to the contents of the larger catalogues devoted to various manufactures. These include protected and open type continuous-current dynamos and motors and alternating-current generators and motors, electrically-driven pumps, arc lamps and accessories, projectors, switchgear and circuit breakers, carbons, etc. There are also given in the pocket catalogue definitions and symbols of the most important electrical terms in use and much useful formulæ.

ADAMS MANUFACTURING COMPANY, LIMITED, 106, New Bond-street, London, W.—The accompanying is a photograph of a



Adams Fan Regulator.

new type of fan regulator, which, it will be observed, is particularly neat and compact, the whole of the switch parts and regulating resistances being enclosed within the metal cover. The apparatus gives the appearance of being of remarkably strong construction.

BRITISH ALUMINIUM COMPANY, LIMITED, 109, Queen Victoria-street, London, E.C.—The latest lists issued by this company give prices for aluminium sheets, tubes, ingots, bars and wire, together with the approximate weights of respectively aluminium, copper, or brass. From the prices given in the lists, aluminium is cheaper than either copper or brass, area for area, or bulk for bulk. Moreover, the lightness and strength of aluminium give it a considerable advantage over other metals—an advantage which is increased by the fact that it is practically unaffected by the majority of acids. But the easiness in the copper market detracts somewhat from that advantage, for a decline in the price of copper having set in, many who would at one time would have adopted aluminium as a substitute, for certain purposes, will be inclined now to stand by copper.

ELECTRICAL COMPANY, LIMITED, 121-5, Charing Cross-road, London, W.C.—The latest fittings catalogue issued by this company has just come to hand. This deals with enamelled-iron, aluminium, cardboard, opal, flint, frosted, opalescent, crystal cut, iced, and silk shades for electric light, on show at the extensive fittings showrooms at 162, Shaftesbury-avenue.

SUN ELECTRICAL COMPANY, LIMITED, 118-120, Charing Cross-road, London, W.C.—We have received a copy of the new catalogue of electrical accessories which has just been issued by this firm. This catalogue is Section B of a series issued separately in sections. It is devoted to electric bells, indicators, etc., and should be of service to electric light engineers, contractors, ironmongers, etc.

PERSONAL.

The Burslem Town Council have increased the salary of Mr. Brenner, the electrical engineer, to £350 per annum.

Mr. Brinley Rees, of Albert-chambers, High-street, Cardiff, has been appointed district representative of Rhodes Motors, Limited, for South Wales.

The Zurich Incandescence Lamp Co. inform us that they have sold their English business to the Stearn Electric Lamp Co., 47, Victoria-street, Westminster.

Sir Wm. Matthews, K.C.M.G., president of the Institution of Civil Engineers, will be the guest of the evening at a house dinner of the Municipal and County Club to be held on Nov. 29.

Mr. W. D. Morgan, of the Scottish Central Electric Power Co., Edinburgh, has been appointed manager of the Airdrie and Coatbridge Electric Supply Co. in succession to Mr. Donnachie.

Mr. F. Williams having resigned his appointment as assistant electrical engineer to the Leek Urban District Council, the Council have appointed Mr. A Hemming to the vacant post.

We are informed that the late Lord Chesham, who was killed when hunting with the Pytchley Hounds, had for many years been insured against accidents with the Railway Passengers' Assurance Co.

FORTHCOMING EVENTS.

FRIDAY, NOV. 15.

Institution of Mechanical Engineers.—At 8 p.m., at Storey's-gate. "Labour-Saving Appliances at the Mines of the New Kleinfontein Co., Transvaal," by Mr. Edward J. Way, of Johannesburg.

SATURDAY, NOV. 16.

Institution of Electrical Engineers. — Students' visit to the Central Telephone Exchange at 3.30 p.m.

MONDAY, NOV. 18.

Institution of Electrical Engineers (Newcastle Local Section). At 8 p.m., presidential address by Mr. James Pigg at the Armstrong College.

Junior Institution of Engineers.—At 8 p.m., at the Institution of Civil Engineers, Great George-street, Westminster, presidential address by M. Gustave Canet on "The Latest Improvements in French and English Modern Artillery."

TUESDAY, NOV. 19.

Institution of Electrical Engineers (Manchester Students Section).—At 7.30 p.m., at Municipal School of Technology, "Power for Works and Factories, with Costs," by Mr. L. J. Lepine.

WEDNESDAY, NOV. 20.

Institution of Electrical Engineers (Birmingham Local Section). At 7.30 p.m., at the University, Edgbaston, inaugural address by Prof. Gisbert Kapp.

Society of Arts.—At 8 p.m., at John-street, Adelphi, inaugural address by Sir Steuart Colvin Bayley.

Royal Meteorological Society.—At 7.30 p.m., at the Institution of Civil Engineers, "The International Balloon Ascents, July 22 to 27, 1907"—reports by Messrs. W. H. Dines, F.R.S., J. E. Petavel, F.R.S., W. A. Harwood, Captain C. H. Ley (R.E.), and Prof. W. E. Thrift; "Discussion of the Meteorological Observations made at the British Kite Stations, 1906-1907."

FRIDAY, NOV. 22.

Physical Society.—At 5 p.m., in the Physics Laboratory, Royal College of Science, Imperial Institute-road, South Kensington, "On Singing Sand from New England," by Mr. S. Skinner; Exhibition of a Micromanometer by Mr. L. Bairstow; Diabolo Experiment by Mr. Vernon Boys; Exhibition of a Gyroscope illustrating Brennan's Monorailway by Prof. H. A. Wilson.

Society of Engineers.—Wednesday, Dec. 11, annual dinner at Hotel Cecil.

LEGAL INTELLIGENCE.

TAYLOR v. MANCHESTER CORPORATION.

This case was heard at the Manchester Assizes on Friday last before Mr. Justice Pickford and a special jury. It was an action brought by Edwin Taylor, a fitter in the employ of Messrs. Ferranti, electrical engineers, against the Corporation to recover damages for personal injuries resulting from an accident. The plaintiff, it was stated, was sent along with a foreman by his employers to construct an additional panel to the switchboard at the station. He told the attendant there to deaden the panel adjoining that which the firm were constructing, and he concluded that this had been done. Whilst explaining to the foreman how the work was proceeding he moved towards one of the panels, and immediately there was a flash, accompanied by a report like thunder. Taylor was held to the live bars by the force of the electric current, which was said to be 6,500 volts, and it was with great

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difficulty that his companion pulled him away. He was then almost pulseless, and strychnine had to be injected to bring him round. His index finger was so badly burned that it had to be amputated, and he was also severely burned on the thigh.

The defence set up was that the plaintiff should have satisfied himself that the place was safe, and it was argued in support that it must have been apparent to any person who knew anything about the work in hand that the panel was alive, and therefore dangerous. It was for the plaintiff to have kept away from it whilst it was in that condition, and not to have gone and touched a live wire. He was a skilled man, and if he had exercised the slightest care the accident could not have happened.

The jury found for plaintiff, and awarded him £250 damages. Judgment was given accordingly.

HALIFAX TRAMCARS.

A claim arising out of the construction of tramcars for the Halifax Corporation was tried before his Honour Judge Gent at the County Court last week, when William Stansfield Rawson, coachbuilder, of Blackwall, Halifax, sued Richard Turner, joiner, Halifax, to recover £15. 10s. for work done.

It appears that the plaintiff was entrusted last July with a sample top for a tramcar to paint and enamel, the defendant finding the material. When the work was finished the plaintiff charged the defendant £5. 17s. for the work. Subsequently the defendant saw the plaintiff's son and ordered him to get other car-tops painted, the defendant again to provide the material. Some of the tops were wanted almost at once, and for these covered roofs the defendant charged £4. 10s. each, the sum of £1. 7s. being allowed for the material.

Defendant said the sample car, which was painted white and varnished, turned yellow in use. At the request of the tramways manager, they substituted enamel for varnish, which would save three or four coats of paint, without, however, reducing the cost of the materials.

COMPANIES' MEETINGS AND REPORTS.

DRAKE AND GORHAM.

The sixth annual general meeting of Messrs. Drake and Gorham, Limited, was held on Monday at the offices, Victoria-street, Westminster.

Mr. B. M. DRAKE presided, and, in moving the adoption of the report, expressed the disappointment of the directors at being unable to pay any dividend this year, but pointed out that the Company were not alone in this respect. The directors had had in view other possible sources of revenue, and had turned their attention to the sale of motorcars, on which they found their clients were inclined to disburse their available surplus in preference to electric lighting. This branch was already showing satisfactory financial results. In the application of electricity as a means of transmitting power the Company had done a great deal of pioneer work, the results of which had not yet been apparent in the balance sheet. The work in hand included the lighting of part of Windsor Castle. The factory had already been the means of introducing improvements in the Company's switchgear and in developing a new conduct system which had been put to use. The Company had started the present financial year with several good orders, and had important inquiries on hand.

Mr. J. C. FORSTER seconded the motion, which was carried.

WEST INDIA AND PANAMA TELEGRAPH.

The half-yearly general meeting of the West India and Panama Telegraph Co. was held on Wednesday.

Mr. WALTER BISHOP KINGSFORD presided, and, in moving the adoption of the report, stated that the receipts amounted to £43,832, as against £36,999 for the corresponding period of 1906—an increase of £6,833. Having regard to the field in which they carried on their business, they could regard this result as not unsatisfactory. The increase was principally due to rather more commercial activity at some of their foreign stations. The expenditure had increased by £4,348 over that for the corresponding period, and this was due to their having re-established telegraphic communication between Dominica and St. Lucia, which they would remember was interrupted by the terrible eruption that took place at Mont Pelée, Martinique, in 1902. The directors felt that the time had arrived when the operation of connecting up Dominica with St. Lucia direct might safely be undertaken, thus restoring the former duplication to that part of their system. The result of the half-year's working was a profit of £13,804, which, with the amount brought forward, amounted to £16,052. The directors recommmended the payment of the full six months' dividend on these shares, also the payment of £1 a share on account of the accrued dividends on the second preference shares.

The report was adopted.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH.

The half-yearly ordinary general meeting of the Eastern Extension, Australasia, and China Telegraph Co. was held on Wednesday under the presidency of Sir J. Wolfe Barry, K.C.B.

The CHAIRMAN, in moving the adoption of the report, said the gross receipts for the half-year under review amounted to £304,000, or a little more than was earned in the corresponding period of 1906. In the latter period, however, an exceptionally large profit was made on exchange, and if that were excluded from the comparison the receipts would show an increase of about £8,000, which was derived from the natural growth of traffic. The working and other expenses amounted to £156,000, against £141,000 for the corresponding period of 1906, showing an increase of nearly £15,000. Of this, £3,000 was due to increased cost of maintenance of cables, £2,000 to additional cost of maintenance and renewals of instruments and electrical apparatus, and most of the balance was accounted for by the supplemental allowances which it was found necessary to make to the staff to meet the continual rise in exchange in the value of the dollar in the Straits Settlements and China, together with the exchange differences affecting the general expenditure in those countries, due to the same cause. The net profit for the half-year was £132,000, and after adding to it the credit balance of £17,344 brought forward from the previous half-year there remained an available balance of £150,000. The usual quarterly interim dividends of 2s. 6d. per share, or at the rate of 5 per cent. per annum, had been paid for the past half-year, leaving a balance of about £75,000 to be carried forward. During the past half-year some of their main-line cables had been partially renewed at a cost, after making allowance for the value of the picked-up cable, of £9,565, and that amount had been charged against the general reserve fund. The directors had considered it advisable, in view of the continued heavy depreciation in the value of all gilt-edged securities, to debit the general reserve fund with £120,000 as a provision on account of investment fluctuations.

The MARQUESS OF TWEEDDALE, K.T., seconded the motion, which was carried unanimously.

EASTERN TELEGRAPH.

The ordinary general meeting of the Eastern Telegraph Co. was held in London on Wednesday, Sir John Wolfe Barry, chairman of the Company, presiding.

In moving the adoption of the report, he said it would be somewhat misleading to attempt comparisons of income, as the present accounts included the most productive quarter of the year—namely, the March quarter—which had hitherto been included in the final half of the financial year. This circumstance accounted for their being able, at the interim half-year, to make a further contribution of £120,000 to the general reserve fund, and to carry forward the substantial balance of over £41,000. He had again to record a considerable falling off in receipts from traffic with South Africa, the decrease applying alike to ordinary, Government, and Press messages, and he could see no indication of any great improvement in the near future. On the other hand, receipts had increased from messages exchanged with India, Egypt, and South America, while other branches showed but slight variation. With regard to investments, it was questionable if these would again reach the high prices at which they were purchased some years ago. The sum of £130,000 had, accordingly, been taken from the general reserve fund and deducted from the figure appearing in the balance-sheet as representing the cost of the investments. This would avoid the necessity of writing down or writing up the value of the securities. The reserves now amounted to £1,698,000. Since the incorporation of the Company no less a sum than £4,386,000 had been applied out of the general reserve fund towards the cost of cables, renewals, etc., which had enabled them to improve the carrying capacity of their system, and by extending their service generally they had been enabled to reply to actual competition and to face with equanimity any threatened competition to which a successful undertaking such as theirs was always liable. The chairman said he had nothing further to add to the remarks he made on wireless telegraphy at the meeting of the Western Telegraph Co. recently.

Sir JOHN DENISON-PENDER, K.C.M.G., seconded the adoption of the report and accounts, which was carried.

VICTORIA FALLS POWER.

A meeting of the Victoria Falls Power Co. was held on Wednesday, at which some formal alterations were made in the articles of association, with a view to a Stock Exchange quotation being obtained for the Company's shares. Mr. H. Wilson Fox presided, in the absence of the president of the Company, Lord Winchester.

After a resolution was passed making some formal alterations in the articles of association with a view of obtaining a Stock Exchange quotation, the CHAIRMAN referred to his recent visit to South Africa and to the prospects of the Company. He said that powerful mining groups with whom previously they had not been successful in negotiating contracts were now daily approaching the Company and asking when they would be ready to supply them with power, and he had not the slightest doubt that as fast as the Company could put up their plant that plant would would be fully occupied with orders. They had more work offered them to-day than they could cope with from their existing stations. They had two stations with an output of slightly over 6,000 kw. These were running day and night as hard as they could go, and the Company were having to turn away customers because they had not the power to supply. Thus, instead of having a long intervening period during the construction of their big plant, when everything would be going out and nothing coming in, they were to-day making working profits in South Africa at the rate of upwards of £80,000 a year, and the only deduction that would have to be made from that would be an allowance for depreciation of plant. Another point they had gained was that they had established very friendly relations with the Government of the Transvaal, who promised to do their best to help the Company in every way. The Company had received within the last couple of months a great deal of friendly assistance from the Government, and he had no reason to suppose that they would in any way change their attitude towards the Company. In regard to the falls, although he could

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not make any definite pronouncement on the subject, he had very good hope that within a comparatively short time the Company would have quite considerable demands for power for industries to be established close to the falls. If so, that would be turning to account at an earlier period than they could have hoped another important asset. Their two great assets to-day were the fact that they were the only large power suppliers on the Rand, and had, therefore, the command of the market, and at the falls they controlled one of the greatest natural producers of force in the world. If they could push these two sides of their work simultaneously, he thought the shareholders would agree that the Company's position would be very good.

BRITISH COLUMBIA ELECTRIC RAILWAY.

The report of the directors of the British Columbia Electric Railway Co. for the year to June 30 last states that the business of the Company shows continued and increasing prosperity in all departments, and the directors are pleased to be able to recommend a further increase in dividend, which will place the deferred ordinary stock on an 8 per cent. basis, and, consequently, the preferred ordinary stock on a 6 per cent. basis. For the 12 months to June 30, 1907, the gross receipts show an increase over those of the preceding year of 329,204dol., and the net earnings, including income from investments in subsidiaries, after charging renewals, show an increase of 186,251dol. The following charges have been made against the revenue account of the year—namely: provision for renewals maintenance (from which £8,567 has been deducted for adjustments and expenditure on renewals during the year), £26,160; bonus to employés, £5,702; amount added to capital amortisation fund, £1,865. The net profit for the year, after making the above deductions, amounts to £105,012; adding the balance brought forward, £2,619 and deducting interest on debentures and debenture stock and the interim dividends on the 5 per cent. cumulative perpetual preference stock for six months to Dec. 31, 1906, on the preferred ordinary stock for nine months to March 31, 1907, and on the deferred ordinary stock for six months to Dec. 31, 1906, there is available for distribution and reserves £51,107. The directors have decided to transfer to reserve fund £18,876 to provide for the dividend on the cumulative perpetual preference stock for six months to June 30, to provide for the dividend on the preferred ordinary stock at the rate of 5 per cent. per annum for three months to June 30, to recommend the payment of an additional dividend on the preferred ordinary stock at the rate of 1 per cent. per annum for the six months to June 30, and to recommend the payment of a dividend on the deferred ordinary stock at the rate of 8 per cent. per annum for the six months to June 30, 1907, making 7½ per cent. for the year, leaving to carry forward £3,480. The reserve fund has also been credited with the sum of £4,123, being the estimated value of certain bonus lands in North Vancouver now being utilised by the Company. The share of profits for the past year distributed among the employés amounts to 27,342dol. During the year an issue of £100,000 4½ per cent. perpetual consolidated debenture stock has been made in order to provide funds for the Company's general requirements, and, in particular, for the construction of a new line from New Westminster to Chilliwack, a distance of 60 miles. Construction work on the Chilliwack line has now been commenced.

OPENINGS FOR CONTRACTORS.

ABERBEEG—New church (£4,600). Mr. E. A. Johnson, Merthyr, architect.

ANSDELL—Parish institute (£4,000).

ATHERTON—Spinning mill, Ena Mill Co.

AUCKLAND—Additions to Guardians' Board-room. Mr. F. Liversay, architect.

AYR—Alterations and additions to post office (£5,000). Mr. W. Scott, architect.

BACUP—Elementary school (£6,000).

BALLYMOYER—Erection of workmen's cottages, Rural District Council.

BANGOUR—Installation of electric light, recreation hall, Edinburgh District Board of Lunacy.

BARNSTAPLE—Secondary school (£4,100), Devon County Education Committee.

BATTERSEA, S.W.—Extension of electric lighting (£2,230), Borough Council.

BELLEEK—Erection of workmen's cottages, Rural District Council.

BENWELL—Bakery, stables, and dwelling-house. Messrs. Shobrooks and Hodges, Newcastle-on-Tyne, architects.

BISHOP'S STORTFORD—Alterations to infirmary for Guardians.

BOURNEMOUTH—Six houses, Phyldon-road, Mr. C. H. Goater; two houses, Parkstone-avenue, Messrs. Smart and Wyeth; pair of houses, Alexandra-road, Messrs. Smart and Wyeth; two houses, Balston-road, Mr. H. W. Andrews; house, the Sandbanks, Mr. A. Stewart; house, Langdon-road, Mr. G. W. Jackson; two houses, Lester-road, Mr. R. D. Saunders; house, St. Clair-road, Mr. L. M. Watts; house, the Sandbanks, Mr. H. F. J. Barnes; three houses and shops, Sandecoates-road, Mrs. L. Webber; house, St. Osmund's-road, Mr. Arch. Smith; pair of houses, Sterte-road, Mr. Geo. F. Ivemy.

BRADFORD—Enlargement of St. Aidan's Church. Messrs. Banister, Fletcher, and Sons, architects.

BRADELEY—Schools (£4,291), Education Committee.

BURSLEM—Isolation hospital (£1,300), Town Council.

CAMLOUGH—Erection of workmen's cottages, Rural District Council.

CANTERBURY—Police station (£2,033), City Council.

CARDIFF—School of Commerce. Mr. I. Jones, architect.

CARDONALD—Double villas, Roxburgh-circus, Mr. W. T. Crosbie, Whiteinch.

CHEPPING WYCOMBE—Elementary school, Borough Council.

CHORLTON—Additions to senior schools at Styal Homes. Messrs. Beaumont and Son, Manchester, architects.

CLACKMARRIS—Additions to Council school. Mr. J. Whittet, Elgin, architect.

CLARKSTON—Twelve houses, Busby-road, Messrs. J. and A. W. Money, Glasgow.

COOKSTOWN—Eighty-three workmen's dwellings (£25,000), Rural District Council.

COVENTRY—Foundry extension and sub-station, Sandy-lane, Daimler Motor Co.; factory, Mile-lane, Messrs. Hollick and Pratt; two houses, Poplar-road, Mr. R. E. Ault; four houses, Cross-road, Mr. W. Thacker; four houses, Kensington-road, Mr. G. Blakeman; four houses, Palmerston-road, Mr. C. F. Woodhall; three houses, Foleshill-road, Mr. J. G. Gray; 12 houses and three houses with shops, Stoney Stanton-road, Mr. T. Randle.

CROOKSTON—Villas, Lennox-road, Mr. J. Young.

DARLINGTON—Houses and shops, Harrogate-hill, Mr. Martin; Cleveland Bridge and Engineering Co., extensions to offices, Smithfield-road; Mr. J. W. Watson, house, Louisa-street; Mr. B. D. G. Biggs, temporary miniature rifle range at rear of drill hall, Larchfield-street; Messrs. J. Guthrie and Son, eight houses, North Lodge-terrace; Mr. Frank Martin, alterations and additions to Britannia Inn, Archer-street; Mr. T. Barningham, 38 houses, Zetland-street.

DAWDON—Elementary school, Durham County Council.

DISS—Secondary school, Urban District Council.

DOBWALLS—Dwelling-houses, Mr. W. Statton, Pellegenna.

DOVER—Additions to machine-house at Buckland Paper Mills; four houses at St. Andrew's-terrace, Mr. W. H. Grigg; extension to the annexe prison, Mr. C. E. Beaufoy.

DROYLSDEN—Extension of Trinity Wesleyan school, (£2,000).

DRUMOAK—Alterations to Council school and erection of schoolmaster's house. Messrs. Walker and Duncan, Aberdeen, architects.

DUDLEY—Secondary school (£18,000), Education Committee.

DURHAM—Training college, Education Committee, County Council.

EASTBOURNE—Enlargement of Holy Trinity Church (£7,500).

EAST HERTFORD—School, Northumberland Education Committee.

EDINBURGH—Church for St. Luke's. Mr. P. Chalmers, Glasgow, architect.

FAILSWORTH—Public library, Urban District Council.

FLOCKTON—Six houses, Urban District Council.

FORKHILL—Erection of workmen's cottages, Rural District Council.

GIFFNOCK—Houses in Busby-road, Mr. J. Allan, Glasgow.

GOVAN—Alterations at Merryflatts Poorhouse, Parish Council.

GWERSYLLT—Elementary school, Education Committee.

HALIFAX—Hospital Lodge (£400), Guardians.

HARPENDEN—Extensions to Council schools.

HAUGHTON—Stables, etc., Mr. Bloom.

HAXBY—Enlargement of parish church.

HEACHAM—Bungalow, Captain Heal, Cambridge.

HEMSWORTH—Shops and houses (£2,730). Mr. P. Rhodes, Leeds, architect.

HETTON—Elementary school, Durham County Council.

HIGHBRIDGE—Auction rooms, Messrs. Palmer and Sons; 48 houses, Church-street, Messrs. Cox and Co.

HULL—Boiler-making, engineers', carpenters', and boat-making shops, offices, and stores. Messrs Freeman and Gaskill, architects.

ILFRACOMBE—Elementary school at Shepherds Park, Devon County Education Committee.

JONESBOROUGH—Erection of workmen's cottages, Rural District Council.

KELLS—Workmen's dwellings (£72,347), Rural District Council.

KILLADYSERT—Workmen's dwellings (£9,458), Rural District Council.

KILLEAVEY—Erection of workmen's cottages, Rural District Council.

KILRUSH—Workmen's dwellings (£28,200). Rural District Council.

KING'S SUTTON—Elementary school (£4,100), Northampton County Council.

KIRKBY—Two houses, Oxford-street, Mr. Bains; four houses, Rosebery-street, Mr. Sewell; slaughter-house, Station-street, Mr. Walker; engine shed and workshop, Bannerman-road, Mr. Hoole; two houses, Harcourt-street, Mr. W. A. Brelsford.

LACHLEY—House at Solomon's Farm, Mr. Neal.

LEICESTER—Receiving home, Board of Guardians. Mr. W. Keites, architect.

LICHFIELD—Alterations to Seven Star Hotel, Stowe-street, Messrs. Cooper and Co.; two houses in Rotten-row, Mr. E. J. Chattle; alterations to workshop and stores, St. John-street, Messrs. John Thorncloe and Sons.

LISBURN—Free library and technical institute, Urban District Council.

LIVERPOOL—Business premises, Elliott-street. Mr. W. A. Thomas, architect.

LLANDUDNO—Pair of villas. Mr. Mines, Liverpool, architect.

LOUGHREA—New wing to the Convent of Mercy. Messrs. Byrne and Son, Dublin, architects.

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LUMPHINNANS—Bowl-house for the Lumphinnans Public-House Society. Mr. J. Houston, Dunfermline, architect.

MACCLESFIELD—Laboratory, Town Council. Office of Borough Surveyor.

MATHRY—Sessions room (£462), Pembrokeshire County Council.

MILFORD—Sessions room (£1,100), Pembrokeshire County Council.

MONEYREA—Unitarian school. Messrs. Hobart and Heron, Belfast, architects.

MONMOUTH—Electricity works (£10,000), Town Council.

MOUNTMORRIS—Erection of workmen's cottages, Rural District Council.

MULLAGLASS—Erection of workmen's cottages, Rural District Council.

MUSSELBURGH—Temporary school. Mr. M. Hardie, Edinburgh, architect.

NEILSTONE—Shop, Main-street, Mr. T. Scott, Barrhead.

NEWLANDS—Motor house at Cairntable, Dr. Campbell.

NORTH SHIELDS—Elementary school, Preston-avenue (£21,155). Messrs. Marshall and Tweedy, architects.

NUNEATON—Secondary school, Town Council.

OGMORE—Elementary school at Llest, Glamorgan Education Committee.

PADDINGTON, W.—Alterations at workhouse, Guardians.

PAISLEY—Houses at Oldhall, Mr. R. Hair.

POOLE—Additions to municipal offices, Town Council.

PORTADOWN—Power station, Belfast and North-East of Ireland Power Co. (£60,000).

POYNTZPASS—Erection of workmen's cottages, Rural District Council.

PWLLHELI—Market hall (£250), Town Council.

RUTHIN—Public offices (£200), Town Council.

RYHOPE—Elementary school, Durham County Council.

ST. ANNES—Three houses, stables, coach-house, and furniture store-room, Oxford-avenue, Mr. Thos. Whiteside; extensions to Oxford House School, Clifton-drive South, Mr. J. F. Brindle; two detached villas, St. Annes-road East, Mr. R. Crichton; detached villa, Queen's-road, Mrs. Brindle.

ST. AUSTELL—Secondary school, District Education Committee.

SALE—Eight shops, Northenden-road. Messrs. Radcliffe, Liverpool, architects.

SALTBURN—Sanitary lodge, Urban District Council.

SCOTSTOUN—Restaurant, Station-road, Messrs. Henderson and Macdonald, Glasgow.

SILKSWORTH—Elementary school, Durham County Council.

SLOUGH—Elementary schools (£7,700). Messrs. Lee and Farr, architects.

SOUTHAMPTON—Fire station (£3,075), Town Council.

STAPLEFORD ABBOTTS—Dwellings, Lord O'Hagan.

STOCKSBRIDGE—Hospital, Town Council.

STOKE EDITH—New station buildings, Great Western Railway Co.

STRATFORD MILLS—Loading shed, Messrs. Orchard and Peer.

STREATHAM, S.W.—Parish hall and club buildings (£2,300), St. Leonard's Church.

STRETFORD—School enlargement (£3,800), Urban District Council.

STROUD—Additions to the "Lodge" at The Hill, Mr. G. P. Milnes.

SUNNINGHILL—Improvements to schools, Berkshire Education Committee.

SWALLOWFIELD—Elementary school (£3,600), Berkshire County Council.

TAMWORTH—Laundry for Guardians (£1,700).

TEDDINGTON—One hundred and fourteen working-class dwellings, Shacklegate-lane, Urban District Council.

TENTERDEN—Restoration of parish church (£1,000).

TORQUAY—Secondary school, Devon County Education Committee.

TULLAHAPPY—Erection of workmen's cottages, Rural District Council.

USWORTH—Fifty houses (£12,000), Durham County Council.

VENTNOR—Enlargement of St. Catherine's Church (£1,500).

WALLASEY—High school, Cheshire County Council, Messrs. Appleyard and Quiggin, Liverpool.

WALLSEND—Houses for Messrs. McKenzie, Redhead, Dees, M'Grew, and Dixon.

WARE—Four houses, Mr. F. Hitch, Star-street.

WARK—Almshouses, Allgood trustees, Messrs. J. Oswald and Sons, Newcastle.

WASHINGTON—Upper standard school, Durham County Council.

WHITCHURCH—Improvement of market hall, Rural District Council.

WHITEHEAD—Church for Church of Ireland. Mr. T. Tiegatt, architect.

WILLESBOROUGH—Two houses, Romney-road, Mr. J. Jones, Ashford.

WILLESDEN—School (£10,348), District Council.

WIMBLEDON—Elementary school, Town Council.

WOLVERTON—Sunday schools and church institute. Messrs. J. O. Scott and Sons, Westminster, architects.

WOODHOUSE—Cemetery chapel (£750), caretaker's house (£350), Urban District Council.

WOODHOUSE—House and shop, Forest Town, Mr. A. F. Houfton; 14 houses, Booth-street, Mr. A. Munks.

WREXHAM—Assembly hall to seat 1,400.

YOKER—Two houses, Bouverie-avenue, Mr. J. G. Wilson.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Algiers.—The Post and Telegraph Department invite tenders for copper wire for telegraph purposes. Tenders by Nov. 20.

Perth (Australia).—The Postmaster-General invites tenders for 80 accumulators for telegraph purposes. Tenders by Dec. 11.

Melbourne.—The Postmaster-General invites tenders for 30 metallic iron telephone switchboards. Tenders by Dec. 31.

London.—The Metropolitan Asylums Board invite tenders for alterations to fire-alarm and telephone systems. Tenders by Nov. 27.

Luton.—Tenders are invited for the supply of traction battery, automatic reversible booster, and traction switchboard. Tenders by Nov. 28.

Sydney.—Tenders are invited for centrifugal pumps and electric motors for the low-level pumping station at Rushcutter's Bay. Tenders by Dec. 9.

Sheffield.—The Tramways Committee invite tenders for the supply of clothing. Particulars from the Tramways General Manager. Tenders by Nov. 18.

New South Wales.—The Postmaster-General, Sydney, invites tenders for one branching metallic multiple magneto switchboard. Tenders by Jan. 8, 1908.

Melbourne.—The Postmaster-General's Department invite tenders for 11 sets and a common-battery switchboard, and 3,000 subscribers telephones, etc., for the Windsor exchange. Tenders by Jan. 7.

Southampton.—The Corporation invite tenders for the supply of a steam generator and boilers, and cables. Specifications from the Borough Electrical Engineer. Tenders to the Town Clerk by Nov. 30.

Madrid.—The Public Works Department invite tenders for the construction of electric tramways in Santander. Particulars from the Direccion de Obras Publicas, Ministerio de Fomento. Tenders by Dec. 1.

Edinburgh.—The District Board of Lunacy invite tenders for the electric light installation at the recreation hall, Bangour. Tenders to Mr. James Kyd, clerk and treasurer, Castle-terrace, Edinburgh, by Nov. 23.

Peterborough.—The Electricity Committee invite tenders for supplying about 2,200 yards of feeder cables. Tenders to Mr. J. C. Gill, city electrical engineer, by Nov. 21. See advertisement in last issue.

Portsmouth.—The Corporation Tramways Committee invite tenders for steel girder rails and fishplates. Particulars from the tramway engineer, Mr. V. G. Lironi. Tenders to the Town Clerk by Nov. 19.

Punjab (India).—Tenders are invited for electric and pumping plant for water supply. Particulars from the Executive Engineer, Special Work Division, Patiala, Punjab. Deposit £133. 6s. 8d. Tenders by Jan. 6, 1908.

Sydney.—The Postmaster-General invites tenders for 1,000 common-battery wall telephones and 100 portable telephones. Particulars from the Commonwealth Offices, 72, Victoria-street, Westminster. Tenders by Dec. 11.

Brisbane.—Tenders are invited for insulators, iron spindlers, and copper wire for the Postmaster-General's Department. Particulars from Captain Muirhead Collins, 72, Victoria-street, Westminster. Tenders by Dec. 16.

Rawtenstall.—The Corporation invite tenders for the supply of lighting (high and low tension) cables, and tramway cables, conduits and accessories, trenching, etc. Applications to Mr. James Whalley, town clerk, by Nov. 29.

Buenos Ayres.—Tenders are invited for the construction of underground electric tramways. Particulars from the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London. Tenders by June 1, 1908.

Stoke-upon-Trent.—Tenders are invited for mains and services, balancer and booster, and switching apparatus. Tenders to Chairman of Electricity Committee, Electricity Works, Stoke-upon-Trent, by Nov. 23. See advertisement in last issue.

Bradford.—Tenders are invited for the supply of miscellaneous stores required by the Tramways Department during the year ending Dec. 31, 1908. Particulars from Manager, Tramway Offices, 15, Bridge-street, Bradford. Tenders by Nov. 23.

Buenos Ayres.—Tenders are invited for (1) the construction of and (2) the concession to work the two principal sections of the underground electric railway. Particulars from the Argentine Legation, 12, Rue van Moer, Brussels. Tenders by May 1, 1908.

Adelaide.—The Deputy Postmaster-General for Queensland invites tenders for a common battery switchboard and 3,000 subscribers' telephones. Specification No. 166. Particulars may be obtained from the Commonwealth Offices, 72, Victoria-street, London, S.W. Tenders by Jan. 8, 1908.

Warrington.—The Cheshire Lines Committee invite tenders for the supply of stores during the year 1908, including telegraph materials, permanent-way materials, and steel fishplates. Tenders to Mr. Glegge Thomas, secretary, Cheshire Lines Stores Department, Warrington, by Nov. 22.

Victoria.—The Deputy Postmaster-General at Melbourne invites tenders for the supply and delivery at Melbourne of 11 sections of a common-battery switchboard and 3,000 subscribers' telephones and other apparatus for telephone exchange, Windsor, in accordance with Victorian specification No. 148. Tenders by Jan. 7.

Spain.—The *Gaceta de Madrid* of Oct. 29 announces that tenders are invited for various materials connected with the 350 metres

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extension of the port of Almeria. The material called for includes six electric cranes and 108 iron cases for the same, also iron necessary for the construction of shelters, besides material for prolonging the eastern quay. Tenders to the Junta de Obras del puerto de Almeria not later than Nov. 28. Particulars from the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

RESULTS OF TENDERS.

St. Annes.—The Town Council have accepted the tender of Callender's Cable and Construction Co. for the supply of cable.

Whitley.—The Council have accepted the tender of Glover and Co. for the supply of electric cable in connection with the new bridge for the sum of £69. 4s. 11d.

Dundee.—The Town Council have accepted the following tenders: Babcock and Wilcox, Renfrew, boilers, economisers, etc.; Willans and Robinson, turbo-alternators; Siemens Bros., low-tension cables; and British Insulated and Helsby Cables, stock cables.

Derby.—The Town Council have accepted the tenders of Johnson and Phillips, at £266. 9s., for the supply of connecting cables at the new power station; Cresswell's Asbestos Co., at £80, for the supply of boiler and pipe covering; and that of Newton Bros., at £46. 12s., for wiring the new power station for arc lighting.

London.—The London County Council have received the following tenders for electric light installation at Charlton fire station:

Spagnoletti, Limited, Goldhawk Works, Goldhawk-road, W.*	£109	15	0
W. G. Cannon and Sons, 107, London-road, Southwark, S.E.	122	7	0
W. J. Fryer and Co., Bravington-road, Paddington, W....	147	0	0
Nursey and Marr, 53, Victoria-street, S.W.	147	0	0
Smeeton and Page, 63, Queen Victoria-street, E.C.	166	5	0

*Recommended for acceptance.

Londonderry.—The Technical Instruction Committee have received the following tenders for wiring and fitting the new Municipal Technical School, Londonderry, for electric light, etc.:

W. Coates and Son, 11, Fountain-street, Belfast (accepted)	£565	0	0
J. Lowden and Co., Ann-street, Belfast	597	0	0
Alliance Electrical Co., 16, Westmoreland-street, Dublin	810	0	0
Dargue, Griffiths, and Co., May-buildings, 51, North John-street, Liverpool	812	0	0
J. Scott, A.I.E.E., Knowsley Electrical Works, Bootle, Liverpool	992	10	0

Contracts for Condensing Plant.—The Mirrlees-Watson Co., Glasgow, have recently received the following orders: City of Glasgow tramways department—surface condensing plant dealing with 50,000lb. of steam per hour for 28½in. vacuum. The plant will be working in connection with a Richardsons-Westgarth steam-turbine. Gloucester Railway Carriage and Wagon Co.—surface condensing plant for working with steam-turbine dealing with 10,000lb. of steam per hour, 28in. vacuum. Bolckow, Vaughan, and Co., Middlesbrough—surface plant dealing with 43,000lb. of steam per hour, working in connection with blowing engines. Martin Bros., Valparaiso—surface plant dealing with 15,000lb. of steam per hour. Chinameca Sugar Estate, Mexico—two barometric jet condensers with dry air pumps, 8,000lb. steam per hour. City of Glasgow tramways department—two sets of motor-driven boiler feed pumps. Fraser and Chalmers—one set of surface-condensing plant working with steam-turbine.

Erith.—The Urban District Council have received the following tenders for an electrically-driven air compressor, including three-phase motor, switchgear, cable connections, and pipework, at their sewage-disposal works:

Ingersoll-Rand Co., 114, Queen Victoria street, E.C....	£606	0	0
General Electric Co., Witton, Birmingham	647	12	6
C. and A. Musker, Limited, Liverpool	654	10	0
Electrical Co., 121-125, Charing Cross-road, W.C.	662	0	0
Worthington Pump Co., 153, Queen Victoria-street, E.C.	663	10	0
British Westinghouse Electric and Manufacturing Co., Manchester	676	10	0
J. Fowler and Co. (Leeds), Leeds	681	15	0
Reavell and Co., Ranelagh Works, Ipswich	685	0	0
Brackett and Co., Hythe Bridge Ironworks, Colchester	697	0	0
Entwistle and Gass, 5, Laurence Pountney-hill, E.C....	710	0	0
Alley and McLellan, 28, Victoria-street, S.W.	724	0	0
W. H. Bailey and Co., Albion Works, Salford, Manchester	825	0	0
Tilghman's Patent Sand Blast Co., Broadheath, near Manchester	835	0	0
Hughes and Lancaster, 16, Victoria-street, London, S.W.	898	3	8
Sommer and Scott, Gloucester	1,030	0	0

Italy.—The construction of the S. Quirico-Nostra Signora della Guardia electric railway, which has been suspended since 1900, is shortly to be resumed and completed. The line was conceded in 1897 to the Società Anonima Co-operativa per la Costruzione ed Esercizio della Ferrovia al Santuario di Nostra Signora della Guardia. The *Bollettino* of Oct. 31 contains full details of the form, length, and proposed working of the line. The *Bollettino* of Oct. 31 further announces that a new project is to be formed for the construction of a line from Brescia to Gardone Val Trompia. The railway, which is to be electric, will be important, the existing tramway traffic being insufficient for the requirements of industry. The same journal states that a French firm have applied for the concession for constructing the Civita-vecchia-Orte railway, at a considerable saving on the project of the Società Veneta.—*Board of Trade Journal.*

BUSINESS NOTES.

TRACTION.

Buenos Ayres and Belgrano Electric Tramways Co.—Receipts for the week ending Nov. 11, £4,302; corresponding week of 1906, £4,033; increase, £269.

Cromarty and Dingwall.—The Board of Trade has recently confirmed the Cromarty and Dingwall Light Railway (Extension of Time Deviation and Amendment) Order, 1907.

York.—At a meeting of the Tramways Committee of the Corporation the electrification of the tramway system was under consideration, and it was unanimously decided to proceed with the work by means of a light railway order.

Finsbury Park.—Lieut.-Colonel Druitt, R.E., Board of Trade inspecting officer of railways, has held an inquiry into the causes of the collision which occurred during Saturday's fog between two passenger trains at Finsbury Park.

Barnes.—The District Council have instructed the surveyor, electrical engineer, and clerk to prepare a report for the consideration of the Tramways Committee as to the feasibility of a system of tramways for the district constructed and worked by the Council.

Yarmouth.—At the last meeting of the Town Council the general manager of tramways reported an increase of 135,834 in number of passengers and of £1,667. 17s. 4d. in the receipts from April 1 this year, compared with the corresponding period of 1906.

Clydebank.—The Clydebank Town Council have passed a resolution to the Committee on Tramways with instructions to take steps to insist on the Corporation of Glasgow meeting their obligations by completing the tramways within the burgh or find a remedy.

Glossop.—A Manchester syndicate is promoting a scheme for the construction of a length of line to connect the Stalybridge Joint Board tramway at Mottram with that of the Glossop tramway at Woolley Bridge, the route going through Mottram and Hollingworth.

Southend.—During the dense fog at Southend on Saturday two tramcars collided. The Rev. G. Padfield, rector of Hawkwell, and the Rev. John Gibson, of Rayleigh, who were travelling in one of the vehicles, were cut and much shaken, and a lady passenger was also injured.

East and West Yorkshire Union Light Railways.—The Board of Trade have confirmed the East and West Yorkshire Union Light Railway (Borrowing Powers) Order, 1907, authorising the East and West Yorkshire Union Railways Co. to exercise further borrowing powers.

Dudley.—It is recommended by the Streets Committee of the Town Council that the tramway companies be approached as to the hardship to the public by the withdrawal of the ½d. fares for children, and that a deputation from the Council wait upon them in reference to the matter.

Rutherglen.—The provost has had a conference with the convener of the Glasgow Tramway Committee regarding the introduction of cars on Stonelaw-road to Burnside Station. The convener stated that the tramway line would be extended to Burnside Station about February next year.

Switzerland.—The Federal Council has approved the expending of 15,000fr. for the construction of a new tramway line from the St. Gothard Station at Lugano to the discharging wharf of the lake steamboats, also 948,666fr. for a narrow-gauge electric railway on the road from Lugano to Tesserete.—*Board of Trade Journal.*

Morecambe Tramways Co.—The company report a decline from fares of £722. On the past year's working there is a surplus of £1,382. A dividend of 3½ per cent. is proposed, adding to the reserve account £150, and carrying forward £462. The directors anticipate that the Morecambe Corporation will shortly give notice of their intention to exercise their rights of purchase.

New York.—There was a serious rear-end collision between two electric passenger trains on the Manhattan Elevated Railroad on Monday last. Both trains were badly wrecked, and 12 persons were fatally injured, a number of others being less seriously hurt. A terrible disaster was very narrowly averted, for only by a few inches did the two trains escape plunging into the street below.

Stalybridge, Hyde, Mossley, and Dukinfield Tramways.—At the last meeting of the Electricity Board the commercial manager reported that the traffic receipts for the five weeks ended Oct. 19 amounted to £4,081. 1s. 3½d., and that the total receipts to that date from March 31 last were £23,920. 12s. 1d. The Traffic Sub-Committee have considered a letter from the town clerk of Mossley with reference to cars running through the loop at Roaches, and it was resolved that the matter be referred to the engineer for attention.

Sind (India).—Messrs. Forbes and Co., of Karachi, submitted proposals some time ago for a series of feeder lines in Lower Sind. The firm has now withdrawn these larger schemes and concentrated their energies on a more modest project and offer to build without any guarantee a line from Mirpur-Khas on the Shadipalli-Hyderabad section of metre gauge, Jodhpur-Hyderabad line to Khudru about 40 miles northwards, and another line from Mirpur-Khas to Judu, about the same length southwards, both on the metre gauge. These proposals are under consideration.

Leith.—The Council have agreed to promote a provisional order for the proposed tramway extensions, and also to resume negotiations with Edinburgh with a view to coming to some arrangement regarding the mutual roads. The feeling of the Council appears to be that, should no satisfactory arrangement be come to with the city, the proposal to extend the tramways to Edinburgh territory should be dropped,

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and the Leith Corporation only go on with the extension from Newhaven to Granton. In the provisional order powers are sought for ½d. fares for working girls and for working men earning less than 30s. a week.

Perth.—Mr. Lambert, in his report for the month ending Oct. 9, states that the total number of passengers carried was 149,268, while the receipts amounted to £694. 18s. 1½d. The increase over last year in passengers was 10,905, while the increase in receipts was £15. 9s. 2d. The number of passengers who travelled on the Scone route was 56,187, giving £326. 12s. 8d. of receipts. On the Cherrybank route, with 50,345 passengers, the receipts were £209. 10s. 1d., while Craigie, with 27,603 passengers, had receipts amounting to £107. 1s. 8d. The receipts on the Dunkeld-road were £51. 14s. 5½d., and the number of passengers carried was 15,133.

Chester.—At a special meeting of the Corporation Tramways Committee the mayor explained the views of the National Sunday Observance (Local) Committee with respect to the service of Sunday trams. The report of the tramways manager having been considered, it was resolved that a service of two cars only be run, both on the Saltney and the Boughton routes, on Sundays, between the hours of 9.45 a.m. and 3 p.m., the ordinary service to be then resumed; that such service be continued for a period of three months; and that the tramways manager be instructed to report to the committee on their working at the end of such period.

Ayr.—Intimation was made at the meeting of the Town Council that the clerk, in accordance with instructions, had seen Mr. R. A. Oswald, of Auchencruive, as to the terms on which he would give a portion of his ground required for the widening of the roadway in order that double rails might be laid, and also that the roadway opposite the entrance to the members' portion of the grand stand at the new racecourse might be straightened. Mr. Oswald had frankly stated that he was opposed to the tramways being carried out on that road, and that he would not give any ground for the purposes required except under compulsion. The Council decided, in terms of previous resolution, to apply for powers to lay the whole route with double rails, and for powers to acquire ground on the south side of the roadway from the railway bridge to the racecourse.

Royton.—The members of the Royton Council have for a long time been dealing with the cost of the tramways in their district, and have been agitating for a complete return showing the amount expended, the amount paid, and the amount to be borrowed to cover the cost of the same. This information was forthcoming at the last meeting. The clerk to the Council said that the amount expended was as follows: tramways order, £703. 8s. 9d.; permanent way, £33,725. 14s. 8d.; electric equipment, £10,539. 1s. 8d.; contingencies and engineer's fees, £2,839. 11s. 2d.—total, £46,104. 7s. 6d. The amount they desired to borrow was as follows: for completion of tramways, £4,668. 7s. 6d.; cost of obtaining provisional order, 1901-4, £703. 8s. 9d.; and cost of electric lighting order, 1901, £245. 4s. 10d. The chairman moved that an application be made to the Board of Trade for their sanction to borrow the amount required, and this was agreed to by the Council.

Clayton-le-Moors.—At the last meeting of the Urban District Council the following letter was submitted from the Corporation of Accrington: "Your letter of the 4th inst. enclosing copy resolution asking if the Corporation could see their way to reduce the fare from Clayton-le-Moors to Accrington to 1½d. has been considered by my Electricity Committee, and I am directed to reply that they do not see their way to do this. This refusal is not made out of mere caprice, but in view of the large capital at stake and the increased frequency of the service the Corporation feel that in justice to their ratepayers they cannot make any reduction in the fare until an experience gained by at least one 12 months' working shows that any reduction of fares would meet all the expenses of working, interest, sinking fund, depreciation, and a reasonable reserve fund. My committee feel that, constituted as your Council is of business men, they would under similar circumstances adopt the same policy.—Yours faithfully, A. H. Aitken."

Hamilton.—Last week Neil Galbraith, tramway motorman, and John M'Garry, tramway motorman, both recently in the employment of the Lanarkshire Tramways Co., were charged with having on Sept. 30, on a single line of rails at Springwells, Blantyre, driven their cars in opposite directions in culpable and reckless manner, whereby they collided, and the lives of the passengers were endangered. Both accused pleaded not guilty, and several witnesses were examined in support of the charge. Sheriff Thomson ultimately held it proved that Galbraith was initially at fault in having left the loop line at Whistleberry Bridge without waiting for the other car to pass, while Mc'Garry was subsequently at fault when, in observing the danger in which the passengers were placed, he failed, in accordance with the rules of the company, to back out and give Galbraith the preference. He did not think that either of the accused drove against each other in a "culpable and reckless manner." In the circumstances he thought a modified penalty of 10s. or seven days met the gravity of the offence.

Matlock.—At the Urban Council meeting the cable tramway manager reported a profit of £22. 0s. 1d. on the month of October working of the tramway, the expenses being £82. 16s. 4d. and the income £104. 16s. 5d. This is £12. 8s. 3d. more than the corresponding month of last year. He had had to get another piece of strand to repair splice in the cable with, as one of the trucks gave out, and he had made it right again. He wanted to keep this cable running, if possible, till nearly Easter, so that the Council would have the new rope in use for the summer traffic. In reference to the crossings at Smedley-street, he recommended that the same be repaired in February, in the slack season, as it would take nearly a week to do the necessary repairs, and the tube could be cleaned out at the same time. It was nearly three years since the cable was stopped to clean the tube out, as he had done the cleaning early in the morning before the cable started. The crossings would be all right till February. He suggested that attention should be given to the hatch boxes, so that the boxes would not be dangerous for traffic on the road.

Belfast.—At the meeting of the Harbour Commissioners the secretary submitted the draft form of contract and specification and plans for the proposed electric tramway along Queen's-road, etc., as finally approved by the city surveyor, city electrical engineer, and the harbour engineer, and it was recommended that, in pursuance of the terms of the agreement between the Corporation and the Commissioners of May 14 last, the work of constructing the electric tramway along Queen's-quay, Sydenham-road, and Queen's-road be proceeded with, in accordance with the specification and plans approved by the city surveyor, city electrical engineer, and the harbour engineer now submitted, at an estimated cost of £19,100, and that advertisements be issued for tenders to carry out the work. At the meeting of the Tramways and Electricity Committee on the 11th inst. a letter was read from Messrs. McLean and Sons, solicitors, intimating that their clients were making arrangements for constructing the tramway line between Holywood and Belfast, asking for an interchange of traffic and a quotation for supplying power to the proposed new system. The committee unanimously decided not to give the Holywood company powers to run over the Corporation lines, but to supply current at a rate fixed upon. The town clerk stated that he was about to take steps to have a Bill promoted in the House of Commons for the purchase of the Cavehill and Whitewell tramway undertaking, which the Corporation has decided to purchase.

Whitefield.—At the Council Electricity Committee meeting it was resolved that the law clerk make formal application to the Board of Trade for their approval to the lease to the Salford Corporation of the tramways in this district. The law clerk had reported that the Board of Trade had required the Lancashire Electric Power Co. to furnish them with evidence that they are in a position to discharge the duties and obligations imposed by the order and the deed of transfer if approved, and that the company had informed him that they had satisfied the Board of Trade on the subject. Resolved that immediately the approval of the Board of Trade has been obtained to the agreement with the Lancashire Electric Power Co. for the supply of electricity in this district the chairman be empowered to affix the seal of the Council thereto. A letter was read from the town clerk of Salford acceding to the request to fix lamps on the tramway standards, subject to an agreement being entered into and payment of an annual acknowledgment in respect thereof. Resolved that the law clerk write the town clerk of Salford agreeing to the proposals. Also to express the thanks of this Council for running covered cars and express the hope that his committee will continue the same service during the winter, and, if possible, augment the same; that the chairman interview the tramway manager of Bury with regard to the various cars running in better conjunction; that the law clerk write the Salford Corporation again pressing them to provide workmen's cars between Whitefield Station and Goats Gate, and between the station and the Unsworth boundary; that the law clerk report as to the powers and liabilities of the Radcliffe and Pilkington Gas Co.

Battersea and Wandsworth.—The long controversies between the local authorities and the London County Council in regard to the electrification of the tramway from Nine Elms-lane to East-hill have been advanced a stage by a joint deputation from the Battersea, Wandsworth, and Lambeth Borough Councils which recently waited on the Highways Committee at Spring-gardens. The original proposals provided for the construction of a single line along portions of the route, and the diversion of one track through side streets in order to avoid the heavy cost of acquiring property for widening the main thoroughfare. The local authorities objected, and insisted on a continuous double line. In a report presented to the Battersea Borough Council on Wednesday last, it was stated that the difficulties, in so far as they concern the Lambeth Borough Council, appear to be with reference to the width of footpaths only, and these difficulties can be met. Wandsworth objected to a proposed length of single line in Wandsworth-road. There appeared to be some difference of opinion between the Wandsworth Borough Council and Spring-gardens as to the work which would be involved by the construction of a double line, and the property it would be necessary to acquire. Considerable modifications were suggested by the Wandsworth representatives, who pointed out that the acquisition of forecourts and the rearrangement of the steps by which some of the buildings are approached would give the required width of roadway. Wandsworth has been asked to prepare detailed estimates of the cost of the modifications thus put forward. Battersea Borough Council objected to the construction of any single line on Lavender-hill. The Highways Committee of the County Council asked for an estimate of the cost of carrying out the additional widening work for a double track, the work to be undertaken by the Battersea Borough Council. The Battersea authority is advised that it would be better for it to proceed under Michael Angelo Taylor's Act for the acquisition of the necessary property than for the Council to make application for special parliamentary powers. Locally it is considered that the operations for the construction of a double line throughout the route will be begun next year, and that the modifications proposed by the local authorities will prevent the necessity of acquiring property valued at some £50,000.

Lowestoft.—The general manager's report at the last meeting of the Council was as follows: "The total receipts from passengers' fares amount to £11,309, showing an increase of £1,040, mostly due to the universal penny fare. After paying all working expenses, repairs, and renewals, we have a gross profit on the working of the undertaking of £2,170, which is swallowed up by repayment of capital and interest. Attention must be drawn to a loss of over £60, due to two days' loss of traffic owing to the heavy fall of snow we had in December, and also to an extra expenditure of £15 for clearing the snow off the track. Though the price of current has been partly reduced, our gross profit

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of £2,170 is not so large as was anticipated, due to the various extra expenditures required, which were not so heavy in previous years by the following amounts: uniforms, £100; current, £100; track, £100; traffic—wages, £350; rolling-stock, £60. Regarding the permanent way, this I consider should be relaid at once with granite setts through the centre portion of the town, and doubled, if possible, and paid by raising loan for same, as considerable saving in wear and tear on the cars would hereby be effected. As to the general accounts, the expenses per car mile have been reduced and kept as low as possible, being equal to 6·39 per car mile, and show a decrease in cost ·42 per car mile. The rebate in the cost of current makes a difference of ·27 per car mile. The total number of passengers carried this year was 2,622,922. being an excess over last year of 430,210, and the total number of passengers for the month of August amounted to 501,722, showing an increase of 34.048 for the month. From the figures given for August, it will be easily seen that the amusements has given us a good increase in traffic, which would have been still more had the weather been more favourable, and I recommend that more consideration be given to encourage amusements during the winter months, when our traffic is slack. The total costs per car mile are made up as follows: interest and repayment amount to per car mile 2 74; traffic costs, 2·58; repairs, ·71; management and general. 60; power, 2 22; repairs to track, ·28—total costs, 6·39; receipts, 7·9. If the expenses of 2·2 for power be deducted from total cost, it will be seen that the total operating costs of 4·17 per car mile are considerably lower than many towns. The total mileage run this year amounts to 343,190, showing an increase of 46,837 miles."

LIGHTING AND GENERAL

Battersea.—The London County Council have agreed to lend the Borough Council the sum of £2,830 for extensions to the electricity undertaking.

Kelso.—The Postmaster-General is seeking the sanction of the Town Council for the erection of a new line of telegraph wire throughout the district.

Dundee.—The Council have appointed a Public Lighting Committee in order to take into consideration the provision of better lighting for the city.

Malvern.—It was reported at the last meeting of the Urban District Council that there were now 150 people using the electricity generated by the Corporation.

Linthwaite.—The District Council are applying to the Huddersfield Town Council for the supply of electrical energy to the central and western portions of the district.

East Dereham.—A telephone service is being established in the town, and the Urban District Council have decided to connect the Council's offices with the exchange.

Walmer.—The District Council have decided to apply for an extension of time wherein to utilise the powers granted under a provisional order to light the town with electricity.

Liverpool and District Electric Association.—The members of the above association paid a visit to the Mersey Railway generating and pumping station, Birkenhead, on Saturday, the 2nd inst.

Aberavon.—At the meeting of the Aberavon Town Council a committee was appointed to confer with the Margam District Council in regard to a joint electric tramway and waterworks scheme for the district.

Fleetwood.—The scheme of Messrs. Morrison and Roebuck for the electric lighting at St. Peter's Parish Church has been accepted by the Church Committee, and the work will be proceeded with immediately.

Windsor.—The Guardians have decided to obtain the opinion of a consulting engineer as to the best means to adopt to decrease the expenditure consequent upon the present method of heating and lighting the workhouse.

Yarmouth.—The Town Council have decided to light the entire borough with electric incandescent lamps. The additional cost is estimated at £2,478, but there will be a saving of £2.664 on gas, thus resulting in a saving of £186 plus a much improved light.

Mysore (India).—Hearing that Dr. Stephans, of Turin, has discovered a process of smelting iron by electricity, the Mysore Government have deputed the State geologist on three months' visit to Italy and Sheffield to study the above and other smelting processes.

Warwickshire.—The County Council have decided to have the existing ventilation shafts overhauled and put into good order, and a new ventilation shaft and additional air inlets to the courts provided. Four electric fans are to be provided at a total estimated cost of about £200.

Sowerby Bridge.—At a special meeting of the Council held on Oct. 24 it was resolved that the clerk take the necessary steps to obtain a provisional order transferring the electric lighting order to the Electrical Distribution of Yorkshire, Limited, and to issue the advertisements required by the rules.

Telephones on American Battleships.—The American battleships are being fitted with a complete system for the control of gun firing by means of telephones and supplemental speaking-tubes connecting the crow's nest, the bridge, and the commanding officer's cabin. The system costs £6,000 for each battleship fitted.

Wadebridge.—At the monthly meeting of the Urban District Council a detailed report and estimate was received from Messrs. Roche and Penney, of Bristol, for an installation of electric lighting, and after some discussion it was decided that the whole Council should meet in committee to consider the question of electric lighting.

Norwich.—The Council have adopted a joint report and recommendation from the Free Library and Health Committees that the library and public baths, St. Andrew-street, be heated jointly by steam from the electricity works at a capital cost of £175, to be divided equally between the Free Library Committee and the Health Committee.

Merthyr.—The Public Works Committee of the Merthyr Borough Council have instructed the town clerk to give three months' notice to the Merthyr Gas Co. to discontinue the lighting of the main road from Swan-street, Merthyr, to the Bush Hotel, Dowlais, the Corporation having agreed to have the road between these two points illuminated by electric light.

Italy.—The *Bollettino delle Finanze* of Oct. 27 contains a notice to the effect that Signor Giuseppe Grolli has made application to the Prefecture of Sondrio for permission to appropriate 60 litres of water per second from the Rio Bondone Canal and the Margatta torrent, in the commune of Teglio, for motive power for industrial purposes.—*Board of Trade Journal.*

Boston.—At the last meeting of the Council an application was received from the Postmaster-General asking for the consent of the Council to the erection of a line of telegraph posts between the Swineshead Post Office and the Fen-houses. The Council have given the necessary permission, subject to the posts being placed to the satisfaction of the surveyor.

Horsforth.—The Electrical Distribution Co. are now laying mains at Horsforth, and it is expected that the supply will be started in the course of a fortnight. It will be remembered that the Horsforth Council are proposing to light the main streets electrically. The electricity supply comes from the Yorkshire Electric Power Co.'s works at Thornhill, 15 miles away.

Buralem.—At the last Council meeting the electrical engineer reported that the number of units generated in October was 36,400, compared with 23,331 in the corresponding month of last year; that the number of 8-c.p. lamps in use, exclusive of street-lighting, was 10,043 compared with 6.336; and that the number of motors in use was 67, representing 3.9 h.p.

Sandown.—Tenders are to be invited for the lighting of Sandown, either by gas or electricity. A lengthy letter has been received by the Council from the Isle of Wight Electric Light Co. regretting that a former letter had given offence to the Council, and at the same time suggested giving the town all possible advantages if they would continue with the electric light.

Dunfermline.—The Council have decided to obtain the opinion of Prof. Sir Alex. Kennedy, Edinburgh, on the following: (1) whether the Council ought to provide a separate generating station; (2) take a bulk supply from the Fife Electric Power Co.; (3) transfer the provisional order to the Fife Electric Power Co., and on what terms; or (4) allow the provisional order to drop.

Rawtenstall.—The Town Council have decided to deal during the present municipal year with the construction of an electricity generating station, the electrification of the tramways, and the running of motor 'buses. The cost is estimated at: parliamentary Bill, £4,000; electricity station and cables, £34,000; purchase of tramways and conversion, £100,000; motor omnibuses, £2,000—total, £140,000.

Wireless Telephony.—The Amalgamated Radio-Telegraph Co. has obtained perfect communication by means of wireless telephony over 50 miles on land, between their laboratory near Berlin and a small station at Jutorbog, the whole city of Berlin intervening. This was achieved by using the undamped continuous waves generated by the Poulsen system, and constitutes a world's record for wireless telegraphy.

Partnerships.—According to the *London Gazette*, the partnership between C. E. Newton, P. Good, and E. A. Good, electrical and general engineers, 11 and 13, Southwark-street, London, E.C., has been dissolved by mutual consent. The partnership between E. C. Sames and H. Sames, carrying on business as electrical engineers, etc., at 10, Newcomen-street, Southwark, has been dissolved by mutual consent.

Enniskillen.—A letter was read at the District Council meeting from the secretary of the General Post Office, Dublin, asking leave to have telephone poles erected along the main street of the town, from the railway station to the co-operative stores on one side and to Portara on the other. A model pole was forwarded by one of the Post Office engineers. After some discussion the consideration of the matter was eventually postponed.

The Motor Club.—The committee of the Motor Club have secured a suitable house—6, West Kensington-gardens—in close proximity to Olympia, which will be open during the show fortnight as a branch of the Motor Club. Everything necessary for comfort and convenience has been provided, and the committee are anxious to see if their enterprise will be so appreciated by their town and country members as to justify arrangements of a similar nature in future years.

Perth.—The last monthly statement of the Public Lighting Committee showed that the cost for public lamps for gas for the period from May 17 to Oct. 1 was £292. 1s. 5d., as against £263. 5s. 6d. for the same period last year, an increase this year of £28. 15s. 11d. The cost for electric current consumed in public lamps for the same period amounted to £340. 18s., as against £340. 19s. 2d., a decrease of 1s. 2d. The number of lamps for September amounted to 1,198, the same number as for August.

Liquidations.—The *London Gazette* announces that the Electrical Publishing Co. has been wound up voluntarily, and Mr. J. H. Moritz, 8, Queen-street, Cheapside, appointed liquidator. A general meeting of the members of the Patent Electric Carbonising Co. will be held at 7 p.m. on Dec. 18 for the purpose of receiving the liquidator's report. A general meeting of the members of the Sandgate and Hythe Electric Co. will be held at 1, London-wall-buildings, London, E.C., at 12 noon on Dec. 16 for the same purpose.

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Rhymney Valley Electrical Scheme.—A further meeting for the promotion of the electric lighting scheme at Bargoed was held at the Junction Hotel on Nov. 7, when it was decided to proceed at once with the undertaking, and the prospectus will be issued during the next few days. Lloyds Bank, Bargoed, are the bankers, and Mr. D. J. Burfoot, accountant, was chosen as secretary. Mr. W. Spickett, solicitor to the Rhymney Valley Electric Supply Co., was present, and also Mr. Lewis, of Messrs. Lewis and Fletcher, Cardiff, the engineers.

Kirkby.—The Fire Brigade Committee have reported to the Urban District Council that it was resolved to ask the Post Office Telegraphs to install a system of electric fire-alarms in accordance with their specifications, as follows: one electric pull at Annesley Woodhouse, one at East Kirkby, and one at Kirkby-in-Ashfield; a direct call from these pulls to seven firemen's houses, actuated by an alarm pull; a telephone circuit between the two officers of the brigade connected with the gasworks and the East Kirkby telephone exchange, at a total cost of £35. 5s. per year.

Telegraphing Photographs.—Particulars are now published of a new system of transmitting photographic images by the ordinary telegraph line which is said to give much clearer definition than the system of Prof. Korn of Munich. According to the discoverer of the new process, M. Edouard Belin, a French engineer, his system, which is quite independent of that of Prof. Korn, will shortly be tried on a telegraphic line such as that between Paris and Marseilles. With his present apparatus for "telestereographie" he is able to transmit photographs to a distance of 1,500 km.

Wireless Telegraphy.—Successful trials of a new system of wireless telegraphy and telephony have been made between M. Poulsen's station at Lyngby and Esbjerg, a distance of about 200 miles. The new system, which is the invention of a German, Herr Aron von Lepel, is much cheaper to install, and its inventor claims that it gives much better results than any other method. Moreover, the apparatus is much smaller and lighter than that required for existing systems The inventor now intends to make experiments between Esbjerg and some other German station and England.

Newcastle-on-Tyne.—An explosion, attended with fatal results, occurred on the 7th inst. at the Newcastle-on-Tyne Electric Supply Co.'s station, Wallsend. About nine o'clock, through some cause unknown, an explosion took place and a portion of the plant was hurled about. Hugh Topham (35), an official, who was standing near was struck by flying missiles and killed. Edward Tebbitt, a middle-aged fireman, was also knocked down and so injured that he had to be removed home in an ambulance. Other workmen near had narrow escapes. Topham leaves a widow and young family.

Sheringham.—At the meeting of the Urban District Council the question of electric lighting for the town was considered. The Chairman said he understood that there was a gentleman in the place anxious to get a provisional order, and it was for the Council to say whether they would be the first in the field and take it on themselves. The clerk thought it likely if the Council did not go for an order the gentleman named would, and then form a company. It was stated that in Sheringham the gas was expensive, and bad too, and the matter was referred to a committee to consider and report as to its feasibility.

West Ham.—The Corporation electricity department has secured a contract with the Wholesale Co-operative Society to supply their flour mills and their new soap factory at Silvertown with electrical power for all purposes. The contract is based on an annual consumption of 5,500,000 units—a supply which exceeds in amount the total output of many of the large provincial towns which have municipal electricity undertakings. For power purposes West Ham charges only 1d. a unit, and gives special discounts to large consumers, and recently the department has installed many of the factories in the district with electrical plant.

Electricity in India.—The Upper India Chamber of Commerce has approved of the recommendations of the committee appointed to consider the amendment of the Indian Electricity Acts as to the desirability of all legislation in this connection being for the present assumed by the Government of India so as to ensure common standardisation of the regulations and terms on which licences are granted and uniformity generally, and as to the constitution of an advisory board for the settlement of technical problems. Further details in connection with the proposals of the Amendment Committee are under consideration by the chamber.

Devonport Dockyard.—Referring to the note in our last week's issue concerning the electrification of Devonport Dockyard, the British Westinghouse Electric and Manufacturing Co. inform us that they have contracted to the Admiralty for over 300 motors with special control gear. These motors have been applied by the Westinghouse Co. to the driving of large machine tools, cranes, and other workshop machinery at Devonport Dockyard. The whole of the apparatus has been constructed at the Westinghouse Works, Trafford Park, Manchester, and not in American competition with British interests as erroneously reported by the *Daily Mail's* correspondent's cable to which we referred.

Swansea.—Users of electric light at Swansea on the 7th inst. had a very exciting experience when at about 7.30 an explosion occurred in a manhole in the Strand. The heavy cover was thrown into the air and a big volume of flame shot up, and lasted for nine minutes, the height of the flame varying from 10ft. to 5ft. The locality was not far from the electric station, and as soon as the occurrence was reported there the current was cut off and the flame extinguished. The manhole is on the pavement, close to the wall of 126, Strand, and the flame scorched the woodwork of the building and blackened the windows. Fortunately, no one was hurt, and the woodwork did not actually ignite.

Woodbridge.—At the last meeting of the Urban District Council the report of the special committee appointed to consider the question of contracting with the Suffolk Electricity Supply Co. to light the town by electricity for £350 per annum was submitted, and stated that the committee, after having considered the question of street-lighting by electricity with "Osram" lamps, and after making inquiries at several towns, and also some members inspecting the lamps when burning, were fully satisfied that the Council would be wise in adopting them, and recommended the Council to enter into a contract with the Suffolk Electricity Supply Co. to light the streets of Woodbridge for seven years, at £350 per annum, subject to the company reimbursing the Council for payment of expert advice. The Council adopted the recommendation of the committee.

Smoking Concert.—The second annual smoking concert of the West Ham Corporation Electric Supply took place last Monday evening at the Pigeon's Hotel, Romford-road, when there was a splendid "turn up" notwithstanding the dense fog. Mr. A. H. Seabrook, engineer and manager, presided, supported by Mr. Alderman Littler, chairman of the Electric Lighting and Tramways Committee. In the course of the evening a large photograph of the department's outing last summer, handsomely framed, was presented to Mr. Seabrook by Mr. Alderman Littler on behalf of the members of the staff, for which gift the former heartily thanked them. A really first-class succession of turns both grave and gay was provided by the versatile and general secretary of the Outing and Entertainment Committee, Mr. W. H. Collings, who contributed not a little to the hilarity of the evening by his inimitable rendering of "Burglar Bill" and one or two other choice items of song and gesture.

Colchester.—The last report of the borough electrical engineer to the committee includes the following particulars:

	1907.	1906.	1905.
Output of electricity in units during September—lighting	64,353	48,785	42,376
Ditto—traction	40,289	38,035	35,675
Used in generating station	17,389	12,455	4,037
	122,031	99,275	82,088

Canterbury.—The report of the Lighting Committee presented at the last meeting of the Council contained a recommendation that a new public lighting cable be laid from St. Dunstan's Church to the S.E. and C. Railway Station road, the estimated cost being £100, and this was agreed to by the Council, who directed the committee to take into consideration the lighting of Hawkes-lane.

U.S.A. Census on Dynamos.—According to a recent U.S.A. census return, 15,080 dynamos of an aggregate of 1,328,243 h.p., or an average of 88 h.p., were constructed in the United States during 1904. The value of these machines was returned as a total of 11,084,234dol., or an average of 735dol. The average value per horse-power was 8·35dol. This compares with a total of 10,527 dynamos constructed in 1900, of a total of 770 832 h.p., and a total value of 10,472,576dol. The average size in 1900 was 73 h.p., the average value 993dol., and the average value 13·58dol. per horse-power. The motors built for power purposes numbered in 1904 no less than 79,877, of which 54,242 were direct-current and 25,635 alternating. The aggregate horse-power was 678,910, or an average of 8½. The total value was 13,120,948dol., or an average of 164dol. per unit and of 19·32dol. per horse-power. The total value of motors constructed for all purposes was 22,370,626dol., or slightly more than twice as great as the figure for dynamos.

Stock Exchange.—The Stock Exchange Committee has appointed Nov. 20 a special settling day in African Rubber Co.'s 5,000 5 per cent. cumulative preference shares of £1 each, fully paid, Nos. 1 to 5,000, and Siputeh Tin Mines' 27,500 shares of £1 each, 15s. paid, Nos. 10,001 to 37,500; and Nov. 27 in Nigeria Bitumen Corporation's further issue of 700 shares of £1 each, fully paid, Nos. 182,708 to 183,407. The committee have ordered the undermentioned securities to be quoted in the official list: British Electric Traction Co.'s further issue of £118,758 4½ per cent. debenture stock, and South Metropolitan Electric Tramways and Lighting Co.'s 19,570 6 per cent. cumulative preference shares of £1 each, fully paid, Nos. 1 to 19,570. Applications have been made to the committee to appoint a special settling day in Batu Tiga (Selangor) Rubber Co.'s 20,000 vendors' shares of £1 each, fully paid. Nos. 40,001 to 60,000, and Boston Consolidated Copper and Gold Mining Co.'s further issue of 59,905 shares of £1 each, fully paid, Nos. 548,036 to 607,940.

Hull.—A Local Government Board inquiry was held on the 12th inst. into the application of the Corporation to borrow the sum of £46,527 in lieu of the sum of £14,000 originally proposed to be borrowed for the purposes of the electric light undertaking. Mr. H. R. Hooper, M.I.C.E., conducted the inquiry. It was explained by the town clerk that the loan was required for extensions of the electric light system for the next three years, and, in reply to the inspector as to what period of repayment was suggested, it was stated that the Corporation wanted as long as the Local Government Board would give them. With reference to the original application, the amount—£14,000—it was explained had been increased to £15,327. They had no tenders then when they applied for that loan, but since then contracts had been accepted and the work was partially done. The details were gone into, and out of the subsequent discussion a question arose with reference to the system of accounts adopted. The inspector pointed out that hitherto the Corporation had been using loans for other work than that specified in the sanction, and he approved of an innovation introduced into the system of accounts by keeping a separate account for each loan. The sum of £46,527 applied for was made up of £31,000 for natural expansion to cover a period not exceeding three years, £15,527 for machinery, etc. The former figure was reduced by the inspector to £20,939, the amount deducted being the value of the cable in stock, and the latter sum was reduced to £15,066.

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Blackpool.—The enterprising borough electrical engineer of Blackpool, Mr. C. Furness, has hit upon a novel idea to further extend the use of electricity in his town. Postcards are being sent out to all his consumers putting before them the advantages to be obtained by using the highly efficient Nernst lamp, which can be purchased either from the electricity works direct or from a local contractor at the same figure. The Corporation employ a man especially for fitting the renewals to clients' lamps at the price of burners only. Thus mutual satisfaction is obtained by all concerned. Satisfied consumers mean "applications to be connected." The scheme has been worked out in conjunction with the electrical company (with whom the orders for lamps, etc., have been placed), who will be pleased to furnish full particulars to any central-station engineer interested.

Buxton.—The report of the electrical engineer to the Council committee states that at the end of the half-year ending September, 1907, there were connected to the mains 26,176 8-c.p. lamps, as compared with 24,012 connected at the close of the corresponding half-year 1906—increase 2,164; the number of motors and their horse-power has gone up from 28 (100 h.p.) to 31 (110 h.p.); the number of units sold: 116,639 for 1907, 99,580 for 1906, an increase of 17,059; and the total revenue has gone up from £2,102. 7s. 6d. in 1906 to £2,362. 8s. 2d. in 1907, an increase of £260. 0s. 8d., whilst the works costs remain about the same. The Local Government Board, in reference to the Council's application for sanction to a loan of £1,700, asked for certain plans and particulars which had been prepared. In reference to one item (£125 for house service meters), as the engineer estimated that this would provide for only two or three years, the committee recommended that it be increased by £100, so as to provide for about five years' supply. This the Council have agreed to do.

Hampstead Exhibition.—In connection with this most successful exhibition, which closed on the 7th inst., a prominent feature was the exhibit of Mr. Eric Rivers Smith, of Heath-street, Hampstead, which was neatly and effectively arranged with cooking and heating appliances of all kinds, including several new and effective designs of radiators. The stand was amply lighted by two of the well-known Ediswan flame arc lamps, which were greatly admired for the steadiness and brilliancy of the light. It will be remembered that the Ediswan Co. make these in both white and yellow flame types, and claim for the former that it possesses several unique features, placing it in a class of its own. Amongst these are the improved magnetic control, and the fact that burning as it does with pure carbons, the light given off is absolutely pure, and has a spectrum exactly similar to that of daylight, so that all colours viewed thereby present a natural appearance. At Hampstead the lamps were burning on alternating current, 210 volts, 90 periodicity, so it is evident that the lamps are equally successful with alternating as with direct current.

Lowestoft.—At the last Council meeting the engineer reported that there were now connected to the mains 813 consumers, representing 40,691 8-c.p. lamps. The town clerk submitted agreements with the Great Eastern Railway Co. and the Midland and Great Northern and Great Eastern Joint Committee for taking cables under their respective lines of railway, and these were approved. The question of electric lighting of the Oulton Broad urban district was discussed, and it was agreed that it was desirable that one or other of the two Councils should obtain the provisional order for the lighting of the urban district. It being ascertained that the Oulton Broad Urban District Council was of opinion that they should obtain the order, this was agreed to, provided a suitable agreement was entered into between the two Councils. Mr. Bruce was instructed to prepare a scheme for the supply of electricity to Oulton Broad for consideration. The electrical engineer reported that he had submitted alternative schemes for the supply of electricity to the Oulton Broad Urban District Council. The price per unit to be charged was discussed, and the Lowestoft representatives suggested the following charges: up to 20,000 units, 3½d. per unit; units between 20,000 and 30,000, 3d. per unit; units between 30,000 and 40,000, 2¾d. per unit. Power charges: 2d. per unit up to 2,000 units, after that 1¾d. per unit. An agreement for five years or less to be entered into, and a coal clause to be incorporated in the agreement, and any addition in price charged by the Lowestoft undertaking to its own consumers to be proportionately charged to the Oulton Broad Urban District Council. At a later meeting the question of the price per unit to be charged for the supply of electricity to the Oulton Broad urban district was further considered, and the Lowestoft representatives stated that they were prepared to recommend the following charges: up to 30,000 units, 3d. per unit; over 30,000 units, 2¾d. per unit. Power charges: 2d. per unit up to 2,000 units, after that 1¾d. per unit. The other provisions as to supply to be as set out in the minutes of the last meeting, with the addition that at the expiration of the five years' agreement the same shall continue until either party shall give six months' notice to determine same, and that any reduction to Lowestoft consumers shall apply *pro rata* to the Oulton Broad Urban Council. The Oulton representatives intimated that they were prepared to recommend the acceptance of the above terms by their Council. The committee recommended that the report of the sub-committee be adopted, and further recommended that the town clerk be directed to proceed with the application for a provisional order for the lighting of the Oulton Broad urban district.

PROVISIONAL PATENTS, 1907.

Nov. 4.

24343. Improvements in and relating to signal lamps. Charles Walter Cox and the Edison and Swan United Electric Light Company, Limited, 34, Castle-street, Liverpool.

24356. Improvements in battery coil and sparking plug testing machines. Ernest Bristowe and George Henman, 18, Fulham-place, Paddington, London.

24363. Improvements in switching devices, specially applicable for use in controlling the electric lamps employed in flashing or revolving lights or for advertising purposes. William Béla Prince, Queen Anne's-chambers, Westminster, London. (Dr. Paul Meyer, A.-G., Germany.) (Complete specification.)

24364. Improvements in or in connection with control of electric motors. Armistead Keith Baylor, Queen Anne's-chambers, Westminster.

Nov. 5.

24461. Improvements in contact breakers or tremblers for induction coils. Sidney Stephen Everett, 18, Hertford-street, Coventry.

24486. Improvements in electrodes. Wilhelm Hagen, 7, Southampton-buildings, London.

24505. Improved device for electrically connecting electric wires and other conductors, also applicable for other purposes. Willy Scheffler and Willy Schumacher, 18, Southampton-buildings, London. (Complete specification.)

24517. Improvements in and relating to processes of melting in electric furnaces and their application to the extraction of easily volatisable metals. Henri Herrenschmidt. 111, Hatton-garden, London. (Date applied for under Patents Act, 1901, Nov. 9, 1906, being date of application in France.) (Complete specification.)

Nov. 6.

8263A. Improvements in the means of propulsion of electrically-driven trains and the like. Sidney Stone and Lorenzo William Migotti, 65, Chancery-lane, London. (Date applied for under Rule 5 of the Patents Rules, 1905, April 13, 1907.)

24546. Improvements in or in connection with resistances for regulating electric current. Norman Russell Booth, 77, Chancery-lane, London.

24550. Improvement in electric radiators and other apparatus where banks of massed lamps or other radiating devices are used. William Fennell and William Pagden Perry, 68, Dudley-road, Tipton, Staffs.

24580. Improvement in the construction of electric heaters and resistances. Harold Hodgkinson Broughton and George Herbert Alderton. 288, Ditchling-road, Brighton, Sussex.

24587. Improvements in or relating to flexible electrical connection devices and the like. Charles Albert Keller, Chancery-lane Station-chambers, High Holborn, London. (Complete specification.)

24589. Improvements in or connected with protective devices for electric circuits. Frederic Pooley and William Richard Macdonald, Queen Anne's chambers, Westminster, London.

Nov. 7.

24635. Improvements in arc lamps. William Alexander Legge, 65, Chancery-lane, London.

24647. Improvement in section insulators for tramway trolley wires. Robert Cunningham, Low Carteraigs, Pollokshaws, Glasgow.

24670. Arrangements on electricity meters for determining the maximum consumption. Elektrizitats-Akt.-Ges. vorm. Schuckert und Co., Queen Anne's-chambers, Westminster, London. (Date applied for under Patents Act, 1901, Nov. 20, 1906, being date of application in Germany.) (Complete specification.)

24671. Arrangements on electricity meters for determining the maximum consumption. Siemens Schuckertwerke G. m. b. H., Queen Anne's-chambers, Westminster, London. (Date applied for under Patents Act, 1901, Nov. 8, 1906, being date of application in Germany.) (Complete specification.)

23672. Improvement in centrifugal pumps and fans. Siemens Bros. Dynamo Works, Limited, Queen Anne's-chambers, Westminster, London. (Siemens-Schuckertwerke G. m. b. H., Germany.) (Complete specification.)

24698. Improved system of electric signalling on railways, tramways, canals, and elsewhere. Edward Edwards Vaughan, 55, Chancery-lane, London.

24702. Improvements in or relating to automatic electrical fire-alarm circuits. Otto Rennert, 31, Bedford-street, Strand, London. (Complete specification.)

24706. Improvements in electric arc lamps. Johnson and Phillips, Limited, and Charles Franklin Tubbs, Birkbeck Bank-chambers, Southampton-buildings, London. (Complete specification.)

24707. Improvements in refractory electric conductors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.) (Complete specification.)

Nov. 8.

24751. Improvements in or relating to commutators for dynamo-electric machinery. Siemens Schuckertwerke G. m. b. H., 139, Queen Victoria-street, London. (Date applied for under Patents Act, 1901, Nov. 12, 1906, being date of application in Germany.) (Complete specification.)

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24753. Improvements in means for rectifying alternate currents. Siemens Bros. and Co., Limited, Queen Anne's-chambers, Westminster, London. (Siemens und Halske Akt.-Ges., Germany.) (Complete specification.)

24769. Improvements in insulated rail joints. Benjamin Wolhaupter, Palace-chambers, Westminster. (Date applied for under Patents Act, 1901, Nov. 8, 1906, being date of application in United States.) (Complete specification.)

24770. Improvements in insulated rail joints. Benjamin Wolhaupter, Palace-chambers, Westminster. (Date applied for under Patents Act, 1901, Nov. 8, 1906, being date of application in United States.) (Complete specification.)

24779. Improvements in and relating to telephonographical apparatus. Siegfried Wertheimer and Josef Beer, 33, Cannon-street, London.

24781. Improvements relating to electric conductors for use in connection with installations of electric light. George Davis, Queen Anne's-chambers, Westminster.

24784. Improvements relating to dynamo-electric machines. Samuel Pinkus, 7, Southampton-buildings, London.

24792. Improved magnetic compass. Sidney Solomon Lawrence, 23, Southampton-buildings, London. (Complete specification.)

24802. Improvements in apparatus for transforming electric currents. Dagobert Timar and Karl von Dreger, 115, Cannon-street, London. (Date applied for under Patents Act, 1901, March 21, 1907, being date of application in Germany.) (Complete specification.)

24807. Electric furnace. Emilien Alphonse Omer Viel, 22, Southampton-buildings, London. (Complete specification.)

24808. Improvements in and relating to alternating-current dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

Nov. 9.

24813. Improved filament for electric glow lamps. John Walton Ward and Richard Henry Stevens, 140, High-road, Ilford, Essex.

24862. Improved integrating train for double-tariff electric energy meters. Vittorio Arcioni, 11, Southampton-buildings, London. (Complete specification.)

24874. Improvements in and relating to electric conductors. Percy Richardson, 70, Chancery-lane, London. (Complete specification.)

24877. Improvements in apparatus for opening and closing electric circuits at predetermined times. John Gunning, Birkbeck Bank-chambers, Southampton-buildings, London.

24879. Improvements in or in connection with the control of electric motors. Armistead Keith Baylor, Queen Anne's-chambers, Westminster.

24894. Improvements in electricity measuring instruments. Thomas Edward Slaughter and Haydn Thies Harrison, 46, Lincoln's-inn-fields, London.

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Nov. 28.)

1906.

24966. Telegraph and like posts. Muirhead.

25557. Track brakes for electric tramcars and the like. Mountain and Gibson, Limited, and Head.

28091. Telephone exchange systems. Clement. (Rights under Patents, etc., Act, 1901, not granted.)

29423. Electric lighting of trains. Preston, Roe, and Roe.

29748. Measuring instruments for electric storage batteries. Brazil and Lydall.

1907.

1049. Electromagnetic clutches. Watzke.

1397. Mariner's compass. Chetwynd, Clark, and Kelvin, and James White, Limited.

3334. Sound signalling on street, road, or like electrically and other self-propelled vehicles or locomotives. Taylor.

3426. Telephone exchange apparatus. Wheatley. (Enochs.)

4931. Electric arc lamps. British Thomson-Houston Company. (General Electric Company.)

6592. Process for the manufacture of leather for producing electrically insulating wearing apparel or for insulating electric conduits. Egger.

6710. Lug or take-off for secondary battery elements. Mason.

7758. Guard for trolley wheels of electric tramcars and the like. McMorran.

9051. Oscillatory circuits of radio-telegraph systems. Amalgamated Radio-Telegraph Company. (Rosenthal.)

11402. Magneto-electric ignition device for multiple-cylinder explosion engines. Rilling.

12968. Means for holding electrical condensers and the like. Marconi's Wireless Telegraph Company and Bangay.

19808. Incandescent electric lamps. Barras and Weddell.

20226. Electromagnetic devices. Allgemeine Elektricitäts Ges. (Date applied for under International Convention, Sept. 12, 1906.)

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £		Last price. £
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	½-¾
—— Ord., 1,125 000	1	..	½-¾
Aron Electricity Meter, 6 p.c Cum. Pref. Shares, 1-125,000	1	..	⅞-1
—— Ordinary, Nos 1 125,000	1	..	3/16 5/16
British Aluminium Co., Ordinary, 2,001-40 000	5	..	4-5 xd
—— 7 per cent. Cum. Pref., 1-40 000	5	..	4½ 5¼ xd
—— "A" 6 per cent. Cum. Pref., 1-20 000	5	..	4½-5
—— 4 per cent. Funding Certificates, 1-20 000	5	..	3¾ 4¼ xd
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	100 103
—— 5 per cent. Loch Leven Deb. (Reg.) Red., 1-3 000	100	..	96 99
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6¼-7
—— 6 per cent. Cum. Pref., 1-100 000	5	..	5⅞-6⅛
—— 4½ per cent. Mortgage Debentures	100	..	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	85 89
British Westinghouse Elec. and Manuf. 6 per cent Pref., 275,001-375 000	3	..	⅝-1⅛
—— 4 per cent. Mortgage Debenture Stock	100	..	55 65
Brush Electrical Engineering, Ordinary, Nos. 1-105 751	2	..	0-¼
—— Non. Cum., 6 per cent., Pref.	2	..	⅜-½
—— 4½ per cent 1st Debenture Stock	100	..	83-86
—— 4½ per cent. 2nd Debenture Stock	100	..	67-70
Callender's Cable, Debentures	100	..	105½-107½
—— Ordinary	5	..	9½-10½ xd
—— 5 per cent. Pref.	5	..	5½-5⅝
Consolidated Electrical Co., Ordinary, 1-110,000	1	..	7/16-9/16
Crompton and Co.	3	..	1⅝-2
—— 5 per cent Debentures	100	..	96-99
Dick, Kerr and Co., Ordinary, 1 260 000	1	..	1½-1⅝
—— 6 per cent. Cum. Pref., 1-305,000	1	..	1-1⅛
—— 4½ per cent. Debenture Stock, Red.	100	..	101-104
Edison and Swan United, "A" Shares, 1-99 261	3	..	1-1⅛
—— "A" Shares, 01-017,139	5	..	2-2½ xd
—— 5 per cent. Debentures	100	..	87-90
—— 4 per cent. Deb. Stock, Red.	100	..	81-84
Electric Construction, Nos. 1 to 112,100	2	..	1/16-3/16
—— 7 per cent. Cumulative Pref.	2	..	½-1
—— 4 per cent. Perp. 1st Mort. Deb	100	..	70-74
Electrolytic Alkali Co., Ordinary, 1-202,218	1	..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock. Red	100	..	—
General Electric Company (1900) 5 per cent. Cum. Pref.	10	..	8-8½
—— 4 per cent. 1st Mort. Deb. Stock	100	..	89-92
W. T. Henley's Telegraph Works, Ordinary	5	..	10½-11½
—— 4½ per cent. Preference	5	..	5-5½
—— 4½ per cent. Debentures	100	..	105½-107½
India Rubber, Gutta Percha, and Telegraph Works	10	..	14½-15½
—— 4 per cent. Debentures	100	..	96-98
National Electric Construction Co., 1-170,000	1	..	13/16-15/16
Parker, Thos., Limited, Ordinary	10	..	10-10½
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5	..	—
Telegraph Construction and Maintenance	12	..	27-30
—— 5 per cent Bonds	100	..	99½-102½
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	..	84-94

Electric Lighting and Supply.—

Name.	Amount paid. £		Last price. £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5	..	4½-5
Bournemouth and Poole, Ordinary	10	..	9½-10½
—— 4½ per cent. Cum. Pref., 7 501-15 000	10	..	9⅜-10⅜
—— 6 per cent. Cum Second Pref., 15 001-22,500	10	..	9⅜-10⅜
—— 4½ per cent. Debenture Stock, Red.	100	..	99½-102½
Bromley (Kent) Electric Light and Power Co	5	..	4⅝-5⅛
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	96-98 xd
Brompton and Kensington, Ordinary	5	..	7-8
—— 7 per cent. Preference	5	..	7-8
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	..	6-7
—— Nos. 80,000-100,000	5	..	5⅜-6⅜
Cambridge Electric Supply Company. £10 Ord.	8	..	12½-13½
Canadian General Electric Co., Common Shares	$100	..	103-104
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	..	98½-101½
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	..	3⅛-4⅛
—— 4½ per cent. Cum Pref., 1-80 000	5	..	3⅛-3⅝
—— 4 per cent. Debenture Stock, Red.	100	..	96 99
—— "City Undertaking," 4½ p c Cum. Pref., 1-40,000	5	..	3⅜-3⅝
—— ditto (1905) 40,001-80 000	5	..	3⅛-4⅛
Chelsea Electricity Supply	5	..	3⅛-4⅛
—— 4½ per cent. Debentures	100	..	102-105
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000	..	—
City of London, Ordinary	10	..	8⅜-9⅜
—— 6 per cent. Cumulative Pref	10	..	10½-11½
—— 5 per cent. Debenture Stock	100	..	122-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs (all pd.)	100	..	95-98
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1 630	£0	..	50-53
Corbett Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100	..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10 001-50,000	5	..	3¼-4¼
—— 5 per cent Preference, 1-50,000	5	..	4⅜-4⅞
County of London Elec. Supply, Ordinary	10	..	6½-7½
—— 6 per cent. Cum Pref.	10	..	10-10⅞
—— 4½ per cent. Debentures Prov Certs. All pd., Red.	100	..	106-109
—— 4½ per cent. 2nd Debentures Prov Certs	100	..	95-98 xd
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5	..	½-1
—— 6 per cent. Cum Pref.	5	..	1-1⅛
—— 4½ per cent. First Mort. Deb	100	..	76-81
Electrical Development Co. of Ontario 5 per cent. 1st Mort. 30-year Gold Bonds, 10 751-15 750	—	..	76-79 p.c.
Electric Lt & Traction Co. of Aust., 6 p.c. Cm Pf., 1-30,000	5	..	2½-2⅝
—— 5 per cent Debenture stock, Red.	100	..	85½-89½
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red	100	..	94-96
Folkestone Electric Supply, Ord., Nos 1-10 000	5	..	4½-⅝
—— 5 per cent. Cum. Pref., Nos. 1-10 000	5	..	4½-5⅛
—— 4½ per cent. First Deb Stock. Red.	100	..	96-99
Hove Electric Lighting, Ord., 1-13 000	5	..	6½-7
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. tock, Red.	100	..	101-104
Isle of Wight Elec. Lt and Pwr., 4½ p.c. Db. Stk., Red	100	..	92-95 xd
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	..	8-11/16
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000	5	..	8¼-9¼
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100	..	98-102
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9⅞-10½

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Name.	Amount paid.	Last price.
	£	£
London Electric, Ordinary	3 ..	1¼-1⅜
—— 6 per cent. Pref.	5 ..	3⅜-4¼
—— 4 per cent 1st Mortgage Debenture Stock, Red.	100 ..	89-93
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red (Prov. Certs.), all paid	100 ..	92-95
Metropolitan Ordinary, 100,001-100,000	5 ..	5¼-5⅜
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	103-107
—— 4½ per cent. Cum. Pref.	5 ..	4¼-5
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	£7 9s
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds. 1935, C 1-1,000 ($100), D 1-3,000 ($500), M 1-4,400 ($1 000)	— ..	7 -73 p.c.
Mexican Light and Power Co., Capital Stock	$100 ..	39 41
—— 5 per cent 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14 000 ($1,000)	— ..	80-82
Midland Electric Power Dis., 4½ p.c 1st Mort. Deb.	— ..	95½ 98½
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009 ..	5 ..	6¼-6⅜
—— do., 57 010-75 000	5 ..	6¼-6⅜
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid	5 ..	6¼-6⅜
—— 5 per cent., Pref., 1-57,009	5 ..	5-5½
—— do., 75,001-87,500 (issued at 10s. prem., 4s paid)....	5 ..	5-5¼
Notting Hill Electric Lighting	10 ..	10¼-11½
—— 4 per cent. First Mort. Debs. Nos. 1 500 (Reg.)	100 ..	95-97
Oxford Electric, Ordinary, 1-96 and 40 14,310	5 ..	5¼ 6
—— 4 per cent. Debenture Stock	100 ..	95-97
River Plate Electricity Co, Ord., 1-119 687 & 120,501-120 507	1 ..	9/16-11 16
—— 6 per cent. Non-Cum. Pref., 1-100,000	1 ..	⅞-1
—— 5 per cent. Debenture Stock, Red	100 ..	95-98
Rosario Electric Co., 6 per cent. Cum Pref., 1-20 000	5 ..	4⅜ 5¼
—— 6 per cent. Cum 2nd Pref., 1-15,000	5 ..	4⅝-5⅜
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	96 98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	— ..	99-101 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5 ..	⅛ 1⅛
—— 4 per cent. Debenture Stock	100 ..	71-75
South London, Ordinary	5 ..	2¼-2⅜
South Metropolitan Electric Light and Power, Ord.	1 ..	⅞-1
—— 7 per cent Cum Pref.	1 ..	15/16-1 1/16
—— 4½ per cent. 1st Mort. Deb.	100 ..	99 102
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	7¼ 8¼
—— 7 per cent. Pref.	5 ..	6-7
—— 3½ per cent. Deb.	100 ..	86-91
Urban Electric Supply Co., Ordinary, 8-30,007	5 ..	1⅜ 2⅛
—— 5 per cent. Cumulative Preference, 50 001 80,000	5 ..	1⅝-2⅜
Westminster, Ordinary	5 ..	8¼-9¼
—— 4½ per cent. Cum. Pref., 110,101-138,251	5 ..	4⅜-5¼

Electric Tramways.—

Name.	Amount paid.	Last price.
	£	£
Anglo-Argentine, 5½ per cent. Cum. Pref., 1-250,007	5 ..	5½ 6
—— Ord.	5 ..	7-7¼
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	128-131
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100 ..	102-105
Barcelona Tramways, Ord., 1-20 000	10 ..	—
—— 5 per cent. Cum. Pref. Shares, 1 10,000	10 ..	—
—— 5 per cent Deb., Red., 1-600	100 ..	..
—— 4½ per cent. Red. Deb. Stock	100 ..	—
Bath Elec Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1 ..	11/16 13/16
—— 5 per cent. Cum. Pref. Shares, 1-75 000	1 ..	13/16-15/16
Birmingham and Midland Trams., 4½ p. c. 1st Db. Stk., Red.	100 ..	94-97
Blackpool and Fleetwood Tramroad	10 ..	13⅜ 17⅝
Bombay Elec. Supply and Trams Co., 6 per cent. Cum. Pref.	8 ..	7½-8
—— 4½ per cent. Deb. Stock, Red.	100 ..	94-96
Brisbane Tramway Invest., Ord., 1-75,000	5 ..	3-3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4⅞ 4¾ xd
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. ..	100 ..	96-100
British Columbia Electric Railway Co., Ord Def.	100 ..	128-133
—— Ord. Pref.	100 ..	112-116
—— 5 per cent. Cum. Perpetual Pref. Stock	100 ..	101-105
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	£8-101
—— 4½ per cent. Vancouver Power Deb.	100 ..	102-104
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10 ..	1¼-1⅜
—— 6 per cent. Cm Pf., 30,0001-60 000	10 ..	4¼ 5
—— 5 per cent. Perpetual Debenture Stock	100 ..	94-97
—— 4½ per cent 2nd Deb. Stock	100 ..	74-78 xd
Bueno Ayres and Belgrano Trams	5 ..	4 7/16 4 11/16
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	4¾-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	4¾ 5¼
—— 5 per cent. Deb. Stock, Red.	100 ..	105-115
—— Prov. Cert., all paid	100 ..	102-105
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100 ..	92-97
Buenos Ayres Gd Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100 ..	99-103
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100 ..	98-103
Buenos Ayres Lacrze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	91-94
Calcutta Tramways, 1-105,000	5 ..	6⅜-7⅛
—— 105,001-137,610	5 ..	5 5¼
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	100 104
Cape Electric Tramways, Nos. 1-480,000	1 ..	⅜-⅝
City of Birmingham Tramways, 5 per cent. Cum Pref.	5 ..	4¼-4⅜ xd
—— 4 per cent 1st Mortgage Deb., 1-3 000 (1917)	100 ..	96-99
City of Buenos Ayres Trams. Co. (1 04), 1-243,000	5 ..	5 1/16-5 3/16
—— 4 per cent. Deb. Stock, Red. 1985	100 ..	98-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	93-97 xd
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	13-14
—— 6 per cent. Cum. Pref.	10 ..	12¾-13⅜
—— 4 per cent. Debentures	100 ..	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	13-14
—— 6 per cent. Pref., Nos. within 1-60 000	10 ..	12¾-13⅜
—— 5½ per cent. Mort. Debs., 1-3,000 Red	100 ..	90-95
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100 ..	97-100
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1,000 ..	85-90
Imperial Tramways, Ordinary	all ..	18-19
—— 6 per cent. Cum. Pref.	all ..	14-14¼
—— 4½ per cent. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30 001-60,000	5 ..	⅞-1⅛
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100 ..	66-71
Kalgoorlie Electric Tramways, 1-250,000	1 ..	1/16-⅛
—— 5 per cent. "A" Deb. Stock	100 ..	89-93
—— 6 per cent. "B" Deb. Stock	100 ..	74-78
Kidderminster and District Lighting and Traction, Pref.	5 ..	10-10½
Lancashire United Tramways, Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	94-97
—— £296 500 2nd Mort. Deb. Stock	— ..	—
—— £83, 30 Deferred Deb. Stock (all fully paid)	— ..	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1 ..	⅛-1⅛
—— 6 per cent. Cum. Pref., Nos 1-425,553	1 ..	⅛ 1⅛
—— 5 per cent. Mort Deb., 1-5,000 Red.	100 ..	92-97
London United Trys. (1901), 5 per cent. Cum. Pref.	10 ..	7½-8¼
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100 ..	82-86
Madras Elec Trams. (1904) 5 per cent. Deb. Stk., Red.	100	96-99
Manila Elec. R.R. and Lightg. Corp., 5 p c 1st Lien and Coll Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1 000 ..	90-92
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 23,436 25 000	— ..	4¼-5
—— 4½ per cent 1st Mort. Deb Stock, Red.	100 ..	96-99
Metropolitan Elec Trams., Defd., 1 000,001-1 314 016	1 ..	1/16 3/16
—— 5 per cent. Cum Pref. 500,001-1,000 000	1 ..	13/16- 5/16
—— 4½ per cent. Deb. Stock, Red.	100 ..	93-96
Mexico Trams. Co, Gen. Cons. 1st Mort 50-year 5 per cent. Gold Bonds	— ..	79-81 p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con. Mort Bonds, 1926 1-5,500 and 7,001-8,000	$1,000 ..	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 001-2,000 1922	100 ..	101-103
New General Traction, 6 per cent. Cum Pref., 1-10 000 and 34 001-74 000	5 ..	¾-1⅛
Oldham, Ashton, and Hyde Tramway, Ordinary	10 ..	2
—— 5 per cent. Cum. Pref.	10 ..	8¾-9
Perth Elec. Tramways (W.A.) 5 per cent 1 Mrt. Deb. Stk.	100 ..	100 101
Potteries Electric Traction, Ordinary, 1-245,000	1 ..	5/16-9/16
—— 5 per cent Cum Pref., 300 001-545 000	1 ..	¼-⅜
—— 4½ per cent Debenture Stock	100 ..	95 98
Provincial Tramways Co., Ordinary 1-24 912	10 ..	5-5¼
—— 6 per cent. Cum. Pref., 1-10 000	10 ..	10¼-11¼
Rangoon Elec. Tramway and Supply Co., 6 p c. Cum. Pref., 1-30,000	5 ..	5-5¼
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100 ..	97-99
Sao Paulo Tramway, Light, and Power Co.	£100 ..	106-109
—— 5 per cent. 1st Mort Deb., Red. 1929, 1-11,000	£500 ..	92-94 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent Cum. Pref., 19,571-169,570, Prov. Certs.	1 ..	⅞-1⅛
—— 4 per cent. Deb St ck, Red. 1940	100 ..	80-84
Sunderland District Electric Tramways, 5 p.c 1st Mort. Debs., Red., 1-1 600	100 ..	84-88
Yorkshire (West Riding) Elec Tram. Co., Ord., 70,001-110,000	5 ..	1-1⅛
—— 6 per cent. Cum. Pref., 1-46,261	5 ..	3⅛ 3¾
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	85-88

Electric Railways.—

Name.	Amount paid	Last price.
	£	£
Central London, Ordinary	100 ..	54-57
—— 4 per cent. Pref.	100 ..	83-86
—— " " deferred	100 ..	4 -43
—— 4 p c Deb. Stock (Prov. Script Certs., fully paid) ..	100 ..	101-104
City and South London, Consolidated Ordinary	100 ..	44-46
—— 4 per cent Debenture Stock	100 ..	101-103 xd
—— 5 per cent. Pref. Stock '91	100 ..	116-119
—— " " " '96	100 ..	113-116
—— " " " '01	100 ..	113 116
—— " " " '05	100 ..	108-111
Liverpool Overhead, 5 per cent. Pref	10 ..	10-10½
—— Ordinary, 1-50 000	10 ..	3¾-4⅛
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	— ..	38-42

Telegraphs and Telephones.—

Name.	Amount paid.	Last price.
	£	£
Amazon Telegraph Co., 1-25,000	10 ..	3-3½
—— 5 per cent. Debs., Red., within 1-1,069	100 ..	85-88
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78 000	$1 000 ..	89 91
Anglo-American Telegraph Co., Ordinary	100 ..	52-55
—— 6 per cent. Preferred Ordinary	100 ..	92-96
—— Deferred Ordinary	100 ..	13⅜-14⅛
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	99-102
Chili Telephone Co., 1-44,000	5 ..	6¾-7¼
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100 ..	84-88
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10 ..	6 7
—— 10 per cent Preference, 1-6 000	10 ..	15¾-16¾
Direct Spanish Telegraph Co., Ordinary	5 ..	3¼-3⅝
—— 10 per cent. Cum. Preference	5 ..	8¼-8⅝
—— 4½ per cent. Debs., 1-600	50 ..	98-101
Direct United States Cable Co.	20 ..	12¼-13¾
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100 ..	100-102
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100 ..	97½-100½
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8 000, 1913	25 ..	98-100 xd
Eastern Extension, Australasia and China, 1-300,000	10 ..	11-11⅜
—— 4 per cent. Mort. Deb. Stock, Perp.	100 ..	98-102
Eastern Telegraph Co., Ordinary Stock	100 ..	12-12⅝
—— 3½ per cent. Preference Stock	100 ..	84-85
—— 4 per cent. Mortgage Debenture Stock	100 ..	99-102 xd
Great Northern Telegraph Co. (of Copenhagen)	10 ..	29-32
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1,200, Red.	100 ..	99-101
Indo-European Telegraph Co.	25 ..	52-55 xd
Marconi's Wireless Telegraph Co., Nos. 255,128-284,190	1 ..	11/16-15/16
Monte Video Telephone Co., Ordinary, 1-72,680	1	15/16-1 1/16 xd
—— 5 per cent. Preference, 1-86,492	— ..	⅞-1
National Telephone, Preferred	100 ..	105½-107½
—— Deferred Stock	100 ..	104-106
—— 6 per cent. Cum. First Pref.	10 ..	10¼-12½
—— 6 per cent. Cum. Second Pref.	10 ..	10-12
—— 5 per cent. Non. Cum. Third Pref.	5 ..	5 3/16-5 7/16
—— 3½ per cent. Deb. Stock, Red.	100 ..	96-98
—— 4 per cent. Deb. Stock, Red.	100 ..	100-102
Oriental Telephone and Electric Company	1 ..	1⅛-1¼ xd
—— 6 per cent. Cum. Pref	1 ..	1⅛-1¼ xd
Pacific and European Tel., 4 p c. Guar. Debs., Red., 1-1,000	100 ..	97-100
United River Plate Tele. Co., Ordinary, 1-100,000	5 ..	6¾-7¼
—— 5 per cent. Cum. Pref., 1-40,000	5 ..	5-5½
—— 5 per cent. Debenture Stock, Red.	100 ..	—
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100 ..	98-101
West African Telegraph Co.	10 ..	10-10¼
West Coast of America, 1-30 000 and 53 001-53,008	2½ ..	1-1¼
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph ..	100 ..	97 100
West India and Panama Telegraph Co., Ordinary	10 ..	7/16-9/16
—— 6 per cent. Cum. 1st Preference	10 ..	7-8
—— 6 per cent. Cum 2nd Preference	10 ..	7¼-8¼
—— 5 per cent. Debs., Red., 1-800	100 ..	99-102
Western Telegraph Co., 1-207,930	10 ..	12½-13½
—— 4 per cent. Debenture Stock, Red.	100 ..	98½-101½

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1907.	1906.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Nov. 6	1,209	1,323	- 119	— h	25½	25	May 31	64,071	15,530,351	1,379,723	0 98	11·14	2,512	6·45
Ayr Corporation	,, 9	181	—	—	—	8	8	,, 15	14,328	3,316,380	353,945	1	9·71	1,830	5·16
Baker Street and Waterloo Ry.	,, 9	2,810	2,105	+ 705	+16,795	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 10	1,018	981	+ 37	- 223	23·53	23·53	March 31	55,025	11,145,531	1,309,903	1·18	10·08	2,338b	6·03
Birmingham Corporation	,, 9	6,307	—	—	—	56½	—	,, 31	17,133	4,709,798	266,526	·86	14·5	8,866	—
Blackburn Corporation	,, 6	1,061	921	+ 139	+ 2,381	24	21	,, 25	48,875	8,661,720	986,953	1·35	11·89	2,036	7·44
Blackpool Corporation	,, 7	379	353	+ 27	- 1,378	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	Oct. 26	311	279	+ 32	- 1,139	16½	16½	Dec. 31	31,846	2,325,677	579,264	3·28	13 19	—	7·27
Bolton Corporation	Nov. 10	2 205	2,017	+ 188	+ 4,489	42	40	March 31	95 766	20,205,196	2,161,130	1·13	10·63	2,394	6·14
Bournemouth Corporation	,, 6	1,468	1,405	+ 63	+ 971	17·41	16·82	,, 31	55,276	10,058,288	1,121,623	1·32	11·83	3 226	7·19
Bradford Corporation	,, 9	4,414	4 166	+ 248	+ 2,827	95	95	,, 31	230,085	47,108,000	5,053,392	1·172	10 927	2,396	—
Brighton Corporation	,, 10	776	797	- 21	- 2,414	9½	9½	,, 31	50,339	11,321,160	1,152,82	1·06	10·48	,914·8	8·014
Bristol Tramway Company	,, 8	4 862	4,641	+ 218	—	51½	51½	Dec. 31	259,799	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	,, 9	1,229	1,116	+ 113	—	40	40	March 31	57,992	11,092,704	1,197,772	1·31	11·61	5,388	8·17
Burton Corporation	,, 10	251	—	- 22	- 446	8½	8½	,, 31	17,950	3,878,269	454,082	1·07	9·21	2,0t 8	6 76
Cardiff Corporation	—	—	—	—	—	32·62	†32·26	,, 31	112,209	24,134,363	2,770,049	1·12	9·72	3,782	9·44
Carlisle Tramways Company	,, 9	171	170	+ 1	- 542	8·5	8·5	Dec. 31	10,713	2,935 002	359,756	—	7·14	—	5.18
Central London Railway	,, 9	5,975	6,874	- 839	-15,174	6	6	,, 31	347,588	4,875,547	1,281,214	1·86	65·10	57,931	55·80
Charing X, Euston, & Hamp. Ry	,, 9	3,040	—	—	—	8	—	—	—	—	—	—	—	—	—
City and South London Railway	,, 10	3,345	3 194	+ 151	+ 8,471	6¼	6¼	,, 31	—	—	—	—	—		
Colchester Corporation	,, 6	193	194	- 1	--	8	8	March 31	10,588	2,457,553	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	,, 7	421	397	+ 24	- 805	15½	15½	Dec 31	24,895	5,814,376	882,256	1·01	6·64	—	4·69
Croydon Corporation	,, 1	1,326	—	- 45	—	12 c	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 8	239	243	- 4	- 23	7 23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	,, 9	182	201	- 19	- 1 041	4½	4½	,, 31	11,250	2,853,200	284,343	·94	9·49	2,500	
Dublin and Lucan Electric Ry.	,, 8	99	93	+ 6	+ 237h	6¾	6¾	Dec 31	6,358	402,511	113,738	3·79	13·78	942	7·33
Dublin U.T.	,, 8	5,685	4,667	+1,023	+30 141	48½	48½	,, 31	267,489	50,050,949	7,077,372	1·28	9 07	691	5 55
Dundee City Tramways	,, 6	1,123	—	+ 16	+ 735	22	22	May 15	53,154	13,086,396	1,005,911	·906	11·96	2,180	7·42
East Ham Corporation	,, 9	380	730	+ 90	- 112	14	14	March 31	56,652	3,689,658	863,816	·64	10·18	2,994	6 79
Glasgow Corporation	,, 9	17,545	16,523	+1,022	+11,600h	79½	79½	May 31	756,480	195,767,519	17,945,595	—	10·12	—	—
Gloucester Corporation	,, 6	243	256	- 13	- 196	15	15	March 31	15,465	3,902,077	563,595	·90	6·58	999	5·32
G.N., Piccadilly and Brompton	,, 9	4,840	—	—	—	9	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	37	37	,, 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 9	1,524	1,406	+ 118	+ 2,500	35	35	,, 31	69,938	12,838,150	1,665,262	1·24	9·71	1,923	—
Hull Corporation	,, 9	2,502	2,375	+ 126	+ 4,067	26	26	,, 31	112,651	27,102,921	2,910,698	1	9·29		—
Ilford Corporation	—	—	—	—	—	10½	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 7	134	120	+ 14	+ 262	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	11,586	3,626,656	419,800	·737	6·62	1,480	5 22
Lancashire United Tramways	,, 6	1,245	1,037	+ 209	+ 13,429	39	38	—	—	—	—	—	—	—	—
Leeds Corporation	,, 9	6,360	5,981	+ 379	+ 9,055	89½	89½	March 25	298,233	64,223,666	7,121,038	1·10	10·02	351	—
Leicester Corporation	,, 9	2,210	2,135	+ 75	—	42	42	Dec. 31	26,011	12,039,252	1,229,507	1	9·79	—	4 82
Liverpool Corporation	,, 2	11,056	10,468	+ 583	+ 8,017	104	104	,, 31	547,625	116,642 663	12,166,419	—	—	—	—
Liverpool Overhead Railway	,, 10	1,419	1,401	+ 15	+ 1,743h	6·65	6·65	June 30	81,302	11,171,865	1,024,275	—	—	—	—
London County Council	,, 2	31,664	24,915	+6,749	+162 562	98	98	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 9	179	181	- 2	—	6	6	Sept. 30	14,511	3,128,867	359,435	1·08	9·68	2,630	6·48
Maidstone Corporation	—	—	—	—	—	2	2	March 31	4,740	850,121	112,227	1·33	10 13	2,370	
Manchester Corporation	,, 9	14,623	13,725	+ 898	+34,603	149	149	,, 31	631,956	126,900,875	14,123,124	1·19	10·73	4,299	6·39
Metropolitan District Railway	,, 9	8,911	8,707	+ 204	- 437	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 10	15,828	15,775	+ 53	+ 5,827	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 9	129	131	- 2	- 25	2¾	2¾	,, 31	6,159	1,992,647	206,358	82	7·14	2,239	—
Newcastle-on-Tyne Corporation	,, 9	4,116	4,022	+ 94	+ 680	50	50	,, 31	197,849	43,063,934	4,326,152	1·07	10·98	3,957	7·0
Newport (Mon.) Corporation	,, 9	632	578	+ 54	+ 1,764	15½	15½	,, 31	30,356	7,252,535	783 435	—	9·29	—	6·4
Oldham Corporation	—	—	—	—	—	34	34	,, 25	65,553	13,466,245	1,504,740	1·16	10·45	1,886	—
Portsmouth Corporation	May 25	2,330	1,578	+ 752	+ 632	28½	28½	,, 31	95,702	19,625,329	197,499	1·17	11·63	—	—
Reading Corporation	Nov. 7	581	590	- 9	- 738	33½	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	11·29	21·29	,, 31	14,881	2,837,110	386,547	1·24	9·24	1,102	7 92
Rotherham Corporation	—	—	—	—	—	9½	9½	,, 31	23,569	5,251,472	593,054	1·07	9·53	2,612	7·49
Salford Corporation	,, 11	4,531	4,335	+ 208	+ 4,266	70¾	70¾	,, 31	214,111	39,213,560	4,894,590	1·28	10·29	—	—
Scarborough Tramways Co.	—	—	—	—	—	4½	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 10	5,627	5,312	+ 315	+ 8,616	35¾	35¾	,, 25	240,565	63,952,283	,049,899	·903	9·543	3,653	5·94
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,365	9,294,771	1,108,369	1·27	11·02	—	7·85
Southend-on-Sea Corporation	,, 5	301	287	+ 14	- 73	9	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	,, 31	39,550	6,766,031	1,027,730	—	9 23	—	4·75
Sunderland Corporation	,, 10	1,184	1,293	- 109	- 780	20	20	,, 31	64,858	15,364 463	1,495,685	1·004	10·36	—	6·37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	4,937	1,315,757	102,751	0·87	11·53	1,371	—
Torquay Tramways	Nov. 7	171	—	—	—	5·16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 9	747	730	+ 17	+ 741	12 68	12·43	,, 31	43,607	7,995,451	862,12	9·27	12·14	3,132	7·50
Warrington Corporation	—	—	—	—	—	9	9	,, 31	17,057	4,418 225	403,363	—	9·85	—	6·33
West Ham Corporation	,, 7	2,273	2,027	+ 246	+ 1,456	14·7	14·7	,, 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	,, 6	328	811	+ 17	+ 260	20	20	,, 31	41,905	8,847,066	950,338	—	10·583	2,062	6·1o

† And 98 miles of interlacing track. a Train mile. b Per mile of single track. c Miles of route. h Half-year's figure k Double track.

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NOTES.

Marseilles Exhibition.—Recently we referred in these columns to the exhibition of applications of electricity which is to be held next year at Marseilles. We are now asked to state that intending exhibitors can have full information by applying to M. Jauffrett, 77, Fleet-street, London, E.C., where the temporary offices of the exhibition are installed.

Electricity on Battleships.—The inaugural address delivered before the Junior Institution of Engineers on Monday evening by the president, M. Gustave Canet, dealt with the subject of army and navy ordnance, and was the means of awakening no little interest in this important branch of engineering. The comparisons made by M. Canet between French and English artillery disclosed a notable difference in the practice of the two nations in regard to the use of electricity for the mounting, etc., of guns, and it would seem that French practice is much more advanced in the use of electricity than is English. The training and elevating mechanism are both hydraulically worked in the British navy, whereas electricity is employed in the French. The same difference occurs with regard to the operation of ammunition hoists and many other details. Discussing the relative merits of the two systems, M. Canet pointed out that while both work perfectly well, they have their respective advantages and defects. The great enemy of hydraulic mechanism, he said, is frost, and, moreover, the weight of the appliances and the size of the pumping machinery are serious considerations. Electricity, on the other hand, is always and every day available on a battleship. The leads can be taken anywhere, and the apparatus is now thoroughly reliable, although short-circuiting and breakage of leads, should they occur, are much difficult to find out than the fracture of water-pipes. The main question which naval designers will have to consider, however, is which system is capable of greater future developments. M. Canet answers this question in favour of electricity. He says: "Hydraulic mechanism, moreover, has approached more closely to the limit of its development than electricity, and, in the future at any rate, I consider that electrical power will be generally considered to possess the balance of advantages." As electricity is still largely retained as motive power on battleships, it is not unlikely that the turrets for ships to be built in the future for the British Government will embody no few of the improvements which French practice has demonstrated.

Power Factor Correction.—In a recent issue of the *Electric Journal*, Pittsburg, there appeared an article on synchronous motors for improving power factor, and the features considered were: (1) the most efficient point to which the power should be raised; (2) the advantage in causing a synchronous motor to give out mechanical power in addition to improving the power factor; (3) the advantage derived by using a synchronous motor in a specific case In the November issue of the *Journal* Mr. C. J. Young returns to the subject, with a suggested graphic chart for determining quickly the power factor improvement obtainable by the use of synchronous motors. Mr. Young's graphic calculator provides an interesting method of determining the capacity of synchronous motor necessary to accomplish certain results. It also provides a very convenient method of determining just what the results will be in regard to power factor improvement and the reduction in generator load by the use of a synchronous motor of given kilovolt-ampere capacity. It further shows just what these results will be when the mechanical output of the synchronous motor is varied—for instance, it indicates the net results in the circuit when the synchronous motor is developing its rated kilovolt-ampere capacity in mechanical power and not furnishing any leading current for power factor improvement. Or, it will show these results when the synchronous motor is floating on the line—that is, furnishing full kilovolt-ampere leading current and not furnishing any mechanical power. Further, it will show the results in power factor improvement and reduction in the generator load at any points between the two extreme limits. Synchronous motors of certain capacities are more or less standard, and it is often desirable to determine quickly just what result a synchronous motor of given capacity will accomplish in the system. As the calculator is drawn in per cent. of generator kilovolt-ampere loads, the capacity of synchronous motor required to accomplish certain results may be quickly obtained, the only calculation necessary being that to determine the vector sum of the true and the wattless component of the power in the motor in order to arrive at the kilovolt-ampere capacity of the motor, and that may be obtained directly by scaling the distance on a chart with a pair of dividers.

Variable Mutual Inductances.—The discussion on Mr. Campbell's paper on "The Use of Variable Mutual Inductances," read before the Physical Society recently, was opened by Dr. Fleming. Dr. Fleming asked Mr. Campbell how his method compared in accuracy with the Carey Foster method, using a commutator to add up the impulses. He had frequently measured mutual inductance by determining the self-inductances of the primary and secondary joined in series, with the windings first helping each other and then opposing each other. He asked if Mr. Campbell's methods were applicable when dealing with the high frequencies used in wireless telegraphy. Mr. A. Russell agreed with Mr. Campbell in thinking that mutual inductance was sometimes easier to calculate and easier to measure than self-inductance. The variable mutual inductance standard shown was very compact, and would be a great acquisition to a physical laboratory. In calculating self-inductance the variable current density over the cross-section of the wire sometimes brought in serious difficulties. The measurement of self-inductance in these cases might possibly be made by Mr. Campbell's method, but the limitations introduced into his formulæ by the assumption that the back E.M.F. was proportional to the rate at which the total current was changing would have to be considered. Mr. Campbell, in reply to Dr. Fleming, said the methods of measuring mutual inductance described in the paper were more convenient and direct reading than that of Carey Foster, although they were not so absolute. They were of higher accuracy than the difference method, in which the primary and secondary were put in series and their combined self-inductance measured both with the windings helping and opposing. In reply to Dr. Fleming and Mr. Russell, the methods of measurement described were not intended, in general, for use with high frequencies of the order of those used in wave telegraphy, where resonance methods appear to be the only ones available. Mr. Campbell mentioned that the correction for the small inductance of the rheostat in method (B) could be got rid of by making the rheostat of constant inductance, this being attained by running a manganin and a copper wire side by side with a travelling contact across them, the current entering by the copper at one end and leaving by the manganin at the other.

Underground Electric Furnace.—The keenness displayed by Rand mining engineers in utilising every invention promising new economies or efficiency is proverbial, and it has received striking exemplification in the installation during the past few weeks of an electric furnace

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for underground use in drill-sharpening at the Village Deep mine. The furnace is at present being subjected to rigid testing operations, the result of which is said to give satisfactory promise. Not only will its success add yet another important item to the plant of the average mine, but it will have another commercial result of even greater importance, inasmuch as it will probably alter the preference of the majority of mine managers for medium-quality drill steels to one for the best qualities. It is a common belief on the Rand that the present system of heating invariably reduces high-grade steel, though it has no deleterious effect on the middle grades, but the uniform and constant temperature promised with the new furnace will remove all ground for using any but the best steel for drilling. The new furnace is by the A.E.G. Electrical Company of South Africa, Limited. From a brief description which appears in the *British and South African Export Gazette*, we gather that the furnace consists of a tank lined with fireproof material, and an interior iron crucible similarly lined. Two electrodes on either side of the tank convey monophase current to the crucible, and are connected with a special transformer, the current thus being regulated with uniformity and precision. The crucible contains metallic salts which are instantly fused by the current, and, in view of the fact that cold salts of this character are not good conductors, an auxiliary electrode is employed to commence heating and fusion by making a liquid track between the main electrodes. By the movement of a lever above the transformer the temperature is easily and precisely regulated between 750deg. and 1,400deg. C. In addition to the simplicity of working, the chief advantages of the furnace include the absence of radiated heat, and the avoidance of burning or internal tension of the metal, it being impossible for the latter to attain a greater heat than that of the salt bath, the temperature of which is even throughout. The bath does not chemically attack the steel, while the formation of a slight crust of the salts prevents oxidation. The rapidity of the work done by the furnace—its efficiency is said to be from five to fifteen times greater than gas—renders it extremely economical, and it is as useful for annealing as for tempering.

Institution of Electrical Engineers. — Two announcements made by Dr. Glazebrook, the retiring president, at the opening meeting of the session last week are of far-reaching importance to the value of the Institution to its members. The Council have at length realised that between the parent body in London and the local sections there has not been that co-operation which ensures the practical utility of the Institution to all its members, irrespective of the districts in which they may dwell. There has been little or no control in the presentation of papers, some of which, while bearing real value, have seldom circulated beyond a provincial audience, unless unearthed and published by the technical Press. The new arrangement made by the Council should be instrumental in removing this disadvantage. It provides for the appointment of a strong Papers Committee, before which every paper to be read before the Institution in London or the local sections will have to be submitted. From these papers the committee will select those which they think suitable for reading before a London audience, and allocate others to the local sections where they are likely to be of most benefit. The Papers Committee consists of representatives from the Council and the local committees, and can, therefore, be said to be thoroughly representative of electrical engineers. While tending to strengthen and raise the prestige of the local sections, the new arrangement will at the same time make it possible for the members of the Institution collectively to enjoy a further measure of benefit from the talent of individual members than has hitherto been possible. This, however, is not the only reform which the Council of the Institution have introduced during the past year. In future all papers will be read in abstract, and thus more time will be available for their discussion. We have repeatedly advocated this measure of reform, and are glad that the Council have at last bowed to the inevitable. It has seemed unreasonable to have a dull rendering of a lengthy paper by an author when those members who are particularly interested in the subject under discussion have been furnished with an advance copy of the paper, and when the members assembled have each a copy of the paper before them. Much time has been wasted, and the opportunity for practical discussion curtailed. Now that the members have a better opportunity for taking part in the discussions, we hope they will show their appreciation by coming forward with practical information, instead of discursive statements which are of little practical avail. In this way will the objects of the Institution be better realised.

Steam v. Electric Locomotives.—Mr. A. H. Armstrong, in a paper presented to the American Institute of Electrical Engineers on the 8th inst., returns to the subject of steam road electrification with a number of interesting statistics, showing a comparative performance of steam and electric locomotives. We have had this subject discussed on countless occasions by almost every engineering society in the world, and it would be thought that there is now very little room for further discussion. But Mr. Armstrong's discussion of the subject differs from many of the others in that it is ranged strictly round the question of direct financial benefits to be obtained from electrification. From the numerous tables embodied in the paper, we think that the following, comparing operating expenses per 1,000 ton-miles steam (simple) and electric locomotion, is typical for average up and down grade operation :

Steam Locomotives.

Grade ..	½ %	1 %	1½ %	2 %
Coal	15 c.	25·5 c.	38 c.	53 c.
Labour	13·5 c.	24 c.	36 c.	50 c.
Maintenance	10 5 c.	17·8 c.	26 c.	36 c.
Total	39 c.	67·3 c.	100 c.	139 c.

Electric Locomotives.

Grade	½ %	1 %	1½ %	2 %
Power	20 c.	35·5 c.	50·5 c.	66 c.
Labour	7·2 c.	12·2 c.	18 c.	24 c.
Maintenance	3·6 c.	6·2 c.	9·0 c.	11·9 c.
Total	30·8 c.	53·9 c.	77·5 c.	101·9 c.

Saving effected by Electric Operation.

8·2 c.	13·4 c.	22·5 c.	37·1 c.

The above table shows that while the percentage saving with electric operation is approximately the same whatever the ruling grade, yet the actual money saving is much greater on the heaviest grades, and it leads to the inference that heavy grade divisions present a more attractive field for electrification than level sections when considered from a purely economic standpoint. Mr. Armstrong urges that on mountain grade divisions the subject of regeneration with electric locomotives should receive very careful consideration, not so much on account of the saving in power which it may effect, but rather on account of the greater safety of operation which it guarantees by eliminating the serious defects of holding trains on heavy grades by wheel and shoe friction. The subject is too wide to be adequately treated in one paper, even though that by Mr. Armstrong is of inordinate length, consequently there is no detailed discussion of many of the points touched upon. Nevertheless, the interesting financial comparisons afford ample

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justification for the electrification extension movement, viewed from an economic standpoint.

Supply to Places of Worship.—It is the practice of several metropolitan borough councils who are electric lighting undertakers to offer a special rate of charge for current supplied to a particular class of consumer. Among the boroughs which have adopted this practice is that of Stepney, whose Electricity Committee assert that the practice has increased the demand for current, and that it has been generally appreciated. Now comes along a request from the clergy and others asking that a special rate of charge should be formulated which would be applicable to places of worship, and Stepney is anxious to comply. But there is a difficulty in satisfying the heterogeneous mass of creeds in the borough, which the Electricity Committee propose to overcome in a novel manner. There is already in existence an arrangement under which the Council supply electricity at special rates, the general conditions being as follows: "Consumers whose maximum demand never occurs between sunset and 7 p.m., or occurs only on Saturday or Sunday, may have their demand indicator cut out of circuit at all times other than between sunset and 7 p.m., each of the remaining five weekdays by payment of an additional meter rental of 6d. per month for each such indicator so cut." It is found, however, that the working of this arrangement does not benefit such places of worship as synagogues, whose maximum load is on Friday evenings, when the station load is also at or near its maximum. The Electricity Committee now propose to amend the arrangement so that all places of worship may come under the same category as the class of consumer mentioned in the following extract from the general conditions under which the Council supply electricity: "To any consumer whose total accounts, calculated on the undermentioned rate for any half-year, reach £60 or over, or who is willing to guarantee this amount as a minimum payment for each such period, the following charges shall be made: Scale C—for lighting purposes. Sixpence per unit for the first 30 hours' use of the maximum demand . . . . during each of the six months ending March inclusive, and for the first 20 hours' use during each of the six months ending September inclusive, and $\frac{9}{10}$d. per unit for all further consumption in each month. In calculating the total amount of a consumer's half-yearly bill for the purpose of arriving at the minimum above mentioned, the accounts for lighting, power, and other purposes on the same or different premises will be added together. Provided that where the accounts of different premises are so added together, the average half-yearly account per service shall not be less than £15." This means that the rate of charge to places of registered worship would, at option of such places, be 6d. and ·9d. instead of 8d and 1d. The granting of such facilities may result in much indirect benefit, inasmuch as they will afford an opportunity to a large number of persons seeing the effect of lighting by this means, and may be instrumental in attracting new consumers.

Electric Narcosis.—Mr. W. Deane Butcher, surgeon-in-charge of the electrical department of the London Skin Hospital, delivered a noteworthy address at the inaugural meeting of the electro-therapeutic section of the Royal Society of Medicine on Oct. 25. It is impossible to give any idea, in a brief abstract, of the many avenues open to the development of the use of electricity in medicine, as disclosed in the address. But we may with advantage to our readers refer them to some of the recent work of Prof. Leduc on electric sleep, to which Mr. Butcher and our esteemed contemporary, the *Lancet* (in whose columns the address is reproduced), refer. This condition is brought about by the application of electric currents to the brain and during which the subject is without voluntary movement, makes no reply to stimulation, and exhibits only some reflex movements—the beating of the heart and respiration—and this state can be maintained for several consecutive hours, ceasing immediately with the stoppage of the current. The current employed is an intermittent one of low tension and unidirectional. The impulses follow one another at the rate of 100 per second and the duration of each impulse is one-tenth of this, or one-thousandth of a second. This form of current is produced by a special design of commutator for this purpose, and the frequency as well as the relation of duration of impulse to duration of interval are what have been found best for the production of electric narcosis after a prolonged and extensive series of experiments. Prof. Leduc has also found that the results obtained when the source of energy is from accumulators are much better than when the street mains are used. The current is applied to the head by means of electrodes placed antero-posteriorly, suitably padded and adapted to the surface contour. The interruption is first started and then the current is gradually turned on—at first quickly, then more slowly. As in chloroform narcosis, excitement first comes on, followed by inhibition, but by raising the current very slowly during the period of excitement, the animal without a movement or sign of pain passes into a state of cerebral inhibition analogous to the narcosis of chloroform or ether. The animal reacts to no stimulus, any operation can be done on it, and the limbs if moved seem to be under no influence except that of gravity. When the current is cut off the awakening is instantaneous. Usually the animal gets on to its feet, looks quietly about, and shows no sign of fright, suffering, or fatigue. In the case of the animals experimented upon there were no after effects, no vomiting, rarely a little stupor, and no resentment or aversion to the experimenters. So far the method has been applied only once to the human subject, and then not to complete loss of sensation, and that was to Prof. Leduc himself at the School of Medicine of Nantes. He describes his sensations very minutely, and his only regret was that they did not carry the narcosis to the degree of complete anæsthesia. As Mr. Butcher says in his interesting address, we may expect great developments in the electrical treatment of neurasthenia and brain affections, since Leduc has shown that the brain is within the domain of electrical treatment.

Single-Phase Work.—The development of the repulsion induction motor has given a decided impetus to single-phase work, and has overcome many of the difficulties which have confined the use of single-phase motors to certain classes of work. This type of motor has undergone considerable development within recent years. It now consists of an ordinary alternating-current stator wound with a suitable primary winding, and a rotor with drum-type or ring winding as in an ordinary continuous-current machine, and fitted with a commutator. By placing a pair of short-circuited brushes on the commutator, and displaced from the axis of the primary coil by a suitable angle, which is somewhere between 15deg. and 30deg., we obtain a repulsion motor which will start with a powerful torque. By adding a second pair of brushes and short-circuiting one or other of the two pairs, we have a reversible motor. In a paper on the development of single-phase work which he read before the Birmingham and District Electric Club last week, Mr. V. E. Walters discussed some of the more important applications of single-phase motors, and claimed the single-phase motor was by no means surpassed by any of its rivals. The single-phase motor has not been altogether satisfactory when used in connection

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with lifts and cranes, but Mr. Walters mentioned that for this class of work, repulsion induction motors are now made which, even on a 100-cycle circuit, will start with twice full-load torque, taking not more than twice full load of current, being easily reversible by means of a simple change-over switch. This type of motor, being fitted with an automatic governor, and requiring no controller, would seem to be an ideal one for the purpose, and is only open to the objection that disastrous results would ensue if it were left in the hands of an incompetent operator. However, a device has been patented to minimise the danger from this source, which, in conjunction with the controller, ensures that if the hand-rope be pulled right over the motor will automatically stop and reverse. Another application described by Mr. Walters was in connection with baking machinery, certain forms of which require most exacting work on the part of the motors that drive them. For instance, a Werner machine driven by a 5-b.h.p. motor direct coupled through worm gear has the following cycle of operations: The dough mixer starts up light and runs for five minutes in the forward direction, the load gradually increasing to a maximum as the mixture thickens; it then stops, reverses against full load, and runs in a forward direction for another five minutes, this cycle of operations being repeated several times. The work is efficiently performed by a repulsion induction motor controlled by a change-over chopper switch only. Motors of the repulsion type are made whose action and performance are similar to that of an ordinary direct-current series motor. They are fitted with a resistance in series with the rotor, and operated by a drum controller. As an example of variable-speed motors Mr. Walters mentioned the case of a 50-cycle single-phase motor, normally rated at 5 b.h.p. at 1,000 r.p.m., which was easily regulated to run at any speed from 1,100 r.p.m. to 190 r.p.m.; the outputs varying from 5·5 maximum speed to ·2 at a minimum. Mr. Walters describes many further applications of modern single-phase motors both to power and traction, and shows that the type is gaining popularity.

Labour-Saving Appliances.—The economic advantages of employing modern machinery in and about the Rand mines are clearly demonstrated by the experience of the New Kleinfontein Company with the use of labour-saving appliances at their mines in the Transvaal. At these mines a complete 200-stamp mill reduction plant was recently installed in place of an old 160-stamp installation, the result of which is seen in the reduction of unskilled coloured labourers by 1,267, and an annual decrease in the working cost, including allowance for maintenance costs and depreciation, of £59,220, this being equivalent to a reduction of 2·99s. per ton milled. A description of the plant, together with the working results, were given in a paper before the Institution of Mechanical Engineers by Mr. E. J. Way, the engineer who designed the plant. The plant itself is of sufficient interest to merit attention, but from our point of view it is chiefly noteworthy as showing some of the applications of the electric drive. The conveyor carrying the ore to the crusher station is driven at its head end by a 50-h.p. motor, which, like all the motors driving the various conveying belts on the plant, is of the slow-speed, back-geared, enclosed type. The speed of these motors is between 580 r.p.m and 600 r.p.m., geared to give a speed to the lag shaft of 160 r.p.m. Each motor is fitted with a speed-controlling switch capable of regulating the speed from 25 per cent. below normal (by means of resistance inserted in series with the field-magnet winding). The main trommel, 18ft. long by 5ft. in diameter, is driven through a chain and sprocket wheel drive and spur gearing by the 50-h.p. motor driving the conveyor carrying the ore to the crusher stations. The "coarse" and "intermediates" sorting conveyors, of which there are four, are Robins belts, 36in. wide, each driven at a normal speed of 50ft. per minute by a 7½-h.p. motor geared to its head pulley; the "return intermediates" conveyor—18in. wide by 79ft. 2in. long between pulley centres—is driven at its head end by a 15-h.p. motor at a speed of 300ft. per minute. All belts are motor-driven, and Mr. Way was able to show that the installation of a belt conveyor system for handling wast rock and residue sands in place of the mechanical haulages of the old plant had not only effected a large saving in unskilled coloured labour, but had also resulted in a very considerable reduction in the working costs. Before the war, on the old plant, the cost of removing the waste rock from the crusher station and the residue sands from the sands treatment tanks and of depositing them on the main waste dump was 7·5d. per ton milled, while at the present time the cost, including maintenance and depreciation, is only 1·9d., a saving per ton milled of no less than 5·6d., or, on the tonnage milled at the present time, of £770 per month, an amount which in the course of the next two years will completely pay off the total capital expenditure on the whole of the present surface conveying equipment. In order to reduce still further the number of unskilled coloured labourers employed underground, Mr. Way has under consideration at the present time a scheme which includes the installation of the monorail system of traction in place of the ordinary tramway system at present in use underground. This system, suggested by the success of the monorail in connection with electric telpherage, consists, as the name implies, of a single rail suspended in the drive, crosscut or winze by means of iron hangers firmly secured in holes drilled in the roof. Switches, turntables, crossings, etc, are easily adapted to the single rail. By the adoption of this scheme Mr. Way hopes to bring down the number of unskilled coloured labourers employed in the actual handling of rock underground to what is practically an irreducible minimum. The only means by which the number could be further lowered—namely, an electric or compressed-air railway system or other mechanical haulage system—whilst perfectly feasible in a coal mine or other mining proposition where the work is all carried out on one plane, is, he says practically impossible under the conditions prevailing in the mines of the Witwatersrand, and, in fact, in metalliferous mining generally.

Automatic Boosting.—At a meeting of the Birmingham Local Section last year Mr. Max. J. E. Tilney described a new method of automatic boosting, and claimed that his booster regulator was designed with a view to the use of existing boosters. Some additional information respecting this regulator is disclosed in a patent recently granted to Mr. Tilney. In the method of regulation already described the three exciting coils of the motor actuating the regulator are replaced by two coils arranged to oppose each other. One of these coils carries a current proportional to the voltage of the circuit, while the other carries a current proportional to the output of the generator when the latter is delivering current. When the battery alone is delivering current the second coil carries a current proportional to its output, while the first is connected in series with the booster field. The regulator motor, E, is provided with three field coils, e, e^1, e^2, of which only e and e^1 are operative when the generator, A, is delivering current, while e and e^2 are operative when the battery, B, is alone supplying current. These pairs of coils always oppose each other, and the common coil, e, is

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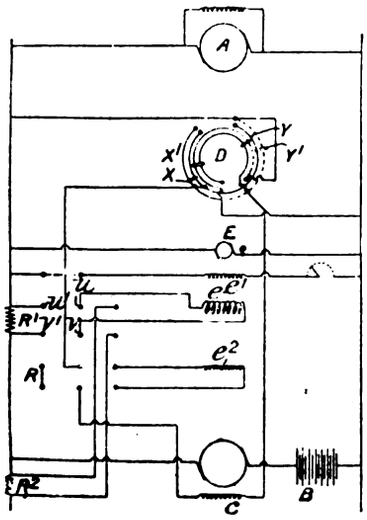
arranged, by means of a change-over switch, to be connected across the resistance R^1 when the generator, A, is operative, and across the resistance R^2 when the battery alone is operative. When the switch is thrown over to the left, the terminals u^1, v^1 contact with the terminals u, v, the booster field coil, c, being at the same time connected to the regulator, D, through the bar, R, and the coil, e^1, connected across the circuit leads. When the switch is thrown over to the right, the terminals u, v contact with the terminals shown in line to the right, the booster coil, c, being connected to the regulator, D, through the field coil e^2. When the brushes of the regulator are in the position indicated by X, Y, the current in the booster field coil, c, is in one direction, and when they are in the position X^1, Y^1, the current in the coil c is reversed. A modification is described for maintaining the output of the generator constant while the battery is discharging,



and to reduce the output when the charging and the charging current has reached the maximum value allowable. In this case the regulator is connected in series with the generator shunt winding, and actuated by a motor governed by two field coils, one carrying a current proportional to the charging or discharging battery current, while the other is connected across the circuit leads. In order to compensate in the regulator for over-correction, due to the time constant in the inductive field circuit of the generators, current and voltage coils may be added to the regulator motor field, one connected across the circuit leads in series with the field winding of the booster and the regulator, and arranged to assist the current winding, while the other is connected across the circuit leads in series with the regulator, and carries a current which varies in the same manner as the preceding coil, but arranged to act in opposition thereto. This compensation arrangement may be applied to an auxiliary machine coupled to a mechanical device for storing energy in place of the electric storage battery.

Proposed Destructor Plant for Stoke Newington.—Very few of the stations in this country which are run in connection with a refuse destructor have found the practice to be satisfactory from an economical point of view, and in the States a large station in New York taking steam from the burning of refuse in a destructor was recently abandoned. One or two municipal undertakings have, however, shown that the practice can give satisfactory results, and apparently the metropolitan borough of Stoke Newington are encouraged by this experience in their proposal to work an electricity generating station in connection with a refuse destructor. We should mention that the borough is at present under a contract to take a supply from the North Metropolitan Electric Power Supply Company, but the contract provides that the Council shall be at liberty to use for its undertaking all the energy that it may generate at its own refuse destructor. According to an official estimate, the destructor is capable of producing steam sufficient to generate electricity to an amount exceeding that which is at present required for the Council's undertaking, but as the times during which such steam is produced do not always coincide with the times of demand of energy by consumers, it will not be practicable to take the whole of the supply from the generating station, and a considerable quantity of energy will have to be taken from the company as before. The Council's consulting engineer, Mr. Stevenson, advises that about two-thirds of the present demand could be usefully met from a generating station in connection with the destructor, and that the proportion of steam generated at the destructor which would be employed in so doing would vary from 50 to 95 per cent., according to the day of the week and the season of the year. The capital cost is estimated at £3,700, as follows: one high-speed engine and dynamo of 80 kw. capacity, and able to carry an overload of 20 per cent. for one hour, steam exhaust and drain piping (with valves, chequer, plating, etc.), one Berryman feed-water heater (with piping and connections), one feed pump (to deal with 500 gallons of feed water per hour), pressure boosting dynamo and motor, switching gear and instruments, rheostat, engine-house cables, instruments at the transformer station, £2,000; mains between destructor engine-house and transformer station in Edwards-lane, including a three-core pilot cable and excavation and laying, £1,230; buildings and foundations, £400; contingencies, £70. Mr. Stevenson's computation shows that the cost of production of energy at this generating station without allowing anything for the cost of steam would be 1·28d. per unit sold. In this computation of cost have been included repayment of and interest on loan, depreciation, wages, and all outgoings at the generating station and additional outgoings at the transformer station rendered necessary by the scheme, but not general establishment charges. The amount payable to the company per unit sold has, during the last year, averaged 2·9d. Upon a moderate computation the saving to the undertaking by the proposed scheme would, after making all proper allowances for repayment of and interest on loan and depreciation, amount to £370 a year at the present time, and this amount would increase as the output of the undertaking increased. The proposal to adopt this practice at Stoke Newington comes as a result of joint consideration between the Electricity and Public Health Committees. Both are sanguine as to the results, and are already making suggestions for the disposal of the savings which are expected. These are to the effect that while the agreement between the Council and the supply company is in operation the saving effected shall belong to the electricity undertaking, and that when it shall have ceased to operate such saving shall be disposed of as directed by the Council. Until then, it is suggested to divide equally between the two undertakings, one half going to the credit of the electricity undertaking, the other being applied towards the cost of the disposal of refuse, the amount of the saving to be ascertained by a computation of the amount which would have been payable to the supply company if the whole output had been obtained from it and a comparison of that amount with the total of the sums actually payable to the supply company for the energy taken from it and the cost of the working of the generating station, including proper allowances for depreciation and loan charges,

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ELECTRIC TRAMWAYS FOR BENARES.

Robrow Shallow-Conduit System Adopted.

The experiment with surface-contact traction which is about to be tried in the East-end of London, has been the means of awakening public interest to the fact that the overhead and conduit systems of electric traction with which they are most familiar are not the only systems of construction in vogue. Engineers are, of course, expected to be more or less acquainted with the principles underlying surface-contact traction, and the wonder is that, while the problem has attracted their attention since the very earliest days of electric traction, so few of them should have attempted to grapple seriously with it. If justification were sought for this general scepticism which has characterised the attitude of tramway engineers towards the question of supplying tramcars with current by means of contacts or studs placed on the surface of the streets, it could only be found in the excuse that the various systems now to the fore have not been tried on a sufficiently large scale to demonstrate their practical and commercial success; that in the case of the systems already in operation in this country no complete data as to capital cost and working expenses are available; that the uncertain results of the electromagnetic equipments yet afford room for engineering improvements. We do not propose to discuss these matters at the present moment, but to place before our readers a description of the "Robrow" shallow-conduit system which is being adopted for the Benares tramways. By the courtesy of Mr. Robert Brown, the inventor of the system (which is based on the system invented by Mr. Wm. Kingsland), we were permitted to inspect a working model of the system just as it will be constructed in India by the Traction Corporation, Limited, and were furnished with much of the information upon which this article is based.

Benares, which stands on the banks of the Ganges, is one of the principal cities in Allahabad, and is the Mecca of millions of devoted pilgrims. Its numerous temples and palaces give it an old-world mysticism, which is even deepened by the wealth of splendour of the powerful potentates who have their residences in its midst. But the historical and religious associations of Benares, great as they are, are not alone of importance, for, besides being being the chief seat of Brahminical learning, Benares is the centre of wealth and commerce, and includes among its manufactures silk, cloth-of-gold, and filigree and brass ware. These industries are carried on in small workshops principally by hand labour. It will thus be seen that there is much opportunity for introducing electric light and power, and we understand that a supply of electricity for these purposes will be available from the central station, from which the tramway supply will be obtained.

The work of tramway construction will commence at the end of this year, and the length of track (measured as single track) will be about 10 miles. The routes will pass through the most densely-populated parts of the city, and connect the two railway stations which are at the extreme ends of the town. The power station will have a capacity of 1,200 kw., direct current being supplied for the tramways at a pressure of 550 volts. Energy will also be supplied for lighting, driving punkahs, and other purposes. At the outset, 24 motorcars and eight trailers will be provided to give a seven minutes' service over all routes. As overhead wires were strongly objected to by the natives, the Order in Council stipulates for the installation of the "Robrow" shallow-conduit system with a surface collection.

The construction of the track follows the normal lines, and although a shallow conduit, some 6in. or 7in. deep, is necessary, the amount of excavation in the roadway for the purposes of installation is no more than is required for the ordinary overhead system. The shallow conduit may

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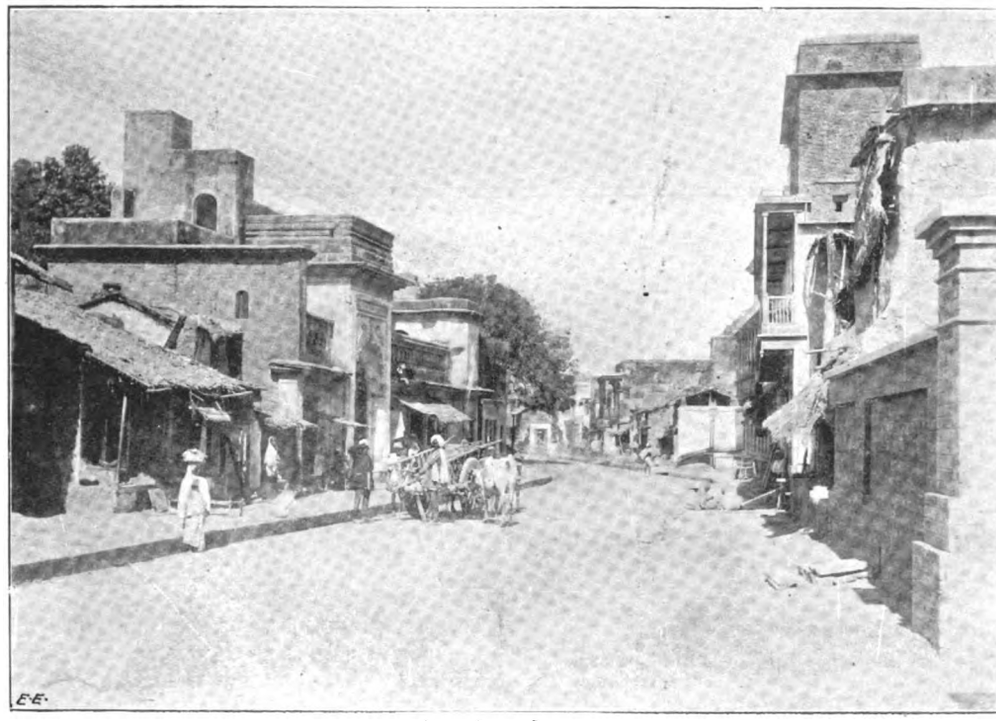
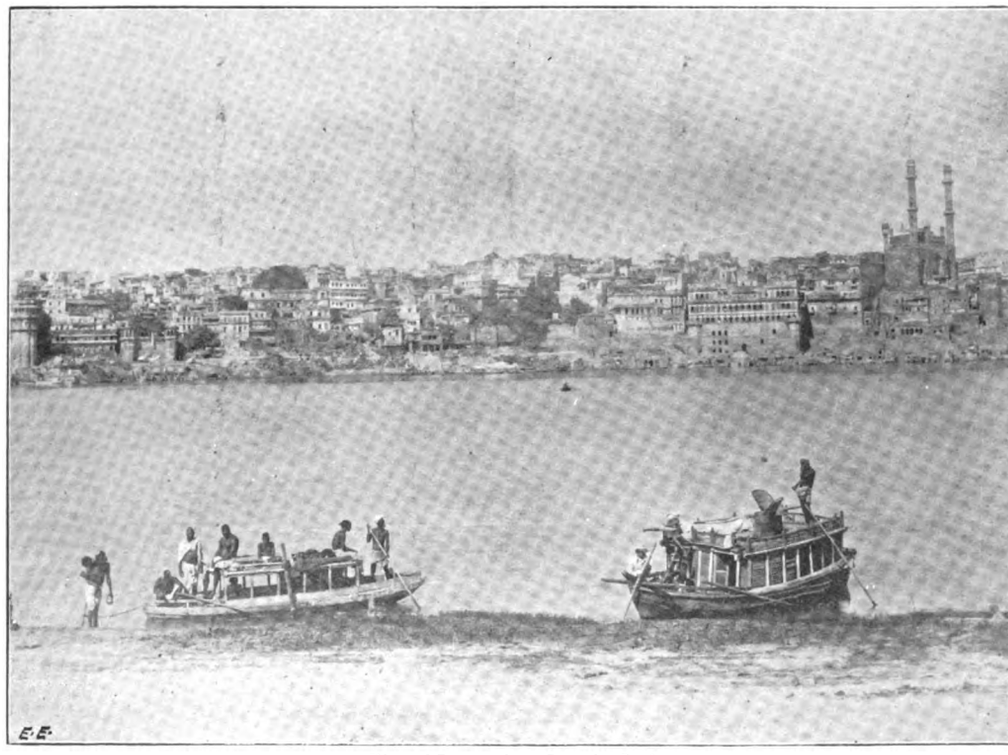
be formed either at the side of the track, in which case the slot leading into the conduit may also form the groove in which the flanges of the wheels run, or two ordinary girder rails may be used and the conduit with groove formed of two additional light rails braced together in the centre of the track. Fig. 1 shows a cross-section of the track with side-slot construction, being a section of the track where the contact studs and switches do not occur, and Fig. 2 shows a cross-section where the studs and switches are fixed. The parts shown in the latter are the stud (1) fixed in its seating (2) of granite, reconstructed stone, or wood block. The stud, it will be noticed, has a cable connection from it to a small terminal box (3) fixed in the side of the street box (4). Within this street box is fixed an operating switch (5) with its operating lever (6) projecting horizontally across the shallow conduit.

With centre-slot construction, the system is equally applicable to any open-conduit system of tramways where the means of propulson is cable or electricity. This application is seen in Fig. 3, which shows the conduit with the operating switch set back out of the line of conduit, with a special extension of the horizontal lever, which not only enables the electric cars to collect their current from the stud on the surface, but also allows the cable cars to continue running all the while it is necessary to use the ropes on that particular route. As the gripper on the cable cars passes the horizontal lever of the switch, it momentarily pushes it aside, and as soon as the gripper has cleared it, the switch returns to its normal or "off" position. Where the cables can be done away with altogether, the switch would be placed partially in the conduit. The working cable in the case of single track is placed along the outside of the track in a shallow trench formed in the concrete, and is tapped into the street boxes at each switch. In the case of double track this single cable would lie midway between the two tracks, and would be led into



Street Scene, Benares.



View of Benares from Opposite Bank.

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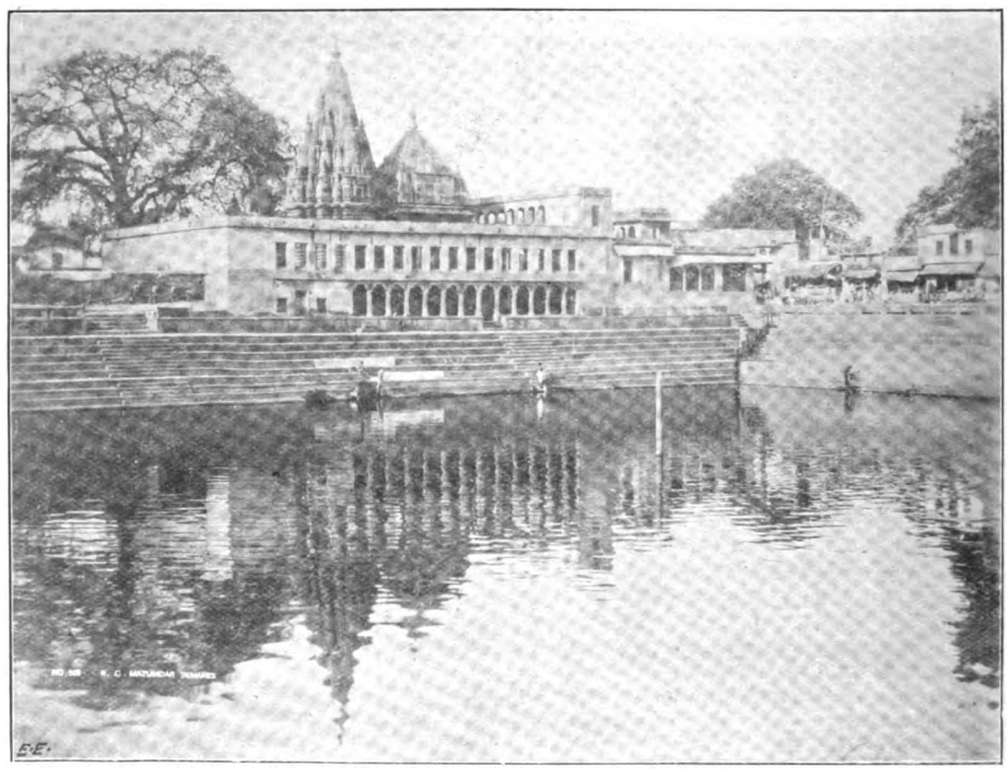
each side. Fig. 4 shows a plan of track with side elevation. The working cable, *a*, is shown situated above the drain pipe.

The drawing of the street box is shown in the track section. A photograph of the actual box with small terminal boxes is now given in Fig. 5. This forms not any box, and start again at the next box. The size of the hatchway on the surface of the road is 10in. by 12in. From this hatchway the operating switch is always accessible without any danger to the employé, and may be replaced with a new one in two or three minutes.

Two terminal boxes are fixed to the street box, one

Street Scene near Kashi.

only a strong receptacle in which the operating switch is fixed, but it also fulfils the function of a draining box to the short length of shallow conduit between the points where these switches are placed. It is also a seating for the running rails to be bolted to. Fixed to the side of the forming the inlet from the working main to which one of the switch terminals is connected, and the other the outlet to the stud forming the connection for the other switch terminal. They are made of cast iron, lined with a specially-prepared vitrified pot insulator, affording very



Durga, or Monkey Temple.

box is one of the two terminal boxes. The depth of the box from the surface of the road to the outside bottom is 17in, and it can be made 3in. or 4in. shallower should the underground necessities demand it. Thus the diversion of gas and other pipes below the surface of the road is altogether unnecessary, as it is possible to tap out the drain at high insulation for the terminal connections. The face of each terminal box, which is inside the street box, is formed of a disc having three equidistant slots, and behind each of these slots there is an inclined plane. The two leads from the switch have special claw connections, and when these latter are inserted through the slots provided for them

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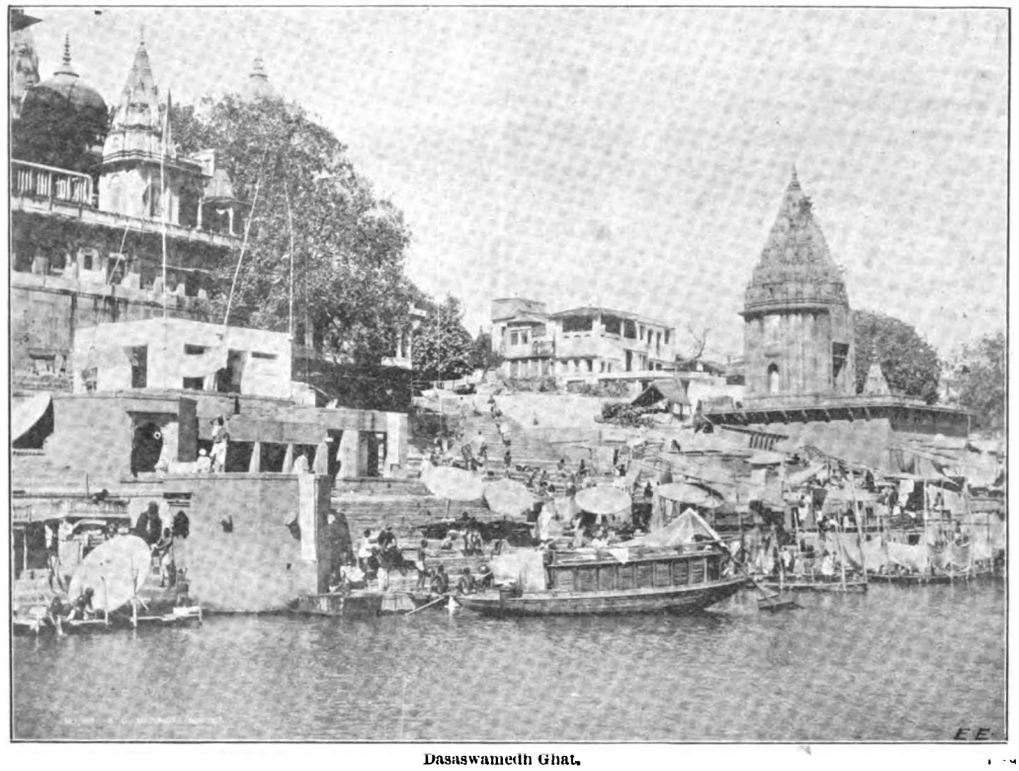
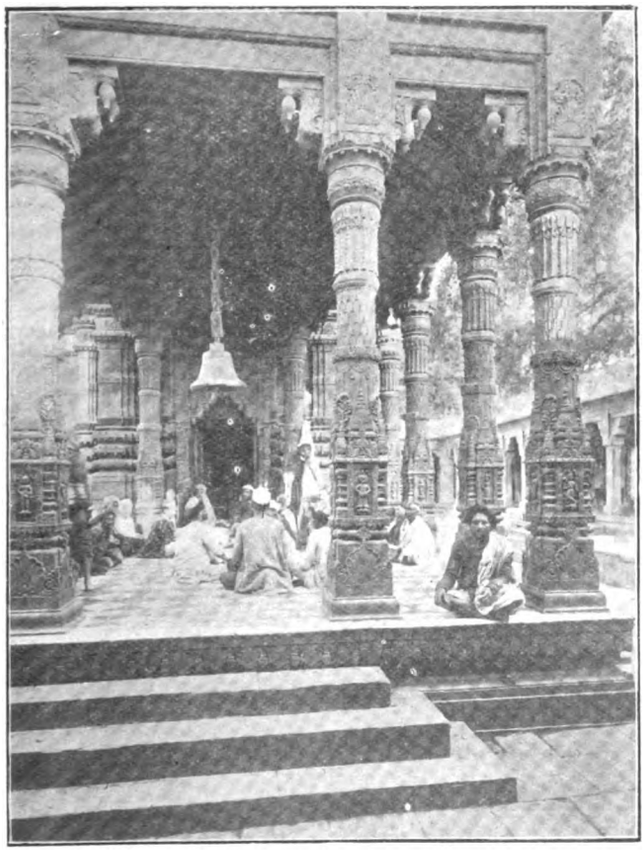
and twisted to the right, the claws at once begin to bear on these inclined planes. By the insertion of an india-rubber washer between the face of the gripper or claw and the face of the disc an absolutely watertight joint is obtained,



Dasaswamedh Ghat.

and the whole can be tightened up with the aid of a hammer. The seating of the stud is formed with reconstructed stone blocks. A reference to the photographs will be sufficient description of the formation this takes. The



Monkey Temple, Benares.

stud itself, as seen in Fig. 7, is a light special steel casting, and after the cable attachment is led up into the stud seating hot bitumen is poured round it, and the stud dropped in its position while the bitumen is warm. As this

is the part which is likely to receive the most wear, the object has been to devise something light and of long life. It is easily and cheaply renewed, and its maintenance charge is almost negligible. It is of oval shape, measures 5in. by 3in., is bevelled in every direction, and the highest part stands $\frac{1}{2}$in. or less above the level of the paving. Its surface can be checkered if desired. The number of studs to the mile of track is governed by the length of the shortest car

Exterior of Bisweswar's Old Temple.

to be used. If an ordinary 6ft. fixed wheel-base truck is used, the distance apart of the studs may be approximately 14ft., and this can be extended up to 24ft. if double-bogie cars only are used. At Benares it is intended to use radial

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trucks with a long wheel base, so that the distance between the studs will be about 15ft.

The vital part of any surface-contact system is the switch, which must be constructed so as to be watertight and to withstand the wear and tear of constant operation, as well as be capable of carrying heavy current without the risk of burning out. In the "Robrow" system the making and breaking of contact is effected by the direct movement of a mechanical switch operated by a bar projecting on the car itself. Fig. 10 shows a vertical section of the switch, and in Fig. 11 is a plan view partly in section. The operation is as follows: A bar, suspended from the tramcar and running in the shallow conduit, throws the lever round through an angle of 90deg. (greater or less), and simultaneously causes the spindle to which it is attached to revolve. At the other end of the spindle, inside the box, a double-armed brush is mounted, which revolves also with the spindle. This brings the brushes into engagement with the terminal jaws on each side of the box, the stud being connected to one of these and the working main to the other, so that, on the operation of the lever, the circuit from the main to the stud is closed by means of the double-armed brush bridging these box terminals, thereby enabling the car to get its current. Up to this point, of course, operation is comparatively easy, but provision has to be made for the immediate return of the lever to its original horizontal position across the conduit as soon as the car has passed, and also for the return of the brushes to their normal position at right angles to the two terminal jaws. This is effected in the upper part of the box, and the mechanism comprises a pair of angular-surfaced sleeves mounted on the spindle with their angular surfaces in contact. The lower sleeve being fixed to the spindle turns with it, while the upper sleeve is prevented from turning by means of a feather working in a channel in the housing, which, however, permits it to slide longitudinally on the spindle. When the fixed sleeve turns with the spindle, its angular surface acting against that of the sliding sleeve tends to cause the latter to turn also, but as it is unable to do so, it is forced to rise, thereby putting still greater compression upon the buffer spring which is bearing on its upper surface under tension. This tension, when the operating bar releases the lever, ensures the return of the parts to their normal positions by reason of the inverse action of the co acting angular surfaces. As in Fig. 12, (*a*) is a complete switch all ready for bolting to its seat in the street box and coupling up to its terminals; (*b*) volute steel spring; (*c*) housing with slot for feather to slide in; (*d*) spindle with its angular-surfaced

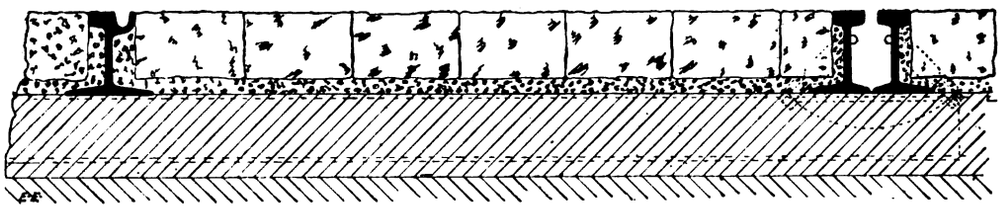

FIG. 1.—Cross Section of Track with "Robrow" Side-Slot Construction.

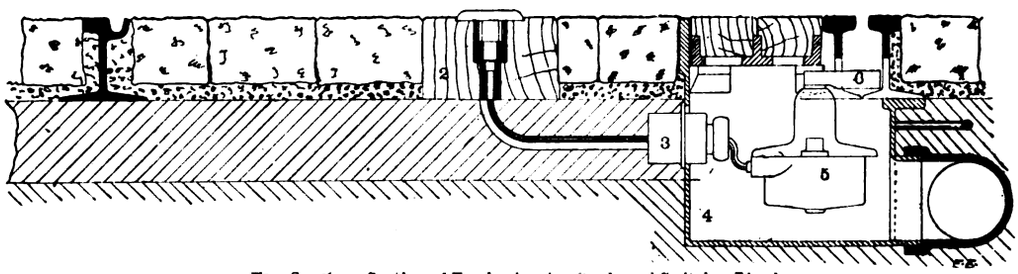

FIG. 2.—Cross Section of Track, showing Studs and Switches Fixed.

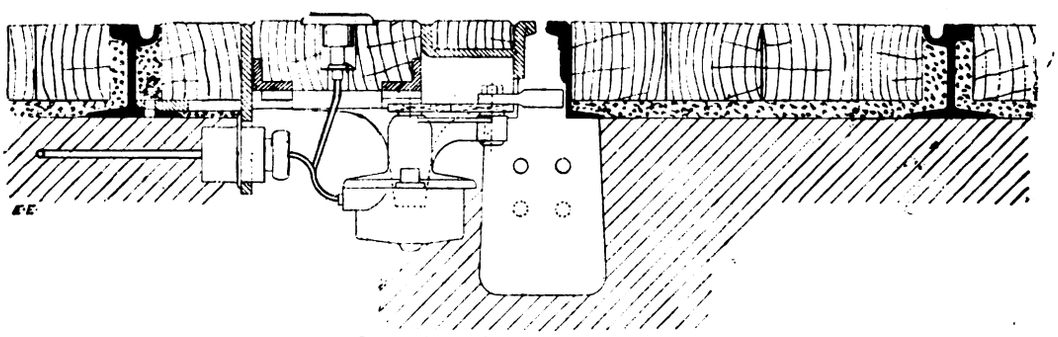

FIG. 3.—"Robrow" System Applied to Cable Conduit.

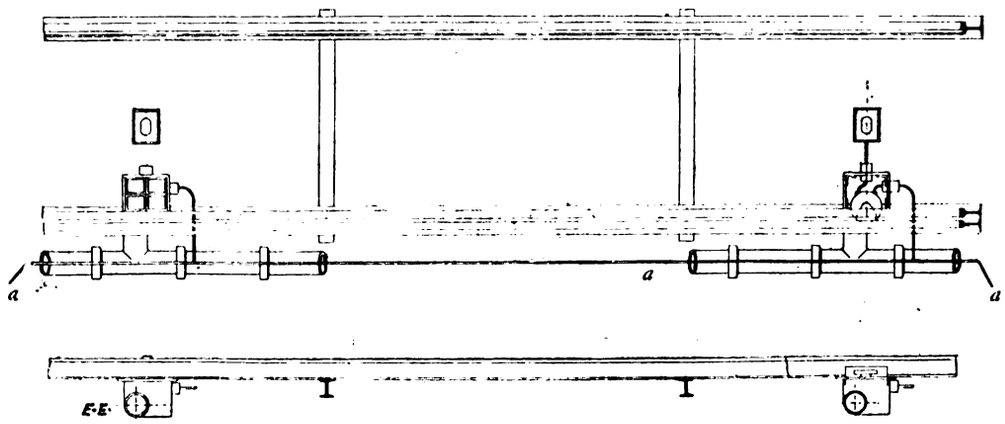

FIG. 4.—Plan of Track, showing Working Cable and Side Elevation.

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sleeves and feather. The inner insulator box, in which the terminal jaws are housed, is made of a highly-vitrified pot (Fig. 13); (*f*) inside of pot with jaws fixed; (*g*) lid; (*h*)

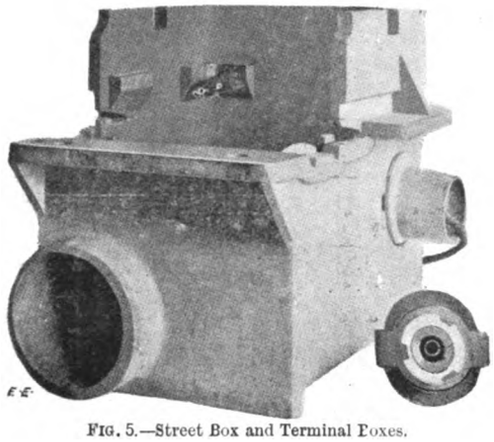

FIG. 5.—Street Box and Terminal Boxes.

outside of pot; (*j*) revolving double-armed brush with a capacity of 120 amperes; (*k*) the pot with the double-armed brush in its normal position when the car is not over the stud; (*e*) shows brushes turned round into the jaws,

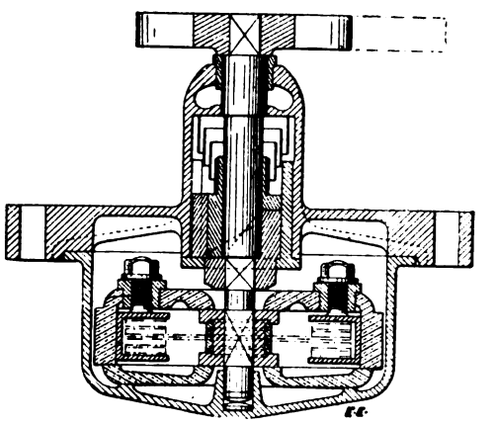

FIG. 10.—Vertical Section of Switch.

which is the position they take up while the car is over the stud. The impact, as between the operating device and

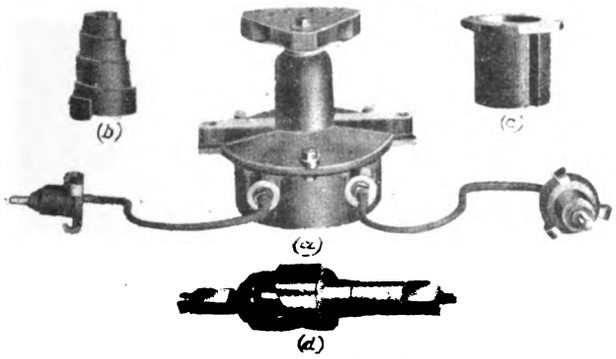

FIG. 12.—Complete Switch and Parts.

the switch, is governed entirely by the speed of the operator, and has no connection whatever with the actual weight of the car which is running.

The special car equipment required for this system consists, in the first place, of a skate or collector formed of a single bar of tee steel, suspended longitudinally to and centrally under the car, either from the axles or from a special bracket attached to the framework. It is hung on slides which enables it to lightly rub on the stud in the centre of the track. While it is impossible for it to get

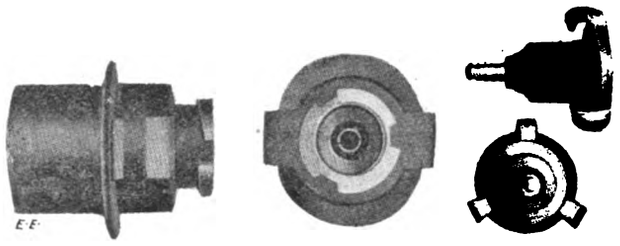

FIG. 6.—Parts of Terminal Box.

lower than a certain fixed adjustable point, the slides permit of it rising according to whatever clearance there may be under the car. The height being so easily adjustable, the skate can be regulated to compensated for the wear on the wheel treads. The only other piece of special equipment on the car is the operating bar, which is hung

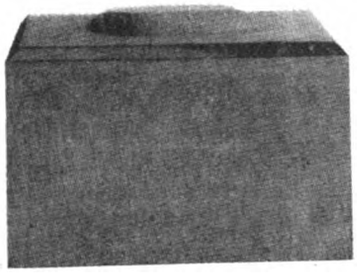

FIG. 9.—Stud in Position.

FIG. 7.—The Stud.

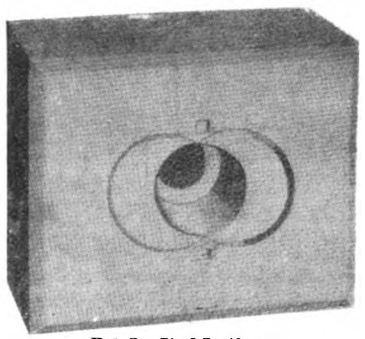

FIG. 8.—Stud Seating.

either from the side frames or from the axle boxes and travels in the shallow conduit for the purpose of operating the switches. This bar is slightly longer than the collecting skate, while the latter is also slightly longer than the distance between the studs on the track. By this means the skate is always on one stud, which is made alive before the skate gets over it, and is not cut out of circuit until after the skate has left it. The action being a positive one, no sparking can ordinarily occur, as the skate is always in current; nor can there be any arcing in the

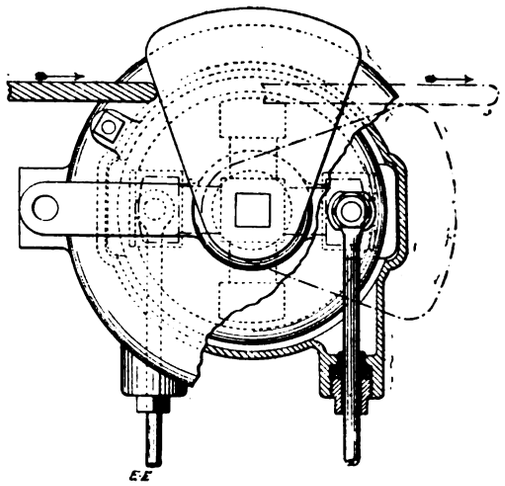

FIG. 11.—Plan View of Switch Partly in Section.

switches, as the "break" is always on the stud. In Figs. 14 and 15 an end and side view of a car is given, showing the operating bar in the conduit and the skate suspension. The weight of the whole of this special car equipment is about 3001b. The special feature of the operating bar is that it is made in two or more lengths jointed together, and is so suspended that it accommodates itself to the curvature in the track. The length of each section of the bar is governed by the sharpest curve which it has to navigate, but this would probably never be less than 30ft. radius. In this event the sections would be 7ft. to 8ft., and each

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length would have no difficulty, while rounding curves, in keeping perfectly straight in the shallow conduit, as there

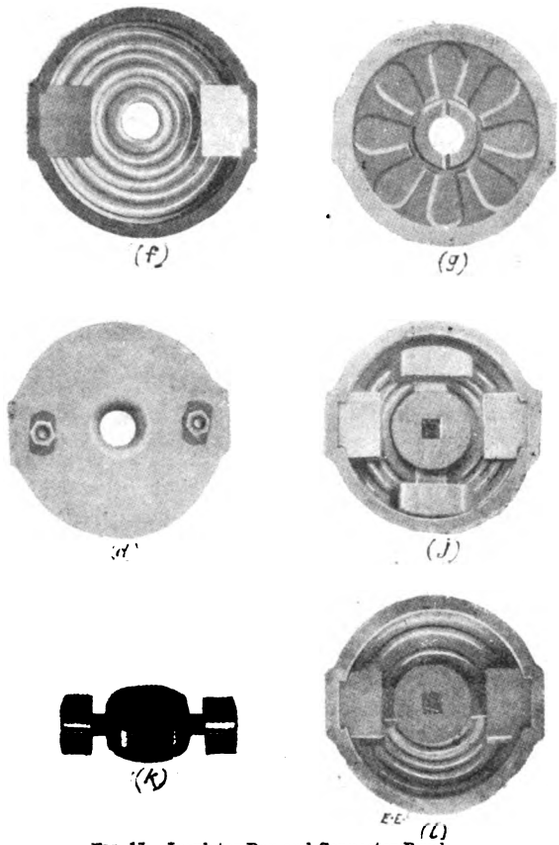

FIG. 13.—Insulator Box and Connecter Brush.

is plenty of room under the rail head for the slight lateral movement that would take place. Where it is necessary to run the cars on to an electric overhead system, or on to an electric conduit system, it can be arranged that this operating bar is either dropped off the car altogether or is raised bodily out of the conduit by means of a small piece of apparatus on the platform under the control of the motorman. The change could be effected in a comparatively few seconds, and if the place for such change over is a normal stopping place for the car it could, of course, be made without any interference whatever with the service. The proprietors of the "Robrow" system guarantee that there shall be no live studs. Nevertheless, in the event of the mechanism of the switch failing to cut out the stud before the car leaves, an earthing device is recommended to be carried by the car, which would blow the fuse in the stud circuit, and so leave that particular stud practically inoperative until the fuse was renewed. The earthing device which has been designed for this system has already been demonstrated practically, and has been found to be quite

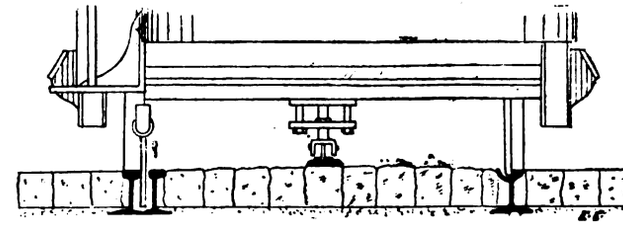

FIG. 14.—End View of Car, showing Operating Bar and Skate Suspension.

efficient. The fuse is placed in circuit with the stud and switch, and the car equipment consists of an insulated extension, B B, from each end of the collecting skate, such extensions being directly connected to earth through the framework and wheels of the truck, as shown in the

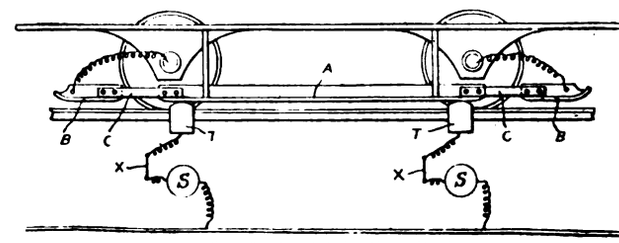

FIG. 16.—Skate with Earthing Device.

diagram (Fig. 16), where X is the fuse in circuit between the switch, S, and stud, T. A is the collector skate, B is the insulated extension of the same section steel, C is the insulating material carrying this extension. If the stud, therefore, should be "alive" by the time the earthed extension makes contact with the stud, the fuse, X, will be blown.

All working parts of the "Robrow" system are easily and cheaply renewable, and at the same time of considerable life. The maintenance charges and running cost should, therefore, be no higher than for the overhead trolley. The cost of installation should be no more 10 per cent. over the cost of a first-class system of overhead, and under

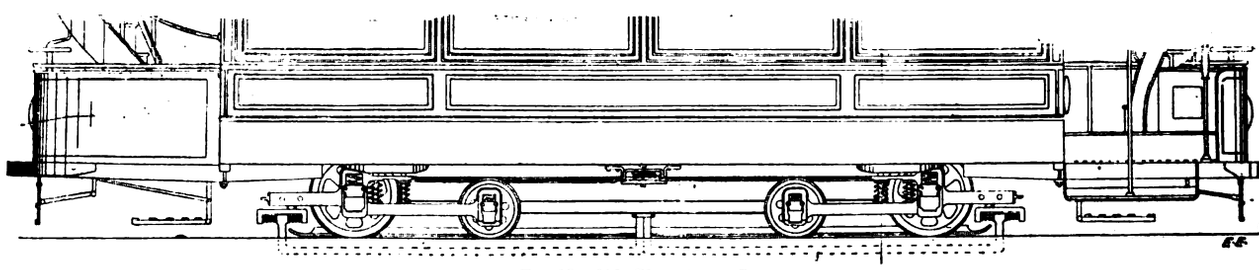

FIG. 15.—Side Elevation of Car.

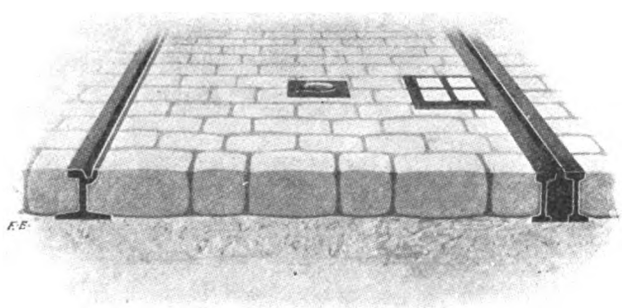

FIG. 17.—Cross Section and View of Complete Track.

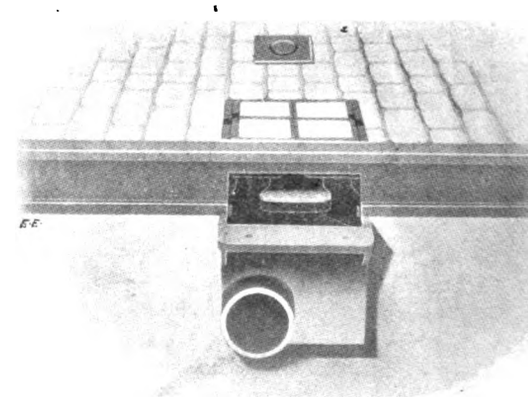

FIG. 18.—Longitudinal Section and View of Track with Running Rail taken away. (Side Slot).

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favourable conditions it may be possible to bring this cost down actually to the same level. The system, as we have already said, is the invention of Mr. Robert Brown, of the Traction Corporation, Limited, 16, Great George street, Westminster, London, S.W. Being convinced of its reliability and economy, the company are prepared to guarantee that there are no live studs; that there is no increase in current consumption as compared with the overhead system; that the maintenance and running charges are no higher than for the overhead trolley. This system, therefore, deserves to be carefully investigated by local authorities and tramway promoters who cannot, or will not, adopt the overhead system.

BIRMINGHAM LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

Inaugural Address of the Chairman,

PROF. G. KAPP.

Gentlemen,—Let me first of all thank you for the honour you have conferred upon me by electing me as your local chairman, an honour which I value all the more as this section of our Institution comprises some of the most important centres of electrical engineering — namely, Birmingham, Stafford, Rugby, Coventry, and Wolverhampton. I think it will be difficult to find in the provinces another district so strongly charged with electrical talent and industry. This circumstance is, of course, highly gratifying to us all as members of the Birmingham Local Section, but to your new chairman this feeling is to some extent marred by the consciousness that he personally is not a representative of the industrial side of the profession. I am neither financially, nor as a manufacturer, nor even as a designer, connected with the trade of the district. My connection with the industry is indirect; my duty is to teach the rising generation to become useful members of the profession. If, then, you have elected a professor to the chair, I take it as a proof that you appreciate the part which science plays in the modern development of industry, and that you take an interest in technical education. It is for this reason that I invite you to look over the laboratories, and that I ask your permission to make a few remarks on the question of technical education. Not in its general aspect. This question has been debated in the Press, the committee room, and on the platform for many years, and yet no agreement had been reached. The reason is obvious. The conditions of the various technical trades are so different that no general formula will suit them all. Even in one particular branch (say engineering manufacture) there is great diversity of opinion. Should the men go through the works before going to college or after? Should they go as workmen, apprentices, or premium pupils? Should a workshop course be part of the college teaching?—and so on. A committee of the German Institution of Engineers, after long deliberation, recommended the practical training at some works to precede the study at a technical high school. The committee of our Institution of Civil Engineers recommend one year's "introductory workshop course" before college, and two or three years' practical work after. This difference of opinion may be due to the fact that the intermediate education in Germany takes longer than here, so that the men would be too old if they deferred their shop training until they have completely finished their studies. The English Committee do not favour workshop courses, where the introductory workshop course has been taken. We in this university think otherwise. I merely mention these few points to show that it would be a hopeless task if I were to attempt to treat the subject from a general point of view. All I can attempt to discuss is what is the best method for this particular district (by which I mean the district of our local section) and this university.

The inspection of the laboratories, which I hope you will make, will show you how far we have up to the present been able to go in a practical way to meet the requirements of the industry for men, and how, on the other hand, the district has rendered us valuable assistance. I do not propose to give a description of our arrangements, since you will find that already in print in the "Electrical Handbook" which was issued by the Institution a year ago. Your inspection will merely be a kind of supplement to this description. The machinery is at work and various tests have been set up, so that you may see in what way the work is done.

I have already said that the district, by which I mean the leading firms of the district, has given us generous help. No finance committee, be it ever so liberal, could afford to buy continually new machinery and apparatus as it is developed and put on the market. Yet it is important that students should become acquainted with the latest type of plant from all leading manufacturers as it comes on the market, for the student of the present time must in the natural order of things become either the designer, the user, or the buyer of plant at some future time. It would be a disqualification for him, and unfair to most manufacturers, if his practical experience were restricted to a few samples of plant (which will then be old) made by a few manufacturers. To meet this difficulty Mr. Chamberlain had suggested that the manufacturers in the district should be asked to lend machines and other apparatus of their latest type from time to time. The suggestion has met with a generous response, and I am glad to take this opportunity for thanking those firms who have lent us plant for their assistance. Some firms have not only lent, but also presented plant, and I am glad to say that among the donors are not only firms in the district but also outside the district and outside of England. Loans are generally for an indefinite time, but on the understanding that if, on account of a sale or for some other reason—for instance, exchange for a more recent type—the firm wishes to have the article back, it is immediately returned. When you go through the electrical department you will see that we have ample facility as regards switchboards, test beds, measuring and regulating appliances to put into work in a proper manner any machine or apparatus of moderate power, so that loans are properly treated, and when returned are in as good a condition as when they reach us. In this manner the firms are working hand in hand with us, and and are materially furthering the cause of technical education. I wish, however, to enlist their help in yet another direction, and this brings me to the main point of my address—namely, a suggestion for their assistance in the training of our men in a still more direct way. My suggestion is not new, but I make it in this place for two reasons. First, because I wish to have the benefit of your criticism on it; and secondly, because I hope that it and your criticism in the discussion may reach the leaders of industry in the district and receive their consideration.

My suggestion, briefly stated, is that firms should allow students to work in the shop during vacation time, no premium being required, nor pay given. The privilege would, of course, be restricted by each firm not only to a certain number, but also to those students who are recommended for it by their professors, or by a committee of their professors. There is nothing new in this suggestion; it is, in fact, well known under the term "sandwich system," and is in use in various institutions both in Scotland and in England. It has also been in use, to a limited extent, in this university, inasmuch as I have been able to persuade a few of my manufacturing friends to take some of my best students on for three months during the summer vacation, but I should like to see the system so far appreciated by the manufacturers that it shall not be a matter on which they require to be persuaded, but a matter into which they enter heartily of their own free will.

The most formidable obstacle in the way of the more general introduction of the "sandwich system" is the "premium pupil system" brought down to us from the good old times when technical instruction could not be acquired in any other way. If carried through in the original spirit, it would even now be a very efficient method of acquiring scientific knowledge and technical skill. The original spirit I define as that which prompts the master to teach his pupil personally. But such a personal intercourse between master and pupil is only possible where the master is personally attending to the details of his business; it is only possible in a very small office or works, and it is

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certainly quite impossible in the big engineering works of our present time. The master (in this case the manager of the works or the head of the particular department where the premium pupil happens to be at the time) has other things to do than teaching science and handicraft; he has to so conduct the works or the department that the shareholders may get a dividend. Thus the instruction of the pupil must be left to the foremen and workmen. This instruction cannot be of a scientific character, but it may nevertheless be very valuable so far as it relates to what may be called the mere handicraft of the business. The only drawback is that the pupil gets very little of it under ordinary circumstances. Neither the foremen nor the workmen have, under modern conditions of hard driving and piecework, time to give instruction to pupils, and what they learn they have to pick up as best they can by exerting their own powers of observation.

Thus it comes that the premium pupil system must on the whole fail to produce really efficient engineers, and it is this failure of an old system which has led to the establishment of technical universities and colleges. Our Continental rivals have recognised this failure sooner than we, and hence they got the start of us in the establishment of technical high schools, but we are now doing our best to catch them up, and in one particular to surpass them. This is in the introduction of workshop courses into the curriculum of scientific instruction.

On this question of workshop courses opinions are divided. I personally do not deny the utility of such courses, and I think it was right that the authorities, after due investigation of what was done in this direction in American colleges, have adopted them, but such courses alone are not sufficient to supply the practical side of technical education. A student may learn in a general way how patterns are made and moulded, how work is lined out and tooled and fitted, but the knowledge thus acquired is only part of what he needs in order to become an efficient member of the staff in a large engineering works. I do not mean to say that for this purpose it is necessary that he should be a perfect patternmaker or moulder or turner or fitter; indeed, it would not be possible for a man to become efficient in all these trades even if he spent his whole life at them. What I mean is, that in addition to the general idea of the handicraft which the student can get by attending the workshop courses at the university, he requires some experience in shop routine—that is, in the way in which engineering work is done commercially. Such experience the university cannot give him: he can only get it in a works producing machinery in the way of business. The student must learn to appreciate the value of organisation, he must observe how work goes through the shop, how experienced workmen tackle the various jobs, what may and what may not be expected from any particular grade of workman, and many other things, some of them peculiar to the work carried on in any particular shop. All this the student can only get to know by working alongside of the men and as one of them

The question then is, How can this opportunity of learning shop routine be best given to the student? Some firms say, let him graduate and then come as a premium pupil on somewhat better terms than are offered to a boy from school. By better terms they mean not a smaller premium per annum, but a reduction in the pupilage period—say two years instead of three. The general objections against the premium pupil system apply also in this case, though in one particular not with quite as much force as in the case of a boy coming straight from school. The university man has already had his science teaching, and the failure of the master to give him such instruction does not count so heavily; the other objection, that the pupil, having paid a heavy premium, considers himself as a sort of privileged person who need not take the work seriously, counts for more, as the man is older than the pupil coming straight from school. But most of all there is the objection on the ground of loss of time and expense. When a man finds that after spending four years in the university he is expected to pay a heavy premium and spend two years more as a pupil at some works, he will consider that he is worse off than the boy from school who goes as a pupil for three or at the most four years. This must act as a deterrent to scientific training, and if there were nothing but the premium pupil system as a completion for the university training, we should very soon see these establishments, which have been started at great cost, denuded of all but the most wealthy and not very energetic scholars, and we should be back to the condition of finding the best posts in our big firms occupied by foreigners, and only the subordinate positions open to Englishmen. Such a state of things is advantageous neither for the rising generation nor for the firms. The moral of all this is that the premium pupil system, in whatever form it may be applied, does not fit our modern conditions of manufacture and is bound to go. Luckily we have something better to put in its place—namely, the sandwich system. By alternating scientific and practical tuition each will be more effective than where they are separated by a long period. If a graduate has to work for two years in the shop after he has completely finished his studies he is in danger of forgetting much of his science. The idea of keeping it up by private reading or evening classes is out of the question, for no man can do mental work after a hard day's toil in the shop. Either one or the other must suffer, probably both. If, on the other hand, the student can devote himself entirely during three or four months in the summer to shop work and need not open a book during all this time, he will certainly do his shop work well, and he will come back to his studies mentally refreshed. Having seen something of practical work, he will be in a better position for profiting by scientic instruction.

If students were permitted to work during the summer vacation for three years in engineering shops they would benefit more than if they worked as premium pupils for two years straight on. Remember that our students take workshop courses, and are, therefore, more or less familiar with what I have called the mere handicraft side of the trade. They will be more useful to the manufacturer than the ordinary apprentice, who has to be taught the very rudiments of the craft.

The suggestion which I put before the leaders of the electrical industry in our district is that they should assist us in our task of educating efficient engineers by giving facilities for work in the vacation; these facilities to be offered to students who have during the session's work shown that they would profit by them and are, in fact, worthy of the privilege. This point might be dealt with by a committee of professors. As a general rule each student would year after year go back to the same firm and thus go through various departments. There might, perhaps be a finishing term of six months after the fourth year, where the man would get a nominal salary, but these are details which would have to be arranged according to the particular circumstances in each case. Here I am only concerned with the general principle. The advantage of the sandwich system to the student is obvious, but I venture to think that it also has advantages for the firm. First and foremost, the advantage which the industry as a whole must derive from the better practical training of the rising generation. Then the advantage to each particular firm. The firm will have an opportunity of watching the men and seeing how they shape. If they are not satisfied with any particular man, they can send him down, but if they are satisfied they will take him during subsequent vacations and gradually become acquainted with what he can do. Thus, if the firm should at any future time require to replenish their staff, they will not have to take a stranger by advertisement, but they will have the pick of the best men out of a group they have themselves helped to train.

Finally, there is the advantage to the university itself. In all such establishments there is a natural tendency of laying more stress on the purely scientific as distinguished from the purely practical side of the work, so that in course of time, if no corrective influence from outside be applied, the latter must suffer. In the sandwich system we have such a corrective influence; the students themselves supply it.

As I have already mentioned, and it is probably well known to most of my audience, the system I suggest as particularly applicable to so important a centre of electrical

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industry as the Midlands is no new thing. It has been introduced in other districts with success. Thus King's College, London, has worked on these lines for some years. In the syllabus of this institution you read: "In order to carry out this arrangement a number of places have been put at the disposal of the college by well-known engineering firms." The Northampton Polytechnic Institute has also adopted the sandwich system, and its principal, Dr. Walmsley, writes me as follows: "I enter each year into correspondence with leading manufacturers for the purpose of inducing them to take our second and third year students into their works. No premium is offered, but on the other hand no wages are asked for; but as a matter of fact very few works care to take the students without putting them on the wages list, even though the amount may be small. The students conform entirely to works' regulations, and it is my particular request in every case that they be not treated as 'gentlemen apprentices.' On the other hand, it is an essential detail of the system that I carefully weed out from the classes at the end of the first and of the second year students who do not show promise of engineering ability or who are undesirable in other respects. In this way I endeavour to insure that the men sent to the works are well worth having, and so far I think I may claim that I have been successful in this respect, as evidenced by the fact that the manufacturers who have once had our students desire to take them again." There are other places in the kingdom where the system is at work. In America it is fairly general, and it has also been introduced in our colonies, notably New Zealand, with beneficial results. I do not wish to weary you by multiplying examples, and the object of my address will have been attained if I have succeeded in drawing your attention to a matter which, if properly taken in hand, will benefit not only our students, but the whole industry of our district.

INSTITUTION OF ELECTRICAL ENGINEERS.

The opening meeting of the session was held on the 14th inst. in the rooms of the Institution of Civil Engineers. Dr. R. T Glazebrook occupied the chair at the outset, and after presenting the prizes and premiums gained during the past session, vacated the chair in favour of Mr. C. P. Sparkes (vice-president). In doing so, he regretted that he could not induct the father of electrical science in this country, Lord Kelvin, as the illness of Lady Kelvin—who, he said, was happily becoming convalescent—prevented his lordship from leaving Scotland at the present time. He read the following letter which he had received from Lord Kelvin:

"I wish I could be with you and our comrades of the Electrical Engineers on the 14th. Will you tell them how very sorry I am not to be present at the opening meeting of the session. The work of electrical engineers throughout the world has grown marvellously from year to year, not only in practical importance, but also in profound scientific interest, From the time, in the middle of the nineteenth century, when their profession had its beginning with the electric telegraph over land and under sea, workers of all grades of electrical engineering have kept closely in touch with purely scientific investigation, which has indeed been largely advanced by their labours. The work of the present session of the Institution will surely be carried out on the lines which have made its meetings so interesting and valuable ever since 1872, when it came into existence as the Society of Telegraph Engineers. Give the members of the Institution my best wishes for all their work, both in the Institution and in carrying out its practical objects, and tell them that I hope to be with them before the end of the present session, and that, in the meantime, I thank them warmly for their great kindness in allowing me to be their president."

Mr. C. P SPARKES expressed his own deep sense of regret at Lord Kelvin's absence, and on his motion the members present unanimously passed a vote of sympathy. Thereupon Prof. S. P. THOMPSON proposed a vote of thanks to Dr. Glazebrook. He said it was the custom for this vote to be proposed by the senior vice-president of the Institution, and to Sir William Preece generally fell that duty. He regretted that Sir William was not with them that evening to discharge his customary function. Prof. Thompson eulogised Dr. Glazebrook's work during his year of office; he had been unfailing in his work on the committees, and had presided at the meetings with dignity and urbanity. Mr. W. M. MORDEY, in seconding the vote of thanks, added his personal concurrence with all that had been said by Prof. Thompson.

In reply to the vote, which was unanimously and enthusiastically carried, Dr. GLAZEBROOK said he would ever value the recollection of the year spent in office, which had given him experience and knowledge If, he said, his work during the past year had been successful, it had been largely due to the help he had received from members of the council and officials of the Institution. He then referred to two events of the past year which, he thought, were of some importance—one, a somewhat novel form of procedure with regard to papers read at the Institution. The council had carefully considered a plan by which it was hoped that each member of the Institution would obtain more value from the work of individual members. A strong Papers Committee had been established consisting of representatives of the local sections as well as of the Council. Every paper which was to be read before the Institution or one of its local sections would come before the Papers Committee before being read, and the committee would select which in their opinion should be read and discussed in London. These papers, and all other papers, would be open to the local sections to choose from for their own programmes, and an endeavour would be made to read the papers in the various local sections as nearly as possible at the time when they were read in London. They would then collect together in the *Journal* the whole of the discussions so as to form round every point of novelty and interest all the talent of the members of the Institution. He appreciated the way in which the local sections had co-operated with the Council.

The other modification of procedure was that all papers read before the Institution should be read in abstract, and that the abstract be handed to the secretary 10 days before reading, so that the president of the section might have an opportunity of going through it and realising all the points of discussion.

The CHAIRMAN (Mr. Sparkes) announced at the close of the meeting that the Council had accepted for publication all the following papers, and had arranged the following programme: Nov. 28, R. Pohl (from Leeds Local Section), "Design of Turbo-Generators"; Dec. 5, J Pigg (from Newcastle Local Section), "Automatic Cab Signalling on Locomotives"; Dec. 19, H. Henderson (from Newcastle Local Section), "Electric Power in Railway Goods Warehouses" (not yet in type); Jan. 9, 1908, J. F. C. Snell, "Cost of Electrical Power for Industrial Purposes"; Jan. 23, R. Goldschmidt, "Standard Performances and Limits of Electrical Machines." Local section papers: Birmingham—V. A. Fynn, "Torque Conditions in Alternating-Current Motors," and T. M. Barlow, "The Heat Conductivity of Iron Stampings" (not yet in type); Leeds—W. H. F. Murdoch, "Magnetic Testing of Iron"; Newcastle—T. W. Wall and S. P. Smith, "Experimental Determination of Losses in Pole Shoes."

THE DIELECTRIC STRENGTH OF INSULATING MATERIALS AND THE GRADING OF CABLES.*

BY ALEXANDER RUSSELL, M.A., MEMBER.

(Continued from page 700.)

12. *Stresses in a Concentric Cable having an Isotropic Dielectric.*—Let the outer radius of the inner conductor be a, and the inner radius of the outer conductor be b. Then the electric stress, R, at a point in the dielectric distant x from the axis is given by

$$R = V/\{x \log_e (b/a)\},$$

where V is the potential difference between the inner and outer conductors. The value of R is independent of the absolute potentials of the two conductors, and it obviously has its maximum $R_{max.}$ when $x = a$. Hence

$$R_{max.} = V/\{a \log_e (b/a)\}.$$

* Paper read before the Institution of Electrical Engineers.

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If V and b remain constant,

$$\frac{d}{d\,a}\,R_{max.} = \frac{V}{\{a\,\log_\epsilon\,(b/a)\}^2}\{1-\log_\epsilon\,(b/a)\}.$$

Hence, if a be less than b/ϵ, where ϵ is the base of Naperian logarithms, $R_{max.}$ will diminish as a increases. In this case we see that the breaking down of the dielectric round the inner core actually diminishes the maximum stress to which the dielectric is subjected. It is only when the radius of the charred dielectric gets greater than b/ϵ that a disruptive discharge ensues. Jona, in his paper to the St. Louis Congress (*vide* § 1), describes an experiment on the disruptive voltages of two single-core cables of very different diameters, but each wound with the same thickness (1·4cm.) of paper insulation. The core of one consisted of a thin wire 0·1cm. in diameter, while the other was a copper cylinder 2·9cm. in diameter. The former broke down at 40 kilovolts, and the latter at from 75-80 kilovolts. The former also got exceedingly hot after being subjected to 30 kilovolts for an hour, whilst the latter was still cold after 50 kilovolts had been applied for the same time. If we calculate the maximum electric stress on the dielectric surrounding the thin wire, on the assumption that no part of it is broken down before the disruptive discharge ensues, we get:

$$R_{max.} = \frac{40}{0{\cdot}05\,\log_\epsilon\,(1{\cdot}45/0{\cdot}05)}$$
$$= 238 \text{ kilovolts per centimetre.}$$

Similarly, the experimental results with the thick cable make $R_{max.}$ lie between 76·5 and 81·6 kilovolts per centimetre. This experiment is quoted by Jona to show that the ordinary formula cannot be applied when b/a is large. If, however, we assume that the disruptive discharge does not occur until the outer radius of the charred dielectric becomes equal to b/ϵ, the experiment on the thin wire gives us:

$$R_{max.} = \frac{40 \times 2{\cdot}718}{1{\cdot}45}$$
$$= 75 \text{ kilovolts per centimetre, nearly,}$$

which, being in substantial agreement with the results given by the test on the thick cable, is a striking confirmation of the theory outlined above.

13 *Suitable Dimensions for a Concentric Main.*—Let us suppose that the maximum working voltage, V, the density of the current in the inner conductor, and the maximum permissible stress to which the dielectric may be subjected are fixed. Let us first suppose that the inner cylindrical conductor is solid and that its radius is a. If, then, V/d be the maximum permissible stress, we have

$$\frac{V}{a\,\log_\epsilon\,(b/a)} = \frac{V}{d},$$

and thus $$b = a\,\epsilon^{d/a}.$$

Hence, also, $$\frac{d\,b}{d\,a} = \epsilon^{d/a}\left(1-\frac{d}{a}\right).$$

If, therefore, a be greater than d, $d\,b/d\,a$ is positive, and, therefore, b increases as a increases, but if a be less than d, b diminishes as a increases. In the latter case it would obviously be advantageous to make the inner conductor hollow, its section remaining constant, so as to increase the value of a and diminish the value of b. The quantity of armouring and insulating material used would be diminished by this procedure. We conclude, therefore, that if a solid inner conductor of the required cross-section would have a radius less than d, the inner conductor should be made hollow and its outer radius should not be less than d. In some cases it would be advantageous to make the inner conductor of aluminium. Although the inner radius of the outer conductor begins to increase when a gets greater than d, the following reasoning shows that the quantity of the dielectric required diminishes until a gets greater than 1·25 d. Using the same notation, the area of the cross-section of the dielectric of the cable is $\pi\,(b^2-a^2)$, and we have to find the value of a that makes $a^2\,(\epsilon^{2\,d/a}-1)$ a minimum. Differentiating with respect to a and equating to zero, we get

$$\epsilon^{2\,d/a} = a/(a-d).$$

Let $a = n\,d$, then $$2/n = \log_\epsilon\,n - \log_\epsilon\,(n-1).$$

By trial we find that $n = 1{\cdot}2544\ldots$ satisfies this equation, and hence, when n has this value the quantity of insulating material required is a minimum. In this case $a = 1{\cdot}254\,d$, $b = 2{\cdot}784\,d$, and $b = 2{\cdot}22\,a$. As the saving of insulating material effected by increasing a from d to $1{\cdot}25\,d$ is only about 3 per cent., it is of little importance compared with the increased cost of the armouring. We conclude, therefore, that high-pressure concentric cables, having isotropic dielectrics, for use at a maximum voltage, V, should be constructed so that $b = a\,\epsilon^{d/a}$, where V/d is the maximum permissible working stress to which the dielectric may be subjected, and a should never be made less than d.

14. *Effect of the Temperature Gradient on the Electric Stress.*—When a concentric main is carrying a current, the temperature of the dielectric is not uniform owing to the heat generated in the inner conductor. If the dielectric is isotropic, the temperature at any point after the flow of heat has become steady can be readily written down, if we assume that the thermal conductivity, k, of the dielectric remains approximately constant over the range of working temperatures. If θ be the temperature of all points at a distance r from the axis of the main, we have, since the heat entering per second an elementary cylinder of the dielectric, coaxial with the main, must equal the heat leaving it—

$$\frac{d}{d\,r}\left(2\,\pi\,r\,k\,\frac{d\,\theta}{d\,r}\right) = 0,$$

neglecting the flow of heat near the ends parallel to the length. Hence

$$\frac{d\,\theta}{d\,r} = -\frac{A}{r},$$

where A is a constant. We have, therefore,

$$\theta = \theta_2 + A\,\log\,(b/r),$$

where θ_2 is the temperature of the outer conductor, the inner radius of which is b. Let us suppose that the inner conductor, supposed of copper, is solid and of radius a, and that i is the current density in it. Then if σ be the resistivity of the copper in ohms, we have

$$-4{\cdot}2 \times 2\,\pi\,a\,k\left(\frac{d\,\theta}{d\,r}\right)_{r=a} = (\pi\,a^2\,i)^2\,\frac{\sigma}{\pi\,a^2},$$

and thus $$A = a^2\,i^2\,\sigma/(8{\cdot}4\,k).$$

Hence $$\theta = \theta_2 + (a^2\,i^2\,\sigma/8{\cdot}4\,k)\,\log_\epsilon\,(b/r),$$

and $$\theta_1 - \theta_2 = (a^2\,i^2\,\sigma/8{\cdot}4\,k)\,\log_\epsilon\,(b/a),$$

where θ_1 is the temperature of the surface of the inner conductor. We have assumed above that the thermal conductivity, k, of the dielectric does not vary appreciably with the temperatures likely to occur in practice. C. H. Lees (*Trans. Roy. Soc.*, p. 433, vol. 204A, 1905) has proved that this assumption is permissible for paraffin wax, glycerine, and various other insulating materials. There appears to be a slight tendency, however. towards lower conductivity as the temperature increases. G. F. C. Searle (*Proc. Camb. Phil. Soc.*, xiv., 2, p. 189, 1907) has devised an exceedingly simple method of determining the thermal conductivity of indiarubber, the value of which he finds to equal 0·0004 nearly. To illustrate the values of $\theta_1 - \theta_2$ likely to occur in practice, let us suppose that $b = 1{\cdot}649$cm., and $a = 1$cm. Let us also suppose that the current density, i, is 150 amperes per square centimetre, that $\sigma = 1{\cdot}8 \times 10^{-6}$, and that $k = 0{\cdot}0006$. The author has no trustworthy data with reference to the conductivities of the dielectrics used in actual cables, and so he takes the value of k for paraffin wax, which has been found accurately by Lees (*l.c. ante*). Substituting in the formula, we get

$$\theta_1 - \theta_2 = \frac{(150)^2\,1{\cdot}8 \times 10^{-6}}{8{\cdot}4 \times 0{\cdot}0006} \times \tfrac{1}{2}$$
$$= 4\text{deg. C. nearly.}$$

It is easy to see from the formula for $\theta_1 - \theta_2$ that, for a given value of b and for a given current density, the difference of temperature between the inner and outer conductors is a maximum when

$$a = b/\sqrt{\epsilon} = b/1{\cdot}649 = 0{\cdot}6065\,b,$$

which is the case we considered. We see, therefore, that the difference of temperature between the inner and outer

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conductors is probably not greater than 10deg. in the most unfavourable circumstances. It is known that the dielectric coefficient and the electric resistivity of an insulating material vary rapidly with the temperature. Jona (*l c. ante*) mentions a case where a rise of temperature of 20deg. C. made the insulation resistance of a paper-insulated cable fall to one-thirtieth of its original value, and even more striking instances could be given. The question of the variation of the dielectric coefficients of dry paper and of solid cellulose has been investigated very thoroughly by Mr. A. Campbell. The following table for oven-dried cellulose is taken from his paper:

Temperature centigrade.	Dielectric coefficient.	Resistivity 10^6 megohm-cm.
20	6·7	—
25	—	1,600
30	6·8	900
40	7·0	330
50	7·2	125
60	7·3	40
65	—	20
70	7·5	—

Let us suppose that a steady pressure, E, is applied across the inner and outer conductors of a concentric main having an isotropic dielectric. The momentary stresses set up initially are the same as if the resistivity were infinite. Now imagine that the dielectric is split up into an infinite number of concentric cylindrical tubes, the material of each tube being at the same temperature. Since these tubes form condensers in series between the conductors, the quantity of electricity per unit length in each condenser will be the same, and thus

$$\lambda \frac{2\pi r}{4\pi d r} d v = \text{constant},$$

where λ is the value of the dielectric coefficient at a distance r from the axis, and v is the potential at the same distance. Hence

$$-\frac{d v}{d r} = \frac{A}{\lambda r},$$

where A is a constant. Now, λ diminishes as the temperature diminishes; it, therefore, diminishes as r increases. We see, therefore, that the effect of λ varying with the temperature is to make the electric stress on the dielectric more uniform. If we assume that λ varies with temperature according to the linear law, we may write

$$\lambda = \lambda_0\{1 + \alpha(\theta - \theta_2)\}$$
$$= \lambda_0\{1 + B \log_\epsilon (b/r)\},$$

where $B = \alpha a^2 i^2 \sigma / 8{\cdot}4\, k$. It readily follows that the electric stress is a minimum where

$$r = b\,\epsilon\,(1 - B/B).$$

In practice, B is very small compared with unity, and hence the electric stress diminishes as we pass from the inner to the outer conductor. Let us now suppose that the direct pressure, E, has been applied sufficiently long to make the electric stresses and the leakage currents assume their steady values. In this case by Ohm's law

$$d v / \left\{\rho \frac{d r}{2\pi r}\right\} = \text{constant},$$

where ρ is the resistivity in ohms of the dielectric. Hence

$$\frac{r}{\rho}\frac{d v}{d r} = -A',$$

or,

$$-\frac{d v}{d r} = \frac{\rho A'}{r},$$

where A′ is a constant. Now ρ increases as the temperature diminishes, and, therefore, as r increases. The variation of ρ, therefore, due to a slight temperature gradient in the dielectric, tends again to make the stress more uniform. But if there be a drop of 10deg. C. between the inner and outer conductors, the electric stresses on the outer layers of the dielectric when the cable is loaded may be much greater than on the inner layers. It will be seen that the effect of the temperature gradient is to turn the isotropic dielectric into a composite dielectric, and hence it may show the phenomenon of residual charge.

(To be continued.)

ELECTRIC FURNACES.

A patent has been granted to the Gröndal Kjellin Company relating to a modification in the design of the well-known Kjellin electric furnace.

In an induction furnace of the type in which an annular fusion chamber surrounds the same part, A, of the core as the primary coil, the primary coil is of tubing, B^1, so that it can be cooled by circulating fluid. It is wound between two annular copper vessels, C, C^1, which have gaps at c (Fig. 1), and are connected to the tubing in such a way

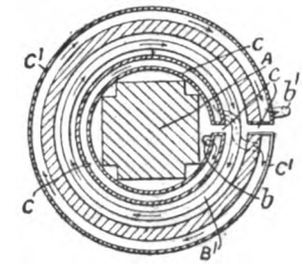

FIG. 1.

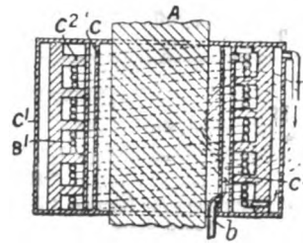

FIG. 2.

that each acts as a turn of the primary coil. The current and cooling fluid enter by a tube, b, pass round the inner vessel, C, through the coil of tubing, B^1, round the outer vessel, C^1, and out by a tube, b^1. The tubing is preferably of copper, and is separated from the adjacent vessels by insulating sheets. A magnetic screen is provided to reduce magnetic leakage near the primary coil. For this purpose the inner wall of the outer vessel may be made with circular or spiral ledges, C^2, and much thicker than the other walls, in order that magnetic leakage may be reduced by the eddy currents set up in this wall.

THE HAMPSTEAD ELECTRIC RAILWAY COLLISON.

The coroner's inquest on the three victims of the electric trains collision, which occurred at the West Hampstead Station of the Metropolitan Railway on Saturday morning, the 26th ult., was concluded on Wednesday. The Board of Trade inquiry, conducted by Major Pringle, has also been concluded. The motormen of both colliding trains gave evidence at the inquest; the most important being that given by the motorman of the Neasden train, which was to the effect that the way was signalled quite clear for him to enter the station, and that he first discerned the standing train when he was 20 yards distant. He then applied the emergency brake to the full. Hollis, the signalman at the West Hampstead box, attributed the collision to the failure of a treadle which should have worked an additional disc instrument, and shown "train on line." He had, he said, on other occasions known the interlocking of the additional disc instrument released when the starting signal lever was in the danger position. Mr. E. G. Phillips, electrical superintendent of the line, said the additional disc instrument could be released only in three ways, and only in the last two with the signal at danger: (1) a train passing over the treadle with the signal off; (2) breakage of the glass of the release box; (3) unlocking of the release box.

The following verdict was returned: "The jury profoundly regret that anything has happened to occasion an inquest at all. They have sorrow for the deceased and sympathy for all concerned, especially with the relatives of those who have lost their lives, and with the railway company in having so long and good a record of freedom from accident broken. The jury further find that the collision whereby the deceased were killed was caused by the culpable negligence of Signalman William John Hollis."

Hollis was then formally committed by the coroner for trial on a charge of manslaughter, being meanwhile liberated on bail.

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Orders for week ending Saturday, Nov. 30.

MONDAY, NOV. 25.—"A" Coy.—Technical drill, 7 p.m.
TUESDAY, NOV. 26.—"B" Coy.—Recruits' infantry drill, 6 p.m.
Technical drill, 7 p.m.
WEDNESDAY, NOV. 27.—"C" Coy.—Technical drill (Hop. Cup), 7 p.m.
THURSDAY, NOV. 28.—"C" Coy.—Recruits' infantry drill, 6.30 p.m.
Technical drill, 7 p.m.
FRIDAY, NOV. 29.—"D" Coy.—Technical drill, 7 p.m.
SATURDAY, NOV. 30.—"B" Coy.—Technical drill (Hop. Cup), 3 p.m.

(Signed) J. H. S. PHILLIPS, Captain,
Acting Adjutant.

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THE

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THE INSTITUTION PAPERS COMMITTEE.

The meetings of the Institution of Electrical Engineers in London are to be vastly improved, for which everyone will be thankful. Up till now there has been a striking similarity between these meetings and the story of the old lady who objected to a certain minister. She had three valid reasons for her disapproval, which were: first, that he read his sermons; secondly, that he read them badly; and thirdly, that they were not worth reading. The education of an electrical engineer does not, as a rule, include a course of elocution, and while as impromptu speakers most of the leading engineers do well, they are not interesting when they read long papers. Again, whatever the value of a communication, the author feels it his duty to go exhaustively into the subject and to give every detail which will help to enlighten his fellow members. Much of this information is bound to be known to a considerable number, and to read it at length is a great waste of time and patience. In fact, at most meetings 80 per cent. of the time is wasted in reading papers which are available beforehand, and which everyone who means to join in the discussion has already read. On the third charge we do not propose to say much, as the Council of the Institution admit that some of the papers read have not been up to the desired standard. Under the new arrangement the Papers Committee of the Institution will have before them every communication presented either to the parent Institution or to any one of the local sections. They will then decide which are to be read in London, and there can be no harm in repeating a good paper before the local sections. At the meeting itself an abstract only will be read, and we believe that the secretary has kindly undertaken to read this abstract, which will be a great gain. In this the precedent of the Institution of Civil Engineers is to be followed. The net result is that time previously wasted in reading the papers will be saved for the discussion which follows, and the Institution meeting will no longer be such a soothing place for an after-dinner nap. One of the benefactors of the Royal Society sent a note with his contribution to the funds to the effect that he subscribed because it was the only place in London where he really enjoyed an afternoon sleep. Now that the dreary wait while the author wades through his paper is abolished, we trust that more lively discussions will be obtained. No doubt the papers will be chosen to that end, but the members interested in a particular subject must make full use of the longer time available. This we trust they will do, not by speaking for a longer time, but by regularly contributing as pointedly as possible their agreements and disagreements with the author's conclusions. The more disagreement there is, the better does a discussion become, and we know that engineers have the right to express their opinions strongly. The value of such discussions, and even of an earlier adjournment into the coffee-room, will greatly enhance the benefit which the Institution already confers on its members.

THE GAS CHALLENGE.

There is one thing for which we have boundless admiration, and that is the belief of gas engineers in the comparative figures of the cost of electricity and gas for lighting. Their belief in the figures which are regularly inserted in the gas papers, and which are now being advertised systematically in the daily Press, is quite on a par with the belief of an old woman in the well-known advertisement of Beecham's pills. She believes that these pills "are worth a guinea a box," but she does not give a guinea for them. We can only conclude that the general belief of the general

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public in the arguments of the gas companies must be tinged with some such reservation, because after being told, on undisputable authority, that gas is twenty-six times cheaper than electricity, the demand for carbon-filament lamps continues to increase. Now that the Osram and other filament lamps have been introduced with a much greater efficiency than the carbon lamp, the gas companies have had to fall back again on figures to support them in their adversity. These figures are, of course, quite conclusive, and show that even with Osram lamps electric lighting is doomed. It is true that the makers of these lamps find it difficult to supply the demand, but the gas companies have an excellent proposition to make which should relieve the manufacturers from this surplus of orders. They propose that two houses exactly alike shall be lighted up, one with gas and the other with metallic filament lamps. This will give more figures, and again more hope to the gas shareholders. As far as we know, the challenge has not been taken up, and we see no reason why it should be. Such trials are being made week by week throughout the country, with the result that gas is being abandoned and Osram lamps installed. Even if the challenge were taken up and figures in favour of the gas lighting obtained, this would have no effect whatever on the spread of electric lighting. Englishmen, in spite of their commercialism, municipal trading, and free trading, do not always buy the cheapest, but insist on having the best, whether it is light or any other article of commerce.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

RE THE RAILWAY CRISIS.

SIR,—Your second article on the above subject has not in the least caused me to modify my opinion that conflict is bound to follow from the present system of railway ownership. There are interests involved which are fundamentally opposed to each other. An example is given of a capitalist, who is also an organiser apparently, to prove the identity of interest between working and idle capitalists, and then the workers are divided into organisers and workers who only obey orders. Neither of these classifications is accurate. The organising capitalist receives a fee for his services which he endeavours to make as large as possible, and in respect to which he may even come into conflict with the other shareholders; so far his interests are identical with those of labour. On the other hand, he receives interest on his shares, and in this respect it is to his advantage to keep everyone else's pay as low as possible. As for organisers being distinct from obeyers of orders I fail to see where such a line can be drawn, for every employé if he has only a boy under him, or a machine to tend, must plan and organise to get paying results. And every worker must obey the orders of the man whose domain includes his own. The identity of interest between all grades of workers and their necessary antagonism to the interests of the non-workers is, I hope, now obvious.—Yours, etc, STAFFORDIAN.

[I do not expect "Staffordian" to agree at present, because neither side has a fixed starting point. Will "Staffordian" define "capital" and "labour"? Will he agree that capital deserves a certain return for its services, also, that labour deserves a certain return for its services? Will "Staffordian" agree that the total combined return for services rendered to any concern by capital and labour is the profit upon the work or service done? Will "Staffordian" state any other point where the interests of capital and labour clash, except the one, and how exactly should the profits realised be divided between them? Does capital require employment? Does labour require employment? Can capital have employment without labour? Can labour have employment without capital? In the latter case, what is the general condition of the labourer? Capital to be used, must have its uses directed and organised by humans. Is the man, or are the men, delegated to organise the working of capital, the equivalent of the capitalist—so far as the labour of the organisation is concerned, or is he a labourer, or has he no position that can be defined? THE WRITER OF "THE RAILWAY CRISIS."]

SIR,—I was interested in the letter of "Staffordian" in last week's issue, and also in your remarks. I do not think "Staffordian" argued the case in the "you're another" spirit and his remarks appeared to me quite logical, nor do I think that your leader touched his case.

In reading your remarks it struck me that you think wages are paid out of capital. But it seems to me that labour is paid out of the value it creates. For instance, if I have £10 worth of castings and I agree to pay a labourer £1 to make these into a useful article, and my machinery depreciates £1 while he is doing it the completed article is worth £12. If I sell it for £13 I pay the man £1 for his wages—and this is evidently not paid out of my capital, for I have still the value of the original capital (£11) in part of the selling price and also £1 profit for myself. If I stock the article it does not alter the case—I hold a machine worth £12—£1 of this value is created by labour and I have merely exchanged £1 for the increased value created by the labourer. If a man takes a week to put a block of stone into position in a dock wall—the capitalist pays him £1, say, but the *value* of the dock wall is £1 more than it was at the beginning of the week—the capitalist still has the capital he had before, no more and no less, and he has paid £1 to labour for the added value labour has created, so it seems that the labourer *is paid out of the value he has himself created*, and not out of capital.

The truth appears to be that labour employs capital, and not the other way, because labour is the first essential, and without labour no capital could have existed. Labour is first exerted on raw material, and part of the selling price of the resulting article goes, under present conditions, to the capitalist as profit, and capital is part of the value created by labour put aside for the further aid to production.

There was a time when capital did not exist, and labour had to produce it. Capital would be worth nothing if labour were not continuously exerted to keep it in being—to use it, otherwise it would depreciate at once to nothing—so that labour is the most important factor in production. You appear, sir, to think that there can be a point of compromise between capital and labour—because both want the work. The labourer is usually landless, and has no money to buy machinery or tools for himself, so that he has only his labour to offer in exchange for the sustenance he needs, and he wishes to extort for his labour as much payment as possible. The capitalist has the means of obtaining, or has obtained the plant, and can consequently get labour to work at his own price and at his own pleasure, unless labour is powerful enough to extort more.

The capitalist wants labour cheap, so that he may make as large a profit as possible. He may then sit down, and in so many years receive in profits as much, or more, than he originally sunk in as capital, and still have his capital value intact. In plain English he may exploit labour for years and years, so that he may live without working—and labour may be living from hand to mouth, or, at least, be getting no bigger proportion of the value it has created than it did at first. Labour, although creating the whole of this value, only receives part of the value created in wages.

The position appears to be this: the capitalist wants to make a profit out of the value labour creates, and labour wants to keep *all* the value it has created. Both want the work, 'tis true; but they both want as much as can be made out of that work. How, then, can there be any lasting compromise or settled working arrangement? Their interests are opposed and always will be while men are only allowed to work when a master can make a profit out of their labour. When I speak of labour, I mean both hand and brain labour.

In order to prove your case that the interests of labour and capital are identical you make new definitions as to which part of a trading concern stands for capital and

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which part for labour. These definings are, I think, quite arbitrary, and do not seem logical. I should be interested to know at what point in the scale of officials of, say, a railway company the change is made from the man acting as a capitalist to the man acting as labour

The manager does not act for the shareholders, who are the capitalists of the concern, any more than the platelayer. They are both working to produce dividends for the shareholders, I take it. The latter expect to make 10 per cent. out of the *whole* of the labour, including that of managers, foreman, and platelayers The manager is employed to make dividends; so is the platelayer. The labour of both is exploited by the shareholders, and their own interest consists in getting the whole result of their labour without paying toll to shareholders who don't work the concern. It seems to me that the whole working staff can be put under the heading "Labour."

With regard to the bond between masters and men being as strong as in older times, I cannot see how you make this out. Most concerns to-day are joint stock companies, and there is no personal element in the question. The capitalist knows hardly anything of the workers who make his dividends. Many shareholders know nothing of the concern or the men who work it, and in big concerns a very small percentage know or see the general manager. The two classes don't know how each other live. But in older times the master was a personality, and came into personal touch with his men, to a much larger extent than could possibly be the case to-day.

Capital is mostly impersonal to-day, and has no personal responsibility to pay a reasonable wage unless the men's trade union can enforce it. It has no responsibility for the labourer it discharges when stock is too high, and will not engage him unless it can make a pecuniary profit out of him. How can there be community of interest under such a system? It is really a warfare, and the labourer must feel it so if he thinks at all. Capital knows it quite well, for it has employers' unions to pit against labour's unions.

This letter has run on too long, I fear, but the subject is interesting, and will bear discussing.—Yours, etc.,

LANCASTRIAN.

[This letter came too late for comment, but it is exceedingly interesting, and I propose to make a few remarks on one point—the "wages' fund"- in the next issue. Unfortunately, in this our friend "Lancastrian" will find the authorities against him.—THE WRITER.]

THE PROTECTION OF BUILDINGS FROM LIGHTNING.

SIR,—I see you are publishing serially my lecture before the Royal Engineers. The illustrations you have had prepared for the purpose from my diagrams show admirably the conditions that I desired to draw especial attention to, and are, doubtless, better than the originals for a printed version, because mine required a fuller explanation than could be given in the published abstract; but as yours represent the air as white, and metals black, in the orthodox manner, the description on page 706 no longer applies and might cause confusion. The method I adopted, though unusual, and suggesting at first sight an inversion of ordinary ideas, is, I think, a good one for a lecture, as it shows the relative resistances (approximately) of the substances through which the breakdown has to occur. When the idea is grasped it enables one, when protecting buildings, to look at the structures from the electrical point of view, and I have therefore adopted it on several occasions when lecturing.—Yours, etc,

ALFRED HANDS.

SINGLE-PHASE VARIABLE-SPEED MOTORS.

SIR,—Replying to the inquiry of your correspondents "G. H. W. and Co.," we venture to request that we should be favoured with a copy of the inquiry, when we will be pleased to quote upon a machine working as nearly as possible to Messrs. "G. H. W.'s" requirements.

As you have pointed out, however, in your note attached to the inquiry, standard torque at variable speed is an impossibility, but we could offer your correspondents something closely approximating to this and possessing very similar characteristics to those of a direct-current series-wound motor in conjunction with an ordinary controller. We have before us when writing a test taken recently on one of our machines, in which the motor was run with full-load torque at a speed varying from 650 r.p.m. to 1,350 r.p.m. with perfect satisfaction, and greater range still would have been possible had the motor been specially designed for the purpose.—Yours, etc.,

RHODES MOTORS, LIMITED.
(G. A. Fielden, Managing Director.)

SIR,—In reference to a letter under the above heading in your issue of the 15th inst., I have much pleasure in being able to inform Messrs. G. H. W. and Co. that Messrs. Brown, Boveri, and Co., Limited, of London, are manufacturers of a special type of single-phase motor which exactly answers their requirements as to speed regulation and torque, but no choking coils, resistances, or auxiliary starting winding are used. The makers will, doubtless, be glad to give full particulars of these machines on application; their address is Caxton House, Westminster, S.W.—Yours, etc.,

G. H. COOKE.

INTERRUPTION OF YORK SUPPLY.

SIR,—As there have been several reports in the local paper during the past week respecting the breakdown of the York electricity supply, and as such reports, which are greatly exaggerated, may have been sent on to you, I am desirous of placing a few facts before you.

At 2.10 a m. on Wednesday morning last a dead short occurred on one of the main feeder cables, which caused the discontinuity of the supply. The faulty section was disconnected as soon as it was possible to obtain the services of the outdoor staff, and within an hour and a half half of the city was again connected up, and other portions connected piece by piece, so that by 6 a.m. the supply was available for nearly all the motors, of which there are some 200 in the city.—Yours, etc.,

J. W. HAME, city electrical engineer.

York, Nov. 19, 1907.

RE QUESTION No. 1,008.

SIR,—I thank M. Moreton for pointing out error in two of my sketches. It was a slip similar, no doubt, to that in his own sketch, in which he makes use of a double-pole field switch and connects it up as a single pole.—Yours, etc.,

S. E. T.

OBITUARY.

James N. Shoolbred.

It is with deep regret that we have to announce the death of a character who was well known in the electrical world, principally through his identification with many important schemes in the early days of electrical enterprise. Mr. James Nelson Shoolbred died on Sept. 8 at Kirkwell, in Orkney, whither he had gone with a friend on a six week's holiday, and with his death, which has somehow escaped earlier notice, an important link with the past is severed.

Though well known to the present generation of electrical engineers through his later works, Mr. Shoolbred was perhaps more famous in the pioneering days of electrical engineering than latterly. Of his early life and education little seems to be known, except that he was born at Bangor, in Wales, in 1835, and that he was a pupil at Oscott College, near Birmingham. Apparently he plunged immediately after his schooling days into the practical work of the profession with which he identified himself, and so equipped himself for the important *rôle* which he was to occupy later. He acted as consulting engineer to many municipalities in the early days of municipal enterprise. The first work of this character which he seems to have had in hand was in connection with the complete electric

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lighting installation for Bradford in the year 1888. Only ten towns were electrically lighted prior to that year, these including Blackpool in 1878 (for street-lighting only), Hastings 1882, and Liverpool 1883-5. There was then nothing till 1887-8, which years witnessed the initial work of Mr Shoolbred. Following Bradford, we find him, two years later, in 1890, acting as consulting engineer to Brighton, and then Birkenhead (1895), Accrington (1897), Birkenhead extensions (1897), Stockport (1898), Doncaster (1899), etc. He acted not only as consulting engineer to these corporations in their general works, but also in connection with the carrying out of the complete electrical installations until taken over. In addition, he seems to have acted for many other towns when seeking provisional orders or parliamentary powers, and no little success in these efforts on the part of the municipality have been due to the advice given by Mr. Shoolbred in the preparation of the proposals.

Despite the busy life which his numerous and arduous professional duties entailed, Mr. Shoolbred yet found time to take a deep interest in the work of many engineering societies, to some of which he contributed valuable papers. To the Society of Telegraph Engineers (as the Institution of Electrical Engineers was then known) Mr. Shoolbred contributed a paper "On the Measurement of Electricity for Commercial Purposes." He was also a member of the committee appointed by the society in 1888 to draw up rules and regulations for the prevention of fire risks from electric lighting. He also contributed papers to the Society of Arts, one of which, presented last year, wherein he outlined a scheme for dealing with the London power problem on lines similar to those on which the London water problem was solved, will, perhaps, be best remembered. He wrote a book on engineering which had a wide circulation.

Mr. Shoolbred was a great expert in tidal work, and was closely connected with the construction of the Mersey estuary. He read a paper on that subject before the British Association. Mr. Shoolbred's papers are in the hands of Mr. J. D. F. Andrews, with whom he was closely associated for several months before his death.

MODERN TENDENCIES IN INDUSTRIES.

Engineers who are searching the power areas of the world in order to discover in what locations industrial enterprise may be most suitably placed, will note with interest two recent tendencies which are now just beginning to make themselves felt, and which will eventually lead to a considerable amount of keen international competition between Great Britain and Scandinavia. The advantages of the latter country as regards water power have been so strongly and so often insisted upon, that a further comment upon the possibilities is superfluous. A new feature of the situation is the determined obstructive attitude which is being taken up by a very powerful opposition in the Norwegian Storthing to what they justly, or unjustly, regard as the exploitation by the foreigner of Norway's mineral and water advantages. It will, of course, be known that before any concession to work the mines and waterfalls of the country can be obtained the express sanction of the King has to be given. These concessions are usually granted on condition that either a lump sum has to be paid down to the State before the commencement of operations, or, alternatively, that the enterprise shall revert to the State free of charge at the end of a period of years. Under the new Act of Sept. 12 it is provided in relation to watercourses that the work of embanking and deepening such channels cannot be undertaken without obtaining the King's consent, even if the use of additional land or soil is not required. This applies to the water power used by any undertaking above 3,000 h.p. This Bill was passed by an opposition strong enough to force it through with the avowed object of crippling foreign enterprise. What the position of the foreign capitalist will be when that opposition gets into power is rather difficult to conceive.

The other tendency which is going to very materially affect the choice of locations for industrial concerns is to be found in the fact that the new Patents Act compels manufacturers to make their goods in this country or lose their patents. The effect which this will have upon imported goods of special manufacture is almost too tremendous to be imagined. Already we are informed that a large firm of electrical engineers whose main works are in Sweden are establishing vast works in the Midlands. For years they have manufactured electrical apparatus, specialising chiefly on telephone instruments, and it has hitherto been their policy to refuse franchises to electrical manufacturers in Great Britain. The new Patents Act has forced their hand, and they have already commenced building operations in the location indicated. The works, when complete, will give employment to nearly 1,000 men. The scope of the Act will not end there. There are rumours that American companies are contemplating establishing British works, and there is no doubt that with the natural advantages for cheap power afforded by the vast coalfields of South Wales and the North-Eastern Counties of England the density of industrial operations will become exceedingly great in this country, especially when it is remembered that, at any rate in the latter area, electric power is so cheap and abundant.

SUB-STATION EQUIPMENT.

At the fortnightly meeting of the Scientific Society of the Glasgow Technical College on Nov. 16, an interesting paper on sub-station equipment was read by Mr. J. Prentice, the superintendent of sub-stations in the Glasgow Corporation electricity department.

At the outset Mr. Prentice gave a *resumé* of the development of the sub-station drawing high-tension current from a distant high-tension generating station, and transforming it to low-tension current for distribution to its own immediate area. The advantages of high-tension as compared with low-tension generation for a large area of supply were: (*a*) the site for the power house could be chosen near a railway station and river, if need be, at some distance from the area of supply without serious loss in transmission, such a position ensuring a cheap and plentiful supply of fuel and condensing water; (*b*) the pressure regulation of all feeding points becomes easy, as the low-tension feeders are comparatively short; (*c*) the total cost per unit delivered is less; (*d*) large efficient turbo-alternators can be used in the power house, very large continuous-current turbine sets not yet being available owing to commutation troubles; (*e*) large power consumers can be supplied without causing fluctuations in the supply to adjoining lighting consumers; (*f*) and there is also the important saving in copper for mains. Going on to describe the sub-stations belonging to the Glasgow electricity department, the lecturer said that four of these sub-stations were on consumers' premises, and were used to supply the consumers' individual requirements. The plant in these sub-stations aggregates 2,000 kw. capacity, and consists of (1) continuous-current motor-generator sets converting from 500 to 220 or 250 volts, or (2) rotary converters with transformers or induction motor-generators converting from 6,500 volts three-phase alternating to 500 or 250 volts continuous

Buildings for sub-stations should be of a plain and substantial design, elaborate frontages being, in the lecturer's opinion, a waste of money that could be better spent in getting more efficient plant. In each sub-station the high-tension switchboard, of terra-cotta brick with concrete partitions, is erected on top of a tunnel carrying the high-tension cables. The brickwork structure consists of a main longitudinal wall 8ft. high by 9in. thick, built parallel to the sides of the sub-station at a distance of 5ft. 6in. out from one of the main walls. The oil switches and series transformers, each in a separate fireproof cubicle, are fixed to the back of this 9in. wall. The high-tension cable trifurcating boxes and feeder isolating links are fixed to the main wall of the building. A concrete platform fitted with glass pavement lights is carried on H beams from the main to the top of the 9in. wall, and is extended inwards so as to overhang about 2ft. On top of the overhung portion of the platform the brickwork is carried to a height of 7ft., and this structure provides the fireproof cubicles for the

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high-tension 'bus bars and potential transformers at the back, and for the feeder and motor isolating switches in front. Horizontal and vertical divisions of brick or concrete are so arranged that each phase of each feeder and of each motor equipment are throughout the board entirely divided off from adjacent phases. The three-core high-tension feeder cable is led up from the cable tunnel to a trifurcating box, where it is jointed to three rubber covered single cables, which are each connected to an isolating link. From the latter cables carried on porcelain supports are taken to three series transformers of the oil-cooled type. A tapping is taken from each cable where it enters the series transformer to supply two oil-cooled potential transformers. From the series transformers the cables run to the oil switches, which are of the hand-operated type, each phase enclosed in a separate tank, the length of break per phase being 16in. The switches are fitted with auxiliary contacts to take up any sparking that may occur when opening circuit under load. From the oil switches connections are taken to front isolating links, and then to the high-tension 'bus bars. On the operating panel of each feeder equipment are mounted an indicating wattmeter and a three-pole reverse-current relay. Each motor panel has an ammeter to each phase, an integrating wattmeter, power-factor indicator, and three-pole overload relay. Further, the motor equipments have no back isolating links. With the above exceptions, the feeder and motor equipments are similar. Under running conditions the 'bus bars are divided into sections, and each feeder supplies its own motor or motors. Should a feeder fail, however, the 'bus bar section switches on the faulty section are closed, thus rendering the motors on this section available for use.

Converting plant in general use comprised motor-generators, rotary converters, and motor converters. The advantages of induction motor-generators are entire control of the direct-current voltage; freedom from variations in the high-tension supply voltage provided the periodicity remains constant; it can be made self-starting for all sizes, and does not require to be synchronised. The advantages of the rotary converter are: high efficiency, say 5 per cent. greater than a motor-generator of the same output; its overload capacity is great; the commutation is exceptionally good; the direct-current voltage does not vary with change of frequency; when the transformers can be placed in a basement the floor space is less than with a motor generator or motor converter of the same output. Compared with an ordinary motor generator the motor converter is more efficient and the power factor improved if the machine is run at or near its designed voltage; for a given periodicity and output the size of both motor and converter is reduced; compared with the simple rotary a larger range of direct-current voltage regulation is obtained. The generator ends of the motor generator sets are multipolar machines of substantial design and with good commutation. A number of the 500-volt generators have fitted a balancing attachment on the choke-coil principle, which allows of an out-of-balance current of 25 per cent. of the machine output to be dealt with, with a drop of 2 per cent. on the heavy-loaded side. In practice this balancing attachment proves satisfactory, and when possible well worth fitting to any machine across the outers of a three-wire supply.

For direct-current switchboards the general arrangement adopted in Glasgow is middle wire panel for generators and feeders in the centre, with the positive generator panels to the left and the negative generator panels to the right of it. The positive feeder panels are arranged to the outside of the positive generator panels, and the negative feeder panels to the outside of the negative generator panels. All panels are of enamelled slate of standard dimensions. Each pole of each generator panel has mounted a reverse current circuit breaker, a shunt ammeter, a shunt wattmeter, and two 'bus-bar selector switches. Each pole of each feeder panel contains two 'bus-bar selector switches, a recording ammeter and voltmeter (giving a combined record of the current on the feeder and the voltage at the feeding point), and a fuse.

The lecturer then went on to describe the cables in use in connection with the sub-stations under his charge, and at the close of the lecture an interesting discussion ensued.

INTERNATIONAL ELECTROTECHNICAL COMMISSION.

The preliminary meeting of the above commission was held in London in June, 1906, at which delegates from some 14 countries were present. The Right Hon. Lord Kelvin, P.C., O.M., was elected the first president, and Colonel R E. Crompton, C.B., honorary secretary. A set of proposed rules relating to the general organisation of the commission was drawn up and adopted subject to ratification by the authorities who had appointed the delegates. These rules have been practically accepted by all countries, and there is, therefore, little doubt of their being finally adopted at the first meeting of the council, which, we understand, is likely to be held next summer. Broadly speaking, the rules are based upon all countries being on an equal footing with equal taxation and equal voting power; they also provide for the manner in which the recommendations are to be arrived at, and place the affairs of the commission and the method of carrying out its objects in the hands of a representative council, consisting of the president of the commission, the presidents of the local committees, who are vice-presidents of the commission *ex officio*, one delegate from each of the local committees, and the honorary secretary. The general objects of the commission are set forth in the following resolution adopted by the Chamber of Government delegates at the Electrical Congress held at St. Louis in September, 1904: "That steps should be taken to secure the co-operation of the technical societies of the world by the appointment of a representative commission to consider the question of the standardisation of the nomenclature and ratings of electrical apparatus and machinery."

We understand that up to the present time local committees have been appointed in Austria, Belgium, Denmark, England, France, Germany, Hungary, Mexico, Sweden, and the United States; and that the question of appointing a local committee is also being considered in Australia, Canada, Japan, New Zealand, Russia, South Africa, and Switzerland. In a movement of this nature progress must necessarily be slow, but the fact that so many countries have already appointed local committees is not only very gratifying, but shows the interest taken in electrical standardisation throughout the world.

From the commencement the Institution of Electrical Engineers (Great Britain) has taken a very prominent part in the matter, and not only have they defrayed the preliminary expenses, but have most generously granted a substantial loan to the commission in order that no financial difficulties should hamper the work of organisation during the first year, which action has been much appreciated by all concerned. The success with which the movement is meeting on all sides will not, however, necessitate any great inroads being made into the funds placed at the disposal of the honorary secretary by the Council of the Institution.

At the end of last year the British local committee appointed a sub committee on nomenclature, under the chairmanship of Mr. A. P. Trotter, the electrical adviser to the Board of Trade. This sub-committee is now engaged in drawing up a list of terms with their explanations in general use in the electrical industry, and the council of the commission, we understand, will most probably publish a glossary of electrotechnical terms in French and English, the languages in which it has been decided all reports of the commission are to be published. Under nomenclature is to be included the question of symbols, which will be taken up at a future date. When the local committees in the different countries have settled down to work, the British local committee, we understand, will appoint a sub-committee on electrical machinery and apparatus to consider in particular what matters can be brought to the notice of the commission, with a view to possible international agreement. The British local committee is working in conjunction with the local committee of those countries taking part in the labours of the commission, and the secretaries of the local committees are kept *au courant* through the medium of the central office now established in London at 28, Victoria-street, West-

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minster, the secretarial work being in charge of Mr. C. le Maistre, A.M.I.C.E., the acting secretary to the commission, to whom all inquiries should be addressed.

EXPERIMENTAL LIGHTING IN THE CITY OF LONDON.

The introduction of "flaming" arcs, especially yellow flaming arcs, and the carbons necessary to produce them, has added to the possibility of lighting large spaces cheaply and at a cost which cannot be approached by gas. Some proofs of this are to be had in the experimental lighting in the city of London at Cannon-street, where the "Gilbert" magazine lamps are used.

The Gilbert patent lamp used in Cannon-street may be properly termed a multicarbon lamp, and is put forward by the Gilbert Arc Lamp Company, Limited, of Chingford. as a practical solution of a magazine lamp, without the unavoidable complication of a magazine lamp proper. The latter naturally suggests separate loose carbons feeding automatically one after the other into burning position and this, independently of the moving and loose carbons, involves certain further requirements in the working of an arc lamp than are customary in this already sufficiently complicated apparatus. The Gilbert lamp gets over all the above-mentioned details at one stroke by simply using a number of small diameter carbons in one, or rather each, holder or slider, the works of the lamp remaining as simple, and in fact the same, as the works of an ordinary open-type arc lamp. Instead of mechanism to change carbons, the carbons remain in place, and the change is merely electrical,

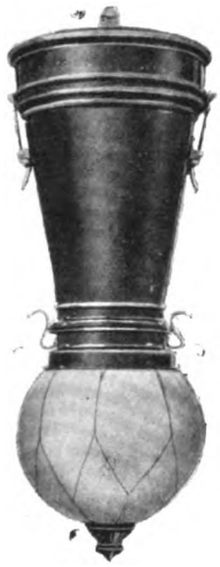

FIG. 1.—"Gilbert" Magazine Lamp.

FIG. 2.—Mechanism for "Gilbert" Magazine Lamp

the arc changing from one pair of carbons to another, and so on, every 15 minutes or so, a much simpler alternative. The first question is naturally whether the change is necessarily objectionable, and an observation of the lamps in Cannon-street will convince observers that this is not so; as a matter of fact, in a reasonably long circuit the fluctuation therein is confined to a momentary variation of about one-eighth of an ampere, and the actual change only means a diminution of light for a second or two. Of course, the works of the lamp are so arranged as to effect this change as quickly as possible, and also so that the exact electrical conditions are under all circumstances immediately recovered and permanently maintained.

The lamps at Cannon-street are 10-ampere, and burn satisfactorily 10 on 400 volts or 12 on 460 volts, and are, therefore, 400-watt lamps, including steadying resistance. The hours of burning vary from 42 to 45, with slightly different compositions of carbons, and to avoid waste of carbons the lamps can be trimmed to burn to within a few hours of the time required of them. The lamps are usually constructed to take six pairs of 16in. carbons. The cost of the cheap carbons works out to about one-third the cost of the flame carbons generally used.

We append an external view of the lamp and of the mechanism. The makers have arranged this type of lamp to burn with as low a consumption of energy as 210 watts.

APPOINTMENTS VACANT.

City Electrical Engineer. Sydney, N.S.W. Commencing salary, £900 per annum. Applications to Mr. Thomas H. Nesbitt, town clerk, by Jan. 16, 1908. See advertisement.

LEGAL INTELLIGENCE.

WOODWARD v. UNDERGROUND ELECTRIC RAILWAYS CO.

James Woodward, a greaser and cleaner, sued the Underground Railways Co. in the City of London Court on Tuesday for £200 damages under the Employers' Liability Act for personal injuries suffered while working for them at the Euston Station of the Charing Cross and Hampstead Electric Railway in May last.

Plaintiff's statement was that he was employed to clean and oil the gates of one of the lifts at Euston Station just before it was opened to the public. He had been working at the same lift for 12 days, and had to get to the top of the lift when it went up with a view to him getting at the airgates. The lift, however, went beyond the switches, and struck plaintiff on the leg breaking it There were limit switches beyond which the car should not go, but owing, as alleged, to it being defective, the vehicle went up too high, and plaintiff was caught between the lift and one of the girders. When defendants' men tried to release plaintiff they found the machine would not work, because the switch was disconnected. After a time the plaintiff was removed, and he had been unable to work since. Plaintiff said he told defendants' foreman that the work was dangerous.

Defendants denied that, and called evidence to show that the lift was not defective in any sense. The representative of the Otis Elevator Co. said they had supplied 140 similar cars to the defendants, 48 for the Central London Railway, and six for the South London Railway. Plaintiff stood in the wrong place.

The jury found for the plaintiff, damages £50.

Defendants gave notice of appeal.

NATIONAL TELEPHONE CO. v. COLE.

At St. Marylebone, on Tuesday, the National Telephone Co. sued Messrs. Cole and Co., of Bayswater, for the balance of an account due. The defence was based on a criticism of the system by which the account was made up, and in order to rebut this plaintiffs called evidence to show that in the early part of the year the company changed their system of registering the calls and the operator, and instead of jotting down the number on a pad as had been the custom, pressed a button which registered the call on the subscriber's meter. This meter was read to the clerk at the head office by an operator at the end of every month, and from the figures sent over the telephone in this way and entered in the books the accounts were made up and sent out.

A clerk from the Telephone Co.'s office proved that by the books there was an amount due from defendants for message fees on April 1 of 17s. 4d., and from April 1 to the end of August the sum due was £2. 18s. 3d. Of these sums £3. 5s. 2d. had been paid, which left the balance of 10s. 5d. owing.

His Honour Sir Wm. Selfe found for the plaintiffs. A record had been taken on one side and not on the other, he said, and he saw no reason to upset the *prima facie* evidence given by the plaintiffs.

BROCKIE-PELL ARC LAMP.

In the High Court on Tuesday, before Mr. Justice Parker, Mr. Clayton asked on behalf of Messrs. Gent and Co. for a compulsory winding-up order, or, in the alternative, that the voluntary winding up of the company might be continued under the supervision of the Court. The company had gone into voluntary liquidation, and it was alleged that shortly before that event debentures for £6.000 were issued to two of its directors to secure a liability they had incurred on behalf of the company by giving a guarantee to its bankers. These directors had been appointed receivers and voluntary liquidators. It had now been arranged that with the consent of the company and these two directors a supervision order should be taken, and that another liquidator, Mr. H. McLellan, representing unsecured creditors, should be appointed additional liquidator, and that the two directors should release these particular debentures without prejudice to their claim to rank as unsecured creditors. Costs of the petition to come out of the assets.

A supervision order was made accordingly.

TRAMWAY ACCIDENT CLAIMS.

Two claims for £100 each were made in the Manchester County Court recently against the Manchester Corporation jointly with Messrs. Thomas Potts and Sons, cab proprietors. The plaintiffs were John William Moores and Thomas Lloyd, and the actions were brought separately in respect of injuries sustained through the alleged negligent driving of the servants of the defendants.

In the case of Moores, his counsel explained that shortly before midnight on April 19 the two men, having finished their work as cab-drivers, were waiting for a car at the "request" stopping-place in Oxford-road, in order to return to their homes. The last car from Rusholme to town approached at such a speed that it over-ran the stopping point by 150 yards before pulling up and allowing one of the men to board it. The car then resumed a speed of about 20 to 25 miles an hour until it reached Ackers-street, where the accident happened, and a number of passengers were injured.

Judge PARRY said that, after listening to the evidence, he had come to the conclusion that both defendants were responsible for the accident. It was well enough known by now that the electric tramcars, legally or illegally, travelled at an exceptional speed late at night. The driver of the cab admitted he was aware of that, and as he was only driving at a speed of four miles an hour, according to his own statement, he ought to have been able to avoid running into the car. In assessing the damages, however, he felt himself bound to

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call attention to the way in which damages were made out when the Corporation were defendants. He had noticed on a number of occasions that not only were large sums claimed, but that when they were looked into there was very meagre evidence indeed in support of them. Now, it must be understood that he should require as strict evidence when the Corporation were defendants as when individuals were sued. Plaintiffs in future must bring absolutely conclusive proofs of all they claimed if they were to succeed. Moores had lamentably failed in this case to prove his claim to £10 in connection with his wife's brokery business. Such a business could not be carried on properly without books, yet no books had been brought or anything else to show that the business was so substantial as to allow a wife to pay her husband £50 a year for some little service he did in connection with it before he went to his cabdriving in the morning. He must, therefore, deal with the claim as one made by a cab-driver alone. If he were wrong, the plaintiff had only himself to blame. Allowing a substantial sum for pain and suffering, he would award him £45 and costs, with certificate for doctor's attendance, against both defendants.

The case of Lloyd was then taken. Interrogated as to the special items in his claim, he explained that one sum of £10 was money lost by him in connection with the purchase of a cab, horse, and harness, which he had been paying for on the hire-purchase system.

His Honour observed that what he had said in the previous case about damages applied to this also. He would allow Lloyd judgment for £35 and costs, with certificate for doctor's attendance, against both defendants.

Two actions to recover damages for injuries arising out of the alleged negligent driving of an electric tramcar were brought against the Salford Corporation in the County Court on Tuesday. The plaintiffs were Samuel Winterbottom and William Norbury. The claim for £50 for personal injuries sustained by Winterbottom was taken first, and was of the usual nature.

After hearing evidence, Judge Shiress Will, K.C., said there was a remarkable conflict of evidence, but he was forced to the conclusion that the evidence called by the plaintiff was based on inaccuracy and exaggeration. If the electric car had been running at a speed of 14 miles an hour, as the cab-driver said, that driver was doubly negligent—if that were possible—in crossing the road in front of it. Knowing the speed at which the cars ran, he must have known he was taking a considerable risk in crossing so suddenly in front of one. He found that the accident was due to the negligence of the cabman, and there must, therefore, be judgment for the Corporation.

Counsel who appeared for Norbury said he could not proceed with the claim in face of that decision, and would, therefore, consent to judgment against his client also.

At the Dewsbury County Court, before Judge Gent, a domestic servant claimed from the Yorkshire (Woollen District) Electric Tramways £20 damages alleged to have beeu sustained by her owing to the negligence of the company in improperly starting a tramcar from which she was in the act of alighting.

For the defence the conductor said the car stopped at Bath-road, but no one attempted to alight, and he gave the signal to the driver to resume running. The driver did so, whereupon the plaintiff came on the platform, and was about to alight, when he told her that she was too late. This evidence was corroborated, and his Honour gave judgment for the company.

COMPANIES' MEETINGS AND REPORTS.

BRITISH COLUMBIA ELECTRIC RAILWAY.

The ordinary general meeting of the British Columbia Electric Railway Co. was held in London last week, Mr. R. M. Horne-Payne, chairman of the Company, presiding.

In moving the adoption of the report, the Chairman said he thought the shareholders had reason to congratulate themselves, particularly on two points that the directors were able to recommend an increase in dividend, which placed the deferred ordinary stock on an 8 per cent. and the preferred ordinary on a 6 per cent. basis, and that at a moment of unparalleled financial stringency, when money is being sought for on almost any terms, however extravagant, by the foresight of the directors the Company was able to show cash and other liquid assets to the extent of over £180,000. With regard to British Columbia generally, he said that from time to time during the past few years outcries had been heard against the Montreal Electric for paying 10 per cent. on their shares at the expense of the public, and similarly against the Ottawa, Toronto, Winnipeg, and all other successful companies, and he now anticipated that the same cry would be raised against their Company. But the people who raised this outcry always failed to mention that it is on a very small portion of the capital that the higher dividend is paid. In the case of their own it was on less than four-fifteenths of the total money raised and expended in the enterprise, the bulk of the money still returning a fraction more than 4½ per cent. He had analysed the results of the Company year by year, and had found that from 1898 to 1902 inclusive they had returned less than 4½ per cent. per annum on the money actually put into the enterprise. In 1903 their investment yielded 4·8 per cent., in 1904 5·1 per cent., in 1905 5·2 per cent., in 1906 5·1 per cent., and this year, including 8 per cent. dividend, the return on the actual cash invested was 5·564 per cent. Touching upon general topics, the chairman said that the prospects of Canada in general, and in British Columbia in particular, have never been brighter. Because Canada has not gone ahead quite so rapidly as during the previous year many people had become disheartened, and were inclined to show a lack of confidence in the country. The fact was beyond all doubt that to-day Canada was one of the most prosperous—possibly the most prosperous—country in the world, and if the march of prosperity stopped for a few months it had been but for Canada's greater good—it had prevented a speculative boom which might have been disastrous, and it had stopped but to gain force for still greater forward strides. In British Columbia the tide of progress had not hesitated; on the contrary, it seemed to be but just beginning. In 1901 the Company were serving altogether a white population of about 75,000. To-day they were probably serving some 150,000, and, personally, he had not the least doubt in 10 years time they would have a white population of between 300,000 and 400,000 to provide for.

Mr. G. P. Morton seconded the resolution, which was carried.

Mr. Norton proposed: "That the payments of the dividends at the rate of 5 per cent. per annum on the cumulative perpetual preference stock and preferred ordinary stock, and the payment of the interim dividend at the rate of 7 per cent. per annum on the deferred ordinary stock paid in April, 1907, be and are hereby approved, and that the following dividends be and are hereby declared—namely: (1) on the preferred ordinary stock at the rate of 1 per cent. per annum for the six months ended June 30, 1907, payable with the next half-yearly dividend on Nov. 30; (2) on the deferred ordinary stock at the rate of 8 per cent. per annum for the six months ending June 30, 1907, making total dividends for the year of 5½ per cent. upon the preferred ordinary stock and 7½ per cent. upon the deferred ordinary stock."

Mr. T. Blundell Brown seconded the resolution, which was carried unanimously.

LONDON ELECTROBUS.

The first annual meeting of this Company was held in London last week, Mr. P. E. Beachcroft presiding.

In moving the adoption of the report, the Chairman explained that the delay in bringing out the balance-sheet, which covered a period of 15 months, and in convening the meeting, was mainly due to the criticisms which had been freely made regarding the Company at its inception. These, he said, had been fully met at the statutory meeting of the Company. Originally over 126 000 shares were applied for by the public, but practically the whole of that capital was returned by the directors, not because they admitted that there was any real flaw in the prospectus, but because they refused to have as their constituents shareholders who were so eager to get out of the Company. The actual shares issued at the present moment were about 46,000, and those had been mainly subscribed for by friends of the directors who believed in the potentiality of the electrobus. As a result of criticism, the directors had been enabled to modify the terms of the prospectus. The patent question was eliminated altogether, and the Company had no liability now in respect to any consideration to be paid for that patent. Twenty thousand pounds was entirely eliminated from the capital as not being payable by the Company, no shares had been issued except for cash, and the 5,000 deferred shares were retained for future service. The directors had expended a considerable amount of capital in proving that the 'bus could do what it professed to be able to do. They had fitted a proper garage with a complete electric installation, and that they had now got with the assistance of the Electric Construction Co. They had also got a generator for the transforming of the current. They had spent a considerable sum of money in regard to alterations and the erection of suitable premises, and particularly in providing accumulator galleries. It was on the question of the accumulator that the burden of criticism was principally directed. The Company was now working with batteries each consisting of 44 two-volt cells of 500 hours capacity, and the mileage which those batteries could run, allowing for over 30 per cent. reserve, was equal to 36 miles. That was a most important and material point. The accumulators which they were now running were those of the Tudor and Gould Companies, and he said that these companies were entirely satisfied with the contracts which they had entered into with the Electrobus Co. A good deal of criticism was directed to the life of an accumulator, and he freely owned that that was a matter which had given the directors some concern, because, after all, they were the pioneers in this country of the adoption of accumulators for heavy vehicles. The results which they had obtained from their experiments had gone to prove, however, that the accumulator, if properly handled, had a very good life; in other words, the loss or depreciation was infinitesimal as compared to what was anticipated at the start. They could with their accumulators run each 'bus four journeys from Victoria to Liverpool-street and back, which was nearly 36 miles; indeed, he might say that they had done five journeys, or over 40 miles. This was a matter which had given immense satisfaction to the Board, because it absolutely refuted the adverse criticisms which had been made in respect to the use of accumulators for heavy traffic. The directors had in their contracts provided for such accumulators as might be required up to 50 or even 100 omnibuses at 2d. per car mile. In the prospectus it was estimated that the total cost of running one 'bus 120 miles would be £4. 9s., which included everything, drivers' and conductors' wages, cost of tyres, current costs, upkeep of garage, insurance, maintenance, and depreciation. Dealing with the question of depreciation, which was an important factor, he pointed out that the depreciation in the electrobus was a great deal less than that of the petrol 'bus, the machinery of the former being nothing near so complicated as that of the latter. Regarding the question of administration expenses, he said that they had only seven omnibuses running, and the shareholders would thoroughly understand that possessing a huge garage capable of accommodating from 50 to 60 omnibuses the administration expenses must be out of all proportion to the expenditure on seven. He, therefore, admitted that although at the present moment

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their takings were considerably in excess of the actual expenditure, outside of administration expenses, they must not lose sight of that important fact. The figures which he had given them showed that the actual cost of running an omnibus was 9d. per car mile. At the inception of the Company they were told that the actual cost of the accumulators alone would be over 10d. per car mile; in fact, some even went so far as to say that the electrobus could not be run at less than 1s. 6d. per car mile, but he proposed to prove by actual figures, that would be countersigned by Sir Douglas Fox, that the actual cost, including everything, was 9½d. per car mile. Since July 15 up to the end of October they were running at the beginning only from four to five omnibuses, and during the four months they carried 227,000 passengers. They ran 20,416 miles and earned £1,172, or an average rate of 13·79d. per car mile. The average number of passengers per car mile was equal to 11·12, and the average payment by each passenger was 1·23d. From Nov. 1 to 12, running with an additional 'bus, they had carried 43,000 passengers, or a total number of 270,000 passengers, and they had got an average rate for that period of 12 days of just under 15d. per car mile run. It did not require much calculation to find that if the cost was 9½d. and they got in receipts 1s. 3d., they would be left with a profit of 6d. per car mile. Assuming, however, that their expenses amounted to 10d. and the receipts averaged 1s. 2d. that would be equivalent to 4d. per car mile, and, running 80 'buses, that would give them a profit of about £40,000 a year. According to the figures in the prospectus a 120 miles' run should have brought in £6, but, as a matter of fact, for July and August the takings were £6. 10s. 9d. per 120 miles, for September they were £6. 18s. 11·16d., for October they were £7. 2s. 10d., and from Nov. 1 to 11 they were £7. 8s. 10d. per 120 miles. As to the estimated profit, if, for example, they allowed the cost to be 10d. per car mile, and allowing less than their average takings—say, 1s. 2d. per car mile—that would give them a revenue of 4d. Now, Sir Douglas Fox in his report put it that if they only accomplished 24,000 miles per annum, which was equivalent to 80 miles per day, working 300 days in the year, and making allowances for depreciation, general expenses, etc., they should make a net profit of £40,000. In order to arrive at that stage, the chairman confessed that it was necessary that they should get additional capital, for what they had done had been carried out on a very limited sum of money. They started with a capital of £300,000, and although the public had flooded the Board with applications for shares, the directors had returned that money in consequence of the criticisms to which the Company was subjected. It was in the minds of the directors that they should at once put then selves in a position to obtain 100 omnibuses, and as an omnibus cost about £700 they required £70,000. Mr. Beachcroft added that two engineers had been sent over here at the request of the Paris General Omnibus Co. to look into this Company's garage, its equipment, and working, no doubt with a view to the substitution of electric traction for petrol, as also in the French capital they were beginning to recognise the advantage of electric 'buses. He testified to the kindness which the Company received from the authorities, and particularly the police authorities, from Sir Edward Henry downwards. He had had an interview with Sir Edward, and had taken him out in an electrobus during the time the Company was under a shadow, and that gentleman expressed himself very pleased with it, and was anxious to do all he could to advance the undertaking. That had been done.

The Chairman then read the report furnished by Sir Douglas Fox and Partners, the gist of which is contained in the chairman's speech, and need not, therefore, be reproduced here.

He formally moved the adoption of the report and accounts, which was seconded by Mr. MUSGRAVE, and carried unanimously.

CAPE ELECTRIC TRAMWAYS.

The ordinary general meeting of the Cape Electric Tramways was held on Wednesday in London, Sir Charles Euan-Smith (chairman of the Company) presiding.

In moving the adoption of the report, the CHAIRMAN stated that the commercial depression in Cape Town and Port Elizabeth still existed. This, with the continued hostility of the Sea Point Municipality, continued to be the main factors which were responsible for the most serious diminution in their revenue. They had carried nearly 190,000 more passengers this year, while the gross earnings resulting therefrom had decreased by about £16,000. By means of retrenchments, however, this shortage of revenue had been met by a saving in the working expenditure of nearly £16 000. At their last meeting he alluded to the one special cause which was then operating so severely to their disadvantage, and that was the ruinous and senseless competition originally instituted by the Cape Government at the instigation of the Sea Point Municipality in operating the Sea Point Railway, which was being carried on by that body regardless of any consideration either of common sense or sound economic principle. In the month of March last the railway department of the Cape Government, acting under pressure from the Municipality, made further reductions in the already reduced fares. These reductions lowered the fares chargeable on the line between Cape Town and Sea Point to a figure actually below that upon which any railway whatever could be operated and at the same time give a profitable result even of the most modest character. In self-defence the directors had to meet such suicidal reductions by following the same course. The result of this competition had immensely reduced their legitimate profits, in the rightful earning of which they had every reason to count on the support of the Cape Government, and had resulted in an increase of the rates. Their Company embarked its capital on the security of an Act of Parliament of the Cape of Good Hope granting it the tramway concession. Had the passing of this Act not been regarded as a sign of friendliness and support on the part of the Government the capital would not have been found. But their fancied security had signally failed to protect them against a serious attack on their legitimate rights in South Africa, which had been connived at by the Government. This action on the part of the Cape Ministry in this Sea Point Railway business, as it affected their Company, was calculated to deal a serious blow to that ideal commercial integrity with which they associated their Colonial Governments. If not rectified even at this late hour, it must ultimately tend to act as a serious deterrent against the future investment of capital in Cape Colony, where the good faith and action of the executive power could no longer be counted on as not open to challenge and suspicion. Sooner or later, however, the directors felt that the voice of common sense and public interest would make itself heard, and the fares would regain their right level. At Port Elizabeth they had had to meet a financial depression and distress which was more acute even than that of the preceding year. The result of the working of the tramways for the past year at Port Elizabeth continued to show a fair profit on operation, and it was gratifying to know that their tramways were immensely appreciated by the public at that place.

Mr. L. BREITMEYER seconded the motion, which was carried unanimously.

AMAZON TELEGRAPH.

The ordinary general meeting of the Amazon Telegraph Co. was held in London on Tuesday, Mr. Geo. Keith presiding.

In moving the adoption of the report, the CHAIRMAN said that there had been a considerable improvement in the Company's business, owing to the better state of the rubber trade on the Amazon. During the past year the traffic receipts amounted to £66,204, being an increase of £2,355, which had been produced by an advance of about 8 per cent. in the ordinary traffic. The receipts had not increased in proportion to the traffic, owing to the loss through the currency equivalent of their gold rates having been fixed during the first half of the year on a falling exchange. The cables as a whole had worked well, and had earned the full subsidy, and the gross revenue came out at £83,815, showing an increase for the year of £2,682. Up to date, during the current year, the traffic receipts had exhibited a considerable advance, but much depended on the rubber crop which had just commenced to come down the river. The Conversion Bill, fixing the value of the milreis at 15d., had become law, and so far had been very successfully carried out, to the advantage of the Company as well as of all producers for export to Brazil.

Mr. E. B. ELLICE-CLARK seconded the motion, which was carried unanimously.

DISTRICT RAILWAY.

A circular has been issued by the chairman of the District Railway setting forth a scheme for putting the Company's finances on a sounder financial basis. Sir George Gibb estimates that at the end of the current half-year the deficit on revenue account, after payment of fixed charges, will amount to £35,000, but arrangements are in progress for raising the moneys required to pay the expected deficit for the current half-year, so that the proprietors of the debenture stocks may receive their interest in full. The security to be given for the advance to meet this deficit will be a contingent sale of the sum of £50,938 consols. It is proposed to seek powers in Parliament to abandon the construction of the deep-level railway, and to obtain a release of the deposits. The present requirements of the Company are: To provide for repayment of the temporary loans, £385,000; to provide for estimated deficits on revenue account after the current half-year, £45,000; to pay for works in progress and for necessary works of renewal and improvement during the next three years, including estimated expenditure on real property belonging to the Company, in order to create additional rentals estimated at £12,000 per annum, £145,000; for working capital, £50,000; contingencies, £50,000; total requirements, £675,000. The directors think that the best course to adopt is to seek the authority of Parliament to issue £750,000 prior lien redeemable debenture stock, ranking next after the rent charge stocks of the Company, for the purpose of raising the required funds. £550,000 of the proposed stock will be issued as soon as the requisite parliamentary powers are obtained, and the balance of £200 000 will be issued if and when required. The proposed issue of £550,000 of the new stock, bearing interest at 4 per cent. per annum, will involve an interest charge of £22,000 per annum, but, as against this, there will be a saving of about £20 000 per annum, which is now payable for interest on temporary loans. The surplus land rental of £26,000 per annum, together with the additional rentals, estimated at £12,000 per annum, which it is proposed to create by the reconstruction of some of the stations and by building on surplus land connected therewith, will thus be preserved for the Company. The surplus lands are not now charged with the debenture debt of the Company, but it is proposed to insert provisions in the intended Bill to extend the charge of the debenture holders, so that it shall comprise these lands.

DORMAN-LONG.

The report of Dorman, Long, and Co. for the year ended Sept. 30 shows a profit of £224.192. which, with the balance brought forward, makes £235,712 for distribution, to be applied as follows: interest on first debenture stock, £16,000; interest on second debenture stock, £14,700; provision for redemption of second debenture stock, £20,000. Interim dividend of 2½ per cent., £31,489; final dividend for year of 5 per cent., £62,979; directors' fees, £3,000; for depreciation, £30,000; balance carried forward, £57,542. Additional furnaces for the production of steel ingots are in course of erection, and to meet the requirements of shipbuilders for small sections and the growing demand for bars a new electrically-driven mill is to be put down. Every department is fully occupied, and the prospects for the coming year are good.

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NEW COMPANIES REGISTERED.

Electric Stores (Wolverhampton). — Registered Nov. 9. Capital, £2,000 in £10 shares. Objects: to adopt an agreement with J. H. Whittaker, to supply electric light and power, etc. No initial public issue. Registered offices: Royal London-buildings, Princes-square, Wolverhampton.

Margarini Valley Rubber Estates, Limited. — Registered Oct. 24. Capital, £3,500 in £50 shares. Objects: to carry on the business of planters, growers, and producers of rubber, cotton, and fibres, merchants, brokers, shippers, etc., and to adopt an agreement with G. Griffiths. No initial public issue. Registered office: 25, North John-street, Liverpool.

British Arc Lamps, Limited.—Registered Oct. 29. Capital, £3,000 in £1 shares. Objects: to acquire certain patents relating to electric light; to adopt an agreement with E. S. M. Perowne, and to carry on the business of lamp manufacturers, electricians, manufacturers of and dealers in motors, rheostats, electric fans and fittings, etc. No initial public issue.

I. T. E. Electric Co. (1907), Limited.—Registered Oct. 12. Capital, £1,000 in £1 shares. Objects: to carry on the business of electricians, engineers, workers of and dealers in electricity, manufacturers of electrical apparatus, etc., and to adopt an agreement with the Cutter Electrical and Manufacturing Co., A. E. Newton, and W. M. Scott. No initial public issue. Registered office: 72, Finsbury-pavement, E.C.

Java Rubber Plantations, Limited. — Registered Oct. 2. Capital, £35,000 in £1 shares. Objects: to acquire and work the rubber estate in Java known as the Soember Tengah Estate, to adopt an agreement with the Rubber Estate Agency, and to carry on the business of cultivators of and dealers in rubber, guttapercha, and gums of all kinds, etc. Minimum cash subscription, 19,500 shares. Registered office: 49, Eastcheap, E.C.

Gamnes Copper Co., Limited.—Registered Oct. 12. Capital, £25,000 in £1 shares. Objects: to acquire and turn to account certain mining claims and rights on Gamnes Farm, and other rights and properties on the Island of Ringvatso, Karlso, District of Tromso, Norway, and to carry on the business of copper and general miners, prospectors, explorers, metallurgists, etc. No initial public issue. Registered office: 1, Gresham House, Old Broad-street, E.C.

Flottmann Engineering Co., Limited.—Registered Oct. 12. Capital, £3,600 in £1 shares. Objects: to take over the business carried on at 36, Park-place, Cardiff, as the Flottmann Engineering Co.; to enter into an arrangement with H. Flottmann and Co., of Bochum, Germany, for the sale of rock drills and air-compressors manufactured by the said company; and to adopt agreements with A. Sgonina and with the said H. Flottmann and Co. No initial public issue.

Robert Warner and Co. (Engineers), Limited.—Registered Oct. 14. Capital, £18,000 in £1 shares. Objects: to acquire the business carried on at Walton-on-the-Naze, Essex, and 97, Queen Victoria-street, E.C., as Robert Warner and Co.; to adopt agreements with F. R. Durham and G. H. Hughes; and to carry on the business of ironfounders, mechanical engineers, manufacturers of hydraulic pumps and other machinery, toolmakers, founders, etc. Minimum cash subscription, 5,000 shares. Registered office: 97, Queen Victoria-street, E.C.

S. P. A. Motor Co., Limited.—Registered Oct. 14. Capital, £1,000 in £1 shares. Objects: to carry on the business of manufacturers of motors, cars, wagons, cycles, and other vehicles, etc.; to acquire all or part of the benefit of a contract dated Jan. 12, 1907, between the Societa Piemontese Automobile Ansaldi Ceirano (S.P.A.), of Turin, of the one part and the Spa Motor Co., of London, of the other part, together with all or any of the assets and liabilities of the business carried on as the Spa Motor Co., and to adopt an agreement with H. E. Hall and H. O. Hall. No initial public issue. Registered office: 15, Riding House-street, W.

Liens Registered.

Armstrong Power and Co., Limited, Electrical Engineers, London.—A 10 per cent. debenture, dated Oct. 30, 1907, to secure £400, charged on the company's undertaking and property, including uncalled capital, has been registered. Holder: W. R. Peck, The Croft, Sutton, Surrey.

Egyptian Delta Light Railways, Limited, London, E.C.—Lien registered Nov. 1 for £20,000 4 per cent. debentures, part of £480,000; amount previously issued, £460,000. Trustees: Sir G. Fitzgerald and Sir J. Heron-Maxwell. Secured by a first charge on the undertaking and assets, present and future, including the uncalled capital and unpaid calls, subject to certain prior charges on the property.

South Metropolitan Electric Light and Power Co., Limited.—Issue on Oct. 22 of £13,500 4½ per cent. debentures, part of series created by resolutions of July 3, 1900, and May 6, 1904, to secure not more than the amount of the share capital paid up for the time being charged on the company's undertaking and property, present and future, including uncalled capital. The debentures are issued to the trustees for further securing debenture stock covered by trust deeds of Aug. 3, 1900, and June 3, 1904. Trustees: H. R. Beeton, 18, Austin-friars, E.C., and W. R. Davies, 10, Moorgate-street, E.C. Total amount previously issued of same series, £237,968.

Isle of Wight Electric Light and Power Co., Limited.—An acknowledgement of indebtedness, dated Oct. 28, 1907, creating a further £25,000 debenture stock (making with £75,000 already created, a total of £100,000 debenture stock, and being supplemented to a trust deed of Aug. 21, 1903, covering £50,000, and an acknowledgment of indebtedness, dated July 25, 1905, covering £25,000 of such stock) has been registered. Property charged: the company's undertaking and property, present and future, including uncalled capital. Trustees: P. de M. Cavell, J.P., Red House, Slade End, Wallingford, Berks; and W. R. Davies, 10, Moorgate-street, E.C.

PERSONAL.

We are glad to state that Mr. James A. Bell, the Aberdeen city electrical engineer, who has been ill and confined to bed for several weeks, is now on a fair way to recovery.

Mr. W. H. Trentham, consulting engineer, informs us that he has taken into partnership Mr A. E. Heming, recently constructional engineer to Marconi's Wireless Telegraph Co. The title and address of the firm will be Trentham and Heming, of 39, Victoria-street, Westminster.

At the second annual smoking concert of the West Ham Corporation electricity department, which took place on Monday evening last, Mr. A. H. Seabrook, engineer and manager, was presented with an enlarged photograph of the department's outing last summer, handsomely framed.

The staff of the Metropolitan Electric Supply Co. met at the Torino Restaurant on Friday evening last to wish Mr. A. W. Wilson, who has been a member of the mains department for the past 18 years, the best of luck on his leaving the company to take up a position with the British Insulated and Helsby Cables, Limited. E. Cunliffe Owen, Esq., C.M.G., the company's secretary, presided, and during a very enjoyable evening presented Mr. Wilson with a gold cigarette-case as a small memento of his long service and great friendship with the staff.

FORTHCOMING EVENTS.

FRIDAY, NOV. 22.

Physical Society.—At 5 p.m., in the Physics Laboratory, Royal College of Science, Imperial Institute-road, South Kensington, "On Singing Sand from New England," by Mr. S. Skinner; Exhibition of a Micromanometer by Mr. L. Bairstow; Diabolo Experiment by Mr. Vernon Boys; Exhibition of a Gyroscope illustrating Brennan's Monorailway by Prof. H. A. Wilson.

Northampton Institute Engineering Society.—At 5.45 p.m., "Two-Stroke Petrol Motors," by Mr. G. A. King.

SATURDAY, NOV. 23.

Institution of Electrical Engineers (Manchester Section).—Visit to the plant of the Mersey Railway, Birkenhead.

Junior Institution of Engineers.—At 10 a.m., visit to the Royal Arsenal, Woolwich.

MONDAY, NOV. 25.

Institution of Electrical Engineers (Newcastle Section).—Annual dinner.

TUESDAY, NOV. 26.

Institution of Electrical Engineers (Manchester Section).—At 7.30 p.m., at the Physical Laboratory of the University, "Further Remarks on the Electrical Operation of Textile Factories," by Mr. H. W. Wilson, A.M.I.E.E.

FRIDAY, NOV. 29.

Society of Arts.—"The Hygiene of Work in Compressed Air," by Dr. Scott Haldane.

I.E.E. (Manchester Students' Section).—Tuesday, Dec. 3, "The Evolution of the Modern Switchboard," by Mr. E. P. Hill.

Society of Engineers.—Wednesday, Dec. 11, annual dinner at Hotel Cecil.

I.E.E. (Dublin Section).—Thursday, Dec. 12, at 8 p.m., at the Royal College of Science.

Rugby Engineering Society.—Thursday, Dec. 12, "Textile Electric Driving," by Mr. J. Shaw.

Electro-Harmonic Society.—Friday, Dec. 13, at King's Hall, Holborn Restaurant, smoking concert.

OPENINGS FOR CONTRACTORS.

ABERDARE—Workmen's dwellings (£10,000), Urban District Council.

ABERYSTWYTH—National library, Cardigan County Council.

ALDERSHOT—Rebuilding Princess Hotel, Union-street. Messrs. Friend and Lloyd, architects.

ALNWICK—Primitive Methodist manse, Seahouses. Mr. G. Reavell, architect.

ALTON—Petty sessional court (£1,388), County Council.

AMINGTON—Houses, Messrs. Sillito and Sons.

ARDSLEY—Extension of Westerton School, West Riding Education Authority.

ASHTON—Billiard hall, Old-street, Mr. T. Caverley; office, Rutland-street, Mr. E. Marshall; extensions to mill, Grosvenor-street, Messrs. Lee and Knott.

ATHY—Workmen's dwellings (£25,920), Rural District Council.

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BALLINAMALLARD—Workmen's dwellings, Rural District Council.
BANGOR—College buildings, Education Committee (£67,675).
BANSTEAD—Additional accommodation at London County Council asylum (£1,031).
BARNES—Additions to hospital, erection of new block, and mortuary (£3,300).
BECKENHAM—Three houses, Kimberley-road, Mr. F. Diver; five houses, Faversham-road, Mr. W. J. Norris.
BELFORD — Memorial nursing home. Messrs. Stevenson and Son, architects.
BEN RHYDDING—Council school, West Riding Education Committee. Mr. J. D. Edwards, architect.
BEVERLEY—Elementary school, East Riding County Council.
BIRMINGHAM—Extension to Council House, Corporation.
BOURNEMOUTH—Elementary schools, Alma-road, Town Council.
BOWBRIDGE—Primitive Methodist chapel (£400).
BOWBURN—Elementary school, Durham County Council.
BOYLE—Workmen's dwellings (£79,660), Rural District Council.
BROADSEA—Elementary school, Fraserburgh School Board.
BRISTOL—St. Alban's Church, Westbury-park. Messrs. Rodway and Denning, architects.
BRIXTON, S.W. — Terrace of houses, Brixton-hill, Messrs. Gush, Phillips, Walters, and Williams.
BULKINGTON—Council offices, District Council.
CANTERBURY—Extension of public lighting, City Council.
CARREGHOFA—Elementary school, Montgomeryshire Education Committee.
CASTLE DONINGTON — Elementary school, Leicestershire County Council.
CAVERSHAM—Additions to Council buildings. Mr. A. J. Smith, surveyor.
CHANDLESFORD — Clubroom at Half-Way House, Lyon Brewery, Winchester.
CHATTISHAM—Restoration of parish church.
CHOPWELL—Parish church (£1,500).
CHURT—Parish institute.
CLOGHEEN—Workmen's dwellings (£18,560), Rural District Council.
CLONELLY—Workmen's dwellings, Rural District Council.
CLOWNE—Eight houses, Morven-street, Mr. A. F. Houfton.
COALVILLE — Elementary school (£9,125), Leicestershire County Council.
COPPULL—Spinning mill, Mavis Spinning Co.
CORK—112 labourers' dwellings, Rural District Council.
CORROFIN—Workmen's dwellings (£22,800), Rural District Council.
CREWE—Training college for teachers, Cheshire Education Committee.
CROOKSTON—Four houses and double cottage, Govan District Lunacy Board. Messrs. H. and D. Barclay, architects, 245, St. Vincent-street, Glasgow.
DARLINGTON—Houses in Newlands-terrace, Messrs. T. B. and W. Shaw; mortuary and public lavatories for Corporation.
DAWDON—Elementary school, Durham County Council.
DESFORD—Elementary school, Leicestershire County Council.
DISS—Elementary school (£2,583), County Education Authority.
DUNDEE—Villa, Blackness-road, Mr F. Watson; additions to factory, Clepington-road, Messrs. Francis East and Co.; warehouse, office, and shops, Hawkhill, Messrs. Thos. Bell and Son; machine shop, etc., Old Glamis-road, Messrs. John Howe and Son; villas, Frederick-street, Downfield, Messrs. Geekie and Mackintosh.
DUNSTABLE — Elementary school, Bedfordshire County Council (£2,300).
DUNSTON—Elementary schools, Durham County Council.
DURHAM—House, Quarrington Hill, Mr. A. Gillett; workmen's club, Messrs. Hett and Croxdale.
DRUMKEERAN—Workmen's dwellings, Rural District Council.
DRUMRUSH—Workmen's dwellings, Rural District Council.
EALING—Council school, Education Committee.
EAST DEREHAM—Establishment of telephone service, Urban District Council.
EDERNEY—Workmen's dwellings, Rural District Council.
EDINBURGH—Fine-art building, Scottish National Exhibition, 1908. Mr. G. D. Gibson, architect.
ELGIN—Additions at Messrs. Low, Sons, and Co.'s net factory. Mr. Charles C. Doig, architect.
ENNIS—Workmen's dwellings (£53,405), Rural District Council.
FENNY STRATFORD—Houses, Mr. H. S. Leon.
FFORCHDWM—Power station for the Whitworth Collieries, Limited. Mr. J. Cook Rees, architect, Neath.
FLEETWOOD—Electricity supply, Broadstone, Limited.
FRASERBURGH—School at Broadsea for Fraserburgh School Board. Messrs. D. and J. R. M'Millan, architects, 105, Crown-street, Aberdeen.
FULHAM, W.—Congregational church, Fulham Palace-road, Messrs. E. Monson and Sons.
FULWELL—Council school, Durham Education Committee.
GARSTON—Public libraries (£3,000).
GELLIGAER—Establishment of fire brigade and necessary appliances, Urban District Council.
GLASCOTE—Houses, Mr. J. Ordish.
GLASGOW—Club premises on a site in St. Vincent-street; Imperial Union Club, Mr. J. A. Campbell, architect.
GLOSSOP—Extension of tramway from Mottram to Glossop.
GORLESTON—Bungalow, Lowestoft-road, Mr. W. Cockrill; six houses, Blackwall-reach, Mr. J. J. Cockrill.
GRANGETOWN—Alterations to the Conservative Club in Corporation-road. Mr. W. H. D. Caple, architect, 2, Church-street, Cardiff.
GRAVESEND—Four houses, Campbell-road, Mr. H. Pinfold; three houses, Havelock-road, Messrs. Rayner and Bridgland; shops and houses, Granville-road, Mr. Box; houses in Churchill-road and Northcote-road, Mr. G. T. Tuffee.
GREENCROFT - Elementary school, Durham County Council.
GRIMSBY—Erection of public conveniences, Town Council (£1,247).
HAMMERSMITH, W.—Special school, Brook Green, London County Council.
HANDSWORTH—Parish church (£8,000), Mr. W. H. Bidlake, Birmingham.
HARLOW GREEN—Elementary school, Durham County Council.
HARPENDEN—Houses, Milton-road, Messrs. H. Salisbury and Son; houses, Kirkwick-avenue, Messrs. Miskin and Sons.
HARROW — Houses, Devonshire-road, Mr. A. J. Smith; houses, Sumner-road, London Ground Rent Co.; additions to laundry, Messrs. Reynolds and Hicks; house, College-road, Messrs. McKilliam and Proctor; shops, Northolt-road, Mr. G. H. Gooderson.
HASTINGS—Studio at 8, West-hill, Messrs. Wm. Gibbin and Son; workmen's dwellings, York-road, Messrs. F. Murray and Co.; schoolroom at the rear of the Congregational Church, Bexhill-road. Mr. Thos. W. Elworthy, architect.
HEATON—Stores for the North-Eastern Railway Directors. Mr. W. Bell, architect, Central Station, Newcastle-on-Tyne.
HEMEL HEMPSTEAD—Factory (£40,000). Plans passed by Council.
HERTFORD—Improvement of Corn Exchange, Corporation (£500).
HESLEDON—Elementary school, Durham County Council.
HOLBORN, W.C.—Restaurant, shops, and offices. Messrs. Palgraves and Co., architects.
HOPWAS—Alterations at the Chequers hotel, Messrs. Truman, Hanbury, and Buxton.
HUDDERSFIELD—Additions and alterations to Thornton Lodge Store, Huddersfield Industrial Society. Mr. J. Berry, architect.
HULL—Garden village on Jalland estate. Mr. P. Runton, architect. Extension Corporation electric light undertaking (£46,527).
IRVINESTOWN — Erection of labourers' dwellings (£17,760), Rural District Council.
ISLEWORTH—Roman Catholic church, Twickenham-road (£3,000). Mr. E. D. Webb, architect.
KEMPTON PARK—Workshops, stores, toolhouses, conveniences, etc., Metropolitan Water Board.
KENNINGTON, S.E.—Special school, Priory-road (£4,937), London County Council.
KENSINGTON, W.—School for London County Council, Friary-road (£4,937).
KESH—Workmen's dwellings, Rural District Council.
KIDSGROVE—Stables, Urban District Council (£300).
KILLADEAS—Workmen's dwellings, Rural District Council.
KILWINNING—Offices, Irvine and District Water Board (£920); offices, Kilwinning Parish Council (£160).
KINGLOSSIE—Police station, Fife Standing Joint Committee.
KINSALE—Workmen's dwellings (£37,200), Rural District Council.
KNARESBOROUGH—Board-room offices and caretaker's house (£2,100).
LACK—Erection of labourers' dwellings, Rural District Council.
LIMEHOUSE, E.—Special school, Farrance-street, London County Council.
LISNARICK—Erection of labourers' dwellings, Rural District Council.
LIVERPOOL—Electricity undertaking (£200,000), Corporation.
LONDON — Electric lighting works, British Mannesman Tube Co. (£30,000).
LONG EATON—Baptist Sunday school, Station-street (£2,400). Mr. E. Hooley, architect.
LYDNEY—Cottage hospital. Mr. A. J. Dunn, Birmingham, architect.
MAGHERACULMONEY—Erection of labourers' dwellings, Rural District Council.
MAIDENHEAD—Private residences at Maidenhead Court. Clerk of Works.
MEDOMSLEY EDGE—Elementary school, Durham County Council.
MERRYWOOD—Council school, Bristol Education Committee.
MEXBOROUGH—Secondary school (£9,126), Education Committee.
MIDSOMER NORTON—Terrace of houses, Burlington-road; six houses, South View-place.
MILLTOWN—Erection of labourers' dwellings, Rural District Council.
MOUNT HERMON—Church of St. Mary. Mr. W. D. Caroe, Westminster, architect.
NEWCASTLE-UPON-TYNE—Underground conveniences, Corporation.
NORTH SHIELDS—Secondary school (£30,000), Education Committee
NOTTINGHAM—New Albert Hall, Trustees; Mr. A. E. Lambert, architect, 22, Park-row. Restoration of St. Mary's Church (£6,500).
OLDHAM—Cotton spinning factory (£80,000), Kent Mill Co.
OSWALDTWISTLE—Offices for Stawhill Ring Spinning Co.

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OVERTON—Erection of parish church.

PAIGNTON—Science and art school in Bishop's-place, Urban District Council. Mr. W. G. Couldrey, architect, Palace-avenue.

PARKSTONE—Three shops and houses, Bournemouth-road. Messrs. Smart and Wyeth, architects.

PENYGRAIG—Alterations to school. Mr. Jacob Rees, Hillside Cottage, Pentre, architect.

PERTH—Elementary school (£15,000), School Board.

PETERHEAD—Shops and tenement buildings in Marischal-street, Trustees of Robertson's Mortification.

POKESDOWN—Church, parish of St. Andrew (£8,550). Mr. C. T. Miles, Bournemouth, architect.

PONTYCLUN—Extension to engineering works. Messrs. Jones and Peregrine, architects.

PORT GLASGOW—Elementary school at Higholm (£14,200).

RADCLIFFE—Fire brigade and equipment, District Council.

REDCAR—Elementary schools, West Dyke (£10,000).

ROBERTSTOWN—National school and office. Mr. T. Bergin, architect, 36, Westmoreland-street, Dublin.

SABDEN—Village lighting, Urban District Council.

ST. ANNES-ON-THE-SEA—Imperial Hydro, Engineer-in-Charge; Conservative Club (£2,500).

ST. ASAPH—Church house, Ecclesiastical Authorities.

ST. AUSTELL—Four houses, Mount Charles, Mr. W. J. Hill.

ST. MARYLEBONE, W.—Alterations and additions to school, London County Council (£1,148).

ST. MELLION—Vestry and additions to parish church. Mr. E. Sedding, architect.

ST. MICHAEL'S MOUNT—Two houses. Mr. W. G. Painter, Steward's Office, St. Michael's Mount, Marazion.

ST. PANCRAS, N.—Workmen's dwellings (£22,000). Messrs. Joseph and Smithem, architects.

SALOP—Extension of the infirmary (£14,000). Mr. Rowland Plumbe, architect.

SCISSETT—Three houses in Cuttlehurst-road. Mr. J. Berry, architect, 3, Market-place, Huddersfield.

SILKSWORTH—Elementary school, Durham County Council.

SLOUGH—Alterations and additions to the premises of Messrs. Horlick.

SOUTHAMPTON—Enlargement of grammar school, Board of Education.

SOUTHEND—Extension to sanatorium (£8,400), Town Council; house, Leigh-road, Mr. S. Barnett; house and bakehouse, Station-road, Mrs. E. L. Burch; house, Holywood-drive, Mr. J. Prestt; house, Imperial-avenue, Mr. J A. Berry; business premises, bakehouse, and stable, Leigh-road, Messrs. E. Bridger and Son; four houses, Ramuz-drive, Mr. J. Mitchell; nine houses, Wenham-drive, Mr. C. H. Jerrard; four houses Westcliff Park-drive, Mr. J. Pettitt; addition (new vestries), St. Mary's, Prittlewell, Rev. T. O. Reay; additions, 3, Southchurch-road, Mr. E. W. Foster; house and shop, bakehouse, and cottage, Leigh-road and Bright-well-avenue, Mr. Charles Annereau; house, shop, motor garage warehouse, and stable, West-road, Mr. J. G. Dinn; two houses, Gloucester-terrace, Mr. M. F. Beadell; house, shop, and stables, Salisbury-avenue, Mr. A. Hedges; house, Fernleigh-drive, Mr. A. Chapman; two houses and shops, 86A-88A, Leigh-road, Mr. J. W. B. Bane.

SOUTHFIELDS—Elementary school (£16,525), London County Council.

SOUTH MOLTON—Parish-room (£600), Churchwardens.

SOUTHPORT—Elementary school (£5,500), Education Committee.

SOUTH SHIELDS—Electric lighting at municipal buildings.

SOUTHWICK—Addition to town hall, Urban District Council.

STANHOPE—Extensions to the premises of the Co-operative Society.

STANTON-UNDER-BARDON—Elementary school, Leicestershire County Council.

STEPNEY, E.—Extension of Corporation electric lighting (£20,000).

SUNDERLAND—Chapel at Sister Home, High Barnes. Messrs. W. and T. Milburn, architects.

SUTTON COLDFIELD—Enlargement of Boldmere and Hill Schools, Corporation.

SUTTON COURTNEY—Congregational church. Mr. Howell, Reading, architect.

TAMWORTH—Factory at Bolehall, Messrs. Cooke and Sons.

THRINGSTONE—Elementary school, Leicestershire County Council.

THURCASTON—Enlargement of elementary school, Leicestershire County Council.

TIERMACSPERID—Erection of labourers' dwellings, Rural District Council.

TORQUAY—Elementary school, Education Committee.

TUNSTALL—Council school (£12,500), Corporation.

TYNEMOUTH—Secondary school, Hawkeys-lane (£30,000). Mr. J. C. Maxwell, architect.

TYWARDREATH—Two houses, Mr. J. H. Rosevear.

ULVERSTON—Alterations and additions at Broughton Beck, Colonel Blundell.

UXBRIDGE—Elementary school, Education Committee.

WANDSWORTH, S.W.—Congregational church, Earlsfield-road, Messrs. Mountford and Clapham.

WARSOP—Post office, Newcastle-avenue, H.M. Commissioners of Works.

WATFORD—Houses, Haddon-road, Mr. Williams; houses, Station-road, Mr. A. Smith.

WEMBLEY—Elementary school, County Education Committee.

WEST BROMWICH—Elementary school, Hill Top. Education Committee.

WEST LULWORTH—Parish room in Red Hill-yard to seat 160 persons. Mr. J. H. Hazeldene, architect.

WESTON-SUPER-MARE—Pumping station at Uphill, Urban District Council.

WHITSTABLE—Additions to Tankerton Hotel; enlargement of Prince Albert Hotel; houses in Clare-road, Mr. F. S. Gann; houses in Kent-street, Messrs. Amos and Foad; houses in Regent-street, Mr. Thomas.

WICKHAM—Elementary schools, Chilton's-buildings, Durham County Council.

WINDSOR—Hospital, Council; rebuilding Fawn Hotel, Messrs. Burge and Co.

WOLVERHAMPTON—Buildings consisting of shops, licensed premises, arcade, shopping pavilion, offices, and showrooms, Corporation. Mr. F. T. Beck, architect.

WORKSOP—Post office, H.M. Commissioners of Public Works.

WORKSWORTH—Grammar school (£4,500), Education Committee.

YARMOUTH—Houses, Burnt-lane, Mr. T. V. Palmer; houses and shops, Parish Church Trustees; five houses, High-road, Mr. A. J. Newby.

YORK—Electrification of tramways, Corporation.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Perth (Australia).—The Postmaster-General invites tenders for 80 accumulators for telegraph purposes. Tenders by Dec. 11.

Melbourne.—The Postmaster-General invites tenders for 30 metallic iron telephone switchboards. Tenders by Dec. 31.

South Shields.—The Corporation invite tenders for the wiring of the municipal buildings. Tenders to the Town Clerk by Nov. 26.

Madrid.—The Post and Telegraph Department invite tenders for the installation of telephone system in Ferrol. Tenders by Nov. 26.

London.—The Metropolitan Asylums Board invite tenders for alterations to fire-alarm and telephone systems. Tenders by Nov. 27.

Luton.—Tenders are invited for the supply of traction battery, automatic reversible booster, and traction switchboard. Tenders by Nov. 28.

Sydney.—Tenders are invited for centrifugal pumps and electric motors for the low-level pumping station at Rushcutter's Bay. Tenders by Dec. 9.

New South Wales.—The Postmaster-General, Sydney, invites tenders for one branching metallic multiple magneto switchboard. Tenders by Jan. 8, 1908.

Fforchdwm.—Tenders are invited for the erection of a new power station at Fforchdwm for the Whitworth Collieries. Particulars from Mr. J. Cook Rees, architect, Neath.

Pontypridd.—The Urban District Council invite tenders for the supply of one mechanical stoker to be used with a Babcock and Wilcox water-tube boiler. Tenders by Dec. 2.

Doncaster.—The Electricity Committee invite tenders for the supply of coal for use in their electricity works. Tenders to the Chairman of the Electricity Committee by Nov. 26.

Napier (New Zealand).—The Town Council invite tenders for lighting and power plant and an electric tramway equipment. Particulars from Mr. F. Bowen, town clerk. Tenders by Dec. 31.

Melbourne.—The Postmaster-General's Department invite tenders for 11 sets and a common-battery switchboard, and 3,000 subscribers telephones, etc., for the Windsor exchange. Tenders by Jan. 7.

Southampton.—The Corporation invite tenders for the supply of a steam generator and boilers, and cables. Specifications from the Borough Electrical Engineer. Tenders to the Town Clerk by Nov. 30.

Madrid.—The Public Works Department invite tenders for the construction of electric tramways in Santander. Particulars from the Direccion de Obras Publicas, Ministerio de Fomento. Tenders by Dec. 1.

Dartford.—The Metropolitan Asylums Board invite tenders for alterations to fire-alarm and telephone systems at the Gore Farm (Convalescent) Fever Hospitals, near Dartford. Tenders to the Clerk by Nov. 27.

Punjab (India).—Tenders are invited for electric and pumping plant for water supply. Particulars from the Executive Engineer, Special Work Division, Patiala, Punjab. Deposit £133. 6s. 8d. Tenders by Jan. 6, 1908.

Sydney.—The Postmaster-General invites tenders for 1,000 common-battery wall telephones and 100 portable telephones. Particulars from the Commonwealth Offices, 72, Victoria-street, Westminster. Tenders by Dec. 11.

Brisbane.—Tenders are invited for insulators, iron spindlers, and copper wire for the Postmaster-General's Department. Particulars from Captain Muirhead Collins, 72, Victoria-street, Westminster. Tenders by Dec. 16.

Rawtenstall.—The Corporation invite tenders for the supply of lighting (high and low tension) cables, and tramway cables, conduits and accessories, trenching, etc. Applications to Mr. James Whalley, town clerk, by Nov. 29.

Buenos Ayres.—Tenders are invited for the construction of underground electric tramways. Particulars from the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London. Tenders by June 1, 1908.

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Bournville.—Tenders are invited for supply of various stores including packing, jointing, valves, rubber goods, belting, and electrical goods. Tenders to Messrs. Cadbury, Bros., Bournville, Birmingham, by Nov. 25.

Buenos Ayres.—Tenders are invited for (1) the construction of and (2) the concession to work the two principal sections of the underground electric railway. Particulars from the Argentine Legation, 12, Rue van Moer, Brussels. Tenders by May 1, 1908.

Aarhus.—The Commercial Intelligence Branch of the Board of Trade are informed by his Majesty's Consul at Aarhus that tenders are invited by the Lighting Department of that city for the supply of a turbine, dynamo, etc. (600 h.p.). Tenders by Nov. 30.

Adelaide.—The Deputy Postmaster-General for Queensland invites tenders for a common battery switchboard and 3,000 subscribers' telephones. Specification No. 166. Particulars may be obtained from the Commonwealth Offices, 72, Victoria-street, London, S.W. Tenders by Jan. 8, 1908.

Victoria.—The Deputy Postmaster-General at Melbourne invites tenders for the supply and delivery at Melbourne of 11 sections of a common-battery switchboard and 3,000 subscribers' telephones and other apparatus for telephone exchange, Windsor, in accordance with Victorian specification No. 148. Tenders by Jan. 7.

Gillingham.—The Corporation invite tenders for the erection of plant capable of effectually burning a minimum of 30 tons of refuse per day of 16 hours, the heat to be utilised in a water-tube boiler for raising steam in connection with the electricity works, Windsor-road, Gillingham. Tenders to the Town Clerk by Dec. 12.

York.—The North-Eastern Railway Co. invite tenders for the supply during six or twelve months from Jan. 1, 1908, of the following: telegraph apparatus, telegraph wire and line stores, arc lamp carbons, electric lamps, electric wires and cables, etc. Specifications, etc., from Mr. E. H. Clark, Stores, Gateshead. Tenders to the Secretary, at York, by Nov. 29.

Copenhagen.—The Commercial Intelligence Branch of the Board of Trade have received from the Acting British Consul at Copenhagen copies of the conditions and specifications relating to a call for tenders for the supply to the Danish State Railways of about 25 000 kg. of fencing wire, 20,000 zinc cylinders for electric batteries, 20,000 kg. of blue vitriol, and 30,000 discs of Morse paper. Tenders should reach Direktoren for Baneafdelingen, Gammel Kongevej No. 1 E, Copenhagen, by Nov. 27.

Spain.—The *Gaceta de Madrid* of Oct. 29 announces that tenders are invited for various materials connected with the 350 metres extension of the port of Almeria. The material called for includes six electric cranes and 108 iron cases for the same, also iron necessary for the construction of shelters, besides material for prolonging the eastern quay. Tenders to the Junta de Obras del puerto de Almeria not later than Nov. 28. Particulars from the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

RESULTS OF TENDERS.

Yarmouth.—The Board of Guardians have accepted the tender of Messrs. Bowers and Barr for fixing overhead telephones at the workhouse for £31. 10s.

Lewisham.—The Electricity Supply Committee recommend the acceptance of the tender of Baxter and Caunter, at £269. 8s. 8d., for the supply of rubber cable.

Maidstone.—The tender of Messrs. Johnson and Phillips for the supply of fireproof cable for the new dynamo at the price of £104. 6s. 8d. has been accepted.

Haslingden.—The Town Council have accepted the tender of the Thermit Co. for the welding of the joints of the tramway lines and the supply of copper for the bonding of the rails.

Grimsby.—The tender of Mr. A. J. Dolby has been accepted for alterations of the electric lights in the reference and lending libraries for £6. 13s. 6d.; £2. 10s. allowed for fittings.

Birmingham.—The Birmingham Tame and Rea District Drainage Board have accepted the tender of Johnson and Phillips, Charlton, Kent, for the supply of electrical pumping plant at £2,702.

Woolwich.—The Borough Council have accepted the tender of Henley's Telegraph Works Co., at £414. 10s., for the supply of additional feeder cable; and that of the Oliver Arc Lamp, Limited, at £70. 10s., for the supply of arc lamp carbons.

Stretford.—The Urban District Council have received the following tenders for lighting and traction mains:

W. T. Glover and Co., Trafford Park (approximate)	£4,147	13	1
Callender's Cable and Construction Co., London	1,258	2	6

Stepney.—The following tenders have been received for the supply of rubber cable:

Baxter and Caunter, 86, Charing Cross-road*	£269	8	8
W. T. Glover and Co., Trafford Park, Manchester	328	16	11
W. T. Henley's Telegraph Works Co., Blomfield-street, London-wall	328	17	0
India Rubber, Gutta Percha, and Telegraph Works Co., 106, Cannon-street	337	5	3

*Recommended for acceptance.

Bermondsey.—The Electricity Committee have received the following tenders for the supply of 2,350 yards of low-tension triple-concentric cable:

Johnson and Phillips*	£1,026	15	10
W. T. Glover and Co.	1,040	5	0
W. T. Henley's Telegraph Works Co.	1,045	0	0
Callender's Cable and Construction Co.	1,046	10	0
British Insulated and Helsby Cables	1,046	16	0
Siemens Bros. and Co.	1,055	10	0

*Recommended for acceptance.

Llandilo.—The following tenders have been received by the Urban District Council for supplying and laying about 200 yards of electric light cable, and for supplying and fixing four lamps: D. P. Davies, Llandilo, £69. 5s. (accepted); B. Thomas, Manchester; Johnson and Phillips, Charlton; Siemens Bros. and Co., Queen Anne's-chambers, Broadway, Westminster, S.W.; Western Electric Co., North Woolwich, London; G. Shilvock, Waterloo-road, Smethwick.

BUSINESS NOTES.

TRACTION.

Geneva Tramways Co. (1906).—The receipts for the month of October, 1907, totalled 213,927fr., being an increase on 1906 of 14,640fr.

Aberystwyth.—The Town Council have decided to call upon the Vale of Rheidol Light Railway Co. to place the line of railway to the harbour in a proper state of repair.

Hebburn.—The District Council have instructed their clerk to write to the Durham County Tramway Co. asking them to decide upon a scheme of tramways to serve the district.

Warmley.—The District Council are petitioning the Tramways Company to commence the proposed extension to Longwells Green forthwith. A further petition is being extensively signed by the inhabitants.

Madras Electric Tramways (1904).—The receipts for the fortnight ending Nov. 15 totalled Rs.17,431, an increase over 1906 of 15·4 per cent. The gross receipts from Jan. 1, 1907, was Rs.301,667, an increase of 20 per cent.

Macclesfield.—Notice has been given by the Macclesfield and District Tramways Co. of their intention to bring in a Bill for the abandonment of the obligations imposed upon them by the Macclesfield Tramways Act, 1906, to construct tramways between Hazel Grove and Macclesfield.

Leven. — A through service from Leven to Kirkcaldy was inaugurated by the tramway company in agreement with Kirkcaldy Corporation on the 13th. Cars are run every 20 minutes from Monday to Fridays, and every 10 minutes on Saturdays. An accelerated service is promised on Sundays.

Fulham.—It is stated that Fulham will offer an emphatic protest against the decision of the London County Council to construct an overhead system of tramways along the Fulham Palace-road, between Putney and Hammersmith. A public indignation meeting is about to be called by the inhabitants of the affected district.

Bexhill.—The electric tramway service between Bexhill and Hastings has been greatly improved by the running of through cars, which obviates the changing by passengers at West Marina. Cars have now been fitted so as to work on the trolley system which exists in Bexhill and on the surface-contact system on Hastings front.

Buenos Ayres and Belgrano Electric Tramways Co.—The receipts for the week ending Nov. 18, 1907, converted to gold were £4,107, and for the week ending Nov. 18, 1906, converted to gold, £3,684. Increase, £423. Aggregates from Jan. 1, 1907, £177,532, and from Jan. 1, 1906, £167,559. Increase, £9,973.

Willesden Green.—The Middlesex County Council have now completed their tramway at Willesden Green, but the Board of Trade have refused to allow it to be used, as the lines interlace in several places. This has been done with a view to economy and to avoid widenings, but the Board of Trade insist upon the widenings being carried out.

Dundee.—The members of the Council Tramways Committee paid a visit of inspection to the works in progress for connecting Downfield with the existing city tramway service. The members expressed satisfaction with the progress which was being made, and it is fully expected that the connection will be completed before the end of the year.

Cardigan.—The County Council have received a letter from the Light Railway Commissioners in which they informed the Council that the order for the construction of the light railway from Llandilo to Lampeter had been settled, and was now before the Board of Trade for confirmation. The clerk said he had not received final notice of confirmation.

Cheltenham.—Three employés of the Cheltenham Tramway Co. were descending Cleeve Hill, just outside the borough, on Nov. 20, on a lorry used for conveying material, when the lorry got out of control, and racing away, capsized a quarter of a mile from the bottom of the hill. Foreman William Smith, 30, was instantly killed, but the other men escaped by jumping off.

Pontypridd.—At a meeting of the Council Tramways Committee it was reported that, with regard to the tramways department, there were carried during the month 270.230 passengers, as compared with 145,374 in the corresponding period of last year, while the receipts amounted to £1,090 and £641 for the respective periods, thus showing a very satisfactory position of affairs.

Barry.—The District Council have agreed to ask Mr. Robert Hammond, of Westminster, to submit an estimate of the cost of the following tramways: (*a*) Whitmore Bay to Court-road as far as Wyndham-street; (*b*) Wyndham-street to Gladstone-square; (*c*) Gladstone-square to the Royal Hotel; (*d*) Court-road (Holton-road end) to Weston-hill, near to Wilfred-street.

Enfield.—An extension of the electric tramway from Lower Edmonton to the northern boundary of Enfield, where it joins the parish of Waltham Cross, is practically completed, and is expected to be opened in about a fortnight. It will be linked up with the Metro-

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politan Tramway Co.'s systems to Stamford Hill and Finsbury Park. Works are proceeding in connection with a further extension.

Wembley.—A special meeting of the Council was held to discuss the Middlesex County Council's application to the Board of Trade for extra grace of 18 months, dating from December, in which to complete among other light railways the tramways in the course of construction from Stonebridge to Wembley. The Council decided to protest against any further delay, seeing the progress that had been made with the work of laying the track.

Stoke Newington.—At the last meeting of the Borough Council, the following resolution was adopted: "That this Council calls the attention of the London County Council to the inconvenience and loss caused to the public by the present regulations as to return tickets on the North London tramway routes and requests that the tickets be made available at any time, the same as previously existed prior to the London County Council acquiring the tram system."

Halifax.—The Board of Trade were recently asked by the Halifax Corporation to nominate a mechanical engineer and an electrical engineer to inquire into the structural form of the Halifax tramcars and types of brakes. The Board of Trade have replied that they wish to preserve their impartiality, and suggest that the Corporation Tramways Committee should approach the societies of Electrical Engineers and Mechanical Engineers, or the Tramways Association, with a view to the nomination of two experts to conduct the suggested inquiry.

Bury.—The clerk to the Board of Guardians has interviewed the manager of the Bury tramways and the chairman of the committee with reference to the lighting of the main road to Bolton. An arrangement has been arrived at by which the Parish Council provides the lamps and fittings, and the Tramways Committee the current. There has been some small differences, and it cannot be expected that the lamps will be lighted on these conditions in perpetuity, but probably for a number of years, or as long as Ainsworth remains a parish council.

Paisley.—The Paisley and District Tramways Co. have issued a notice to the effect that the special workmen's cars leaving Glenfield in the evenings will be discontinued. It is stated that the reason of this action is that some passengers had been in the habit of interfering with the trolley poles and switches, and using abusive language to the conductors when these officials interfered. It is further stated that similar complaints had been made regarding cars on the Johnstone route, and the company may probably take extreme measures in that section also.

Southampton.—At the Council meeting the report of the Electricity and Tramways Committee which was submitted showed that the receipts from the tramways for the half-year ending Sept. 30 amounted to £28,253. The car mileage was 572,834, and there were 5,367,540 passengers carried. The traffic receipts per car mile were 11·837d., while the total receipts per car mile were 12·246d. After all expenses had been paid, there was an available balance for the depreciation and renewals fund for the half-year of £5,521, which was an increase of £2,320 on the figures for the corresponding half year of 1906.

Liverpool.—At the first meeting of the new municipal year of the Liverpool Tramways and Electric Lighting Committee the Lord Mayor said the undertaking controlled by the committee was hardly equalled in the country, either as a commercial undertaking or through its beneficial effect upon the population. He had the strongest hope and belief that the work would continue to yield that most admirable result. The traffic returns showed that during the fortnight ended Nov. 9 the receipts were £21,927. 2s. 4d., an increase of £676. 7s. 5d. on the corresponding period of last year. The passengers numbered 4,768,684, an increase of 156 836.

Cromarty and Dingwall Light Railway.—The Board of Trade have now confirmed a new order passed by the Light Railway Commissioners providing for a deviation railway to meet the views of certain proprietors and for other purposes. The difficulties of the past in regard to alignment, capital, and compensation have proved most formidable, but with one exception they have now been all surmounted. It is confidently expected that in the spring of next year the cutting of the first sod of the new line will take place, which, besides connecting Cromarty with the main line, will develop the latent possibilities of a large and rich agricultural district.

Mansfield Woodhouse.—An accident, which was fortunately unattended with serious consequences, occurred on the Mansfield tramway system at Mansfield Woodhouse at a late hour on Nov. 14, a car jumping the metals and dashing into a stone wall. It appears that the car was negotiating an awkward turn near the station, and owing to the wheels being locked through the brake having been applied, and to the fact that the metals were very greasy, it left the metals, ran along the road for nearly a dozen yards, and then crashed into a stone wall, part of which it demolished. The car had three passengers, one outside and two inside, but happily neither they nor the motormen were injured.

Seaforth.—The passengers on a Seaforth and Breckfield-road car which passed along Breckfield-road North, Liverpool, on the evening of the 14th, had a painful experience. A joiner named Aneurin Davies, who was returning from his work, and had been quite cheerful and talkative to his fellow passengers, was suddenly seen to reel over and become unconscious. The car was brought to a standstill, and Dr. Duncan was quickly summoned. He found on arrival that the man's life had passed away. The sensational occurrence caused a painful scene in the car, which was well filled. It is stated that the deceased had for some time past been under medical treatment for kidney and heart trouble.

Gravesend.—At the last meeting of the Council the town clerk reported that as the result of his negotiations with the solicitor to the tramway company the latter were prepared to accept £75 in full settlement of their claim for overcharge in respect of current supplied provided that the supplementary agreement varying the original agreement in so far as it related to the reading and recalibration of meters, etc., as settled by the company was accepted by the Corporation. The town clerk explained that the supplementary agreement was a friendly arrangement to secure satisfactory reading of the meters and that he had in conjunction with the electrical engineer practically settled the same with the company. The action of the town clerk was approved and the claim of the tramway company settled as suggested.

Rhondda.—A special meeting of the District Council has been held to consider the question of award by arbitration as to the widening and reconstruction of Taff Vale Railway bridges over the route taken by the Rhondda Valleys tramways, now in course of construction. It was stated that the Taff Vale Railway Co. had asked the award to be settled by way of a special case, which would involve litigation through the whole of the courts, and thus the work of construction of the tramways would be delayed, and as the company contested the Council's right to interfere in any way with the structure of the bridges the Council had determined to promote a Bill in Parliament in the terms of the notice already given. The Council approved of the parliamentary notice, which is being promoted without prejudice to the rights of either party.

Motherwell.—An alarming tramcar accident occurred on the Hamilton-road, Motherwell, on the 16th. A car proceeding downhill in the direction of Hamilton dashed into a two-horse van in which there were two boys, but both escaped unhurt. The driver was thrown into a hedge, but without sustaining much injury. The van, however, was thrown into the side of the road and was badly damaged. The car continued its career, and next dashed into a one-horse van, which was knocked off the road on to the pavement, and the horse was so badly injured that it had to be destroyed. The driver was thrown from his van on to a spiked railing at the tramway power station, and he hung suspended by the leg till released. A boy in this van was thrown against the fence, and 7in. of his scalp torn off. The car was crowded at the time, and there was a panic amongst the passengers.

Belfast.—At the weekly meeting of the Tramways and Electrical Committee on the 18th inst. the manager, Mr. Nance, recommended the building of a number of top covers for the cars, the cost being estimated at £117 each. The covers will be made in the Corporation workshops. At the meeting a voluminous report from the expert of the Citizens' Association was submitted, in which it was alleged that a sum of £48,210 had been overpaid in connection with the reconstruction of the tramway system of the city. Mr. Cutler, the city surveyor, said that he was prepared to stand over his figures, and courted the fullest investigation, and that he would prepare a report on the matter. A motion thanking the association for bringing the matter before the committee was defeated. The items in which it is alleged that overpayment was made include alleged errors in measurements of the line. The Corporation have every faith in Mr. Cutler's figures, and deservedly so.

Barnes.—The tramway question continues to be a source of the greatest anxiety to Barnes ratepayers, the greater number of whom are determined to make a firm stand against the introduction of tramcars. Owners of residential property in Castelnau are busily engaged in organising a meeting of protest. On Saturday notices were affixed to the lamp-posts in several streets signifying the Richmond Electric Light Co.'s intention to promote in the next session of Parliament a Bill authorising the construction of tramways to Richmond and Barnes. It is understood that the Richmond company will ask for powers for the construction of two tramways—one to start from the Fountain, Kew-road, *via* Lower Richmond-road, High-street, Mortlake, High-street, Barnes, to Castelnau and Hammersmith Bridge, and the other from Lower George-street, *via* Sheen-road and along the Upper Richmond-road, to Barnes Railway Tavern, from which it will run past Barnes Station, across the Common, and through Rock's-lane to Hammersmith Bridge.

Highgate.—On the 14th inst. the first electric car was driven over the newly-electrified tramway between Highgate and Highbury. Officials of the London County Council and representatives of the contractors (Messrs. Dick, Kerr, and Co.) travelled on the car, the progress of which was watched by large crowds of people all along the route. By the completion of this section the work of electrifying the whole of the tramway between Highgate and Moorgate-street (a distance of 4½ miles) has been finished, and a connection has also been formed with the electric trams which have their terminus in Aldwych. At the Highgate terminus the lines join up with those of the Middlesex County Council (which are worked by the Metropolitan Electric Tramways Co.), so that it will now be possible to travel by electric cars all the way from the City or Aldwych to High Barnet, in Hertfordshire, the fare for the whole distance being 6d. There has been no interference with the horse-drawn cars during the work of electrification, which has been carried out without a hitch or accident of any kind.

Melbourne.—According to Mr. Tait, chairman of the Victorian Railway Commissioners, the suburban railway revenue of Melbourne for the financial year ended June 30 last was £645,448. This, says the *Melbourne Argus*, does not include receipts from the carriage of parcels or mails, or items under the heading of "miscellaneous." During the same period the Melbourne tramway revenue amounted to £620,997. In tram and train fares, therefore, £1,166,455 was thus paid in 12 months. The population of Melbourne and suburbs being 531,000, this works out at £2. 4s. per annum, or 10¾d. per week, for each man, woman, and child. Making due allowance for what is paid by the non-resident population (people from the country and visitors from other states), it is evident that each suburban family must spend a considerable sum in travelling to and from their homes. The average number of journeys per head of population per annum is

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121 by the railways and 115 by the tramways. Our suburban revenue averages 2·41d. per passenger journey. The average passenger fare on the Melbourne tramways is 2·05d.

Chadderton.—At the meeting of the District Council a deputation from the Nimble Nook Improvement Society was received, and a petition was presented signed by upwards of 200 ratepayers (including a number of cotton-spinning concerns), asking the Council to endeavour to obtain tramways communication between the neighbourhood of Butler Green and Oldham. The deputation were told that the Council had already been considering the question of further tramway facilities for Chadderton, and had had a conference with the Oldham Corporation on the subject three months ago at which the matter was adjourned for further consideration, with a view to the formulation of some scheme likely to be acceptable to the Oldham Corporation and the urban district of Chadderton, which would have to guarantee the loss (if any) upon the working of the system. After a general discussion the Chairman assured the deputation that the petition and their statistics and arguments would receive full and sympathetic consideration by the Council, who would be glad to avail themselves of the society's assistance as opportunity might arise.

Morecambe.—A special meeting of the Town Council has been held to consider the expediency of purchasing the Morecambe Tramways Co.'s undertaking and to promote a Bill in the next session of Parliament to secure the necessary powers. The town clerk explained that notice to purchase must be given within six months from June 4, 1907. This referred to the earliest constructed portion of the company's line, but a second portion belonged to them until 1913, and a further portion was the property of the Corporation and was leased to the company. To make these matters fit it was proposed to embody in an agreement with the company a clause giving them running powers over the first portion in order that they might continue to utilise their lines in Heysham, and also to purchase the second portion over which the company had powers until 1913. If, however, no agreement was arrived at the Corporation could still proceed to secure parliamentary powers. It was decided to promote a Bill in the next session, and the town clerk was instructed in the necessary manner. The Morecambe Tramways Co. has a capital of £22,000, and last year paid 5 per cent., and this year will pay 3½ per cent. It has a balance to revenue account of £1,382 and a reserve fund of £2,700. There are no debenture holders or preference shares.

Plymouth.—At a meeting of the Corporation Tramways Committee on the 18th, two matters referred to them by the Council were considered. One was Mr. Johnson's motion to increase the wages of the able-bodied adult conductors in the tramway service to a minimum of 21s. per week. Some time ago the Council decided to pay all unskilled able-bodied adult male labourers in their employ a minimum wage of 21s. per week; but the tramway employés were not regarded as coming within this category. The committee, however, decided not to make any alteration in their remuneration, and rejected the proposal. The other matter discussed was the alleged breach of the contract of relaying the the track at Mannamead. On a previous occasion the committee reported that the contractor, Mr. W. C. Shaddock, sub-let certain portions of the work without authority, and that portions of such work were carried out by piecework and not by day work. They also found that the execution of the work under the contract occupied 10 days in excess of the time limit. While reporting these facts, however, the committee made no recommendation, and the Council referred the matter back to them with instructions to bring up some definite proposal. The committee were now informed that the Corporation had not been in any way prejudiced by the acts complained of, and they decided to recommend that no penalties should be enforced against the contractor.

West Bromwich.—A meeting of the West Bromwich Trades Council was held on the 13th, when the question of the carrying of lifting jacks upon the local tramway system was considered. The Chairman said he had made inquiries, and was informed that lifting jacks were now carried on all cars. It was stated that strict orders had been issued by the tramway company that no car must leave the depôt without a lifting jack. This applied not only to the ordinary cars, but special cars, and the orders were being carried out. A letter was received from the town clerk of Dudley (the secretary of the local authorities Joint Tramways Committee) on the subject of the stoppage of half-fares for children. He pointed out that that committee was bringing every possible pressure to bear upon the tramway company to continue the ½d. fares, but the company was acting within its statutory powers, so that they could only bring moral pressure to bear upon them. It was mentioned that the West Bromwich Town Council had been asked to grant a concession to the company in the shape of permission to run smaller cars and a less frequent service than provided for in the original agreement, and the Trades Council passed a resolution that in view of the attitude of the tramway company on the question of half-fares for children the Town Council be called upon to refuse any concession and to enforce the original agreement.

LIGHTING AND GENERAL.

Wireless Station Destroyed by Fire.—The Marconi wireless tion at Siascouset, Massachusetts, has been destroyed by fire.

Atcham.—The Rural District Council have given permission for the placing of telegraph poles between Stapleton Common and Longden.

Springhead.—The Board of Trade have agreed to allow the Urban District Council further time in order to put the Springhead electric lighting order into force.

Walsall.—The Council have authorised their clerk, on the recommendation of the Finance Committee, to raise loans to the amount of £5,394 for the electricity undertaking.

Dover.—The Admiralty have decided to erect a large electricity station at Dover for power and lighting for the Naval Harbour. The contract for the work has been secured by a Dover contractor.

Notice of Intended Dividend.—The *London Gazette* announces that the last day for receiving proofs in the estate of A. Matson, electrical engineer, 10, Hardwick-terrace, Stockton-on-Tees, is Nov. 30.

Hertford.—The Hertford and Ware Joint Hospital Board have decided to have the telephone connected with the scarlet-fever block of the hospital and the administrative block and from thence to the matron's bedroom.

West Ham.—The Wholesale Co-operative Society have decided to contract with the Corporation for an electricity supply to their soap factory at Silvertown. The contract is based upon an annual consumption of 5½ million units.

Arbroath.—A direct-current three-wire station is about to be put down generating at 500 volts, and it is hoped by offering the current at a low rate for power to induce the flax manufacturers and others in the district to use the supply

Physical Society.—It is announced that the third annual exhibition of electrical, optical, and other physical apparatus will be held at the Royal College of Science, South Kensington, on Friday evening, Dec. 13, from 7 to 10 o'clock.

Liquidations.—The *London Gazette* states that a general meeting of the members of the N.S. Electric Storage Co. will be held at 139, Queen Victoria-street, London, E.C., at 2 p.m. on Dec. 16, for the purpose of receiving the liquidator's report.

Dundee.—On the recommendation of Mr. Richardson, the Electricity Committee last night appointed three of their number to look out for suitable sites for two of the sub-stations in the Clepington and Lochee districts in connection with the new generating station scheme.

Gravesend.—The Council have agreed to an extension of the mains in Ferndale-road. An offer from the National Telephone Co. to place part of the private wire of the sanatorium on their poles, thus doing away with most of the wayleaves, and maintaining such part at £7 per annum, has been approved.

Beckenham.—The Electricity Committee have reported that they are not prepared to consider the question of free wiring the Railway Hotel unless a guarantee of consumption for a substantial number of years is given, and with this instruction the matter has been referred back to the officers for further negotiation.

Newcastle.—At a meeting of the Lighting Committee of the Corporation on the 19th, Alderman Barker Ellis was re-elected chairman. It was decided to recommend the Watch Committee to approach the City Council with a view to seeing whether an extension of the electric lighting in Westgate-road could not be made.

Brierfield.—In connection with the proposed electrical supply, a report prepared by the surveyor and the accountant *re* electricity generating station in towns of a similar size to Brierfield was read at the last meeting of the District Council, and a sub-committee was appointed to visit the towns chosen from the report.

Pontypridd.—At a meeting of the Pontypridd District Council Electricity Committee on Tuesday, Mr J. E. Teasdel, engineer and manager, reported that the revenue derivable in respect of the electricity generated during the preceding four weeks amounted to £608, as compared with £473 in the corresponding period of last year.

Clitheroe.—A new electric light plant has been completed at Cobden Mill, Clitheroe, owned by Messrs. J. Stallard and Sons. The mill, which during the installation has only been running from light to dark, has now commenced to run full time. The Town Council have succeeded in securing a renewal of their electric lighting order for a further period of 12 months.

Ashton.—At the ordinary meeting of the Corporation Electricity Committee the monthly list of applications for the supply of electricity was read and approved, among which was one for a cable to be laid to a tannery in Whitelands to supply current for a motor, and this was granted, subject to the owner entering into an agreement to take the current for a period of not less than three years.

Dundeee.—Overgate was on the 13th inst. lighted for the first time with electricity. The old gas lamps have been discarded, and the new light introduced with effects which were universally regarded as satisfactory. The new lamps have been so arranged that the light is diffused from the centre of the thoroughfare overhead, and the latest specially-prepared carbons have been introduced.

South Wales Electrical Power Distribution Co.—Authority from Parliament is sought to sanction the working arrangement entered into between the South Wales Electrical Power Distribution Co. and the Treforest Electrical Consumers' Co., the sale of the Neath and Bridgend stations, repeal of the Carmarthenshire Act of 1903, and the annulment of agreements for the supply of power to local and other bodies.

Willington.—A letter from the County of Durham Electrical Supply Co. was considered at the last meeting of the Urban District Council. In it the company stated that their price for private consumption would be 3¾d. per unit, less 5 per cent., providing the Council allowed the company to erect overhead poles. They would erect steel lattice poles instead of wooden ones at the same price to meet the Council's wishes. The latter course was agreed upon by the Council.

Cullen.—There was laid before the last meeting of the Town Council a letter and plan from the Telephone Co. asking permission to erect poles in the town where shown on the plan. Permission was granted at a rent of 1s. per pole per annum during the pleasure of the Council, and on condition that the poles be erected to the satisfaction of the Streets and Roads Committee, along with the surveyor, and having special regard to any possible obstruction of traffic.

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Acton.—The Electricity Committee have considered a report from the electrical engineer (Mr. J. M. Blair) on the use of electricity for side-street lighting, instead of gas as at present. In the course of a discussion it was pointed out that cables are being laid in the streets, and by the time that the Council generates its own electricity Acton would be covered with cables. It would then be possible to light the district with electricity at about half the cost of gas.

Oldham.—The engineer's report which was submitted to the Council Electricity Committee at their last meeting showed that the number of lamps connected to date was: arc, 638; incandescent, 23 388; motors, etc., 348; equivalent lamps of 8 c.p., 103 340; increase during fortnight of arc, 2; incandescent, 100; motors, etc., 2; equivalent to lamps of 8 c.p., 1,901; making a total of arc, 640; incandescent, 23,488; motors, etc., 350; equivalent to lamps of 8 c.p., 105,241.

Morley.—The borough electrical engineer reported at the last meeting of the Council Electric Lighting Committee that the output from the electricity works for the month ending Sept. 30 was 13,703 units, as compared with 11.859 the same period of last year, being an increase of 1,844 units. There had been sold to consumers by meter 10,108 units, against 8,735 the same month last year, being an increase of 1,373 units. Thirty motors had been connected up to date with an aggregate of 97 h.p.

Emsworth.—At the monthly meeting of the Urban District Council it was proposed that the Council take into consideration the lighting of Emsworth by electricity. It was stated that the Havant Council were also considering the lighting of that town with electric light, and as the Portsmouth Corporation were bringing the power to the Alexandra Hospital, it would perhaps be an inducement for them to come on to Havant and Emsworth if an application was made. The matter was referred to committee, most of the Council supporting the scheme.

Essay-Writing Competition on Wireless Telegraphy.—We publish in our advertising columns to-day particulars of an interesting essay-writing competition promoted in connection with the Dorset Field Club. The "Cecil" medal of solid silver and a prize of £5 in books or instruments will be awarded to the writer of the best paper on "Wireless Telegraphy." Candidates must be between the ages of 18 and 30, and either born in Dorset or have lived there for twelve months. Full particulars may be obtained of Mr. H. Pouncy, *Dorset County Chronicle* Office, Dorchester.

Bridgend.—The clerk to the Bridgend District Council has written to the Guardians: "The Council are favourably considering the question of the extension of their system of electric lighting at Merthyrmawr-road, and have decided that the extension shall at once be carried out as far as the corner of Grove-road. In view of the extension they are asking whether the Board of Guardians would be disposed to become consumers of energy for lighting at the cottage homes in the event of the cable being extended." The Guardians have referred the letter to the Cottage Homes Committee for consideration and report.

Whitehaven.—At the meeting of the Town Council Electricity Committee the electrical engineer reported on the progress which was being made with the erection of the new condensing plant, and stated that it should be ready for a trial run during the course of the following week. It was resolved that there be an opening ceremony in connection with the new condensing plant, and that the chairman of the committee be asked to formally set the engine running. It was also agreed that the steam-piping at the electricity station be altered in accordance with the suggestion of the electrical engineer, and that the piping thus thrown out of use be sold.

Stoke Newington.—At the last meeting of the Borough Council letters were received from the Islington and Finsbury Borough Councils referring to the recent increase in the price of gas supplied to public lamps and to the re-imposition of meter rents, and stating that the Board of Trade had been approached with the object of urging that a Government inquiry be ordered with a view to the protection of the public interests and to prevent further charges being made. A proposal recommending the adoption of a scheme for the erection and equipment of an electricity generating station at an estimated cost of £3,700 is to be considered at the next meeting.

Greenock.—The new electricity station of the Greenock Corporation in Dellingburn-street was opened last week. The Corporation some time ago decided to build a refuse destructor, and as the electricity department has been producing its full capacity of current for several years, it was decided that the heat available from the burning of the refuse should be utilised for raising steam for the further production of electricity. The destructor is not yet completed, but the latter part of the scheme has now been started, and the Corporation can now meet the demand for electricity for lighting and traction purposes. The total cost of the destructor and electric power station is estimated at about £41,700.

Wood Norton.—Messrs. R. Dawson, Limited, carried out a very large temporary electric light installation, including complete generating plant, with steam-engine, at the Duke of Orleans' estate at Wood Norton, Worcestershire, in connection with the wedding of Princess Louise of France and Prince Charles of Bourbon, which took place there on the 16th inst. Over 300 men were employed night and day erecting a chapel, banqueting hall, kitchen, etc., and into these temporary buildings upwards of 500 lights were installed. A part of the extensive grounds also was illuminated, eight projectors being used for this purpose, and for flooding the courtyard between the duke's house and the temporary buildings.

Battersea.—The six months' working of the electricity department, from April to September, 1907, shows an increase of 14 per cent. in the income over the figures of 1906 and an increase of 24 per cent. in units sold over the same period. With regard to the cost of production, the coal costs have been reduced by 30 per cent., and the total costs have been reduced by 26 per cent., which means that the cost of production on an increased load of 24 per cent. is less than that of the corresponding period last year—a saving of £580. 9s. 3d. and an increase in the revenue of £1,421. 18s. 4d. The cost per unit sold is ·5d. less than the corresponding period last year, which means a saving on the total units sold of over £2,200.

York.—About 2 30 on the morning of the 13th inst. there was a breakdown of the York electrical service, due, it is believed, to water penetrating into the conduits. The streets which are lighted by electricity, the post office, and other places where there are electrical installations, were plunged into total darkness, and throughout the day considerable inconvenience was experienced by the users of electric motors, of which there are a large number in the city. Some time elapsed before the defects could be located, but the engineering staff were able to execute such temporary repairs as to remedy some part of the breakdown by noon, whilst by four o'clock in the afternoon the repairs were completed and the full service renewed.

Telegraph Construction Across the Sahara.—Some interesting particulars of telegraph construction in the Sahara Desert are given in a Canadian paper, the *Victoria Times*. In order to avoid interference with camel caravans the wires have to be supported at a height of 15ft. from the ground, and are carried on hollow steel poles 18ft. long. As the latter have to be transported on the backs of camels they are made telescopic, so as to close up to a length of 5ft., and are extended and locked when erected. The line already constructed extends through Algeria to Beni Abbes, a distance of 150 miles. Thence it will be carried to Adrar, 800 miles south of the Mediterranean in the heart of the desert, and finally the Burem on the Niger, a stretch of 860 miles.

Hastings.—The Electricity Committee have had before them the provisions of the agreement of Aug. 8, 1899, entered into by the Corporation with the Southern Electrical Installation and Wiring Co., and on July 17, 1903, assigned by the liquidator of the company to Mr. Frederick Bruce. Having regard to the fact that for some considerable period no premises had been wired under the provisions of the agreement, and to the probability of statutory powers being at no distant date conferred upon undertakers generally under the Electric Lighting Acts to themselves undertake work of this description, they recommended that the necessary six months' notice be given to Mr. Bruce to determine the agreement, and the Town Council have adopted the recommendation.

Liverpool and District Electrical Association.—On Tuesday, the 19th inst., a meeting of the above association was held at the Common Hall, Hackins Hey, Liverpool, when the subject of "Commutation of Direct-Current Machines" was further considered, and some very helpful remarks were contributed by Mr. J. J. Richardson (vice-president), illustrated by sketches. On Saturday, Nov. 23, by kind permission of the Canadian-Pacific Railway, the members will pay a visit to the ss. "Empress of Britain," in the Sandon Dock, at 3 15 p.m. On Dec. 3, at Chapman's Vegetarian Café, Eterle-street, Dale-street, Liverpool, a paper will be read by Mr. G. V. Bird on "The Localisation and Remedy of Faults in Motors and Dynamos." Meeting commences at 8 p.m.

Scotstoun.—Messrs. Yarrow and Co. have adopted electric power for their new works at Scotstoun, except in the case of the steam-power hammers in the smiths' shops. The electric current is supplied from the Clyde Valley Co.'s works at Yoker, which are about a mile further down the Clyde. The power is taken from the company's mains at 11,000 volts, three phase, 25 cycles, and led to the sub-station at Messrs. Yarrow's works, where it is transformed by oil-immersed static transformers of 600 kw. capacity to 400 volts. The Clyde Valley Co. have also contracted, in addition to Messrs. Yarrow's installation, to supply current to Messrs. Napier and Miller's shipyard at Old Kilpatrick, the Clyde Trust workshops and slip at Renfrew, and the Coventry Ordnance works at Scotstoun. Each of these forms a complete electrically-driven equipment.

Manchuria. — In the development of the telegraphic system in Manchuria, the Japanese are pursuing an active policy. They have established telegraph lines at Yingkow and to the south of that place, and have opened public offices at Yingkow and several other places. They have connected the Japanese lines with the railway telegraph lines connecting with Dalny, where the lines are joined by cable with Japan and the rest of the world. Japanese offices accept messages to all parts of the world, and charge Japanese rates. China has protested, but without avail. Negotiations are at present proceeding between China and Japan in regard to the South Manchurian railway telegraphs. Russia has agreed to China's demands in respect of the North Manchurian railway telegraphs, and has concluded a convention with her.

Stock Exchange.—Applications have been made to the Stock Exchange Committtee to appoint a special settling day in and to grant a quotation to Mexico Tramways Co.'s 6,000,000dol. common stock, in shares of 100dol. each. The committee have also been asked to appoint a special settling day in Hampden Cloncurry Copper Mines' further issue of 10,000 shares of £1 each, fully paid, Nos. 200.001 to 210.000; Rheinbach Copper Mines' 30,007 shares of £1 each, 15s. paid, Nos. 1 to 30,007. The committee have further been asked to allow Victoria Falls Power Co.'s 800,000 preference shares of £1 each, fully paid, Nos. 1 to 800,000, to be quoted in the official list. The committee have appointed Nov. 27 special settling day in Boston Consolidated Copper and Gold Mining Co.'s further issue of 59 905 shares of £1 each, fully paid, Nos. 548,036 to 607.940, and have ordered Shawinigan Water and Power Co.'s 6,500 000dol. capital stock, in shares of 100dol. each, to be quoted in the official list.

Newport.—Some months ago the Corporation applied to the Local Government Board for power to borrow a sum of about £10,000 for the extension or their electrical undertaking. An inquiry was held

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by a Local Government Board inspector, who went into the finances of the undertaking very minutely. Amongst other information given was that the revenue account had an adverse balance of £2,861. A meeting of the Electricity and Tramways Committee was held on the 15th, when a letter was read from the Local Government Board stating that the Board could not entertain the question of a further loan on capital until this adverse balance shall have been dealt with by the Corporation. A sub-committee was appointed to confer with Mr. Lewis Haslam, M.P., and Colonel Sir Ivor Herbert, M.P., with a view to an interview with the President of the Local Government Board on the question.

Cheltenham.—The report upon the working of the Corporation electricity undertaking presented by the borough electrical engineer, Mr. Walter J. Bache, to the Electricity and Lighting Committee at their meeting last week is the best ever yet published. The revenue account shows an income of £23,369 and an expenditure of £9,175, giving a gross profit of £14,194. Financial charges for the year amount to £10,261, so that during the year the undertaking made a net profit of £4,050. From this, however, must be deducted £2,051, the interest upon and annual instalments towards the repayment of the loan to cover the accumulated deficit of former years. There is, therefore, a balance of £1,999 on the year, and with a balance brought forward of £1,873 the committee have a sum of £3,872 at their disposal. This excellent result is largely due to economies at the works, in spite of the increased cost of coal, so that the average cost of production per unit sold has been reduced from 1·17d. to 1·08d.

Shrewsbury.—The statement of the Electric Lighting Committee to the Town Council shows an increase of 10·6 per cent. in the number of the Board of Trade units of current sold as compared with the corresponding quarter of last year. With respect to the gas lighting, the committee regret to report that the gas tester had to bring under their notice the fact that, according to the tests made by him, the illuminating power was below that prescribed by the Act, and that the quantity of sulphur per 100ft. was excessive; for instance, on two specific occasions his sulphur test showed 35·15 grains per 100ft., the maximum allowed under the repealed regulations was 20 grains per 100ft. With respect to the illuminating power, three observations were specially taken, which gave an average of 14·41 candles, which was below the standard of 15 candles. The gas company did not admit the accuracy of these tests, but the inspector is absolutely certain as to the correctness of the tests, and pointed out that the gas company had not up to the present ever admitted being in the wrong.

Southwark.—At the last Council meeting the Electric Light Committee reported that they had had under their consideration a report from the electrical engineer stating that the question of additional plant at the electric light station was a matter which would require the early and serious attention of the committee in order to ensure a sufficient amount of stand-by plant for next winter, and to meet the demand for power and lighting which might reasonably be expected by them, and as the manufacture of the generating plant would not take less than eight to ten months, it was desirable that a decision should be come to as soon as convenient. As it was at present, the load during the present winter would leave only one of the large sets spare, and additional consumers would encroach on that during the next few weeks. The engineer also submitted statistics showing that it would cost something like £14,500 to provide the necessary plant, etc., to meet the growing demands of consumers, and he estimated that the outlay would be warranted by financial results; as, for instance, that with the installation of additional plant, and taking the past year as a moderate basis on which to arrive at an average for the next three years, by the time the whole of the proposed expenditure had been incurred the output would have reached 2,000,000 units per annum, and the total income would have been increased by just over £3,000, sufficient to meet all charges and provide a substantial reserve. The committee, in spite of this report, were unable to recommend the necessary additions to the plant, but the Council over-ruled them.

PROVISIONAL PATENTS, 1907.

Nov. 11.

23285A. Improvement in or relating to the supporting or carrying of dynamo-electric machines. Hugh Christopher Cole Cornish Silver, 173, Fleet-street, London. (Date applied for under Rule 5 of the Patents Rules, 1905, Oct. 9, 1907.)

24923. Improved method and apparatus for telephonic communication between railway trains and stations. Wilhelm Dugász, Simon Káldor, and Béla Szende, 18, Southampton-buildings, London. (Complete specification.)

24930. Improvements in the system and mechanism for automatically signalling and controlling electrically-driven trains. Albert Edward Hodder and William Robert Taylor Carr, 108A, Cannon-street, London.

24933. Improvements in devices for measuring the rate of the charging and discharging of an accumulator or storage battery. Alfred August Konradin Gese, 65, Chancery-lane, London. (Complete specification.)

24954. Improvements in and relating to distributors for electric ignition systems of internal-combustion engines. Francis Leigh Martineau, 70, Chancery-lane, London.

24992. Improvements in dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

24993. Improvements in signals for railways and the like. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

Nov. 12.

18013A. Improved contact arrangement and stand for incandescent lamps. Nikola Kessler and Giovanni Jelich, 100, Wellington-street, Glasgow. (Date applied for under Rule 5 of the Patents Rules, 1905, Aug. 8, 1907.)

18013B. Improvements in means for transmitting rotary motion from a motor. Nikola Kessler and Giovanni Jelich, 100, Wellington-street, Glasgow. (Date applied for under Rule 5 of the Patents Rules, 1905, Aug. 8, 1907.)

25026. Improvements in magnetic brakes. Edgar Harry Cockshott and Alfred Walter Maley, 408, Meanwood-road, Leeds.

25070. Improved trolley head or collector for electrically-propelled vehicles worked on the overhead conductor system. Herbert Brown, 33, Chancery-lane, London.

25089. Improvements in and connected with the manufacture and construction of the electrodes of secondary batteries. Henry Garde, 38, Chancery-lane, London.

25095. Improvements in autographic telegraphs. Richard Joseph Crowley and Alfred Wood Somers, 24, Southampton-buildings, London.

25096. Improvements in coherers suitable for use in wireless telegraphy. Richard Joseph Crowley and Alfred Wood Somers, 24, Southampton-buildings, London.

25115. Improvements in systems of generating and distributing electric current. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

25116. Improvements in dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

25117. Improvements in electric arc lamps. The British Thomson-Houston Company, Limited, and William Herbert Dalton, 83, Cannon-street, London.

25118. Caloric output indicator for alternating electric currents. Vittorio Arcioni, 7, Southampton-Buildings, London. (Complete specification.)

25123. Improvements in and relating to electric meters. Vittorio Arcioni, 4, South-street, Finsbury, London. (Complete specification.)

25126. Improvements in apparatus for the electro-deposition of metals. Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London. (Complete specification.)

Nov. 13.

25148. Improvement in or relating to electric ignition in combustion engines. Elson Ashton and George Henry Ashton, 4, St. Ann's-square, Manchester.

25187. Improvement in telephone silence cabinets. Horace James Quilter, Broad Sanctuary-chambers, Westminster.

25198. Improvements in electrical crushing machines. Robert Hacking and Oswald Robert Mounsey, Broad Sanctuary-chambers, Westminster.

Nov. 14.

26560A/06. Improvements in and relating to electrically-operated locks and fastenings. Edward Burns, 4, Corporation-street, Manchester. (Date applied for under Rule 5 of the Patent Rules, 1905, May 21, 1907.) (Complete specification.)

25272. Device for electrically welding overlapping or superposed metals. William Edward Evans, 27, Chancery-lane, London. (Allgemeine Elektricitäts-Ges., Germany.) (Complete specification.)

25286. Improvements in or relating to electric telegraphy. Sidney George Brown, 7, Southampton-buildings, London.

25304. Improvements relating to incandescent electric test or like lamps. Harry Brough, 18, Southampton-buildings, London.

25305. Improvements in and relating to the regulation of electric motors. Arthur Scherbius, 18, Southampton-buildings, London. (Complete specification.)

25309. Improvements in connection with dynamo-electrical machines. Felten und Guilleaume-Lahmeyerwerke Act.-Ges., 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Nov. 14, 1906, being date of application in Germany.) (Complete specification.)

25313. Improvements in alternating-current commutating electric machines. Allgemeine Elektricitäts-Ges., 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Nov. 15, 1906, being date of application in Germany.) (Complete specification.)

Nov. 15.

25324. Improvements in electro-depositing apparatus. Wilson Hartnell, Volt Works, Kirkstall-road, Leeds.

25331. Mode of signalling by electric current between existing signal-boxes and the cab of a railway engine and the like. Oswald Fowler and Walter Thomas Rayment, 61, Fairholt-road, Stoke Newington, London. (Complete specification.)

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25333. Improvements in the manufacture of electric accumulators for sparking apparatus and for lighting in motorcars and for traction purposes. William Thomson, Royal Institution Laboratory, Manchester.

25340. Improvements in and connected with electric track circuits for railways. Frank Bartholomew Holt and Arthur Wallis, Imperial-chambers, Albert-street, Derby.

25350. Improvements in continuous-current dynamo machines. José Arenas y Garcia, 31, Bedford-street, Strand, London. (Date applied for under Patents Act, 1901, Aug. 2, 1907, being date of application in Spain.) (Complete specification.)

25354. New electric vulcaniser. Fred Swain and George Lees Baker, 23, Wellington-street, Castle Hill, Northwich.

25355. Improvements in and relating to electric arc lamps. Pierre Marie Capitaine, 43, Boulevard Voltaire, Paris, France.

25388. Improvements in conduits for protection of electrical conductors inside buildings. Arthur William Sclater, 182, Oxford-street, London.

25397. Improvements in and relating to metering devices. Sebastian Ziani de Ferranti, 18, Southampton-buildings, London.

25398. Improvements connected with the raising and lowering of arc lamps and the like. Adolph Wunderlich and Gwylim Anwyl Hughes, 18, Southampton - buildings, London.

25402. Improvements in telegraph sounders. Dennis Abner Whitney, Fife House, Kingston-on-Thames. (Date applied for under Patents Act, 1901, Nov. 15, 1906, being date of application in United States.) (Complete specification.)

Nov. 16.

25426. Improvements in or connected with portable electrical vibratory apparatus. Felix Singer, 57, Chancery-lane, London. (Complete specification.)

25444. Improvements in electrical ignition devices for internal-combustion engines. Victor Barreto, 37, Essex-street, Strand, London.

25448. Improvements in microphones and telephonic receivers. Victorien Tardieu, 118, Holborn, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Dec. 5.)

1906.

22647. Safety portable manual electric generator for lighting miners' safety lamps. Bowie and Phelps.

25202. Electric controllers or switches. British Thomson-Houston Company. (General Electric Company.)

25203. Electric motor control systems. British Thomson-Houston Company and Sporborg.

25569. Electric block signals. Finnigan.

25863. Current-collecting devices for electrically-propelled vehicles. British Thomson-Houston Company. (General Electric Company.)

26211. Electrolytic production of metallic sheets, tubes, wire strip, or the like. Cowper-Coles.

16212. Anodes for electrode position. Cowper-Coles.

26664. Manufacture of magnetic material. Hadfield.

26665. Manufacture of magnetic material. Hadfield.

29123. Electrical apparatus for lighting gas. Nehmer.

1907.

244. Electrical automatic signalling systems for railways. Sayers.

727. Leads for improving commutation in dynamo-electric machines. British Thomson-Houston Company. (General Electric Company.)

1334. Electrical switches. Morris and Lister.

4583. Apparatus for automatically opening and closing electric circuits. Brookes. (Foote, Wolfe, and Young.)

5332. Wireless telegraph or signalling systems. Dunwoody. (Date applied for under International Convention, March 23, 1906.)

5576. Apparatus for treating electric conductors, especially applicable in the manufacture of filaments for incandescent electric lamps. British Thomson-Houston Company. (General Electric Company.)

6498. Electric sparking devices. Jeffery and Jeffery.

6603. Coin-freed electricity meters. Tourtel.

6675. Electric bells. Fischer.

9921. Electric heaters. Howell. (Date applied for under International Convention, May 7. 1906.)

11262. Electrical measuring instruments. Northrup. (Date applied for under International Convention, May 26, 1906.)

12761. Telephone transmitters and receivers. Jankelowitz.

13837. Electric signalling apparatus. Allgemeine Elektricitäts Ges. (Date applied for under International Convention, June 16, 1906.)

23351. Electric searchlights. Geb. Siemens und Co. (Date applied for under International Convention, Nov. 6, 1906.)

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £	Last price. £
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70 000	1 ..	⅛ ⅜
—— Ord., 1,125 000	1 ..	¼ ½
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 ..	⅜ ½
—— Ordinary, Nos 1 125,000	1 ..	3/16 5/16
British Aluminium Co., Ordinary, 2,001-40 000	5 ..	3¾ 4¼
—— 7 per cent. Cum. Pref., 1-40 000	5 ..	4½ 5
—— "A" 6 per cent. Cum. Pref., 1-20 000	5 ..	4½ 5
—— 4 per cent. Funding Certificates, 1-20 000	5 ..	3¾ 4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	100 103
—— 5 per cent Loch Leven Deb. (Reg.) Red., 1-3 000	100 ..	96 99
British Insulated and Helsby Cables Ord., 1-100,000	5 ..	6½ 7
—— 6 per cent. Cum. Pref., 1-100 000	5 ..	5⅞ 6¼
—— 4½ per cent. Mortgage Debentures	100 ..	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	85 89
British Westinghouse Elec. and Manuf. 6 per cent Pref., 275,001-375 000	3 ..	¾-1¼
—— 4 per cent. Mortgage Debenture Stock	100 ..	55 65
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	0-½
—— Non. Cum., 6 per cent., Pref.	2 ..	⅜-½
—— 4½ per cent 1st Debenture Stock	100 ..	83-86
—— 4½ per cent. 2nd Debenture Stock	100 ..	67-70
Callender's Cable, Debentures	100 ..	105½-107½
—— Ordinary	5 ..	9½-10½
—— 5 per cent. Pref.	5 ..	5½-5⅝
Consolidated Electrical Co., Ordinary, 1-110,000	1 ..	7/16-9/16
Crompton and Co.	3 ..	1⅝-1⅞
—— 5 per cent Debentures	100 ..	96-99
Dick, Kerr and Co., Ordinary, 1 260 000	1 ..	1¼-1½
—— 6 per cent. Cum. Pref., 1-305,000	1 ..	1-1¼
—— 4½ per cent. Debenture Stock, Red.	100 ..	101-104
Edison and Swan United, "A" Shares, 1-99 261	5 ..	13/16-1 1/16
—— "A" Shares 01-017,139	5 ..	2-2½
—— 5 per cent. Debentures	100 ..	87-90
—— 4 per cent. Deb. Stock, Red.	100 ..	79-82
Electric Construction, Nos 1 to 112 100	2 ..	1/16-3/16
—— 7 per cent. Cumulative Pref.	2 ..	¼-1
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	59-61
Electrolytic Alkali Co., Ordinary, 1-202,218	1 ..	3/16-5/16
Ferranti, Limited, 5 per cent 1st Mort. Deb. Stock Red	100 ..	—
General Electric Company (1900) 5 per cent. Cum. Pref.	10 ..	8-8½
—— 4 per cent 1st Mort. Deb Stock	100 ..	89-92
W. T. Henley's Telegraph Works, Ordinary	5 ..	10½-11½
—— 4½ per cent. Preference	5 ..	5- ½
—— 4½ per cent. Debentures	100 ..	105½-107½
India Rubber, Gutta Percha, and Telegraph Works	10 ..	14½-15½
—— 4 per cent. Debentures	100 ..	96-98
National Electric Construction Co., 1-170,000	1 ..	13/16-15/16
Parker, Thos., Limited, Ordinary	10 ..	10-10¼
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5 ..	—
Telegraph Construction and Maintenance	12 ..	27-30
—— 5 per cent. Bonds	100 ..	99½-102½
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10 ..	8¼-9¼

Electric Lighting and Supply.—

Name.	Amount paid. £	Last price. £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10 000	5 ..	4½-5
Bournemouth and Poole, Ordinary	10 ..	9½-10½
—— 4½ per cent. Cum. Pref., 7 501-15 000	10 ..	9⅝-10⅜
—— 6 per cent. Cum. Second Pref., 15 001-22,500	10 ..	9⅝-10⅜
—— 4½ per cent. Debenture Stock, Red.	100 ..	98½-102½
Bromley (Kent) Electric Light and Power Co.	5 ..	4⅜-5⅛
—— 4½ per cent. 1st Debenture Stock, Red.	100 ..	95-98
Brompton and Kensington, Ordinary	5 ..	7-8
—— 7 per cent. Preference	5 ..	7-8
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5 ..	6-7
—— Nos. 80,000-100 000	5 ..	5½-6½ xd
Cambridge Electric Supply Company £10 Ord.	8 ..	12½-13½
Canadian General Electric Co., Common Shares	$100 ..	88-92
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100 ..	98½-101½
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5 ..	3⅛-4⅛
—— 4½ per cent. Cum. Pref., 1-80 000	5 ..	3⅜-3⅝
—— 4 per cent. Debenture Stock, Red.	100 ..	96 99
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5 ..	3⅜-3⅝
—— ditto (1903) 40,001-80 000	5 ..	3¼-4¼
Chelsea Electricity Supply	5 ..	3¼ 4¼
—— 4½ per cent. Debentures	100 ..	102-105
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000 ..	—
City of London, Ordinary	10 ..	9-10
—— 6 per cent. Cumulative Pref.	10 ..	1 1-1¼
—— 5 per cent. Debenture Stock	100 ..	122-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	95-98
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1 630	50 ..	50-53
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100 ..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10 001-50 000	5 ..	3½-4½
—— 5 per cent. Preference 1-50,000	5 ..	4⅜-4½
County of London Elec. Supply, Ordinary	10 ..	6¼-7¼
—— 6 per cent. Cum. Pref.	10 ..	10-10½
—— 4½ per cent. Debentures Prov. Certs. All pd., Red.	100 ..	100-103
—— 4½ per cent. 2nd Debentures Prov. Certs.	100 ..	9 -93
Edmundson's Electricity Corporation, Ordinary, 1-50 000	5 ..	¼-1
—— 6 per cent. Cum. Pref.	5 ..	1-1⅜
—— 4½ per cent. First Mort. Deb.	100 ..	76-81
Electrical Development Co. of Ontario 5 per cent. 1st Mort. 30-year Gold Bonds, 10 751-15 750	— ..	76-79 p.c.
Electric Lt. & Traction Co. of Aust., 6 p.c. Cum. Pf., 1-30,000	5 ..	2½-2⅝
—— 5 per cent. Debenture Stock, Red.	100 ..	85½-89
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red.	100 ..	94-96
Folkestone Electric Supply, Ord., Nos. 1-10 000	5 ..	4⅜- ½
—— 5 per cent. Cum. Pref., Nos. 1-10 000	5 ..	4⅜-5⅛
—— 4½ per cent. First Deb. Stock Red.	100 ..	96-99
Hove Electric Lighting, Ord., 1-13 000	5 ..	6½-7
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100 ..	101-104
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk., Red.	100 ..	92-95
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref. 1-150 000	1 ..	1/16-3/16
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000	5 ..	8-9
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100 ..	98-102
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9½-10½

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Name.	Amount paid. £	Last price. £
London Electric, Ordinary	3	1¼-1⅜
—— 6 per cent. Pref.	5	3⅜-4¼
—— 4 per cent 1st Mortgage Debenture Stock, Red.	100	89-93
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red (Prov. Certs.), all paid	100	92-95
Metropolitan Ordinary, 100,001-00,000	5	5¼-5⅜
—— 4½ per cent. First Mortgage Debenture Stock	100	103-107
—— 4½ per cent. Cum. Pref.	5	4¼-5
—— 5½ per cent. Mortgage Debenture, Red.	100	57-92
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds 1935, C 1-1,000 ($100), D 1-3,000 ($500), M 1 4,000 ($1 000)	—	7 -73 p.c.
Mexican Light and Power Co., Capital Stock	$100	37 39
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14 000 ($1,000)	—	79-81
Midland Electric Power Dis., 4½ p.c 1st Mort. Deb.	—	95½ 98½
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009	5	6¼-7
—— do., 57 010-75 000	5	6¼-6⅜
—— do., 75,001-87 500 (issued at £2 prem., 16s. paid)	5	6¼-6⅜
—— 5 per cent., Pref., 1-57,003	5	5-5½
—— do., 75,001-87,500 (issued at 10s. prem., 4s paid)	5	5-5½
Notting Hill Electric Lighting	10	10¼-11½
—— 4 per cent. First Mort. Debs. Nos. 1 500 (Reg.)	100	95-97
Oxford Electric, Ordinary, 1-96 and 40 14,310	5	5¼ 6
—— 4 per cent. Debenture Stock	100	95-97
River Plate Electricity Co., Ord., 1-119 687 & 120,501-120 507	1	9/16-11 16
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	⅛-1
—— 5 per cent. Debenture Stock, Red	100	95 98
Rosario Electric Co., 6 per cent. Cum Pref., 1-20 000	5	4⅜ 5¼
—— 6 per cent. Cum 2nd Pref., 1-15,000	5	4⅜ 5⅜
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	86 98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	—	99-101 p.c.
Smithfield Markets Electric Supply. Ord., 1-12,000	5	¼ 1⅛
—— 4 per cent. Debenture Stock	100	71-75
South London Ordinary	5	2-2¼
South Metropolitan Electric Light and Power, Ord.	1	⅛-⅜
—— 7 per cent Cum Pref.	1	15/16-1 3/16
—— 4½ per cent. 1st Mort. Deb.	100	99 102
St. James's and Pall Mall, Ordinary, 101-20,080	5	7¼ 8¼
—— 7 per cent. Pref.	5	6-7
—— 3½ per cent. Deb.	100	86-91
Urban Electric Supply Co., Ordinary, 8-30 007	5	1⅜ 2⅛
—— 5 per cent. Cumulative Preference, 50 001 80,000	5	1⅝-2⅜
Westminster, Ordinary	5	8-9
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	4¾-5¼

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine, 6 per cent. Cum Pref., 1-260,007	5	5⅜-5¾
—— Ord.	5	7-7¼
—— Permanent 6 per cent Debenture stock, 1888	100	128-141
Auckland Elec Trams., 5 p.c. 1s Mor. Deb. Stk., Red.	100	102-105
Barcelona Tramways, Ord., 1-20 000	10	—
—— 5 per cent. Cum. Pref. shares, 1-10,000	10	—
—— 5 per cent Deb., Red., 1-600	100	—
—— 4½ per cent. Red. Deb. Stock	100	—
Bath Elec Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1	11/16 13/16
—— 5 per cent. Cum. Pref. Shares, 1-75 000	1	1316/-15/16
Birmingham and Midland Trams., 4½ p. c 1st Db. Stk., Red.	100	94-97
Blackpool and Fleetwood Tramroad	10	13⅜-13⅞
Bombay Elec. Supply and Trams Co., 6 per cent. Cum. Pref.	8	7¼-8
—— 4½ per cent. Deb. Stock, Red.	100	94-96
Brisbane Tramway Invest., Ord., 1-75,000	5	3-3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4¼-4⅜
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	96-100
British Columbia Electric Railway Co., Ord Def.	100	128-133
—— Ord. Pref.	100	112-116
—— 5 per cent. Cum. Perpetual Pref. Stock	100	101 105
—— 4½ per cent. 1st Mt. Debs., Nos. 1 6,250, of £40 each	40	98-101
—— 4½ per cent. Vancouver Power Deb.	100	100-103
British Electric Traction, Ord. 1-300 000 & 60,001-90,000	10	1¼-2
—— 6 per cent. Cm Pf., 30,0001-60 000	10	4⅜ 5⅛
—— 5 per cent. Perpetual Debenture Stock	100	93-96
—— 4½ per cent 2nd Deb. Stock	100	74-78
Bueno Ayres and Belgrano Trams	5	4¼-4⅜
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	4⅜-5¼
—— "B" 6 per cent. Cm. Pf., 1-27 500	5	4⅜ 5¼
—— 5 per cent. Deb. Stock, Red.	100	105 115
—— Prov. Cert., all paid	100	104-105
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100	91-95
Buenos Ayres Gd Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100	99-103
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	98-103
Buenos Ayres Lacrcze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	91-94
Calcutta Tramways, 1-105,000	5	6⅜-7⅛
—— 105,001-137,610	5	5 5¼
—— 4½ per cent. 1st Deb. Stock. Red.	100	100 104
Cape Electric Tramways, Nos. 1-480,000	1	⅛-⅜
City of Birmingham Tramways, 5 per cent. Cum Pref.	5	4¼-4⅜
—— 4 per cent 1st Mortgage Deb., 1-3 000 (1917)	100	95-99
City of Buenos Ayres Trams. Co. (1 04), 1-248,000	5	4⅞-5¼ xd
—— 4 per cent. Deb. Stock, Red. 1985	100	98-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	93-97
Cork Electric Tramway and Lighting Co., Ordinary	10	13-14
—— 6 per cent. Cum Pref.	10	12¾-13⅜
—— 4 per cent. Debentures	100	90-95
Dublin United Tramways (1896), Ord., Nos 1-60 000	10	12 -13½
—— 6 per cent. Pref., Nos. within 1-60 000	10	12⅞-13⅜
—— 3½ per cent. Mort. Debs., 1-3,000 Red	100	90-95
Hastings and Dist. Elec. Tram Co., 4½ p.c. Deb. Stk., Red.	100	97-100
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1,000	85-90
Imperial Tramways, Ordinary	all	18-19
—— 6 per cent. Cum. Pref.	all	14-14½
—— 4½ per cent. Deb. Stock	100	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30 001-60,000	5	⅞-1⅜
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100	66-71
Kalgoorlie Electric Tramways, 1-250,000	1	1/16-⅛
—— 5 per cent "A" Deb. Stock	100	89-93
—— 6 per cent "B" Deb. Stock	100	74-78
Kidderminster and District Lighting and Traction, Pref.	5	10- 0½
Lancashire United Tramways, Limited, 5 per cent Prior Lien Deb. Stock, Red.	100	94-97
—— £296 500 2nd Mort Deb. Stock	—	—
—— £83, 30 Deferred Deb. Stock (all fully paid)	—	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1	⅞-1⅛
—— 6 per cent. Cum. Pref., Nos 1-425,553	1	⅞-1⅛
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100	92-97
London United Trys. (1901), 5 per cent. Cum. Pref.	10	7½-8¼
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100	82-86
Madras Elec Trams. (1904) 5 per cent. Deb. Stk., Red.	100	96-99
Manila Elec. R.R. and Lightg. Corp., 5 p.c. 1st Lien and Coll Tr Sinkg Fund Gold Bonds of 1953, Red., 1-1,635	$1,000	90-92
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 201-21,635 and 23,436 25 000	—	4½ 5
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100	96-99
Metropolitan Elec Trams., Defd., 1 000.001-1 314 016	1	1/16 3/16
—— 5 per cent. Cum Pref. 500,001 1,000 000	1	13/16- 5/16
—— 4½ per cent. Deb. Stock, Red.	100	93-96
Mexico Trams. Co., Gen. Cons 1st Mort 50-year 5 per cent. Gold Bonds	—	79-81 p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con. Mort Bonds, 1926 1-5,500 and 7 001-8,000	$1,000	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 601-2,000 1922	100	101-103
New General Traction, 6 per cent. Cum Pref., 1-10 000 and 34 001-74 000	5	⅜-1⅜
Oldham, Ashton, and Hyde Tramway, Ordinary	10	2
—— 5 per cent. Cum. Pref.	10	8¾-9
Perth Elec. Tramways (W.A.) 5 per cent 1 Mrt. Deb. Stk.	100	100 103
Potteries Electric Traction, Ordinary 1-245 000	1	5/16-9/16
—— 5 per cent Cum Pref., 300 001-545 000	1	⅛-⅜
—— 4½ per cent Debenture Stock	100	93 96 xd
Provincial Tramways Co., Ordinary 1-24 912	10	5-5½
—— 6 per cent. Cum. Pref., 1-10 000	10	10¼-11¼
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum Pref., 1-20,000	5	5-5½
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100	97-99
Sao Paulo Tramway, Light, and Power Co.	$100	103-107
—— 5 per cent. 1st Mort. Deb., Red. 1929, 1-11,000	$500	91-93 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1	⅝-1⅛
—— 4 per cent. Deb Stock, Red. 1940	100	80-84
Sunderland District Electric Tramways, 5 p.c 1st Mort. Debs., Red., 1-1 600	100	84-88
Yorkshire (West Riding) Elec Tram Co., Ord., 70,001-110,000	5	1-1¼
—— 6 per cent Cum Pref., 1-46,261	5	3⅛ 3¾
—— 4½ per cent. 1st Deb. Stock, Red.	100	84-87

Electric Railways.—

Name.	Amount paid £	Last price. £
Central London, Ordinary	100	57-60
—— 4 per cent. Pref.	100	83-85
—— " " deferred	100	4 -43
—— 4 p c Deb. Stock (Prov. Script Certs., fully paid)	100	10 -104
City and South London, Consolidated Ordinary	100	43-45
—— 4 per cent Debenture Stock	100	101-103
—— 5 per cent. Pref. Stock '91	100	116-119
—— " " " '96	100	113-116
—— " " " '01	100	113 116
—— " " " '05	100	108-111
Liverpool Overhead, 5 per cent. Pref	10	10-10½
—— Ordinary, 1-50 000	10	3¼-4⅛
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	34-38

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price. £
Amazon Telegraph Co., 1-25,000	10	3-3¼
—— 5 per cent. Debs., Red., within 1-1,069	100	85-88
American Telephone and Telegraph Coll. Trust 4 per cent. Bonds, 1-28 000 and 53,001-78 000	$1 000	89-91
Anglo-American Telegraph Co., Ordinary	100	54-57
—— 6 per cent. Preferred Ordinary	100	95-98
—— Deferred Ordinary	100	13¾-14¼
Anglo-Portuguese Telephone Co., 5 per cent 1st Mort. Deb. Stock, Red.	100	99-102
Chili Telephone Co., 1-44 000	5	6¾ 7¼
Commercial Cable Co., Ste., 500-year 4 p.c. Deb. Stk., Red.	100	84-88
Cuba Submarine Telegraph Co., Ordinary, 1-16 000	10	6 7
—— 10 per cent Preference, 1-6 000	10	15-16 xd
Direct Spanish Telegraph Co., Ordinary	5	3¼-3⅜
—— 10 per cent Cum. Preference	5	8¼-8⅝
—— 4½ per cent Debs., 1-600	50	98-101
Direct United States Cable Co.	20	12¼-13¾
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100	100-102
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100	97¼-100½
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8 000 1913	25	98-100
Eastern Extension, Australasia and China, 1-300 000	10	11¼-12¾
—— 4 per cent. Mort. Deb. Stock, Perp.	100	98-102
Eastern Telegraph Co., Ordinary Stock	100	122-127
—— 3½ per cent. Preference Stock	100	8 -85
—— 4 per cent. Mortgage Debenture Stock	100	99-102
Great Northern Telegraph Co. (of Copenhagen)	10	30-33
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1 200, Red.	100	99-101
Indo-European Telegraph Co.	25	52-55
Marconi's Wireless Telegraph Co., Nos 255,128-284,190	1	⅜-⅝
Monte Video Telephone Co., Ordinary 1-72,680	1	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492	—	⅞-1
National Telephone, Preferred	100	106-108
—— Deferred Stock	100	104-106
—— 6 per cent Cum. First Pref.	10	10¾-12¼
—— 6 per cent Cum. Second Pref.	10	10-12
—— 5 per cent Non Cum. Third Pref.	5	5¼-5⅝
—— 3½ per cent. Deb. Stock, Red.	100	96-98
—— 4 per cent Deb. Stock Red.	100	100-102
Oriental Telephone and Electric Company	1	1⅛-1⅜
—— 6 per cent. Cum Pref	1	1⅛-1⅜
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1 000	100	97-100
United River Plate Tele. Co., Ordinary, 1-100 000	5	7-8
—— 5 per cent Cum. Pref., 1-40,000	5	5-5½
—— 5 per cent. Debenture Stock, Red.	100	—
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	98-101
West African Telegraph Co.	10	10-10¼
West Coast of America, 1-50 000 and 53 001-53,008	2½	1 1/16-1 5/16
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100	97 100
West India and Panama Telegraph Co., Ordinary	10	7/16-9/16
—— 6 per cent. Cum. 1st Preference	10	6¾-7⅜ xd
—— 6 per cent. Cum 2nd Preference	10	6¼-7¼
—— 5 per cent. Debs., Red., 1-800	100	99-102
Western Telegraph Co., 1-207,930	10	12¼-13¼
—— 4 per cent. Debenture Stock, Red.	100	98½-101½

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1907.	1906.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Passenger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Nov. 13	1,191	1,183	+ 7	— h	25½	25	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	,, 17	1,019	965	+ 53	− 176	8	8	,, 15	14,528	3,316,380	363,945	t	9·71	1,830	5·16
Baker Street and Waterloo Ry.	,, 16	2 845	2,115	+ 750	† 17,545	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 10	1,018	981	+ 37	− 225	23·53	24·53	March 31	55,025	11,145,531	1,309,903	1·18	10·08	2,338b	6·03
Birmingham Corporation	,, 16	6 368	—	—	—	56½	—	,, 31	17,133	4,709,788	266,526	86	14·5	8,366	—
Blackburn Corporation	,, 13	1,091	980	+ 110	+ 2,487	24	24	,, 25	48,875	8,661,720	986 953	1·35	11·89	2,036	7·44
Blackpool Corporation	,, 14	357	332	+ 45	− 1,334	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	Oct. 26	311	279	+ 32	− 1,139	16½	16½	Dec. 31	31,846	2,325,677	579,264	3·28	13 19	—	7·27
Bolton Corporation	Nov. 17	2.174	1,914	+ 260	+ 4,749	42	40	March 31	95 766	20,205,196	2,161,130	1·13	10 63	2,394	6·14
Bournemouth Corporation	,, 13	1,339	1,239	+ 100	+ 1,071	17·41	16·82	,, 31	55,276	10,058,288	1,121,623	1·32	11 83	3 226	7·19
Bradford Corporation	,, 16	4,547	4 212	+ 335	+ 3,162	95	95	,, 31	230,085	47,108,000	5,053,392	1·172	10 927	2,396	—
Brighton Corporation	,, 11	715	707	+ 8	− 2,706	9½	9½	,, 31	50,339	11,321,160	1,152,82	1·06	10·48	,914·5	8·0.4
Bristol Tramway Company	,, 15	4 735	4,532	+ 203	—	51½	51½	Dec. 31	259,799	45,312,373	6 127,135	—	—	—	—
Burnley Corporation	,, 16	1,424	1,296	+ 128	—	40	40	March 31	57,992	11,092,704	1,197,772	1·31	11 61	5,388	8·17
Burton Corporation	,, 17	247	—	- 21	- 467	8½	8½	,, 31	17,950	3,878,269	454,082	1·07	9·21	2,0 8	6 76
Cardiff Corporation	—	—	—	—	—	32 62	†32·26	,, 31	112,209	24,134,363	2,770,049	1·12	9·72	3,782	9 44
Carlisle Tramways Company	,, 16	180	172	+ 8	− 534	8·5	8·5	Dec 31	10 713	2,935 002	359,756	—	7·14	—	5.18
Central London Railway	,, 16	6,223	7,003	− 780	− 15,954	6	6	,, 31	347,588	4,875,547	1,281,214	1·86	65·10	57,931	5·80
Charing X, Euston, & Hamp. Ry	,, 16	2 565	—	—	—	8	—	—	—	—	—	—	—	—	
City and South London Railway.	,, 17	3,230	2,918	+ 312	+ 8,783	6½	6½	,, 31	—	—	—	—	—		
Colchester Corporation	,, 6	191	191	- 1	—	8	8	March 31	10,588	2,457,653	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	,, 14	398	397	+ 1	- 804	15½	15½	Dec. 31	24,895	5,814,376	882,256	1 01	6·64	—	4·69
Croydon Corporation	,, 15	1,281	—	+ 23	—	12 c	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 15	250	214	+ 6	− 17	7 23	7·23	March 3	—	—	—	—	—	—	—
Dover Corporation	,, 16	162	190	- 28	- 1,069	4½	4½	,, 31	11,250	2 853,200	284,343	·94	9·49	2,100	
Dublin and Lucan Electric Ry.	,, 15	99	95	+ 4	+ 231h	6½	6½	Dec 31	6,358	402,511	113,738	3 79	13·78	942	7 33
Dublin U.T.	,, 15	5,189	4,500	+ 638	+ 30 842	48½	48½	,, 31	267,489	50,050,949	7,077,372	1· 8	9 07	691	5 56
Dundee City Tramways	,, 13	1,102	1,018	+ 84	+ 821	22	22	May 15	52,154	13 086 396	1,005 911	·906	1·96	2,180	7·42
East Ham Corporation	,, 16	803	796	+ 7	- 105	14	14	March 31	56,652	3,689,658	863,816	64	10 18	2,994	6 79
Glasgow Corporation	,, 16	17,248	16,243	+1,005	+12,605h	79½	79½	May 31	756,480	195,767,519	17,946,595	—	0 12		—
Gloucester Corporation	,, 13	241	234	+ 7	—	15	15	March 31	15,466	3,902,077	563,596	·0	6·68	999	5·32
G.N., Piccadilly and Brompton.	,, 16	4 930	—	—	—	9	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	37	37	,, 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 16	1 538	1,403	+ 135	+ 2,695	35	35	,, 31	69,938	12,838,150	1.665,262	1·24	9·71	1,923	—
Hull Corporation	,, 16	2,479	2,300	+ 179	+ 4,216	26	26	,, 31	112,651	27,104,921	2,910,698	1	9·29		—
Ilford Corporation	—	—	—	—	—	10½	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 14	133	122	+ 11	+ 274	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	11,586	3,626,656	419,800	7·27	6 62	1,480	5 22
Lancashire United Tramways	,, 13	1,218	1.041	+ 177	+ 13,632	39	38	—	—	—	—	—	—	—	—
Leeds Corporation	,, 16	6,364	6,004	+ 360	+ 9,413	89½	89½	March 25	298,233	64.223 666	7,121,038	1 10	·0 02	351	—
Leicester Corporation	,, 16	2,146	2 121	+ 25	—	42	42	Dec. 31	26,011	12 039,252	1,229,507	1	9·79	—	4 82
Liverpool Corporation	,, 9	10,871	10,783	+ 88	+ 8,105	104	104	,, 31	547 625	116,642 663	12,166 419	—	—	—	—
Liverpool Overhead Railway	,, 17	1,393	1,351	+ 41	+ 1,781h	6·65	6 65	June 30	81,302	11,171,865	1,024,275	—	—	—	—
London County Council	,, 9	32 239	25,268	+7,071	+169 532	98	98	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 16	169	155	+ 14	—	6	6	Sept. 30	14,511	3,128,867	359,435	1 08	9·68	2 630	6·48
Maidstone Corporation	—	—	—	—	—	2	2	March 31	4,740	850,121	112,227	1·33	10 13	2,370	
Manchester Corporation	,, 16	14,248	13,177	+1,071	+ 35,538	149	149	,, 31	631,966	126,800,875	14,123,124	1 19	10 73	4,299	6·99
Metropolitan District Railway	,, 16	8,724	8,618	+ 106	− 331	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 17	15,585	15,449	+ 136	+ 5,963	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 16	138	128	+ 10	− 16	2½	2½	,, 31	6,159	1,992,647	206,358	82	7 14	2,239	—
Newcastle-on-Tyne Corporation	,, 16	4,020	4,018	+ 2	+ 683	50	50	,, 31	197,849	43,061,934	4,326,152	1·07	10·98	3,867	7·0
Newport (Mon.) Corporation	,, 16	614	575	+ 39	+ 1,802	15½	15½	,, 31	30,356	7,252,535	783 435	—	9 29	—	6·4
Oldham Corporation	—	—	—	—	—	34	34	,, 25	65,553	13,466,245	1,504,740	1 16	10·45	1,886	—
Portsmouth Corporation	May 25	2,330	1 578	+ 752	+ 632	28½	28½	,, 31	95,702	19,625,329	197,499	1·17	11 63	—	—
Reading Corporation	Nov. 7	581	590	- 9	- 738	33½	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	11·29	21·29	,, 31	14,881	2,837,110	386,547	1·24	9·24	1,102	7 92
Rotherham Corporation	—	—	—	—	—	9½	9½	,, 31	23,569	5,251,472	593,054	1 07	9·53	2,612	7·49
Salford Corporation	,, 18	4,360	4,053	+ 307	+ 4,573	70¾	70¾	,, 31	214,111	39,213,560	4,894,580	1·28	10 29	—	—
Scarborough Tramways Co.	—	—	—	—	—	4½	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 17	5,593	5,077	+ 520	+ 9,136	35¾	35¾	,, 25	240,565	63 952,283	,049,899	903	9 543	3,653	5 04
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,365	9 294,771	1,108,369	1·27	11·02	—	7 83
Southend-on-Sea Corporation	,, 13	271	258	+ 13	- 60	9	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	,, 31	39,550	6,766,031	1,027,730	—	9 23	—	4 75
Sunderland Corporation	,, 17	1,273	1,262	+ 11	- 769	20	20	,, 31	64,858	15.364 463	1.496.685	1·004	10·36	—	6 37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	4,937	1,315,757	102,751	0·87	11 53	1,371	—
Torquay Tramways	Nov 14	164	—	—	—	5·16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 16	753	704	+ 49	+ 791	13 68	13·43	,, 31	43,607	7,996,451	862,12	9·27	12·14	3,13	7 50
Warrington Corporation	—	—	—	—	—	9	9	,, 31	17,057	4,418 225	403 363	—	9 85	—	6·33
West Ham Corporation	,, 14	2,085	2,090	− 5	+ 1,451	14·7	14·7	,, 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	,, 13	901	800	+ 1	+ 260	20	20	,, 31	41,905	8.847,066	960,338	—	10 585	2,062	6·15

† And 98 miles of interlacing track. a Train mile. b Per mile of single track. c Miles of route. h Half-year's figure k Double track.

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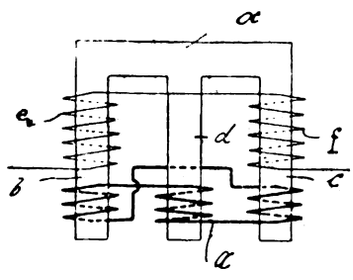
NOTES.

Finsbury Technical College Old Students' Association.—The success which attended the dinner held in December last has encouraged the council to make arrangements for a similar gathering before the close of the present year. The second annual dinner will take place on Wednesday, Dec. 11, at the Criterion Restaurant, Piccadilly-circus, W., at 7 p.m. for 7.30 o'clock, when the chair will be taken by Mr. C. G. Redfern, president of the association. The cost of tickets will be 5s. Any old students (day or evening) desirous of attending should communicate with one of the following: Mr. S. E. Gritton (mechanical), Talfourd Cottage, Reigate, Surrey; Mr. E. W. Moss (electrical), 20, Huddleston-road, Tuffnell-park, London, N.; Mr. F. H. Carr (chemical), Kelvin, Church-avenue, Sidcup, Kent.

North-East Coast Institution of Engineers and Shipbuilders.—This institution opens its twenty-fourth session to-night (Nov. 29) in the lecture theatre of the Literary and Philosophic Society, Westgate-road, Newcastle-on-Tyne, when, among other business, a paper on "Notes on the Effect of Work and Time on the Properties of Mild Steel and Iron" will be read by Mr. J. H. Heck. The second general meeting of the session will be held in Newcastle-upon-Tyne on Friday, Dec. 20, 1907. The following papers will be read and discussed: "Notes from Four Years' Working of the Educational Committee Recommendations," by Mr. W. G. Spence; "Floating Docks," by Mr. H. R. Jarvis. On Jan. 24, 1908, Mr. J. Hamilton Gibson is down for a paper on "Torsion Meters as applied to the Measurement of the Horse-Power of Marine Steam-Turbines."

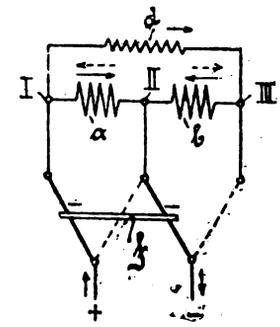
Humming of Alternating Electromagnets.—For the purpose of preventing humming the Lahmeyer Company have recently patented the arrangement shown in the illustration. Besides the working winding, *e f*, on the two outer limbs there is an auxiliary winding of a few turns on the middle core. This auxiliary winding is short-circuited



through a few turns on the outer limbs, and, owing to the inductive effect, a current is induced in it out of phase with the main magnetising current. The result is that the pull of the magnet never falls to zero, as is the case with an ordinary single-phase magnetising coil. Our contemporary, *Elektrotechnik und Maschinenbau*, recently published a description of the above patent.

Victorian Railways.—In view of the important developments that are expected to take place in the electrification of the Victorian State Railways, it is of interest to turn to the results of the working of the St. Kilda and Brighton Electric Street Railway for the year 1906 7, statistics concerning which appear in the report of the Railway Commissioners. This line has been extended a distance of 1·06 miles. The expenditure at June 30, 1907, on account of the construction of the line was £38,635, and for rolling-stock was £14,304, a total of £52,939. The revenue of the line for the year was £9,590, and the ordinary working expenses £7,451, equal to 77·70 per cent. This would have left a net revenue of £2,139, or £159 in excess of the amount required to meet the interest at the rate of 3·74 per cent. on the total capital cost at June 30, 1907—viz., £1,980—but, unfortunately, a fire took place at the power-house and car-sheds on March 7, which destroyed the sheds and the bodies of 17 cars, and did considerable other damage. The estimated cost of making good the loss and damage done by this fire is £15,200, of which £9,941. 2s. 2d. had been expended at June 30. This expenditure was incurred for replacement purposes, and has been debited to the working account, making the net loss for the year in the operation of this line, including interest charges and expenses as above, £9,782. The average mileage of railway worked was 4·62, and the car mileage 303,777; 1,030,242 passengers were carried at an average fare of 2·21d.

Residual Magnetism in Electromagnetic Switches.—In certain apparatus it is essential to ensure rapid loss of magnetisation on switching off, and, according to *Elektrotechnik und Maschinenbau*, the Lahmeyer Company employ the arrangement shown in the diagram with this



object. *a* and *b* are the windings of two electromagnets, one or the other of which is switched out by the action of the switch, *f*, for the purpose, for instance, of putting one or the other of two spur wheels into gear with a constantly rotating wheel. The two coils are connected in series and are bridged by a resistance, *d*. With the switch in the position shown, coil *a* is traversed by a current in the direction of the full-line arrow. When *a* is to be demagnetised and *b* to be magnetised the switch is moved to the dotted position, and then the principal current passes round *b*, but at the same time a small reversed current flows through *a* and *d*, as shown by the dotted arrow.

Institution of Electrical Engineers.—The Council announce that they will be glad to receive papers on subjects of interest to electrical engineers, either for discussion at general meetings or for publication in the *Journal* as original communications. Members are, therefore, specially invited to submit papers in any of the following sections, or on other suitable subjects not included in one of these classes: (1) traction, light, and power distribution; (2) telegraphs and telephones; (3) manufacturing; (4) electro-chemistry or electro-metallurgy. The Council state that their work in arranging the plan of the session would be greatly facilitated if, whenever possible, authors proposing to contribute papers would first communicate with the secretary, who will also supply information as to the preparation of manuscript and drawings in the form most suitable for reproduction in the pages of the *Journal*. Papers which, having been accepted by the Council for publication, are printed in the *Journal* are eligible for premiums, whether read at an ordinary general meeting or at a meeting of a local section, or published as an original communication. For those papers which are adjudged by the Council to be sufficiently meritorious the following premiums are awarded: For papers read before the Institution—the Institution premium

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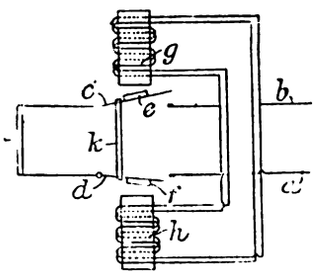
value £25; the Paris Electrical Exhibition premium, value £10; the Fahie premium, value £10. For original communications not read at a meeting, but published in the *Journal* of the Institution—one premium, value £10; one premium, value £5.

Electric Distribution.—A patent recently granted to Mr. J. S. Highfield describes an electric distribution system for direct currents in which two or more conductors are arranged in parallel, each being provided with a device by which it may be cut out of the system on becoming earthed. The current from one of the 'bus bars of a central station passes by way of the switches, *c d*, to the circuits, *a b*, arranged in parallel. Electromagnets, *g h*, are provided with two opposing windings, each of which is



connected in series with the circuits, *a b*. If the conductor *a* becomes earthed, the excessive current flowing through it excites the electromagnet *g*, which attracts the polarised armature, *e*, thus breaking the circuit *a* by the switch *c*. To prevent the electromagnet *h* from opening the switch *a*, the arm of the switch *c* is attached to a hook bar, *k*, which engages with the arm of the switch *d*, and locks it in its closed position. When used in high-tension systems, the opening of the switch is retarded by a dash-pot or like device in order that the regulating gear of the generator may reduce the voltage before the circuit is opened.

Concerning Exhibitions.—Next year promises to be a very busy one as far as exhibitions are concerned, and electrical manufacturers who intend exhibiting must be in some way concerned as to which of the exhibitions should receive their favour. There is, of course, the electrical exhibition to be held in Manchester which is being organised under the auspices of the National Electrical Manufacturers' Association. This is an exhibition which manufacturers can hardly fail to ignore, seeing that it is receiving such influential support from an important industrial area. The fact that it is being taken in hand by the trade, which is joined for the occasion by many leading professional men, and others, who represent big purchasers of electrical materials (both heavy and light), cannot but impress manufacturers of the suitability of such an exhibition as a business medium. Elsewhere in the columns of this issue we publish a statement as to the position of affairs concerning this exhibition, which, we think, indicates a satisfactory outlook. Then there is the Franco-British Exhibition to be held in London next year. Although this exhibition will make a popular appeal by reason of the variety of its display and the attractiveness of the entertainments which it will hold, there is no gainsaying the fact that the commercial and industrial classes both in this country and in France will bestow upon it a great deal of attention. The engineering section promises to be representative of the most important manufactures, and the action of the Institution of Electrical Engineers in giving its patronage to the electrical section is justified by the display which certain of the largest electrical manufacturers will make. A visit to the extensive grounds at Shepherd's Bush last week showed that the work in connection with the construction of the various pavilions is progressing favourably, and there is no doubt about the work being fully completed in time for the opening of the exhibition in May next year. Nor must we forget to mention the international exhibition of the applications of electricity to be held next year in Marseilles. This exhibition, too, is to be held in an important centre, where electricity is extensively used, and where there are many prospective applications.

Rail Corrugation.—German electric railway engineers are no less troubled than their English confrères with the question of rail corrugation, and that the problem continues to attract their earnest attention is evident from an elaborate report thereon presented by the Track Committee of the German Street and Interurban Railway Association at a recent congress in Mannheim. This report was based principally upon experiments with dummy wheels and rails of different degrees of hardness, and from these trials the conclusion arrived at is that corrugation arises when the strains on the track approach or equal the elastic limit of the rail. A copy of the report appears in our contemporary, the *Street Railway Journal*, from which we abstract the following as being the most interesting conclusions arrived at. The phenomenon just mentioned is said to occur (1) when the wheel tyre is harder than the rail head; (2) through sliding wheels caused by quick, intensive braking, too sudden application of power in starting, slipping in curves, inequalities in hardness of the rail head, etc.; (3) increase in pressure on the rail per wheel, particularly of the part not flexibly supported; (4) increase of speed. A practical demonstration may be given with regard to the physical changes in wheels and rails. Electric railway service in Hamburg was commenced about 1894, but at first the old wheel tyres, which were as hard as the rails (tensile strength of 60-65 kg. per square millimetre). No corrugation occurred. In 1896 harder wheel tyres (92 kg. per square millimetre) were introduced, and corrugations appeared as rapidly as the new wheels were introduced. Not only did they occur on the new rails but also on the old ones, which through years of service had never shown this phenomenon before. In one instance a change from steam railroad operation with soft-tyre wheels to electric service with hard-tyre wheels on one of the old lines quickly produced corrugation.

Newcastle Local Section.—The opening meeting of this section of the Institution of Electrical Engineers was addressed by the chairman, Mr. James Pigg, who chose as his subject that of education. It will probably come as a surprise to many to be told after this that we are neglecting the educational needs of our industrial community, for the reports of the various technical and engineering societies that have appeared during the past few weeks indicate the contrary to be the case. So much attention has been bestowed upon the subject recently, that one might almost imagine that it has not long been discovered, and might be tempted to ask how it was that we attained industrial pre-eminence in the absence of a properly organised system of technical education. Most of the papers that we have read dealing with this subject have been of interest, and, including that from Newcastle, have borne a certain value, inasmuch as they draw attention to defects discernible in our educational system. But in the majority of cases the criticism has been destructive rather than constructive, and it is improbable that an acceptable system would be formed from the joint considerations expressed in the multitude of addresses adumbrated. That, however, is not a charge which can be made against any of the speakers, very few of whom pose as experts on a question for the solution of which we must search far deeper than many who have not made a life study of it can see. The mistaken notion commonly held is that the

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question of education just commences to concern our industry when the youth has left the ordinary day school and is seeking to enter a technical school or workshop. But we think the importance of the indirect bearing upon the industries of this country of the system of elementary education, and the disadvantage arising from the absence of a satisfactory connection between that, and secondary then specialised education, should not be lost sight of.

Christmas Boxes.—A letter from Sir Edward Fry which appeared in the *Times* one morning last week, and dealt with the question of Christmas boxes and the Prevention of Corruption Act, serves as a timely reminder of the approach of that season of the year when men are wont to give tangible expression to their goodwill and generosity. As the forthcoming Christmas will be the first after the Prevention of Corruption Act of 1906 has come into existence, much interest will be naturally evinced in the question as to how far the giving and receiving of Christmas boxes come within the scope of the Act. The point to which Sir Edward especially draws attention is the difficult question of Christmas boxes from tradesmen to servants, and he is in no doubt whatever that such gifts, if made without the master's consent, are corruptly given, and he advises, as the only safe course for those who wish to make Christmas gifts to servants, that the express consent of the master be obtained, and if it be not obtained, then to abstain from making the gift. The question as it appeals to our point of view, however, is how far the Act affects the granting of presents by manufacturers to their clients. It would seem that this aspect of the question differs somewhat from the one referred to by Sir Edward Fry, for here the present is not from tradesman to servant, but, in the first place, from principal to principal, and is seldom in the nature of anything but a more elaborate and novel "reminder" than those distributed at other times of the year. At all events, such presents are usually given quite openly and without any corrupt motive. The Attorney-General has declared that Christmas boxes are not within the scope of the Act in question, for he has publicly stated "that Christmas presents which really have that character and are openly and honestly given as such cannot be within the Act." Of course, this would not apply to any unscrupulous dealer who sought to ingratiate himself into the favour of prospective buyers by sending presents to responsible members of firms' staffs with a view to inducing business; but those who direct their generosity in the proper channels, and do not make it entirely subservient to their interests, have little to fear, we think, from the new Act.

German Electrical Proposal. — The *Standard's* Berlin correspondent sends a report of proposals for the creation of a State monopoly of electricity in Germany. He says: "A representative of the *Tageblatt* has received the following information from the Imperial Treasury: 'The State monopoly of electricity would produce extremely large revenues for the Imperial Exchequer. Of course, an enormous capital would be necessary to purchase all the electrical works in Germany, numbering over 2,000, of which 800 supply electrical current. The necessary capital to purchase the works and to inaugurate a State monopoly could be quickly obtained by loan, for which, in view of the large profits, high interest could be paid. The Imperial Government regard the idea of a State monopoly of electricity with approval for another reason—viz., that it is highly concentrated, so that it is easier for the Government to overtake than many other industries less highly centralised. The workmen and other employés now drawing wages from the present electrical works could derive nothing but advantage from their transfer to State control. Apart from the fact that they become State officials, the Government could guarantee them a better old-age pension than they obtain as employés of private concerns. Those factories which now maintain electrical works and produce the current required for their own purposes would, of course, be compelled to abandon their own electrical works, and obtain the current from the State establishment.'" This sweeping proposal is confirmed by the Ministry of Public Works, from which a statement has been issued saying that "the Imperial Government recently dispatched Herr Wittfeld, together with several other high officials, to study the application of electricity to industrial purposes in the United States." The idea contained in the above is not new, and has already been discussed in Germany. But on this occasion it would seem that the Imperial Government regard it with a certain amount of approval. The prospects of its being carried out in a country like Germany, however, are too remote to be discussed now, for the public and the various democratic parties of the State would surely oppose the passing of such an enterprise into the hands of their mortal enemies of the bureaucracy.

Publications Received.—"The Elements of Electrical Engineering." Tyson Sewell, A.M.I.E.E. (London: Crosby Lockwood and Son, 7, Stationers'-court, Ludgate-hill, E.C. Price, 5s. net.) The publication of a fourth edition of this work has afforded an opportunity of adding a description of the newer forms of arc and incandescent lamps, while the author has dealt with the three-wire system of distribution in the form of an additional appendix. We need add little to our observations in reviewing the earlier editions of this well-known work which, we repeat, should be extremely serviceable to all classes of electrical students.—The *Mechanical World* Pocket Diary and Year-Book for 1908 (which we congratuate on having attained its majority, this being the twenty-first year of publication) is the first of its kind in the field this season. In this issue some important changes have been made. The notes on electrical transmission of power have been omitted, and this has allowed for the introduction of a deal of new matter. In particular, there is a lengthy section on condensing plant and another on the important subject of superheating. The matter on reverberatory and reheating furnaces has been rewritten and greatly extended, a section on friction clutches has been introduced, and several new tables have been added. The diary is published by Messrs. Emmott and Co., Limited, Manchester, at 6d. net.—Several volumes have from time to time appeared treating upon electrical engineering for the benefit of those concerned with electrical plant, but who have had no regular training in electrical engineering. One of the latest of such volumes is the "Electric Power Users Handbook," published by Mr. P. Hunter-Brown through Messrs Hodder and Stoughton, Warwick-square, London, E.C., price 5s. net. All central-station plant is dealt with, including alternating-current and direct-current equipments. The book is of convenient size for the pocket, and as the information which it gives deals with practical subjects and is concisely presented it should be of service to that class to which it appeals.

Institution Dinner at Glasgow.—The Glasgow Local Section of the Institution of Electrical Engineers held their sixth annual dinner on Nov. 20, when Prof. Francis G. Baily, of Heriot-Watt College, Edinburgh, presided over a company of 200. A letter of apology was read from the president, Lord Kelvin, regretting his inability to be present owing to the state of Lady Kelvin's health. Mr. E. George Tidd, who has been honorary secretary of the local section since its inception seven years ago, recently

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resigned that office, and was succeeded by Mr. James E. Sayers, of Messrs. Sayers and Caldwell, consulting engineers, Glasgow. Prof. Baily, in presenting a silver tea service and tray to Mr. Tidd on behalf of the section as a tangible expression of their gratitude for the services he had rendered to them during his term of office, said that what of success had attended their efforts as a section was in great measure due to the untiring zeal of Mr. Tidd. Mr. Tidd suitably replied. In proposing the toast of the "Imperial Forces," Mr. W. M. Mordey, of the Council of the Institution of Electrical Engineers, London, said the Council had recently been in conference with the War Office, and, as a result, 150 reserve officers of the Royal Engineers would shortly be appointed. These would be selected jointly by the Institution of Civil Engineers and the Institution of Electrical Engineers acting with the War Office. Fifty of these men would be electrical engineers. Their Institution were similarly to be consulted in the selection of engineering officers for the new Territorial Army. Engineer-Commander Jenkin and Lord Kingsburgh replied. Replying to the toast of "The Institution," proposed by Sir John Ure Primrose, Mr. C. P. Sparks, vice-president of the Council of the Institution of Electrical Engineers (London), said the present membership of their society was 6,000, and they had now six local sections at home and two abroad. The development of local sections had given them an enormously increased number of papers to consider, and they were now faced with the problem as to the best means of having the most outstanding of these papers discussed by the best men in the whole membership of the Institution. To tackle this question a committee had been formed composed of an equal number of representatives from the Council and delegates from local sections to carry out this idea, which had already been adopted with success in America. The work of the Institution also included a share in the work of the Engineering Standards Committee, as well as in the formation of an electro-technical commission of the leading countries of the world, the first president of which is Lord Kelvin.

Prof. Kapp's Birmingham Address.—It is unusual to have a discussion on a presidential address, but Dr. Kapp, at the end of his address to the Birmingham Local Section last week, invited the members to depart from the conventional course on that occasion in the hope that the manufacturers present at the meeting might give them the benefit of criticism on the points he had brought forward in his important opening address. There was a ready response to the invitation, for after Dr. W. E. Sumpner had opened the discussion by expressing his general agreement with the "sandwich" system of training advocated by Dr. Kapp, Mr. R. K. Morcom rose to express his disapproval of the system, which, he said, was "a case of thick bread and thin meat." He said a man had to learn that what was theoretically best was not necessarily the best commercially, and that economy in the use of material was not always advisable. Mr. Morcom advocated a shorter theoretical training than was usual with a practical course either before or after. Mr. Brown agreed with Mr. Morcom. Immediately a man became of the slightest real use he would have to go away. If he got so far that he could be given any responsibility at all, then to do so would only be to upset the works system. Mr. R. A. Chattock suggested as an alternative that a man should be allowed to alternate a year's practical work with a year's theoretical training. Mr. J. C. Vaudrey expressed the opinion that a course of technical education should be followed by a practical training in works. In connection with the mechanical training, he suggested that it would be convenient for a student to spend one vacation in the foundry and another in the pattern shop. Mr. Halford preferred the "sandwich" system to the apprentice system, while Mr. Jackson pointed out that a similar system to the "sandwich" system had been tried in connection with Whitworth scholars, but had been given up mainly because it had been found that many of the men would not work. Mr Pearson said it would take a student a much shorter time to learn what was necessary in the shops than it would the average man. Mr. Marples suggested that a "sandwich" system might be arranged with alternate theoretical and practical courses, each lasting six months, some students taking the former at the same time that others were taking the latter. He thought that in this way there would always be an equal number of men asking for employment in works, and they would be able to deal with twice the present number of students in existing universities. While opinions are divided as to the best system of training, there can be no gainsaying the importance of another element bearing upon the question which nearly all the speakers at the Birmingham meeting (with the exception of Dr. Sumpner and Mr. Aston Hill) seem to have overlooked. Whatever the result of any system, a great deal depends upon the character of the individual, his keenness and intelligence, and his fitness for the particular work.

The Future of Electricity in Medicine.—We referred on a previous occasion to Mr. W. Deane Butcher's recent address at the inauguration of the electro-therapeutic section of the Royal College of Medicine, and touched more particularly at that time upon recent work on the inducement of sleep by electrical means. Other portions of his address are, however, of similar interest and importance, for Mr. Butcher places before us a glowing perspective of the *rôle* which electricity is destined to play in the future development of the healing art. He gives us to understand, on the authority of Scribonius Largus, that the electro-therapeutic treatment was known as far back as A.D. 34, and quotes in evidence the record of patients suffering from rheumatism and gout being placed in a bath containing electric eels. Since that time (if it may be regarded as the beginning of electro-therapeutic treatment), and up to recent times, the progress of medical electricity has been a slow one. But that progress of late years has been greatly accelerated. Seldom, indeed, in the evolution of a science has such a rapid advance been made as that of Röntgen diagnosis and electro-therapeutic treatment during the last decade. Mr. Butcher in his address (which is published in the *Lancet*) traces the general trend of the advance in the directions indicated, and predicts the course of its future development. He deals first with Röntgenography or skiagraphy, describing the focus tube and photographic plate. Diagnosis by means of the Röntgen rays is, he says, developing rapidly, particularly in diseases of the chest. Of great importance is the possibility of diagnosing, by the X-rays, lung diseases which are wholly beyond the ken of the older methods of diagnosis. In addition to diagnosis, there is a possible use for electricity during the preparation and straining of microscopic specimens. In the early days of the Röntgen rays they were used commercially in the operation of tanning leather. It is quite possible that some interesting facts as to skin structure might be obtained by careful experiment on the ionic penetration of the skin under the influence of the X-rays or radium. In anatomy, the tedious process of dissection to trace the blood supply is now replaced by a series of Röntgenograms of a suitably injected organ. In pathology also specimens of the blood supply of the neoplasm and its influence on the glands can best be examined by the same means. In another section of his address Mr. Butcher deals with the application of electricity to the

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treatment of disease, and points to the development of high-frequency treatment. As to the future, Mr. Butcher concludes with the following passages: "We look forward to great progress in electrical theory and a classification of our ideas as to the rationale of electricity as a result of the epoch-making discoveries of the last few years. The electron theory is so beautiful and so simple that we can only hope that the physicist will leave it alone as it now stands. For us who have to visualise the passage of electricity through the human body it is no small matter to have replaced the vague conception of an electric current by the mental picture of a double train of moving ions."

Lighting of Factories.—The illumination of factories and workshops is a problem which deserves to be very carefully considered by electrical engineers in order that its importance may force itself in due proportion upon the attention of owners of such premises. It is not only the hygienic interests of the workpeople employed that invest the problem with such importance, for the Legislature will not fail to enforce regulations for the safeguarding of those interests (sometimes, indeed, to the discomforture of employers), but the bearing of the question upon the economy of production is too direct to be neglected. The chance arrangement of lights in a factory or in workrooms leads either to the production of too much light, and consequent wastage, or insufficiency of light. The financial losses attendant upon the former are obvious, but they are no less positive in the case of the latter. It will doubtless be recollected by many that the question of illumination and its relation to output was investigated several years ago in a cotton mill in this country, where it was found that an improvement in the lighting not only increased the output proportionally, but very greatly reduced the amount of "seconds" turned out, thus adding to the value of the product on both accounts. And if the question as it concerns other industries were investigated, we have no doubt that similar results would be found. In the current month's issue of *Illuminating Engineering* some suggestive figures are given as to the relative costs of lighting and labour at a machine. The writer takes electric light as the basis for his calculations, and assumes that current is purchased at the retail price of 5d. per unit (kilowatt-hour), therefore a 16-c.p. lamp will burn for 18 hours for the consumption of one unit costing 5d. The ordinary workman, receiving, say, 10d. per hour, would only have to lose a trifle over a minute and a half out of an hour to represent a loss equal to the cost of the light, while the skilled workman, receiving, say, 2s. per hour, would have to lose only a little over half a minute every hour to represent a similar loss. In other words, the ordinary workman losing 13 minutes in a day of eight hours, or the skilled workman five minutes in the same time, would equal the cost of running the lamp for the entire working day. But, instead of electricity costing 5d. per unit, it may be generated in large works, where power is already at hand, as well as the fixed charges of superintendence, etc., required for its generation, the current can be produced as low as 1d. per unit, which would reduce the above figures to one-fifth—that is, the common workman would have to lose only about 2½ minutes in an entire working day of eight hours, and the skilled workman but a little over a minute, to represent the cost of the lamp for a day. This calculation furnishes us with additional proof of the fallacy which has been only too long prevalent—viz., that the lighting of factories, equipped with the most modern and expensive machinery and tools and employing many skilled workpeople, can be properly and economically arranged on other than a scientific and well-considered plan.

Electrical Legislation and Enterprise. — The students' section of the Institution of Electrical Engineers opened their session on the 20th inst. with an address from Mr. Robert Hammond, hon. treasurer of the Institution, on "Electrical Legislation." The subject is one that ought to command some attention from the students, many of whom will probably be adopting the electrical profession, in some capacity or other, when they will be able to appreciate the value of an acquaintance with the various legislative enactments affecting the industry. Mr. Hammond treated his subject from the historical rather than from the controversial side, and commenced with a reference to Mr. Madgen's Institution paper in 1901 dealing with "The Electrical Power Bills of 1900," in which that gentleman drew attention to the serious effect upon the electrical industry of certain of the enactments of Parliament. It will be remembered that as a result of the paper the Council of the Institution appointed a committee of gentlemen, representing various shades of opinion upon the subject under consideration, with a view to determining whether they could recommend the Council to take any action with a view to assisting the industry. From the committee's report it was gathered that the Legislature was to blame for the backwardness of electrical engineering in this country. There are those, however, who urge that the slow growth of electric lighting in the United Kingdom was due mainly to the fact that gas lighting being cheaper in this country than in any other part of the world, the electric light encountered in this country more severe competition than elsewhere, and hence was naturally of much slower growth. Mr. Hammond did not stop to discuss this point, but passed on to a survey of the various Acts. The first step towards electrical legislation was the appointment by the House of Commons in 1879 of a Select Committee on lighting by electricity. No immediate legislation followed the recommendations of the committee, but in 1882 there was passed the Electric Lighting Act. Mr. Hammond declared this Act to have become of value, so far as private enterprise is concerned, only on the repeal of Section 27, limiting the tenure of the companies to 21 years. The supplementary Electric Lighting Act of 1888 came in for criticism from Mr. Hammond, principally as regards Section 1. Although under this Act the limiting of the tenure of the companies was extended from 21 years to 42 years, this concession to private enterprise was seriously hampered by making it necessary in applying for a provisional order to obtain the consent of the local authority. The result of this section is seen in the fact that, outside the Metropolis, the only places of over 100,000 inhabitants supplied by companies are Newcastle-on-Tyne, Bournemouth, and Preston, the remaining operations of companies being mainly directed to places where the local authorities did not deem the business good enough to engage their attention. Mr. Hammond devoted a section of his address to tube railway legislation, beginning with the Select Committee of 1892. He traced the history of Power Bill legislation since 1882, and explained the well-known Kitson clause, concluding with the bulk supply proposals for the Metropolis. The interesting address was interspersed with some references to electrical enterprise in the eighties. Mr. Hammond was well to the fore in those days, and it is interesting to note that he recalled the fact that when the British Association met in York in 1881 to celebrate its fiftieth anniversary, he illuminated the main streets of the city with the electric light. In the same year a miniature central station was laid down by Mr. Hammond to deal with the public lighting of the town of Chesterfield, when for the first time arc and incandescent lamps were fed from a high-tension circuit.

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NOTES ON THE TESTING OF MULTI-RANGE AMMETERS AND VOLTMETERS AND LOW-READING VOLTMETERS.

BY A. E. MOORE, A M I E E.

The advent of the moving-coil instrument has so facilitated the use of one instrument for different current or voltage ranges, that portable testing instruments of this type are usually arranged with a number of suitable shunts and series resistances as multiple-range instruments. Now, in testing such instruments it is, of course, necessary to check the readings on each particular range, and it becomes a question as to what is the best method of expressing the accuracy or error of the instrument. Before attempting to answer this question, it will be well to consider what is the best method of recording the readings observed on such an instrument. This latter question is somewhat open to debate, and certainly depends on the nature of the observations to be taken. Consider, for example, one of the "combined ammeter and voltmeter testing sets" as now supplied by many instrument makers.* These sets consist of a moving-coil instrument arranged, by means of suitable resistances and shunts and a change-over switch, to indicate volts and amperes. They frequently have in all some 10 or more ranges, and have their scales divided into 120 or 150 divisions. The indications (in divisions) have to be multiplied by a constant which depends on the particular range used. The constants are usually very convenient ones (1, 2, 5, $\frac{1}{10}$, $\frac{1}{100}$, etc.), so that the multiplication in some cases only means the fixing of the decimal place. If a small number of observations are to be taken on one range only, then the actual value of the amperes or volts may generally be written down directly. But if, as is, perhaps, the more general case, the set is arranged to read simultaneously amperes and volts, as in the case of testing machines, etc., it is easier and certainly safer to write down the actual divisions deflection on the scale of the instrument and afterwards to multiply out the readings by their respective constants. It usually happens that the constants by which the deflections have to be multiplied to give the ampere reading and the volt reading are different, and errors are easily introduced by wrongly estimating the fractions of a sub-division when the multiplication is carried out mentally on the scale reading. For example, if the constant for the amperes is 5 and that for the volts 4, then a small division on the scale must be divided by the eye in one case into tenths or fifths, and in the other case into quarters. If, however, the actual scale deflection is first noted down, the sub-division is always the same.

Now to consider the method of expressing the errors. It is very usual to express the inaccuracy of an instrument by stating the percentage errors of the instrument at the particular points checked. Or the inaccuracy may be expressed as a correction, being the amount (amperes or volts, etc.) which must be added to or subtracted from the observed reading to give the true value. With an instrument having a single range, and calibrated directly in amperes or volts, etc., this latter method is sufficiently good, because it is a simple matter to correct the observed readings. Table I. is illustrative of this.

TABLE I.

True amperes.	Amperes indicated by instrument.	Correction (amperes).	Error (per cent.).
20·52	20 0	+0·52	2·5 low.
40·45	40·0	+0·45	1·1 ,,
60·25	60·0	+0·25	0·4 ,,
79·80	80·0	−0·20	0·25 high.
99·30	100·0	−0·67	0·7 ,,

If, however, the instrument has a number of ranges, it is necessary to have a correction table for each range, and, moreover, before the correction can be applied it is first necessary to have multiplied out the readings by their constants.

* The observations recorded in the example chosen must not be taken as indicating in any way the degree of accuracy to which commercial instruments of this form are calibrated. The instrument referred to in the example has had its coil and springs burnt out and replaced but without a new scale being drawn for it. The method described is useful in such cases.

Now, let it be first assumed that the electrical proportionality of the scale is correct—that is, that the deflection indicated is proportional to the current through the instrument. In such case the instrument will have a constant percentage error over the whole scale for any one particular range. Now, suppose that the error is expressed as a percentage one, and that the instrument reads low. Let the error be 1 per cent., and the constant, K, for the particular range nominally 2; also let d be the scale deflection on the instrument. Then obviously the correction may be applied in one of three ways: (1) by calling the observed current 99 per cent. of the true current, the true current being $(d \times K)\frac{100}{99}$; (2) by calling the deflection 99 per cent. of the true deflection, the true current then being $\left(d \times \frac{100}{99}\right) K$; (3) by calling the constant 99 per cent. of the true constant, the true current then being $d\left(K \times \frac{100}{99}\right)$. This third method will obviously be the simplest, since $d\left(K \times \frac{100}{99}\right) = d \times K_1$, where $K_1 = K \times \frac{100}{99}$ — *i.e.*, the true constant for the instrument. K_1 in this case would thus be $\frac{2 \times 100}{99} = 2{\cdot}02$. It would appear better, then, when standardising the instrument to determine the values of the constants by which the indications must be multiplied to give *true* amperes or *true* volts on the different ranges. If, however, the proportionality of the scale is incorrect, then $d \times K_1$ will not represent the true current, etc., at different parts of the scale. But since the proportionality of the scale will be the same for all ranges, a correction curve may be determined by means of which the observed deflection may be corrected, the corrected deflection being afterwards multiplied by the determined constants. It may be well at this point to describe the method of obtaining the correction curve. To do this, any one of the voltage or current ranges is chosen, and the relation between true current and deflection on the instrument determined by comparison with a standard instrument.

TABLE II.

Deflection on instrument = D.	True amperes = A.	Ratio $\frac{A}{D}$	Corrected deflection = D_1 (= A ÷ 0·1016)	Correction in divisions (= D_1 − D).
10·0	1·038	0·1038	10·21	+ 0·21
20·0	2·080	0·1040	20·47	+ 0·47
30·0	3·115	0·1038	30·66	+ 0·66
40·0	4·135	0·1034	40·70	+ 0·70
50·0	5·150	0·1030	50·70	+ 0·70
60·0	6·160	0·1027	60 63	+ 0·63
70·0	7·161	0·1023	70·48	+ 0·48
80·0	8·162	0·1020	80·33	+ 0·33
90·0	9·162	0·1018	90·18	+ 0·18
100·0	**10·161**	**0·1016**	**100·00**	—
110·0	11·172	0·1016	110·00	—
120·0	12·185	0·1015	119·93	− 0·07
130·0	13·185	0·1014	129 78	− 0·22
140·0	14 195	0·1014	139·71	− 0·29
150·0	15·200	0·1013	149·61	− 0·39

The readings thus obtained for an actual instrument, using a potentiometer as the standard, are entered in columns 1 and 2 of Table II., and the ratio, current ÷ deflection, is given in column 3. If this ratio is a constant for all deflections, then the scale readings are truly proportional, and no scale correction will be necessary; but if not, it is necessary to decide at what point other than the zero the instrument shall need no correction—*i.e.*, at what point on the scale it is intended to determine the true constants for the different ranges. In instruments whose scales are divided into 120 or 150 divisions, the most convenient point will be 100 divisions. Now, by dividing each of the currents in column 2 by the ratio $\frac{A}{D}$ at 100 divisions (in column 3), the corrected deflections for the scale are obtained. The corrections, column 5, are the differences between the observed deflections and the corrected deflections. A table showing the observed deflections and their corresponding corrections, or

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a curve plotted from columns 1 and 5, is then used with the instrument, and it represents the proportionality, or scale corrections for *all* ranges. It is now only necessary to determine the true constants at 100 scale divisions for the different ranges by comparison with a standard instrument. The scale corrections and the true constants for the different ranges may then be recorded as in Table III.

TABLE III.

Scale corrections. Columns 1 and 5, Table II.		Determined constants (for the different ranges).		
Deflection.	Correction.	Range.	Nominal constant.	True constant at 100 divs.
10·0	+0·21	3 volts.	0·02	0·02011
20 0	+0·47	30 ,,	0 2	0·2022
30·0	+0·66	150 ,,	1	1·003
40 0	+0·70	300 ,,	2	2 011
50·0	+0·70	600 ,,	4	3·992
60·0	+0·63	1·5 amperes.	0·01	0·01012
70·0	+0·48	15 ,,	0·1	0·1016
80·0	+0·33	150 ,,	1	0·993
90·0	+0·18	600 ,,	4	4·002
Etc.	Etc.			

Table IV. illustrates the method of recording the observations on the particular instrument for which the above corrections are given, the observations being voltages and exciting currents for a continuous-current dynamo. The recording of the observations in this way appears at first sight to entail more work than the ordinary method, but it is really not so, and the liability to errors in reading is very much reduced.

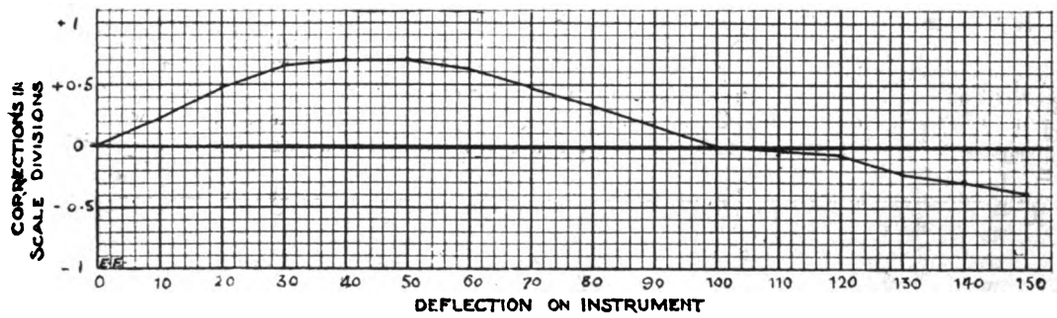

FIG. 1.—Correction Curve.

TABLE IV.

Volts				Amperes			
Deflection on instrument.	Corrected deflection.	Constant.	True volts.	Deflection on instrument.	Corrected deflection.	Constant.	True amperes.
6·3	6·4	1·003	6·4	0	0	0·1016	0
11·1	11·35	,,	11·4	3·6	3·7	,,	0·38
23·4	23·9	,,	24·0	11·0	11·3	,,	1·15
59·2	59·8	,,	60·0	30·3	31·0	,,	3·15
85·0	85·2	,,	85 5	49·8	50·5	,,	5·13
106·2	106·2	,,	106·5	72·6	73·0	,,	7·42
124·7	124·6	,,	125·0	105·3	105·3	,,	10 70
134·4	134·1	,,	134·5	147·4	147·0	,,	14 93

Summarising the above then: (1) obtain the corrections for the scale as in Table II., and plot a correction curve as in Fig. 1; (2) determine the true constants for the different ranges by determining the true current or volts required to give 100 divisions deflection on the scale, and record as in Table III.; (3) to record observations when using the instrument, note down the actual scale deflections, apply the necessary corrections, and multiply the corrected deflections by the true constants, as in Table IV. The above method is very useful in connection with instruments provided with uniformly divided scales, as, for example, when mirror galvanometers are used as ammeters and voltmeters. It is also equally convenient for use with all multiple-range instruments, whether ammeters, voltmeters, or wattmeters.

The Testing of Milli-Voltmeters.—Most of the permanent-magnet type of moving-coil sets referred to above are arranged to indicate milli-volts, or fractions of a milli-volt. The writer, therefore, gives the following description of a method of checking low-reading voltmeters which he has found to be a very convenient one.

The standard instrument used for checking any instrument should, whenever possible, be such that it can be read to one figure more than the instrument to be tested—*i.e.*, if the instrument to be tested can be read to one-tenth of a scale division, the standard should give readings equivalent to one-hundredth of one such scale division. Now, undoubtedly for continuous-current instruments the potentiometer forms by far the most convenient standard, and generally, if suitable shunts, etc., are chosen, the potentiometer reading will show at least one figure more than the reading on the instrument under test. If, however, the instrument to be tested is a milli-voltmeter reading, say, one-fifth of a milli-volt per scale division, it is probable that the reading on the potentiometer will be so small that it cannot be read with any greater degree of accuracy than the deflection on the milli-voltmeter. Or quite possibly the deflection on the milli-voltmeter may be read with a greater degree of accuracy than the reading on the potentiometer. So that it becomes necessary to adopt some method whereby the potentiometer reading may be increased. Now, it is usual practice to provide all milli-voltmeters with suitable fixed lengths of flexible connecting leads, and the indications of the instrument represent the potential difference across the remote ends of these leads. It is only for instruments so arranged that the method here described is particularly useful.

The method consists in measuring, by means of the potentiometer connected across a standard resistance, R_1, the current flowing through a second standard resistance, R_2, of smaller value, and across which the milli-voltmeter is connected (see Fig. 2). The resistance R_2 may be chosen of such a value that the reduction in resistance brought about by connecting the milli-voltmeter in parallel with it is negligibly small. If this is inconvenient, the resistance of the voltmeter must be known and a correction

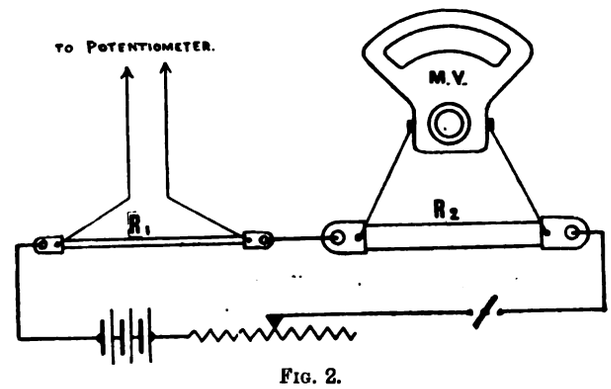

FIG. 2.

made, but the resistance of R_2 should always be low as compared with that of the instrument. The resistance R_1 should be chosen of such a value that a large reading on the potentiometer is obtained for the current, which, passing through R_1 and R_2, will produce the necessary deflection on the milli-voltmeter. For example, take an instrument reading to 30 milli-volts by fifths of a milli-volt—*i.e.*, having 150 scale divisions—and let it be assumed that the resistance of the instrument and its connecting leads is two ohms. Now, if this instrument is connected across a resistance of 0·001 ohm, a current of 30 amperes will produce a full scale deflection on the instrument, and in this case the reduction in resistance brought about by connect-

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ing the 0·001 ohm and the milli-voltmeter in parallel will only be one part in 2,000—*i.e.*, the combined resistance of the 0·001 ohm and the milli-voltmeter will be

$$\frac{0{\cdot}001 \times 2}{0{\cdot}001 + 2} = \frac{0{\cdot}002}{2{\cdot}001} = 0{\cdot}0009995 \text{ ohm.}$$

The resistance R_1 may thus be very conveniently chosen 0·05 ohm, in which case the current of 30 amperes stated above will produce the usual drop of 1·5 volts across it. Thus the milli-voltmeter reads 150 divisions, readable, say, by tenths of a division, for 30 milli-volts, while the potentiometer reads 15,000 divisions to represent the same potential difference—*i.e.*, one division on the potentiometer will correspond to $\frac{1}{100}$ of a scale division on the voltmeter. It is advisable that observations be also taken with the current and the milli-voltmeter connections reversed, in order to correct for thermo-electric errors, if present. If the resistances, R_1 and R_2, are made of manganin, this latter effect will probably be *nil*.

ELECTROMAGNETIC TRACK BRAKE.

Trials at Leeds.

Recent accidents with tramcars due to the failure of brakes, etc., have been sufficiently numerous to reveal the imperfections of existing braking arrangements for electric tramcars, and to afford an ample measure of justification for the prominent attention which the question of improvements is being given by tramway engineers. On Monday last we had the opportunity, together with representatives of other engineering journals, of inspecting a new form of electromagnetic brake which the Leeds Corporation are experimenting with on some of their cars, and of witnessing a number of exacting tests to which the new brake was submitted—thanks to the courtesy of Mr. J. B. Hamilton, the Leeds tramway manager, who granted permission for the trials to take place. To Mr. A. W. Maley, one of the assistant engineers in the tramway department, is due the invention and patenting of the brake, which appears to be a combination of the Newell magnetic track brake with the wheel shoes removed, and in place of which has been fixed auxiliary brake blocks, as shown in Fig. 2. This is operated in the first place as an ordinary slipper brake, or it can be used from the controller as an emergency brake energised from the motors. It is also connected in such a way that the switch under the canopy at each end of the car can be thrown in so that it may be energised from the trolley wire. It is thus seen that first of all the brake is put on the track as an ordinary slipper brake for coasting or service stoppages, and in case of emergency is used as a rheostat brake. In case of failure of the motors, current could be taken from the trolley wire. The only drawback in connection with this is, that with all these movements one has to depend on the human element.

There are several advantages brought about by the use of these auxiliary brake blocks, which are cast iron. One is, when coasting down a gradient and used as an ordinary hand brake, there is a tendency to take the weight of the wheels away from the track, preventing skidding and allowing greater freedom for motors if brought into use for energising emergency brake. The mechanical appearance of the whole fitting is very neat. The two cars on trial were equipped as follows: car No. 87—Dick-Kerr 35 A motors, B.T.H. B-13 controllers, Westinghouse latest type of brake; this car had top-deck cover, was mounted on 6ft. wheel base, standard Brill truck, its weight unloaded being 10 tons 12cwt. Car No. 270 had exactly the same equipment and weight as No. 87, but was fitted with patent electro-mechanical track brake. The auxiliary track blocks were, as already stated, of cast iron, but we understand that any other material may be used if preferable. We have already explained the action of the mechanism. The magnets on both cars were the Westinghouse type, with poles longitudinally along the rail, and giving a vertical pull of about 4,000lb. on 100lb. standard rail when magnets are saturated. The retardation of these magnets when so energised is from 1,600lb. to 1,800lb. for the two on clean rail at a speed of three to four miles per hour. This has been found by separately exciting the magnets and towing the car by another car. A large spring balance specially made to the instructions of Mr. J. Burbridge was used for the purpose of all towing tests.

For the purpose of the trials a piece of track outside of Leeds, called Whitecote-hill and Rodney-lane, was selected (see Fig. 3). This is, we believe, one of the worst gradients that is used in connection with tramway work in this country, and the tests were made on a piece of track with a gradient of 1 in 8·4. The state of the track was very dry when the tests were made. Below we give particulars of the tests carried out under our inspection, with the results for each test, the figures recorded being checked independently by each of the Press representatives present.

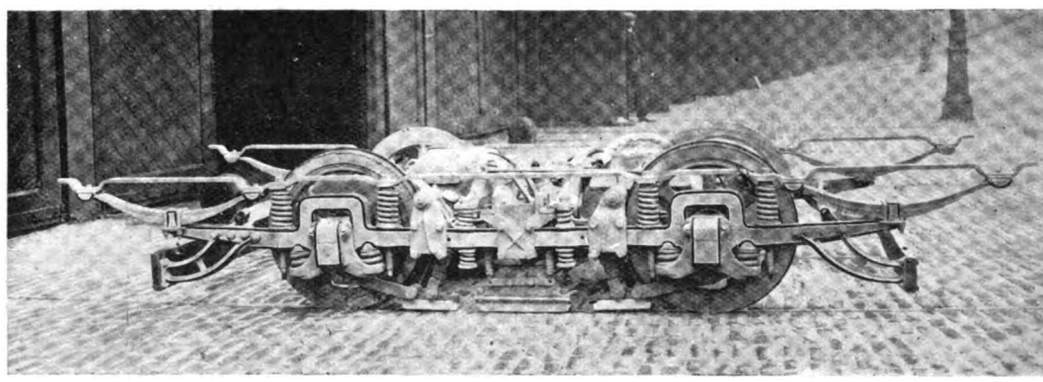

FIG. 1.—Maley's Brake fitted to Standard 6ft. Wheel Base, Brill Truck.

The result of the test undertaken (with car No. 87) demonstrated the amount of braking due to the magnets separately excited with 42·5 amperes each. The car had an initial speed before application of magnets of five to six miles per hour, and was stopped by wheel brake, in addition to magnets on the lesser gradient immediately above Leeds and Bradford road. The magnets operated in conjunction with the motors (car No. 87) resulted in coasting the above gradient at three to four miles per hour, the current generated per motor being 28 amperes at 166 volts. With the manual operation of the track brake the car coasted down at speeds up to 10·3 miles per hour, and stopped when desired. To afford an accurate idea of the work done on the brake as distinct from the motors, the brake was energised from the trolley by special switch on the canopy, with the following results:

Speed, miles per hour.	Amperes per magnet.	Distance to stop.
11·4	39	104ft.
15·0	39	229ft.

It is interesting to note in connection with the condition of rail that last week, when the brake was under the inspection of Mr. Baker, of Birmingham, and Mr. Simpson, of Preston, the results were as below:

17·9	37½	137ft.
18	37½	126ft.

In this case the rail was wet and rather greasy, which enables better stops to be made than when the rail has a coating of nearly dry, black deposit.

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Test were then undertaken to show the high-speed stops by brake energised by motors. Table I. gives the figures reached when the car was carrying 18 passengers, and Table II. when the car was laden with six; Table III. gives the results of last week's trial, which is of interest as showing how the state of the rail affected the stops.

In connection with the figures appearing in Table II., it was noticed, more so on the last two stops, that the tachometer belt was slipping, as in spite of running over the brow of the hill on full power for 150 yards the reading indicated as noted above. It was generally agreed that a more correct estimate of speed would have been 30 miles per hour.

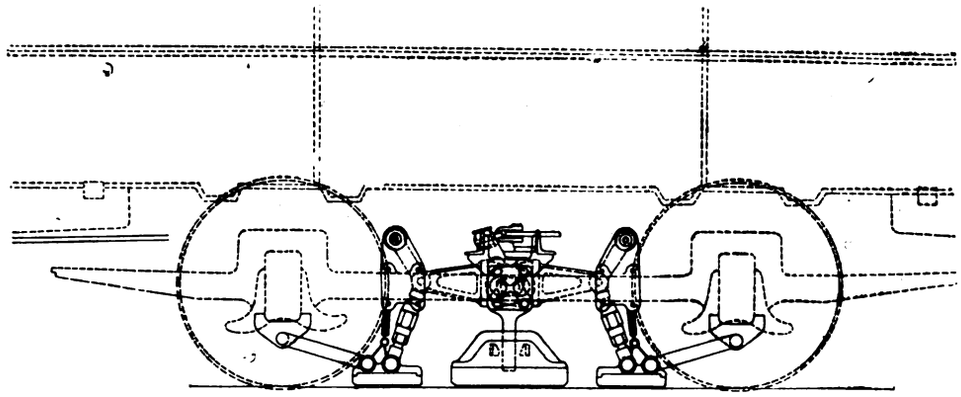

FIG. 2.—Electromagnetic Track Brake.

TABLE I

Speed on application of brake.	Amperes per motor. Max. observed. Kick only.	Volts per motor. Max. observed. Kick only.	Distance to stop. Feet.
19·3	84	700	109
17·8	90	663	64
21·6	102	803	115
25·4	110	663	198

TABLE II.

23·6	90	829	152
27·0	94	893	246
26·3	84	918	231

TABLE III.

19·0	70	561	83
19·5	90	561	74
19·7	80	446	60
24·0	80	765	132

wheels skidded almost continuously for approximately 150 yards until the bottom of the hill was reached.

As time was getting short it was decided by common consent to abandon the endeavour to make stops by reversing the motors. It may be said, however, that according to previous trials a stop cannot be made by reversing. The test carried out at the suggestion of the Board of Trade with a car loaded with three tons of iron afforded an indication of the retarding force required on a grade of this kind (1 in 8·4). If car was allowed to gain an initial speed of about five miles per hour, and first notch of controller (power side) applied (motors reversed), the car continued to run forward. On application of second notch the car gradually came to a stop and remained stationary. On the application of the third notch the car commenced to move slowly back. Any attempt to make a stop resulted in wheels slipping and revolving in reverse direction with reduction of retarding power, and hence worse result. On the lower part of the hill, when coasting with brake (manually applied) at about six miles per hour, the electromagnetic brake was applied in addition. Result, a very sudden stop. A similar result would be obtained if all three brakes were applied simultaneously. A speed of 25 to 27 miles per hour was obtained on the gradient, and the car was pulled up on the track in a marvellous manner.

It may be mentioned that this brake has been inspected in an experimental form by both the sub-committees of the two associations who have been at work for some considerable time on the subject of brakes, and whose report will shortly be looked for. It is also to be again inspected by these committees in its present form, which includes modifications and improvements which have suggested themselves during the long period of trials which have been in progress by the engineering staff of the Leeds city tramways almost continuously during the present year, under the direction of the general manager, Mr. J. B. Hamilton, and the chief engineer, Mr. John Burbridge. The brake has been inspected also on behalf of the Board of Trade by Major Pringle, and it is as a result of the trials which were carried out in his presence that permission was granted to put three cars fitted with this brake in service.

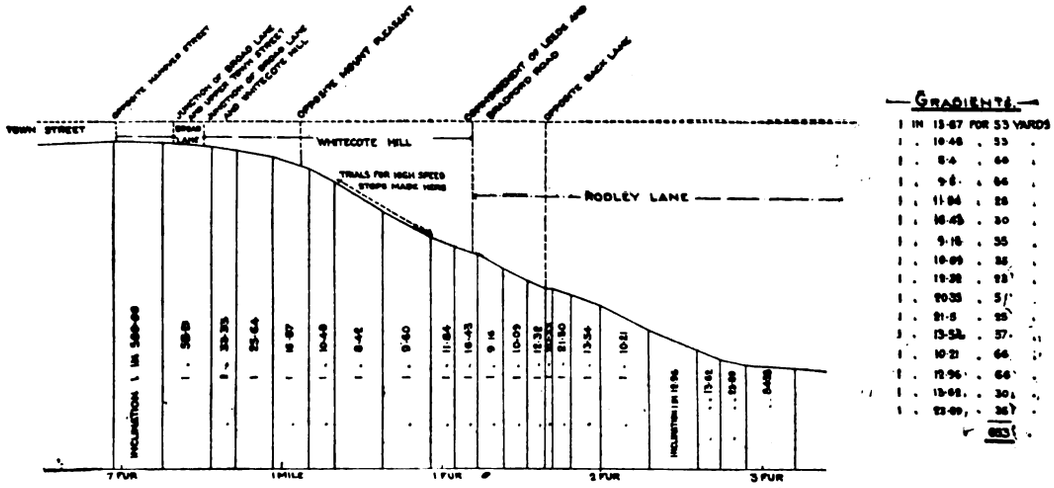

FIG. 3.—Plan showing Gradients.

The next test was in coasting down hill with car No. 270 with brake energised by motors, with a view to noting current required. At an estimated speed of 10 miles per hour six amperes per motor were required, and the voltage per motor was 120; at an estimated speed of five miles per hour the amperage per motor was three to six generally (eight maximum) and the voltage 120. An attempt was then made to make high-speed stops on the rheostatic brake—*i.e.*, motors only—with car No. 270 on a 1 in 10·2 to 13 grade at the lower part of the hill. Two speeds were tried, 22½ miles per hour and 19 miles per hour, but in each case, in spite of careful operation of controller, the

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There is no doubt that there are a considerable number of advantages to be gained by using a brake of this kind. One is that it does away altogether with wheel shoes, and it may also tend to deal to some extent with the removal or keeping down of corrugations. Further, in the case of the trolley leaving the wire and the motors failing at a critical time, used as an ordinary hand brake it has much advantage over the ordinary slipper, owing to the steadying effect on the car of the auxiliary brake blocks.

Although in our opinion this is one of the most perfect brakes we have seen in connection with tramway work, the difficulty is that the whole of the operations cannot be carried on through the one controller. In case of emergency, a man, even if he has the presence of mind, would have to decide the best move to make.

We must acknowledge our indebtedness to Mr. Hamilton for his kindness in permitting the trials, and enabling us to inspect Mr. Maley's brake in actual operation. The success of its performance reflects great credit upon its inventor, Mr. Maley, who acknowledges the assistance rendered by his colleagues in getting the brake developed to its present form and in conducting the large amount of experimental work which has been necessary, particularly the advice and help of the chief engineer, Mr. J. Burbridge.

THE DIELECTRIC STRENGTH OF INSULATING MATERIALS AND THE GRADING OF CABLES.*

BY ALEXANDER RUSSELL, M.A., MEMBER.

(*Concluded from page 737.*)

15. *Concentric Main with Composite Dielectric.*—To simplify the formula, let us suppose that the dielectric consists of

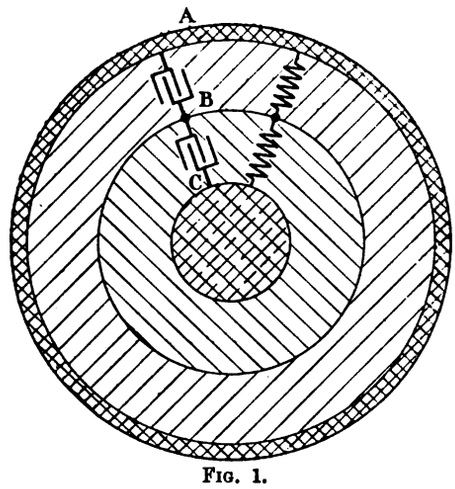

FIG. 1.

two layers of different isotropic insulating materials at the same temperature throughout. Let ρ_2, λ_2 be the resistivity in ohms and the dielectric coefficient of the inner layer next the inner conductor, and let ρ_1, λ_1 be the corresponding quantities for the outer layer. Let r be the radius of the cylindrical boundary, B, between the two wrappings (see Fig. 1). Then if R_1, R_2 be the resistances per unit length to the flow of leakage electric currents across them, and K_1, K_2 be the capacities in farads per unit length of the cylindrical tubes formed by the wrappings, we have

$$R_1 = \frac{\rho_1}{2\pi} \log_\epsilon \frac{b}{r}; \qquad R_2 = \frac{\rho_2}{2\pi} \log_\epsilon \frac{r}{a};$$

$$K_1 = \frac{\lambda_1}{2 \log_\epsilon (b/r)} \times \frac{1}{9 \times 10^{11}}; \qquad K_2 = \frac{\lambda_2}{2 \log_\epsilon (r/a)} \times \frac{1}{9 \times 10^{11}}$$

Now, the leakage current, i_R, across an isotropic dielectric is in phase with the potential difference applied at its boundaries, and the capacity current, i_K, is 90deg. in advance of this potential difference. If v', v, and v'' denote the instantaneous values of the potential of the outer conductor, the boundary between the two media, and the inner conductor respectively, we have

$$i'_R = \frac{v' - v}{R_1}; \qquad i''_R = \frac{v - v''}{R_2};$$

$$i'_K = K_1 \frac{d}{dt}(v' - v); \quad i''_K = K_2 \frac{d}{dt}(v - v''),$$

where i'_R, i''_R denote the leakage currents, and i'_K, i''_K the capacity currents in the media between A and B and between B and C respectively. We also have

$$i'_R + i'_K = i''_R + i''_K = i,$$

since the sum of the leakage and capacity (displacement) currents in each medium must equal the total current flowing across the dielectric. Let V_1, V_2 denote the effective values of $v' - v$ and of $v - v''$, and let ϕ_1 and ϕ_2 denote respectively the phase difference between V_1 and V_2, and the effective value of i. Then if f be the frequency and $\omega = 2\pi f$, we have

$$\left.\begin{aligned} \tan \phi_1 &= \omega K_1 R_1 = f \lambda_1 \rho_1/(18 \times 10^{11}), \\ \text{and} \quad \tan \phi_2 &= \omega K_2 R_2 = f \lambda_2 \rho_2/(18 \times 10^{11}). \end{aligned}\right\} \quad \ldots \text{(A)}$$

If, therefore, $\lambda_1 \rho_1 = \lambda_2 \rho_2$, V_1 and V_2 are in phase with one another, and thus:

$$V = V_1 + V_2,$$

where V is the effective value of the applied potential difference. In general, however, $\lambda_1 \rho_1$ is not equal to $\lambda_2 \rho_2$, and, therefore, $V_1 + V_2$ must be greater than V. Now, by reciprocating the well-known formula,

$$\frac{A_1}{A} = \frac{\{R_2^2 + L_2^2 \omega^2\}^{1/2}}{\{(R_1 + R_2)^2 + (L_1 + L_2)^2 \omega^2\}^{1/2}},$$

for the currents in a divided circuit, we get:

$$\frac{V_1}{V} = \frac{\{1/R_2^2 + K_2^2 \omega^2\}^{1/2}}{\{(1/R_1 + 1/R_2)^2 + (K_1 + K^2 \omega^2\}^{1/2}}. \quad \ldots \text{(1)}$$

the formula for the voltages across leaky condensers in series. By differentiating this expression with respect to ω it is easy to see that V_1 increases with ω when $\lambda_2 \rho_2$ is greater than $\lambda_1 \rho_1$. In this case the electric stresses in the medium next the outer conductor increase as the frequency increases, and the stresses in the inner medium diminish. If $\lambda_2 \rho_2$ were less than $\lambda_1 \rho_1$ the converse effects would take place. We see from (1) that, when $\lambda_2 \rho_2$ is greater than $\lambda_1 \rho_1$, V_1/V has its minimum value when ω is zero—that is, with steady pressures—and its maximum value when ω is infinite—that is, with an alternating voltage of very high frequency.

16. *Numerical Example.*—Let us assume that the radius of the inner conductor is 1cm. ($a = 1$), the radius of the boundary 1·5cm. ($r = 1{\cdot}5$), and the inner radius of the outer conductor 2·25cm. ($b = 2{\cdot}25$). Let us also assume that for the outer jute wrapping $\rho_1 = 10^{12}$, $\lambda_1 = 2$, and that for the vulcanised rubber inner wrapping $\rho_2 = 10^{16}$, $\lambda_2 = 4$. If the direct voltage applied to the conductors be 30,000, then, putting $\omega = 0$ in (1), we find that

$$V_1 = 0 \text{ and } V_2 = 30{,}000, \text{ very approximately.}$$

Thus practically all the electric stress comes on the rubber. Let us now suppose that an alternating pressure of very high frequency is applied between the conductors. In this case, putting ω equal to infinity in (1), we get

$$\frac{V_1}{V} = \frac{\lambda_2 \log_\epsilon (b/r)}{\lambda_1 \log_\epsilon (r/a) + \lambda_2 \log_\epsilon (b/r)} = \frac{2}{3},$$

and thus V_1 is 20,000 volts and V_2 is 10,000. Hence, as the frequency increases from 0 to infinity, V_1 increases frm 0 to 20,000, and V diminishes from 30,000 to 10,000 volts. From (A) we see that

$$\tan \phi_1 = 10 f/9; \text{ and } \tan \phi_2 = 2 \times 10^5 f/9.$$

Hence, at the frequencies used in practice, the error made by assuming that ϕ_1 and ϕ_2 are both 90deg. is small. It readily follows from (1) and (A) that

$$\frac{V_1}{V_2} = \frac{R_1 \cos \phi_1}{R_2 \cos \phi_2},$$

and thus, if f be greater than 9, V_1/V_2 would be equal to 2 very approximately. In practice, therefore, we see that in the case considered the maximum pressure across the outer layer with alternating pressures may be very much larger than when a direct pressure is applied between the conductors, the value of which equals the maximum value of the alternating pressure between the conductors. On

* Paper read before the Institution of Electrical Engineers.

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the other hand, the electric stresses on the inner dielectric may be much less with the alternating pressures.

17. *The Electric Stresses with Direct and Alternating Pressures.*—The preceding example illustrates that the electric stresses to which the insulating materials may be subjected with direct and alternating pressures are sometimes quite different. Whether the cables break down sooner with direct or alternating pressures depends on the relative values of the dielectric strengths of the materials which are subjected to the greatest stresses in the two cases. Unless we know the physical constants and the dimensions of the various wrappings, it is impossible to say whether the cable will break down more readily with direct or with alternating pressures of the same maximum value. In the general case, if

$$\rho_1 \lambda_1 = \rho_2 \lambda_2 = \rho_3 \lambda_3 = \ldots,$$

the stresses with direct pressure will be the same as with alternating of the same maximum value. Even, however, if this relation between the coefficients were approximately true at the start, it would soon cease to be true owing to the heating of the dielectric. Hence the electric stresses will, in the majority of cases, be different with direct and alternating pressures. At the moment of switching on the direct pressure the distribution of the electric stresses depends on the dielectric coefficients of the wrappings, but after a few seconds the distribution depends on the resistivities. With alternating pressures, as the author has previously pointed out, the mere fact that the pressures across the various layers are out of phase with one another may unduly increase the pressure across a particular layer. It is to be noticed also that at the moment of switching on, if the cable is charged, an excessive stress may be thrown on the dielectric. For this reason, especially when testing cables, care should be taken to discharge them before closing the switch.

18. *The Grading of Cables.*—Let us first consider the grading of cables for use on alternating-current circuits. As early as 1898 Jona had constructed single-core cables, the insulation wrappings of which were arranged so that those nearer the core had greater dielectric coefficients than those more remote. The layers next the core were generally of rubber, and round them were wound layers of paper or jute having smaller dielectric coefficients. The more costly rubber insulation was thus concentrated where its high dielectric coefficient partially relieved the excessive electric stress, and its great dielectric strength enabled it to withstand easily this diminished stress. The value generally accepted for the dielectric strength of pure vulcanised para is 15-20 effective alternating kilovolts per millimetre, or 20-30 direct kilovolts per millimetre. According to Jona, the value of the dielectric coefficient λ of pure vulcanised rubber is 3. We can increase the value of λ without appreciably weakening the dielectric strength by "loading" it with certain materials The following data, taken from Jona's paper (*l c. ante*), illustrate that λ can easily be varied throughout wide limits :

	λ
58 per cent. para, 26 per cent. talc, 14 per cent. oxide of zinc, 0·02 per cent. sulphur	4-4·2
64 per cent. para, 16 per cent. talc, 8 per cent. sulphur, 8 per cent. nimium, 4 per cent. oxide of zinc	5
55 per cent. para, 22·2 per cent. talc, 22·2 per cent. sulphur	6·1

I am indebted to Mr. Jona for a sample of one of his graded cables. This cable was tested with a pressure of 150 kilovolts at the Milan Exhibition without being appreciably affected by the test. The pressure was measured by the ingenious high-tension electrostatic voltmeter devised by Mr. Jona, which seems most useful for measuring these high pressures. In the sample of the Jona graded cable which I have received, the conductor consists of 19 strands of copper wire, the diameter of each of which is 3·3mm. The cross-section of the copper is, therefore, 162mm.^{2}. Round this, for reasons explained later, is a close-fitting lead tube, the outer diameter of which is 18mm. The insulation is built up as follows :

	Thickness in mm.	λ.
First layer, rubber	2·5	6·1
Second layer, rubber	2·3	4·7
Third layer, rubber	4·5	4·2
Fourth layer, impregnated paper	5·2	4

The total thickness of the insulation is, therefore, 14·5mm. ($b/a = 2·61$), and the cable is lead covered. If R, R′, R″, and R‴ be the maximum electric stresses on the four layers when the applied pressure is 150 kilovolts, we find by the formulæ given in Appendix A, R = 124, R′ = 132, R″ = 123, R‴ = 97·4 kilovolts per centimetre. If a dielectric of homogeneous substance had been used, the maximum electric stress would have been 174 kilovolts. Hence the grading has reduced the maximum electric stress by about 24 per cent. If air had been the dielectric, a disruptive discharge would have ensued at 23 kilovolts. Mervyn O'Gorman (*l.c. ante*, p. 636) has shown that to get uniform electric stress we must have at all points in the dielectric

$$\lambda r = \text{constant},$$

where λ is the dielectric coefficient and r the distance of the point from the axis of the cable. He suggests that by suitably "loading" paper insulation an approximation to this ideal cable might be constructed. In Appendix A the formulæ for the grading of direct-current cables are given. When applying direct voltage suddenly to a cable, it has to be remembered that the value of the stresses initially may be quite different from their value after the steady state is reached. In a cable, the dielectric of which consists of different insulating wrappings, the relative values of the voltages between each of these wrappings will initially be inversely as the capacities of the condensers formed by the inner and outer layers of these wrappings, but when the steady state is reached these ratios are as the resistances offered by the wrappings to a radial flow across them, and hence the stresses may be quite different in the two cases. It is, therefore, advisable to apply the direct pressure to a cable gradually.

19. *The British Standard Radial Thicknesses for Jute or Paper Dielectrics.*—The nominal area of the cross-sections of the conductors and the radial thicknesses ($b - a$) of the dielectric for concentric cables given in the following table are taken from a report issued by the Engineering Standards Committee (E.S.C.) in August, 1904 (p. 8):

		660 volts		11,000 volts	
S.	a.	$b - a$.	R_m.	$b - a$.	R_m.
sq. in.	in.	in.	k.v. per mm.	in.	k.v. per mm.
0·025	0·089	0·08	0·64	0·35	4·3
0·050	0·126	0·08	0·59	0·35	3·7
0·075	0·155	0·08	0·57	0·35	3·3
0·100	0·178	0·09	0·50	0·36	3·1
0·125	0·199	0·09	0·49	0·36	3·0
0·150	0·219	0·09	0·49	0·36	2·9
0·200	0·253	0·09	0·48	0·36	2·7
0·250	0·282	0·10	0·43	0·37	2·6

In the above table S represents the cross-sectional area, a the radius of the cylindrical conductor whose cross-sectional area is S, $b - a$ the thickness of the dielectric given by the E.S.C., and R_m^2 the maximum working electric stress when the amplitude factor of the applied alternating pressure is $\sqrt{2}$. It will be seen that the electric stresses on the dielectric are very different in the high-pressure cable from what they are in the low-pressure cable, and the dielectrics in cables of different sizes are subjected to appreciably different stresses. In the first five of the high-pressure cables the dielectric surrounding the high-pressure conductor will begin to be broken down before the disruptive discharge takes place, because in these cables the ratio of b/a is greater than ϵ (2·718). The specified thicknesses, therefore, are not economical. Take, for instance, the main in which the nominal cross-sectional area of the conductor is 0·025 square inch. With a solid cylindrical conductor, a equals 0·089in., and b is, therefore, equal to 0·35 + 0·089 = 0·439in. Thus $b/a = 4·92$. If we make the inner conductor hollow, and a = 0·142in., b = 0·3865in., we get the same maximum stress on the dielectric, but its thickness has been reduced by 33 per cent. and the outer radius by 12 per cent. As the armouring, etc., would also be substantially reduced the cable would be less costly. If we merely kept b = 0·439in., but increased a to 0·1616, so that $b/a = \epsilon$ nearly, then the carrying capacity of the cable would be nearly quadrupled, the thickness of the dielectric diminished 20 per cent., and the maximum electric stress would have been reduced to 3·8 kilovolts per millimetre. The fact that the dielectrics of cables are not quite isotropic is sometimes advanced as a reason for making the

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radius of the inner conductor smaller than the value indicated by theory. This practice, however, is founded on a misapprehension, as the effect of diminishing the radius is to increase the electric stress, and there is no reason why dielectrics of heterogeneous substance should be subjected to greater stresses than those of homogeneous substance. The want of isotropy may possibly be a reason for increasing the diameter of the inner conductor, the thickness of the insulating covering remaining the same. In order to simplify the formulæ for the electric stress, we have assumed that the inner conductor is a smooth cylinder. In practice the inner conductor is nearly always stranded, and it is necessary, therefore, to consider the effect of the stranding. Owing to the greater curvature of the surface of the strands, we can see, from first principles, that the effect will be to increase the maximum stress. Jona found experimentally that the brush discharges from solid wires and stranded or braided wires having the same exteral size begin at practically the same voltages Hence we may infer that the stranding of the conductor does not much affect the dielectric strength of the cable. It is important, however, to be able to calculate the stress exactly, and this can be done by means of a formula due to Prof. Levi Civita (*vide* Jona *l.c. ante*). The formula is given in terms of Gauss's hypergeometric series, but Joan has computed these series for useful values of the variables, so that approximate solutions can be readily obtained. The results show that the effect of the stranding is generally to increase the maximum stress on the inner dielectric by about 20 per cent. It is worth while, therefore, to prevent this increase in the stress on the inner wrapping by making the surface of the conductor smooth. This can be done by covering, as Jona does, the inner conductor with a thin lead tube. For extra high-pressure cables the gain in the strength is well worth the slight increase in the cost of the cable.

20. *Conclusions.*—(1) When part of the dielectric under stress breaks down, a disruptive discharge ensues only when the effect of this partial breakdown is to increase the electric stress on the remaining portion. (2) The dielectric strength of air under given conditions can be found accurately by finding the disruptive voltages between spherical electrodes at distances greater than 0·5cm. apart. Under normal conditions it is about 3·8 kilovolts per millimetre. (3) The dielectric strength of other gases can be found in a similar way experimentally by the help of the tables given in § 5. Helium has an extraordinarily high dielectric strength. (4) The dielectric strength of oils can be found by noticing the disruptive voltages between spherical electrodes immersed in them, provided that the distance apart is greater than 0·3cm. An excellent way of drying oils is by letting heated air bubble through them. (5) In finding the dielectric strength of solids it is advisable when possible to embed the spherical electrodes in the material under test. (6) High-pressure concentric cables having an isotropic dielectric for a maximum working pressure V should be constructed so that $b = a\,\epsilon^{d/a}$; where V/d is the maximum permissible working stress to which the dielectric may be subjected, b is the inner radius of the outer conductor, and a is the outer radius of the inner conductor. The smallest permissible value of a is d. When the core is stranded it should be encased in a thin lead tube (7) The effect of the temperature gradient in the dielectric of a concentric main, when working, is often to make the electric stress between the two conductors more uniform. Jona's experiments indicate that the dielectric strengths of paper-insulated cables do not vary much when the range of temperature does not exceed 60deg. C. They are probably slightly less at the high temperatures. C. E. Skinner's experiments (*l.c. ante*) on glass, treated cloth, mica, etc., show that the dielectric strengths of many insulating materials in the solid form diminish as the temperature rises. (8) With a composite dielectric subjected to alternating pressures, the potential differences across the layers are usually out of phase with one another. It is only in a limited number of cases, however, that the increase of the stress due to this cause has to be considered, as the leakage currents are usually negligibly small in comparison with the capacity currents. (9) The effect of alternating and direct pressures in producing stresses in the dielectric are sometimes quite different. (10) High-pressure cables for alternating or direct current circuits should be graded so as to make the maximum electric stress on the dielectric as small as possible, and stranded conductors should be encased in thin lead tubes.

In conclusion, the author has pleasure in acknowledging his personal indebtedness to Mr. Jona, the engineer to Messrs. Pirelli and Co., of Milan, to Mr. C. E. Skinner, of the Westinghouse Company, and to his old pupil, Mr. J. F. Watson, of Callender's Cable Company, for much of the information given in this paper.

Discussion.

Dr. J. A. Fleming said that the dielectric was mostly considered as an insulator, but there was another aspect of the subject, in that the dielectric could be considered as a means of storing energy. It was an interesting fact that a certain amount of energy could be stored up in the dielectric, which energy would be proportional to the volume of the dielectric. The storage capacity of air could be considered by taking a condenser consisting of two plates 1m. square, 1cm. apart, and Mr. Russell's value of dielectric strength as 3·8 kilovolts, which gave the capacity of the condenser at about 1-1130 microfarad. Charged to 38,000 volts, the energy storage would equal 64 joules, or 47 foot-pounds, per cubic metre of air. In a condenser made of glass, the dielectric constant would be 7 and the dielectric strength 200 kilovolts, and the energy stored would amount to 125 joules in 10,000 cubic centimetres, or 12,500 joules, or 9,125 foot-pounds, per cubic metre of glass. The amount of energy stored in an ebonite condenser 1m. square, 1cm. thick, would equal 14,100 joules, or 9,273 foot-pounds, per cubic metre of ebonite, and in a mica condenser having a capacity of nearly 1-200 microfarad, the energy stored would equal 900 joules per 10,000 cubic centimetres, or 66,000 foot-pounds per cubic metre of mica. Comparing the cost dielectric for a given storage, say, of 1,000 joules, he found that the necessary amount of ebonite would cost £70, micanite £15, glass £4, and air nothing. But he added that the dielectric strength of air could be considerably increased by compression. At 15 atmospheres air had a dielectric strength of about 60 kilovolts per centimetre, or equal to that of many oils. In conclusion, he said that electricians had not yet exhausted the possibilities of compressed air as a dielectric either for transformers, switches, or cables.

Mr. G. H. Nisbett (British Insulated and Helsby Cables, Limited) said he disagreed with many of Mr. Russell's conclusions. No attempt had been made to justify the assumption that the behaviour of air or gas under high electric stress was comparable to that of a solid dielectric under similar conditions. He had observed no such effect of partial breakdown of extra high-tension cables, and thought that the effect mentioned could be explained by mechanical reasons. He said the wax materials which were used in the insulation shrunk away and left air-spaces between the conductor and the solid dielectric; or the effect might be due to the bending of the cable. In his opinion, it was necessary to use a fluid dielectric so as to ensure the exclusion of air, and that the cable when bent should be close to the dielectric. Dealing with the application of high testing pressures, Mr. Nisbett asserted that a dielectric would break down with long-continued pressure which it would stand for a few minutes. Taking the case of a cable predetermined to break down at 20,000 volts in two hours, the pressure might be applied for 1¾ hours without failing; if it were tested again with the same pressure after a short interval, it might break down again in a quarter of an hour, but if the cable were given a 24 hours' rest, the original insulation resistance would return. It did not seem to him that any reasonable damage occurred to the solid dielectric unless actually punctured. He pointed out that test pressure to be applied should be capable of breaking down a space of air equivalent to the thickness of the dielectric, if it were to show the presence of cracks and fissures in the insulation. With regard to the influence of the size of conductor, he emphasised the difference between the breakdown pressures found by Mr. Jona for two single-core cables of different diameters, but each wound with the same thickness of paper insulation. Mr. Nisbett thought this difference was due to mechanical reasons; for instance, it was impossible to wind a thin wire with ¼in. radial thickness of paper without breaking. He quoted an experiment of his own, in which 7/16 and 37/16 cables were used, which gave exactly opposite results to those of Mr. Jona; the cables were similarly insulated, and the 7/16 broke down at 53,000 volts and the 37/16 at 37,700 volts. There might be some fractional theoretical advantage in grading, but this was entirely outdistanced by practical considerations. From the particulars of Mr. Jona's cable quoted by Mr. Russell, from which it was seen that the cable was built up roughly of two-thirds rubber and one-third paper, the insulation would cost £700 per mile, while ungraded paper insulation of the same thickness would cost £150, and would stand the same tests. Compound

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cable had the disadvantage of high capacity, and its use would be dangerous to high-tension work. Mr. Nisbett entered upon a defence of the cablemakers. He thought the latter had been unduly attacked, and that they had cause for complaint, inasmuch as they were never informed of the circumstances under which the cables were to work, nor of the temperature, the shape of the voltage curve, nor the E.M.F. He mentioned a case which occurred in London where some 6,000-volt cable was found, after having been at work some time, to be exposed momentarily to 18,000 volts pressure. If the cable had broken down, he supposed there would have been a claim for the repair of the damage. Under these circumstances it was necessary to provide an ample margin of safety, the wisdom of which policy was proved by the general success of the British networks.

Mr. W. H. PATCHELL thought that they were to be congratulated at having such a paper, inasmuch as it had enabled the members to see a cablemaker. He drew attention to the fact that all the credit for the system of lead sheathing round the cable and grading the insulating material was not due to Mr. Jona, but to Mr. O'Gorman. At the Niagara Falls station the 20,000-volt cables gave infinite trouble, which, however, was entirely overcome by the use of graded cables. When in the States he was shown a specimen of this cable, which had varnished cambric round the core and paper outside.

Mr. M. O'GORMAN said it was six years since the question dealt with by Mr. Russell was broached in this country without any practical steps having been taken. But in Italy and in Germany the matter had been taken up and regarded with more than academic interest. With regard to the question of stress and strain of dielectrics in relation to potential gradient, he asked whether Mr. Russell was justified in assuming that the actual strain in the dielectric was directly proportional to the stress. He thought the straight line law was the best, and Mr. Whitehead and he had worked an independent proof of Mr. Russell's conclusions. Our dielectries were too irregular to be of commercial use, and varied as much as 30 per cent. Until much of the bad material were got rid of it would be preferable to postpone the grading of cable for the present. As to the question of costs, reducing the size of the cable only did not particularly reduce the cost, the chief saving being in the insulating materials. He explained Mr. Nisbett's theory as to the recovery of cables by the fact that small quantities of water collected at the points of greatest stress, but dispersed again if the cable was given a rest.

Mr. A. CAMPBELL criticised Mr. Russell's nomenclature, and objected to the term "dielectric coefficient," which meant the same as "specific induction capacity" or "dielectric constant." Instead, he suggested the adoption of Oliver Heaviside's clear nomenclature, using the word "permittivity." With regard to the question of the testing of isotropic solids, he said Mr. Russell's difficulty might be overcome by embedding the electrodes in an auxiliary insulating material.

Mr. C. P. SPARKS (vice-president) said there was a practical difficulty in the grading of cables due to the presence of different chemical properties in the insulating materials. Speaking as a user, he said it was important that cables should last over long periods. He wanted them to last about 25 years, which was the low limit of life, to ensure which it was preferable to have only one kind of insulating material. He described his experiences with rubber and paper insulated cables, which differed from those of Mr. Russell. His experience with 17 miles of small rubber-covered concentric cables having a cross-section of 0·075 square inch, diameter of inner core 0·36in., and a dielectric wall of 0·09in., in use during the last 11 years at 2,000 volts, 50 frequency, was that 32 faults had developed. With 22 miles of cable, 0·15 square inch cross-section, 0·05in. diameter, 0·11in. dielectric wall, only three faults were developed in 10 years. A third cable, 49 miles in length, 0·15 square inch cross-section, 0·5in. diameter, 0·14in. dielectric wall, worked four years at 2,000 volts and two years at 6,000 volts without any faults. As to paper-insulated cables, he had used 200 miles at 2,000 volts without finding any fau t in the cables themselves, although faults had occurred in the joints. He felt considerable sympathy towards the cablemakers, who spent much time and money with a view to introducing improvements in the building of cables. In the matter of cable-making, he was sure England was not behind, but was leading the way.

J. T. MORRIS (*communicated*): Instead of grading the dielectric, another possible method of obtaining an approximately even distribution of the potential gradient in the insulation of a cable, is one which was suggested by me some two years ago at a course of lectures on extra high-tension cables. It can most easily be applied in the case of alternating-current transmissions. To the best of my belief it is novel. The plan is to insert one or two wrappings of conducting layers (such as thin copper tape or thin lead sheathing), so that the dielectric of the cable is divided into two or three equal parts. These conducting sheaths are then connected to suitable tapping points on the transformer supplying the cable, thus maintaining these sheaths at the desired intermediate potentials.

THE PROTECTION OF BUILDINGS FROM LIGHTNING.*

BY ALFRED HANDS, F.R.MET.S.

(Concluded from page 629.)

8. Some 10 or 12 years ago lightning was said to have struck down inside a brick chimney on the ridge of a small corrugated iron building situated close to Happisburgh Lighthouse. It did not damage the chimney; it did not even avail itself of the large amount of conducting material afforded by the metal sheeting to get to earth; it passed down the centre of the flue, and then, in some mysterious way, got to a gas-pipe and caused a fire by lighting the gas. In order that you may be able to see into the interior, I have covered the model with wire gauze in place of metal sheeting, but the effect, from an electrical point of view, is the same. We will let a spark strike the lighthouse and see what happens. [*Experiment.*—Spark strikes lighthouse and fire breaks out in small building.] In explanation I may say that the lightning conductor system in use for English lighthouses is practically that recommended by Faraday in 1843: A stout bar of half-round copper is connected to the metalwork of the lantern and carried down inside the lighthouse, being connected to all the metals in the interior. At the bottom it passes out to an ordinary copper-plate earth connection. In this case a pipe from the gasmaking house passed underground to the lighthouse and up to the top to provide gas for the lantern, and this pipe was, of course, in connection with the lightning conductor. Another pipe, in connection with the first one, passed underground to provide light for a small building, which was in use at the time as men's quarters. There was, therefore, a line of metal connected to the lightning conductor at the top of the lighthouse and carried along underground into the small building, but not connected to the iron framework or corrugated iron covering of the latter. There was a small gap between the pipe and the framework of the building, and here, owing to the surging effect I have described, a spark would occur, lighting the gas, as it has done in the experiment. The cure in this case is a very simple one. Connect the outer sheathing of the building to the gas-pipe where it enters the structure, or (else) the gas-pipe to the iron framework where it passes near to it, and no spark will occur.

We next come to effects that are by no means uncommon, but have hitherto been misrepresented owing to their not having been understood; cases in which objects are struck by lightning and effects occur at some distance away. For instance, a church spire might be struck, with or without a conductor upon it, and persons in a neighbouring house, who happened to have metals in their hands at the time, might receive slight shocks that would, perhaps, appear severe because they were unexpected. A man walking with a gun on his shoulder near a tree when it was struck would get a shock, and say he had been struck too. Workmen handling metal tools are especially liable to these effects when near lightning-struck spots. The Vicar of St. Agnes, Scorrier, Cornwall, sent me this year an account of a storm in which there was only one flash; this struck and damaged his church, and men in a mine about 500 yards away and at a depth of 260 to 320 yards below the surface received shocks. I regard these effects as due to a surging or wave effect, somewhat similar to what I have been describing, but with the earth as the conductor between in place of a line of metal. It is often thought that when a lightning flash reaches the earth—to put it in popular language—the effect is all over; but we must bear in mind that generally before a discharge occurs the potential of a locality is raised—or lowered as the case may be—enormously, and this altered potential does not necessarily return to the normal again without effect. Taking a water analogy again, I would liken it to a waterspout forming on the surface of a lake and then suddenly collapsing. The effect would not be over the moment the column of water struck the surface; there would be a surging or wave effect that might loosen the banks at some distance away where they happened to be weak. So with a lightning discharge we may imagine the sudden rise and fall of potential as setting electrical waves flying through the earth; where metals were so placed as to give rise to a difference of potential of sufficient magnitude, there the effects would be felt as shocks by persons in the position of links between those metals and the earth, or the effects would appear as sparks where two metals were so placed as to be just in the right way to catch these waves. This is how the matter presents itself to my mind, and I have found it explain many incidents that had appeared mysterious and that could have been foreseen under this aspect of the matter, and, it appears to me, under this aspect only. The greatest distance to which I have so far been able to trace effects of this kind has been about half a mile, but possibly, if the discharge were exceptionally severe or the conditions unsually favourable, effects might be traced even further. These cases are difficult to

* Lecture delivered at the School of Military Engineering, Chatham.

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reproduce because of the difficulty of reproducing the exact conditions in a lecture theatre. In the experimental reproduction I must be content to have my models only a few yards apart. I have been tempted to select this case principally because, from seeing the marks where a slight fire had occurred, I was able to deduce the circumstances, and also in this case there was a witness.

9. I was at Heathfield Station, in Sussex, one day when I noticed marks of burning and a combination of metals that led me to think I had accidentally come across an interesting case, and, having time to spare, I examined the buildings carefully. The railway line here is in a cutting, over which there is a road bridge. Above the platform on one side of the station is the booking office, abutting on to and level with the road. From one end of the booking office a footbridge, roofed with corru-

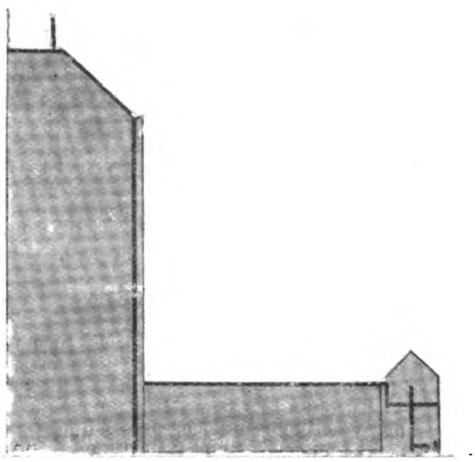

FIG. 4.—Corporation Granary, Bristol.

gated iron, leads across the line to give access to the other platform. From a gas-main along the road a pipe runs into the footbridge just outside the booking office, and rises up to a gas jet not far below the roof of the footbridge. Some telegraph wires terminate in shackles on the wall of the booking office above the footbridge, and from these shackles insulated wires were carried into the booking office, passing on their way down the roof of the footbridge and within about an inch of the gas-pipe, thus forming a connecting link between the iron pipe and the iron roof. The rubber covering of these wires had been ignited just by the gas-pipe, and the small fire occasioned had scorched some adjoining woodwork. I came to the conclusion that lightning had not struck the station, although inquiries elicited the fact that the fire had occurred during a thunderstorm. A signalman walking along the line towards the station said he did not see lightning strike there, although he was

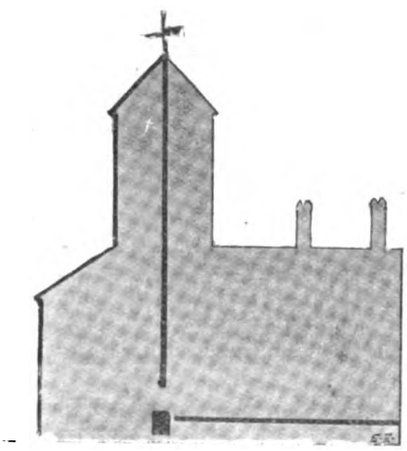

FIG 5.—A Sussex Mansion.

looking that way and saw the fire occur. I indicated two directions, in one of which I thought it probable that some object within about half a mile had been struck at the time of the occurrence; and I was told that a house, just about half a mile away and in one of the two directions I had indicated, had been struck, and, it was believed, at precisely the same time. What no doubt happened was this. When the lightning struck the house the discharge passed away in all directions; the portion going in the direction of the station was in due course more or less concentrated along the gas-pipe leading to the station; the potential of this pipe, terminating near the roof of the footbridge, was raised, but that of the roof, which was insulated, remained normal; thus a difference of potential was created, which was sufficient to cause a spark between the two, across the gap between the pipe and the insulated wires, and this spark ignited the covering of the wires and caused the fire. [*Experiment.*—Spark strikes house and fire occurs at railway station.] In this type of case there is no metallic connection between the buildings; the earth carries the wave or impulse. Whatever the object the discharge strikes, and whatever resistance it meets with, it must go to good earth, and the earth forms the conductor that carries the wave or impulse to the second object. All that is required at what I may call the receiver end is the suitable arrangement of metal to produce the difference of potential that will cause a spark. In the instance under reference it was the gas-pipe passing along the road from the direction of the struck building (but not actually from that building) and the long length of corrugated iron roofing insulated from the ground on a wooden frame. The spark could

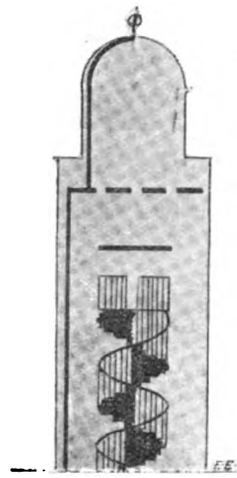

FIG. 6.—A Tower at Westminster Cathedral.

have been prevented by making a proper connection between the iron roof and the gas-pipe, or by placing the telegraph wires so that they should not form a partial connection. It is not only one "earthed" and one insulated metal that would cause such a spark. Two "earthed" metals, such as a gas-pipe and a water-pipe entering a building from opposite directions and on opposite sides, and crossing or closely approaching one another inside the building, would be liable to cause a spark; and when they do enter from opposite sides in this manner (rather unusual) the case wants looking into very carefully. The cases I have described are ones that have actually occurred. It may be said, it is easy enough to see these things after the events; what we require to do is to see them before they occur. So I will show you a few complications I have had to deal with that had not been struck by lightning.

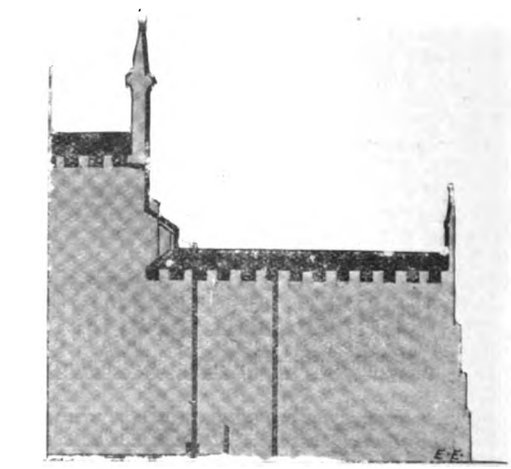

FIG 7.—Lady Chapel, Gloucester Cathedral.

10. Fig. 4 shows one end of the Bristol Corporation granary. This had a conductor system in perfect order. But a telephone wire had been run to a shackle close to one of the conductors, and thence on to the instrument in a small wood-lined building used as offices, where it passed across a soft metal gas-pipe. Had the granary been struck, a part of the discharge would have been led by this alternative path to the gas-pipe, fusing a hole in it and causing a fire; so I ordered the telephone wire to be moved well away from the conductor.

11. Fig. 5 shows part of a mansion in Sussex. A conductor had been fixed from the vane on the tower and well earthed, but afterwards metal rods were run from the vane to work an indicating dial in the hall. On the basement floor, below the dial, was an iron door, and running near this, almost in contact with the door, was a water-supply pipe. The distance from the

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dial to the door would, under ordinary circumstances, have been too far for part of the discharge to break through, but had anyone been standing looking at the dial at the moment the vane was struck, his body would have so far weakened the gap that a very severe, or possibly fatal, shock would have resulted. So a connection was run from the dial to the iron door, water-pipe, and conductor earth.

12. Fig. 6 is one of the east towers of Westminster Cathedral. The ledges were covered with lead, brick buttresses separating one piece of lead from another. Sparking would have been liable to occur from the one sheet of lead in contact with the conductor to the others, so connections were put in from one piece of lead to the next all round the tower. Inside the tower was an iron staircase, the top enclosed by a sort of wood canopy roofed with lead. Had anyone been standing at the top of the stairs at the moment the conductor was struck, his head would have been perilously near the lead; he would have formed a connecting link between the two masses of metal, and would have been liable to a rather unpleasant shock due to an induced effect. So I had a connection made from the lead to the handrail of the staircase and on to the conductor.

13. Fig. 7 is the Lady Chapel at the east end of Gloucester Cathedral. On one of my periodical visits of inspection, I found that a radiator stove had been put in, with a metal flue pipe that was carried up and in connection with the lead roof, which was, of course, connected to the conductor. The stove rested on a gas-pipe, so that there was an alternative path from the conductor system, consisting of the lead roof, the flue-pipe, the stove, and the gas-pipe that passed along the entire length of the cathedral. I recommended that the gas-pipe should be diverted to the other side of the chapel.

14. Fig. 8 shows rather a complicated case; a large hall lighted by gas pendants from a supply pipe passing along under the ridge. Usually such a building would be protected by a point at each gable, with a copper tape carried along the ridge from one gable to the other and down to earth at some place between. But here a dangerous alternative path exists right under the ridge, and the conductor would require to be kept away from it. Therefore, an independent conductor at each

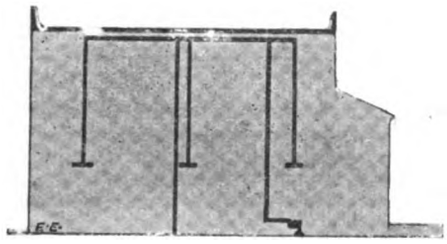

FIG. 8.—Type of Ordinary Large Hall.

end, both perfectly earthed, would be necessary. Chimney shafts often present difficulties in regard to protection. When hoop iron is built in for bond there is a weak spot wherever the iron comes near the conductor; therefore, when the hoop irons are being laid, tail pieces should be brought out from them to be connected to the conductor when it is fixed. In such cases the danger of side-flash would be near the top and bottom rather than in the centre. Sometimes a metal steam-pipe is carried up inside a shaft. Here it is necessary to connect to the conductor at the top, and either connect at the bottom also, or otherwise earth the pipe. Besides this it is necessary to trace the pipe to its source, and make connections to any metals near it at places where damage would occur through sparking, and also possibly between one metal and another. The various effects and complications I have described may justify me in saying that it is impossible to protect buildings from lightning by means of set rules. Each case must be studied separately, and such a system of protection applied as the complications found in the case may show to be necessary.

Methods of Protection.—Now, how are buildings to be protected? We may say broadly that there are three methods that might be adopted. Firstly, there is the cage system. If you have a metal box you can get no electrical effects in the interior, and if a building could be metal plated, so as to be like a biscuit tin with the lid on, it would be quite lightning proof, but no metal must be allowed to pass into the interior without being first connected to the metal sheathing. The advantage of this method would be that no knowledge of the subject and no study of the problem involved by the complications of metal in the structure would be necessary. It is *par excellence* the novice's method. It is not even necessary to cover the building with continuous sheets of metal; if conductors were arranged so as to form a closed meshed network all over it—so as to make it resemble a birdcage—it would still form a screen against effects in the interior. But a mere skeleton of a cage, the system that the Lightning Research Committee advocates in one part of its report and condemns as inefficient in another, does not afford this screening effect even to a partial extent; and the worst damage that has occurred to buildings through faultily applied conductors could still occur to one fitted with what I call the bastard cage system, if the conditions were conducive to those effects. In fact, I regard a partial cage system as liable to be extra hazardous, because, while one can arrange to keep a limited number of conductors on a building clear of metals that might cause complications, it might be found impossible to arrange them in all directions in this way. If an explosives magazine was fitted with such a system, I think I could add a contrivance that would cause it to explode if lightning struck anywhere within half a mile. We have a good example of the failure of the partial cage system in the Hotel de Ville, Brussels, one of the very few buildings that have been fitted with this system. It was struck and set on fire about 16 years ago. For the majority of buildings the complete cage system is quite impracticable. Apart from the prohibitive cost, I have yet to find the architect, or even the owner, who would consent to have his building turned into a glorified aviary. Then such a luxury as a telephone service would have to be dispensed with, since to connect the wires to the cage would be impossible, and, if introduced without being connected, they might nullify the screening effect of the cage. This system may, however, be applied with advantage in protecting explosive magazines; indeed, it is often a most difficult matter to protect them in any other way, because, I presume, the metals in the interior are constantly liable to change and rearrangement. If one could be certain that the problem one studied in the first instance would be the one always in existence and not a different one set from time to time, a much more simple method could be devised. The second method is to connect every particle of metal in and about the structure to one another and to the conductor system. Then no sparking or side-flash would occur, because there would be no gaps between metals where, owing to difference of potential, sparks could occur. This method is the one attempted by Trinity House for light-houses, but for ordinary buildings it is impracticable also.

The third method, which I regard as the practical one, gives, I think, the maximum of efficiency with the minimum of cost; but it necessitates a profound study of the subject and very careful consideration of the buildings to be protected. First, one must determine what are the parts of the building liable to be struck, and run continuous lines of metal from these to good earth connections, either as main conductors or as mains and branches, as may be most effective; then one must consider the effect that would occur if either of those conductors was struck by lightning, and make connections across any sparking gaps, either between the conductor and other metals, or between those other metals themselves, if the sparks were calculated to do harm. There are some metals about a building that should not be brought into connection with the conductor system, and these should be carefully avoided by giving the conductor a course that is beyond sparking distance. The question as to what shall and what shall not be connected is the most difficult one of all to decide, and no fixed rule can be laid down; it must be decided by the problem found to be involved.

In considering the subject of protection from lightning I think that too much importance has hitherto been attached to the form and composition of the conductor, and too little to the fact that its efficiency depends very little on what it is, but almost entirely on the way in which it is applied. The subject is somewhat analogous to the work of a medical practitioner, who has to consider the systems and characteristics of his patient and prescribes the remedies that his diagnosis of the case suggests; the result will depend on the ability of the doctor and the correctness of his views. Although the case that the lightning protection expert has to study is not one of existing disease, it is one where the possibility of bad results is before him; he has to consider the case on its merits, to determine all the effects that might occur, and to arrange his preventive devices in the way that he considers will be successful; he has, in fact, to diagnose the case, and the result will depend on the correctness of his diagnosis. None of us can lay claim to infallibility, and anyone might make a mistake or fail to notice some factor that might have an important bearing on the matter; but the fact remains that the possession of knowledge, experience, and ability to discriminate as to the importance of details should enable a man to protect a building effectively, while absence of these would probably result in failure. At all events, it is in this direction, I think, that we should strive to improve our methods, and not in trying to devise theoretically perfect, but practically impossible, mechanical ones, the only advantage of which would be to save the trouble of having to study the subject.

I have devoted the time at my disposal to the points I regard as of paramount importance, but you would probably consider my remarks incomplete if I did not refer to the relative value of copper and iron for conductors. So far as regards conductivity and dissipation of energy, the matter is, I consider, of such trifling importance that it sinks into insignificance in comparison with considerations of durability. A conductor is expected to last a long time, and iron, even if galvanised, is very perishable; so we are left with copper as the alternative of these two

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metals. As regards the advantage of iron dissipating the energy of a discharge, this has been demonstrated experimentally, and such work is often of very great value; but there are cases where it is necessary to take proportion into account. I might show you that by hanging a sheet of tissue paper loosely in front of a popgun I could impede the velocity of the cork, but if I suggested the advisability of hanging sheets of tissue paper before men exposed to rifle fire, you would probably think my friends ought to put me under restraint. The experiments that show the superiority of iron are, I think, almost on a par with this. They show that a thin iron wire about 100ft. long has a decided advantage in dissipating the energy of a 6in. spark, but if you were to repeat the experiments with a conducting wire about 1-16in. long and a 6in. spark—which would be about proportional to a lightning conductor 100ft. long being struck by a lightning flash half a mile in length—you would see what I mean by saying that, in my opinion, the matter is of trifling importance.

Conclusion.—There are, I presume, many present who are taking up the subject of protection from lightning as a serious study, and to those I would say, do not think it is a dull one, merely because I may have failed to put it attractively. You will find that the deeper you go into it the greater the interest grows. New problems and fresh complications are constantly being met with, and the field is very far from being exhausted; there is room for further investigation. And do not be discouraged because you meet with or hear of cases that appear, at first sight, inexplicable; there can be no such things as vagaries or freaks of lightning. I have devoted considerable time to investigating so-called vagaries, and never yet found one that, on being thoroughly probed into, did not prove to be consistent and in accordance with our knowledge of the subject. There are laws governing all natural phenomena, and lightning, like every other force in nature, must be amenable to law. We do not yet know all those laws, but they are gradually being revealed, and, where we do not understand them, we should try and clear up the mystery, and not dismiss the matter by saying that in one respect nature is erratic.

CORRUGATIONS ON TRAMRAILS.*

BY ARTHUR THOMAS ARNALL, STUD.I.C.E.

The extended use of electric traction has brought into prominence a peculiar effect of traffic sometimes found on the running surface of the rails: it becomes corrugated into a wave-like formation. For many years this has been noticed on various lines, and of late it has become quite general. These corrugations cause a most objectionable noise in the working of the cars, and are undoubtedly the cause of greatly increased wear and tear in the bearings, and of looseness and unsoundness in all parts of the car. The vibration also causes a rapid disintegration of the adjacent paving. The cement grouting and foundations are pulverised, water is freely admitted below the paving and metals, to be surged to and fro under the passing traffic, with a resulting large increase in the cost of maintenance.

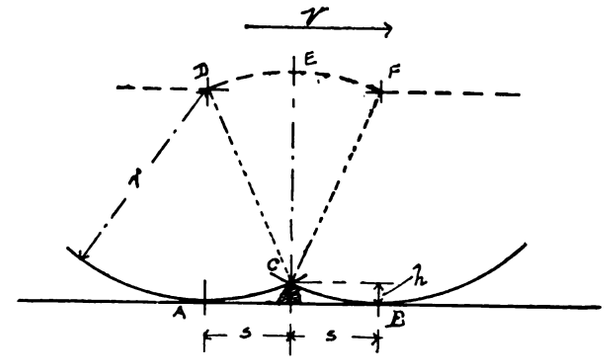
The following peculiarities are to be noticed in connection with corrugations. They have generally a pitch of about 2in., but often both longer and shorter, seldom perhaps so short as 2in. or so long as 3in. The part of the wave crest near the groove is generally in advance, so that the corrugations are not quite square with the rail. On curved tracks they appear on the outside rail, seldom on the inner one, and then only faintly. They frequently begin on a joint or other local looseness or peculiarity, and spread longitudinally in the direction of the traffic. On straight tracks they may affect either rail, but rarely both together in the same place. They are not formed until a certain speed is exceeded; neither are they formed on very sharp curves: probably because the speed in these parts of the track is too low. The pitch is uniform, or it may show a gradual alteration on a long stretch of rails. But neither the pitch nor depth show any variation dependent upon their position in the length of a rail.

The conditions necessary to produce corrugations appear to be: (*a*) uniformity of rolling stock; (*b*) uniformity of average speed; (*c*) an average speed exceeding a certain limit. For instance, on the Birmingham cable tramways the corrugations are not formed on a section worked at seven miles per hour, whereas they very quickly appear when the cars engage with another cable running at nine miles per hour. When they are first formed it is very evident that the rail is subject to a rhythmical rubbing action, and not to a succession of hammer-like blows. At a later stage the rubbing action may not be so obvious, but there is nothing to suggest that the corrugations are due to hammer-like action.

When two equal wheels fixed to the same axle are caused to roll along a curved track, the outer wheel has a farther distance to travel than the inner one; how much farther depends upon the radius of the curve, the gauge, and the distance travelled, but the exact amount is not material. After passing any given distance along the curve—if there has been no slip on the inner wheel—we may say that the outer wheel has rolled a distance equal to the inner one, and has been pushed without rolling a further distance forward equal to the difference in the lengths of the two rails. If we assume no slip on the outer wheel, the inner one has been pushed bodily backwards for a like distance. Circumstances may determine in what proportions the inevitable slip shall be taken up by the two wheels.

The essential mechanical results to be recognised are: (1) that on whichever side the slip takes place it has the effect of twisting that part of the axle between the two wheels; (2) that the twist is in the same sense whichever side the slip causing it may be; and (3) that the forces tending to cause it are always in action so long as the track is curved, the wheels are of unequal diameter, the motive power is applied near one end of the axle, or any cause exists which prevents the friction on the two wheels being equal. In this paper the effects of a curved track only will be considered.

Since speed beyond a certain limit is such an essential feature in the case, it may be supposed that centrifugal tendency will make the pressure greater on the outside rail, so that slipping will be confined to the wheels on the inner rail. The friction will there be a mixture of rolling and sliding; on the outer rail there is rolling friction only, modified in a way which has to be explained. The true nature of rolling friction is probably that explained in a paper by Prof. Osborne Reynolds before the Royal Society in 1875. The rolling body produces a deformation of the surfaces in contact, and a certain sliding friction is set up between them as they recover their original forms. It is unnecessary to add anything to this, so long as the velocity of the rolling body does not exceed a certain limit, in this paper called the "critical speed." But the new conditions which arise when this limit is exceeded must be taken into consideration in any attempt to deal with the question of corrugations.



Suppose, in the diagram, a wheel of radius r passing along with velocity V meets with a hard obstacle of height h. It leaves the rail at some point A, and meets it again at some point B, and while passing from A to B the axle traverses the arc, D E F, whose centre is C, the summit of the obstacle.

Let S = half the distance between A and B, then

$$S = \sqrt{2rh - h^2}.$$

But h being very small, we may say

$$S = \sqrt{2rh} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The time occupied by a body falling through a height h is

$$t = \sqrt{\frac{2h}{g}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The velocity of a wheel which passes over a space S in t seconds is

$$V = \frac{S}{t} = \frac{\sqrt{2rh}}{\sqrt{\frac{2h}{g}}} = \sqrt{rg} \quad . \quad . \quad . \quad . \quad (3)$$

If the speed of the wheel exceed this velocity, it cannot reach the level again until it has passed a greater distance than S—*i.e., for a certain space it must be free from contact with the rail.* The importance of this result arises from the fact that the critical velocity is independent of the height of the obstacle—that is to say, in rolling along a rough rail, at a speed greater than V, an unloaded wheel 2 r in diameter is not in continuous contact with the rail: every element of roughness, which is not crushed out of existence by the weight, frees the wheel for a small space from contact with the rail, and creates what may be described as a "looseness of contact" between the two surfaces.* From (3) it can be seen that V, the critical

* Paper read before the students' meeting of the Institution of Civil Engineers.

* The distance traversed by the wheel before it again comes in contact with the rail is greater than the above consideration would imply The critical velocity, V, as there defined is the lowest at which a body

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speed, depends only upon the radius of the wheel and the value of g. The acceleration is equal to 32 *only* when force is that due to the weight of the wheel, axle, and other load that may be upon them below the springs. When the acceleration is increased by the resilience of the loaded springs it takes a new value, which may be found thus: The motion of the springs—so far as they are concerned with the corrugations—is very small. We may, therefore, consider them as "embodied forces."*

Let f = acceleration due to springs. (3) now becomes

$$V = \sqrt{r\,(g+f)} \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

To find f: Let W = mass above springs = W g in poundals; P = mass under (and moved by) the springs.

Then $$W\,g = P\,f. \qquad f = \frac{W}{P}\,g.$$

From (4)

$$V = \sqrt{r\,(g+f)} = \sqrt{r\left(g + \frac{W}{P}\,g\right)} = \sqrt{r\,g\left(\frac{P+W}{P}\right)} \quad (5)$$

As an illustration: The total weight of a certain electric car is 10 tons, or 5,600lb. at each wheel. Of this, the dead load of wheel, half axle, quarter motor, and its gearing, being the parts below the springs, amounts to 940lb., leaving 4,660lb. above the springs.

$W = 4{,}660$lb. mass;
$P = 940$lb. mass;
$r = 1{\cdot}3$ (a 31in. wheel) say.

Then $$V = \sqrt{1{\cdot}3 \times 32 \times \left(\frac{5{,}600}{940}\right)},$$

$= 15{\cdot}7$ foot-seconds

$= 10{\cdot}7$ miles per hour.

The acceleration, f, however, as treated in the example, is not at all effective, because of the friction between the axle boxes and the horn plates. This must be considerable on a curved track. It virtually constitutes an additional load to be shifted by the resilience of the springs, and, therefore, makes the downward acceleration less than it otherwise would be. The critical speed at which loose contact commences is, therefore, lowered, and the conditions favourable to vibration arise at a lower speed than that obtained by the method indicated. It follows that for speeds below this limit, whatever their value may be, the wheels of the car may be supposed to roll—and perhaps slide—in continuous contact with the rail, and above it the contact will not be continuous. The effects of centrifugal force on a curve may modify the action as affecting the two rails, but the general result will be as stated.

The principle of looseness of contact above a certain critical speed being admitted, it is evident that as a car rounds a curve we have all the elements necessary for a torsional vibration of the wheels and axles. The drag on the inner wheel caused by the slip twists the axle against the resistance caused by the wheel which does not slip: the loose contact gives frequent opportunities for the wheel to free itself, and the wheel flies backwards, to be caught up again upon resuming contact with the rail. By "backwards" is here meant the direction opposite to the rolling motion; it, therefore, gives a forward push to the metal displaced on the rail surface.

The action of the wheel may be very closely imitated by pressing the end of the middle finger in a nearly vertical position on the table and pushing it stiffly forward. In general it will not slide, but progress in a series of little jumps. The outer wheel of a tramcar on a curve moves in the same way. There is a rolling motion in addition, but it does not interfere with the vibration due to the rub and twisting of the axle. It has the effect of spreading out the corrugations, and bringing fresh parts of the wheel into contact.

In the *Minutes* of the Institution of Civil Engineers, vol. clxii., p. 385, a convenient formula is given for determining the periods of free vibrations of loaded shafts. It is there shown that in a shaft of mild steel, if d = diameter of shaft in inches, l = length of shaft in inches, I = moment of inertia of the "load" in $\frac{W}{g}\,r^2$ pounds-foot units; then the frequency, f, of the vibrations, or the number per second $= 50\,d^2\sqrt{\frac{1}{L\,I}}$.

Applying this to the case of the car wheel and axle above dealt with, we have: I = 12·8 pounds-foot units; l = 36in. on a 3ft. 6in. gauge tramway, or 50in. on a 4ft. 8½in. gauge tramway, giving

Diameter of axle.	Vibrations per second. On 3ft. 6in. gauge.	On 4ft. 8½in. gauge.
3·5in.	28	24
4·0in.	37	32
4·5in.	47	40

The periods of freedom given by the loose contact are, however, too short to admit of more than a fraction of the complete swing being completed: the swing is arrested as soon as the wheel comes to a bearing again upon the rail, the shock and simultaneous rub pushes the metal of the rail forward, and an element of the corrugation is formed. As soon as the contact is complete, the axle is again twisted up and the action repeated.

Uniformity of structure and speed result in identity of effect produced by successive cars, and if the conditions conduce to vibration in one car they will in all. A remedy for corrugations, therefore, will probably be found by interfering with the uniformity in such a way that successive cars shall not produce identical effects. The exigencies of the service do not admit of the speed being interfered with, but there seems nothing to prevent the stiffness of the axles being varied so that the corrugations they tend to form shall not be all of the same pitch. The effects could not then accumulate. The above table of vibrations shows that a small variation in the diameter of axle is sufficient to produce a large variation in the period of free vibration of the wheel, and as this is quite independent of the period of freedom from contact on an uncorrugated rail, it follows that axles of different diameters would not tend to form corrugations of the same pitch.

The only part of the car having any influence on the result is the piece of axle clear between the wheels. This may be increased in diameter without difficulty and diminished without danger, for it is not a part liable to fracture. The only other interference with standing dimensions that would be necessary is an increase in the size of the eye on the motor frame—it would have to be made large enough for the thickest axle, and smaller axles provided for by suitable brasses.

It is useless to attempt to stop the vibrations, since they arise from mechanical conditions which are practically beyond control, but the desired end could be attained if their effects on the rail did not accumulate. Probably a sufficient variation in pitch would be produced by a small increase or reduction in the diameter of one axle on every car, or it might be necessary to use axles of three or four different diameters. Further investigation is necessary before the precise value of the axle diameter on the corrugations can be determined, but it is believed that a fuller knowledge of the influence of this factor in the question will lead to a remedy being found for the present costly and troublesome nuisance.

PERSONAL.

Mr. F. Spencer, tramways manager to the Halifax Corporation, and Mr. C. H. Spencer, rolling-stock superintendent, have resigned their positions.

Mr. G. W. Walker, assistant to the professor of natural philosophy in the Glasgow University, has been appointed superintendent of the Eskdalemuir Observatory.

We are informed that Mr. R. H. Hayne, having resigned his position as secretary and a director to Messrs. F. A. Glover and Co., is no longer connected in any way with this company.

Mr. Thomas Wilkinson, assistant to Mr. J. Bell, the city electrical engineer of Aberdeen, has secured an important appointment as outside superintendent engineer with a large contracting firm in the South.

Prof. Sir William Crookes, the discoverer of thalium and other new elements and the inventor of innumerable devices for showing the effects of such elements as radium, has been designated as the winner of the Nobel prize for chemistry, worth £7,800.

Mr. Alexander Stewart Rae, jun., and Mr. George Stephen Rae, both sons of Mr. Alexander Stewart Rae, sole partner of the firm of George Stephen and Son, and who have been associated with him in the business for many years, have been assumed as partners.

Mr. W. Hodgson has been presented by the staff of the Salford electricity department with an illuminated address and a handsome travelling clock on the occasion of his retirement from the Salford Council, and from the position of chairman of the Electricity Committee.

Berlin.—The Reichstag Chamber has been connected with the reporters' room by a loud-speaking telephone, which enables the reporters to hear everything that goes on without actually sitting in the gallery.

can move in a circle of radius r under the conditions given. For centrifugal tendency $F = \frac{m\,V^2}{r} = \frac{W\,V^2}{g\,r}$; so $V^2 = \frac{F\,r\,g}{W}$, which $= r\,g$ when F = W. If, therefore, this value of V be exceeded, the centrifugal tendency in passing the highest point exceeds the weight, so the wheel could not remain in contact with the obstacle. The "jolt" will carry it to a greater height than h, and it will describe a path everywhere above the arc, D E F; so the time during which it is not in contact with the rail will be greater than that due to a free fall through the space h. It will suffice to mention this point: the actual time of freedom from contact is not a material part of the argument, and it is not necessary to suppose the "freedom" to be absolute.

* This approximation is sufficient for the present purpose, but a thorough investigation of the effects of differently loaded springs would form an interesting subject for a future paper.

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TRANSATLANTIC WIRELESS TELEGRAPHY.

If one wants to know the worst faults of a given type of engine, it is useless to ask the makers for full details. These can always be obtained gratis, and with a due proportion of exaggeration, if one goes to the maker of a rival engine. Provided the communications are strictly private the law of libel can be avoided, but it is not easy to get such statements confirmed in writing. One may be sure that when discussing the faults of one engine with the sales manager of another type that any breakdown due to the ignorance of the staff working the engine will be attributed to the engine itself. With this introduction we proceed to the subject of our leader, which is commercial wireless telegraphy across the Atlantic. This has been established by the Marconi Company, and those who are interested in the faults and difficulties of this first Transatlantic service by ætheric waves cannot do better than read the communication by Prof. R. A. Fessenden which was published simultaneously in two of our contemporaries last week. To estimate the real value of this expert's conclusions, one must remember that he is the inventor of certain wireless telegraph apparatus. We should think little of him as a man if he did not believe that his system was superior to that of Mr. Marconi's. Unfortunately, however, the company which is working his patents was not sufficiently early in the field or strong enough in management to establish a commercial system cotemporaneously with that of the Marconi Company. The success of the latter undertaking is now seriously handicapping the development of Prof. Fessenden's system. It also adds point to the communication in which he criticises the Transatlantic service now rendered by his rivals. Coming now to the first part of the communication in question, we find that Prof. Fessenden can give exact dates and times of a large series of messages which were transmitted either with difficulty or inaccurately by the Marconi Transatlantic system. That he has read these messages does not convey the same stigma as if he had read Mr. Marconi's private letters. There is in our opinion little, if any, secrecy in wireless telegraphy, which may be compared with the communications shouted between two telephone erectors on house tops on the opposite side of the street. Still, not only have these messages been read, but in some way Prof. Fessenden is also able to read a cablegram sent by the Western Union Telegraph Company to Mr. Marconi. No doubt our contemporary, the *Electrician*, with its intimate connection with and knowledge of the submarine cable business, is able to explain how this lack of secrecy in submarine telegraphy comes about, but it does not trouble to do so. As it stands, our contemporary quite agrees with Prof. Fessenden in his communication, which no doubt is gratifying to those shareholders in cable companies who are needlessly scared at the present time, and inclined to fear that wireless telegraphy may replace instead of supplement their undertakings. We hope that the majority of electrical engineers will take a broader view of the question, and look forward to the time when the Marconi Company will have overcome the small troubles revealed by Prof. Fessenden in their Transatlantic signalling. We also hope that at the same time Prof. Fessenden's apparatus will be so fully occupied receiving commercial messages from England that his operators will not find it worth while to read the private messages of those members of the public using the Marconi system.

THE REPORT OF THE L.G.B.

Every year the Local Government Board issues a report giving remarks and statistics upon things a year or more

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old. Thus the report of 1906-7 comments upon and tabulates figures relating to 1904 5. We suppose there is some use in this, but in our opinion the real value is infinitesimal compared with the cost of production. Historians of the thirtieth century may tabulate the figures for long periods, construct curves, and determine the laws relating to various things occurring now. That the outstanding loans to local authorities reached the figure of £466,459,269 in 1904 5 is probably true, but why cannot we have the figures for 1906-7. Surely these are made up to March 29, 1907, and if given might do some good Two years behind time, and this for a Government of a so-called business nation. What is the value of ancient history, for whatever that may be it is the measure of the value of these books. We are gravely informed that in 1904-5 electric light undertakings returned a revenue of £2,566,987, and tramways and light railways a revenue of £5,362,412. Really; and yet the authorities have to fill up and send to the Board specified returns, and probably have long since done so, to March, 1907. The practical man wants to know about things later than two years ago. The very department that ought to be able to furnish the very latest figures evidently does not take the trouble to do so, hence a report which ought to be very valuable is nearly valueless.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TRANSATLANTIC WIRELESS TELEGRAPHY.

SIR,—A number of articles have been appearing in the daily Press directed to showing that the wireless telegraph service at present carried on by our company between Glace Bay and Clifden is now, and is likely to prove in future, from a commercial standpoint, quite valueless. Recently, also, a communication from Mr. R. A. Fessenden has appeared in the *Electrician* and in the *Electrical Review* intended to show that the statements that commercial wireless telegraphy has been inaugurated across the Atlantic are premature. The evidence adduced by Mr. Fessenden in support of this conclusion, even if accepted as correct, must be considered insufficient by any unprejudiced person, but perhaps you will spare me some space to reply to the Press attempts which are being made generally to cast doubt upon the wireless Transatlantic communication.

In the first place I would remark, parenthetically, that if the wireless system is now, and will always prove, as valuless as some of its critics would have us believe, it seems a work of supererogation to go to so much trouble and expense to demonstrate its defects. Nevertheless, considerable sums of money have been spent by interested parties to secure publication in the daily papers of articles which are admittedly paid for, and are intended to show that long-distance wireless telegraphy is, and always will be, without commercial value. It is the fate of all new inventions to suffer from these attempts, and the more revolutionary the invention the greater the hostility, but men who have followed the progress of epoch-making inventions in the past must find in the incredulity and criticism with regard to wireless telegraphy the strongest evidence of its ultimate, if not of its present, value.

It is not so very many years since the project of laying a cable across the Atlantic was regarded by some business men and by pseudo-scientists as a wild-cat scheme, and in every failure of the early attempts these critics found evidence of the value of their conclusions. Yet a very little consideration should have shown them that successful telegraphy over 300 or 400 miles of cable was ample evidence of absence of any inherent physical difficulty in telegraphing over 2,000 miles of cable. In the same way, if, as has been proved beyond dispute, messages are received on ships in mid-ocean by wireless telegraphy over distances of 1,500 miles, it seems clear that there is no inherent impossibility in transmitting wireless messages from England to the continent of North America. Fortunately, however, the value of such a conclusion is susceptible of proof which is indisputable; and it is no longer a question of speculation whether messages can be transmitted across the Atlantic—as has been proved by the numerous dispatches transmitted by our wireless stations which have appeared in the newspapers during the last few weeks.

The critics now, however, fall back upon a second line of defence. It is no longer said to be impossible to transmit messages over such a distance, but the transmission is alleged to be uncertain and irregular and liable to frequent interruption by atmospheric disturbances; the speed is said to be low, and lack of secrecy is pointed to as a damning defect. In the same way, no doubt, the critics of Transatlantic cable telegraphy talked when the 1858 cable, after a few weeks' working, gave up the ghost.

The difference between the long-distance wireless transmission of to-day and the cable transmission of that date is, however, that the wireless stations are still working merrily, and, as might be expected where running machinery is involved, the service to-day is, in detail, an improvement on the service of a few weeks since. It would be idle to pretend that the service is not capable of considerable improvement; we are not yet doing the thousand words a minute which Mr. Edison confidently prophesies, but it is an indisputable fact that whereas the speed of a cable is limited by its capacity, the capacity of the ether does not limit the speed of wireless transmission.

But lest what I have written should appear rather as an apology for the results now achieved than as an indication of far better results in the near future, it is material to state what *is now* being achieved; and these results are considered by commercial men, judging from actual experience, as proof positive of present commercial value. In support of this statement I cannot do better than quote from an article which has appeared in the *New York Times*, of which Mr. Marconi sent me last week by wireless telegraphy from Glace Bay to Clifden the following account:

Handed in { Marconi private wire, Galway, 8.58 p.m. } Received here { West Strand, 10.12 p.m. }
Hall, Expanse, London. Nov. 21, 1907.

New York Times, under heading "The Growth of Wireless," published Monday, 18th, leading article: "No better evidence is required of the utility of the Marconi wireless telegraph system than the service of news from abroad—than the fact that considerably more than a page of fresh foreign news and gossip in the *Sunday Times* was sent from Clifden, Ireland, to Glace Bay by that system, and delivered in Times-square quickly and accurately. Our wireless dispatches from Europe come to us in excellent shape, comparing favourably with those by cable, and the facilities of the wireless system improve weekly. The cable companies will do well to recognise the significance of the situation. The indisputable success of the wireless does not mean a restriction of the volume of their business or a decrease in their profits. Quite the contrary, it means that telegraphing between Europe and America will become much more common. It must also become cheaper. The wireless is not going to put the cables 'out of business,' as there will be plenty of work for both systems, but for the cable folks to 'stand pat' and decry the 'wireless' seems a foolish policy. In our wireless dispatches yesterday included the latest news about the Kaiser's English visit, and the rumours concerning his illness; the sailing of 'Mauritania'; the political complications in Great Britain likely to ensue from the Premier's breakdown in health; Alpine railway plans; the Sultan of Turkey's latest grievance; Bernard Shaw's newest self-revelation; Nathan Strauss's sterilised milk distribution in England; a bit of musical and theatrical gossip; the federation of exploration work in Egypt; Lord Curzon's projected reforms at Oxford; and the latest social news. An equally interesting selection of foreign news from many points was included in the cable dispatches of the *Sunday Times*. The wireless Transatlantic service is no longer experimental. Marconi has invented and developed it, and put it successfully in operation. It is a rival to the cable service, but not necessarily an unfriendly rival. We cannot have too many ways of speaking across the ocean."—MARCONI.

The attention which the newspaper draws to the significance of long telegrams by wireless telegraphy, covering a sheet about the size of the *Daily Mail*, can hardly be criticised as premature, for the telegrams to which he refers are by no means the first long dispatches which have

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appeared in that newspaper, transmitted by our long-distance station at Clifden to Glace Bay.

Some comment has been made upon the fact that the news "By Marconi's Wireless Telegraph," which has appeared in the London Press, has been somewhat intermittent since the service was inaugurated on Oct. 17 last, and I may perhaps be permitted a word of explanation on this point. The correspondents of the newspapers are accustomed to dispatch their news at certain hours. As the transmission of wires from New York to Glace Bay over the land lines occupies five or six hours, it has frequently happened that New York messages have either not arrived in London in time, or have not been transmitted at all by the correspondents through our stations in view of their knowledge that delay would ensue between New York and Glace Bay. These drawbacks are, however, not drawbacks of the wireless system *per se*, but defects of the ancillary arrangements which can readily be remedied; and it should be noted by those who make a great point of the rapidity with which messages can be sent by the cables from London to New York, that these achievements depend more upon efficient land-line arrangements than upon the actual speed of working over the cable.

The cable companies claim that a message can be sent from the London Stock Exchange to the New York Stock Exchange, and a reply obtained, within three or four minutes. These messages are generally short messages, and whether the actual speed of transmission over the cable is 50 words a minute or 25 makes very little difference. The main point is to have direct connection from the London Stock Exchange to the point where the cable lands, and a similar direct connection on the other side. If, in addition to these arrangements, it is secured that the persons communicating are at either end of the line, all ordinary delay in the collection and distribution is eliminated.

The argument against wireless based upon the want of secrecy, is an argument without value. Whether messages are sent over the ordinary land lines, or the cables, or by wireless, absolute privacy can be secured only by coding, and where secrecy is important coding is always resorted to. In countries where wireless telegraphy is controlled by the State, publication of messages received at a station for which they are not intended is prohibited, but where there is no such prohibition, to make a business of interception is not merely unprofitable, but harmless, as all messages of a secret character are sent in code.—Yours, etc,

MARCONI'S WIRELESS TELEGRAPH COMPANY, LIMITED
(H. Cuthbert Hall, Managing Director.)

RE QUESTION No. 966.

SIR,—With reference to the method of finding a fault described in your issue of May 31, 1907, p. 746A, Fig. 4, would you please give particulars of (1) the range of scale of the multi-voltmeter used, (2) the makers of same.

As the difference of the distance of the fault from A and C (Fig. 4) may be small, the difference in the voltmeter readings will be correspondingly small, which necessitates that the range of scale of the voltmeter be small. Again, there may be some small resistance in the fault, due to which a few extra cells might be used, and thus raise the voltage above that which the voltmeter scale measures. How is this difficulty disposed of?—Yours, etc.,

A. B. C.

SALE OF BUSINESS.

SIR,—Our attention has been drawn to an advertisement in one of your contemporaries *re* the sale as a going concern of the Electro-Motor and Dynamo Co. As we have been informed of this from two or three different quarters, and it has been pointed out that confusion may arise, with the result that considerable damage might ensue to our business, we shall be greatly obliged if you would kindly inform your readers that the above company have never had any connection with our firm.—Yours, etc.,

ELECTROMOTORS LIMITED.
(B. Longbottom, General Manager.)

Manchester, Nov. 26, 1907.

COMBINED STEAM-TURBINE AND GAS-ENGINE PLANT.

SIR,—I am indebted to Mr. Fedden and to Mr. Fox for their letters criticising my attempt to give figures showing the relative capital and running cost of steam-turbine and gas-engine generators.

The main question upon which we appear to differ is that of the capital cost of a 16,000-kw. steam-turbine plant. I can only say that since my figures were published, engineers, with recent tenders before them for steam-turbine plant, have been good enough to send me particulars of capital costs which entirely confirm my figures. I can only conclude, therefore, that Mr. Fedden, in arriving at his total capital cost of £9·13 per kilowatt, must have omitted some items.

The following is a more detailed statement of my original estimate, with Mr. Fedden's amended figures for some of the items:

Capital Cost per Kilowatt of a 16,000-kw. Steam-Turbine Plant.

	Detailed estimate.	Original estimate.	Mr. Fedden's estimate.
Engines and generators (erected)	£4	£6	£3·75
Condensing plant	1		?
Circulating pipes, etc.	1		?
Boilers	2·5		3·5
Coal and ash conveyors	·23		
Steam-pipes, pumps, etc.	·53	5·06	?
Economisers, flues, chimneys, coal stores and boiler stores	1·8		
Engine-room buildings, cranes, and engine foundations	1·12	1·12	1·12
Switchgear	·32	·32	·32
	£12·5	£12·5	£8·69
5 per cent. contingencies	·6	·6	·44
	£13·1	£13·1	£9·13

Dealing with the question of overload capacity raised by Mr. Fox, I fully recognise that the advantages of steam-turbines over gas-engines in this respect are very great, and this feature makes the steam-turbine particularly suitable for dealing with the peak load and for providing the spare plant capacity, as suggested in my original statement. I do not, however, agree with Mr. Fox that it would be necessary in the case of a power station equipped with gas-engine plant alone to install a very much greater normal capacity of gas-engine plant than of steam-turbine plant. As many writers in the past have pointed out, the correct amount of plant to allow for overload capacity cannot be expressed in a percentage of the maximum load. It is more important to provide that the overload capacity shall be such that in the case of one plant being laid off for repairs, there shall still be a further spare plant in case of a breakdown.

In my original estimate I assumed that the maximum load to be dealt with was 13,000 kw., and I based my estimates of capital cost upon the assumption that for this purpose four 4,000-kw. steam-turbines would be required, having an overload capacity of 50 per cent., or eight 2,000 gas-engines having an overload capacity of 10 per cent. Now, it is obvious that in the case of the steam plant should one turbo-generator be laid off for overhaul and one of the remaining plants should break down at the time of maximum load, the available plant capacity will be 8,000 kw. + 50 per cent. overload = 12,000 kw., or 1,000 kw. short of the maximum demand. If, on the other hand, one of the gas-engines is laid off for overhaul and a second engine breaks down, there will still be available six 2,000-kw. sets = 12,000 kw., having an overload capacity of 10 per cent., or a total of 13,300 kw.—that is to say, a capacity of 300 kw. above the maximum demand.

The running costs of a 16,000-kw. gas-engine plant on a 100 per cent. load factor were arrived at on the following basis.

Fuel.—One ton of coal (costing, say, 10s.) will produce in a good by-product producer 150,000ft. of gas of a net calorific value of 135 B.Th.U. per cubic foot (20,200,000 B.Th.U.) and from 85lb. to 95lb. of sulphate of ammonia, having a realisable value of from £10 to £12 per ton (say, 85lb. at £11 per ton) = 8s. 4d. An additional 20 per cent. of fuel, costing 2s., is required for raising steam for producers and driving auxiliaries. Acid and stores for producer

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cost 1s. 6d. per ton of coal gasified. 10,000 B.Th.U. will, therefore, cost on the above basis,

$$\frac{10{,}000 \times (10s. + 2s. + 1s.\ 6d. - 8s.\ 4d.)}{20{,}200{,}000} = \cdot0302d.$$

Allowing 10,000 B.Th.U. per brake horse-power, and taking the efficiency of the generator at 95 per cent., the net cost of coal per kilowatt-hour $= \frac{\cdot0302}{\cdot746 \times \cdot95} = \cdot0426d.$

Producer Repairs.—The cost of producer repairs may be taken at ·0056d. per kilowatt-hour.

Generating Plant Repairs.—Particulars of the actual cost of repairs at four independent installations where Ehrhardt and Sehmer engines have been running for a considerable period are tabulated below. Compared with these actual results the original estimate of ·011d. per kilowatt is high:

	Capacity of plant.	Period covered.	Total cost of repairs.	Approximate output kw.-hours.	Repairs per kw.-hour.
A.	550 b.h.p.	22 months	£98 10 0	4,500,000	·0054
B.	350 ,,	3 years	*367 10 0	3,600,000	*·024
C.	550 ,,	44 weeks	62 1 7	2,300,000	·0065
D.	1,650 ,,	1 year	250 0 0	7,500,000	·008
Aggregate— 3,100 b.h.p.			£778 1 7	17,900,000	·0091
Original estimate— 16,000 ,,		1 year	£6,400 0 0	140,000,000	·011

* Includes repairs to producer plant.

Oil, Waste, and Stores.—The actual consumption of oil on an Ehrhardt and Sehmer engine, carefully checked for a considerable period, has been found to be ·00039 gallon per kilowatt-hour generated = at 1s. 6d. per gallon, ·007d. The cost of waste and stores has similarly been found to be ·0004d. per kilowatt-hour.

Labour.—A reasonable allowance for labour would appear to be—for by-product recovery plant:

Twenty-five men, averaging 4s. per shift	£5	0	0
For engine-room plant:			
Six drivers at 5s. per shift*	1	10	0
Eight greasers at 3s. per shift*	1	4	0
One switchboard attendant at 4s. per shift	0	4	0
One charge engineer at 7s. per shift	0	7	0
	£8	5	0

* For the two 2,200-h.p. engines at the Hoesch Iron and Steel Works one driver and two greasers are employed per shift for the two engines.

The cost per kilowatt-hour $= \frac{165 \times 12}{12{,}800} = 0{\cdot}155d.$

The total working cost may, therefore, be summarised as follows:

	Gas-engine plant. Detailed estimate.	Gas-engine plant. Original estimate.	Steam-turbine. Original estimate.
Fuel	·0426	·0482	·141
Repairs—Producer	·0056		
Gas-engines and generators	·0110	·0110	—
Turbines and boilers	—	—	·015
Oil	·0070	·0075	·003
Waste and stores	·0008		
Labour	·0155	·0155	·012
Interest and depreciation	·0517	·0517	·036
	·1342	·1339	·207

My original estimates were based on a 15 per cent. load factor, and a 100 per cent. load factor to indicate upon what basis the curves giving the total costs for any load factor were constructed.

As a reply to the general criticism that my statement was obviously prejudiced in favour of gas-engines, I cannot do better than quote the comparison given by Mr. Stott, the chief engineer of the New York Rapid Transit Railway, in his paper on "Power Plant Economics," before the American Institute of Electrical Engineers. Mr. Stott gives the following figures as representing the relative capital and running costs of different systems of generating electricity:

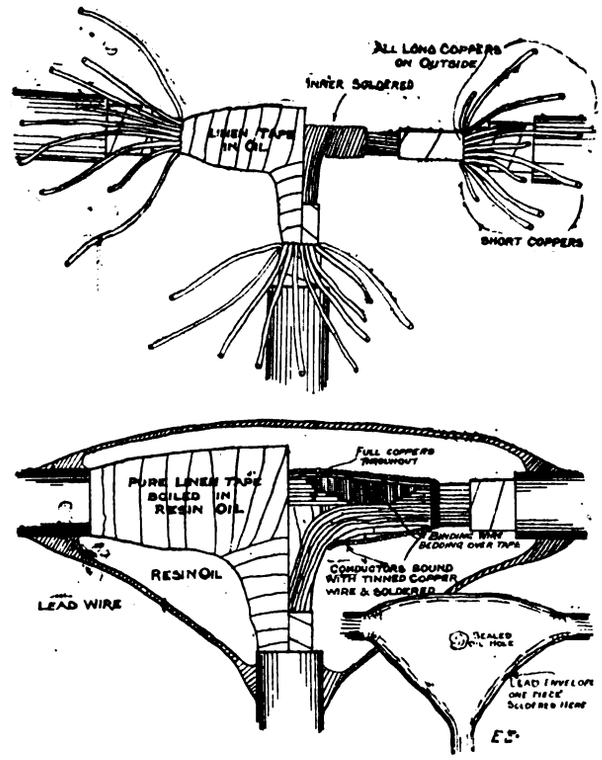
	Capital cost.	Running cost.
Reciprocating engines	100 per cent.	100 per cent.
Steam-turbines	82·5 ,,	76·64 ,,
Reciprocating engines and exhaust steam-turbines	77 ,,	75·72 ,,
Gas-engines	100 ,,	50·67 ,,
Gas-engines and steam-turbines	91·2 ,,	46·32 ,,

In the summary of his paper Mr. Stott adds: "An internal-combustion engine plant in combination with a steam-turbine plant offers the most attractive proposition for efficiency and reliability to-day, with the possibility of producing the kilowatt-hour for less than half its present cost."

From the above it would appear that future competition in electric generating plant will not be between turbines and reciprocating engines, or between turbines and gas-engines, but the main contest will be reciprocating engines combined with exhaust turbines *v.* steam-turbines combined with gas-engines.—Yours, etc., LEONARD ANDREWS.

LEAD WIPED JOINTS.

SIR,—I enclose sketch of tee joint in a concentric paper-insulated cable. I have made some hundreds of these joints and also triple-concentric of similar class, and have



FULL COPPERS THROUGHOUT
PURE LINEN TAPE BOILED IN RESIN OIL
RESIN OIL
LEAD WIRE
CONDUCTORS BOUND WITH TINNED COPPER WIRE & SOLDERED
SEALED OIL HOLE

never had one fail, although some have been standing over eight years. I trust that this sketch will be of some use to your correspondent.—Yours, etc., G. H. W.

THE RAILWAY CRISIS.

SIR,—A fortnight ago I endeavoured to point out that a statement made by the writer of "The Railway Crisis," that the interests of masters and men are identical, was incorrect. Another article in support of the first failing to convince me, I am asked to reply to a number of questions, but among these is one which admits the very point for which I have been contending. It reads: Will "Staffordian" state any other point where the interests of capital and labour clash except this one, and how exactly should the profits realised be divided between them?—clearly implying that on the question of division of profits there is ground for conflict.

Having come to agreement on the chief point hitherto in dispute, we can proceed to the questions and points which they raise. "Lancastrian" in last week's issue really answers most of these questions, and I can endorse all he says.

Q. Define capital and labour.—A. Capital is wealth withheld from consumption to aid in the production of further wealth. Labour is the human element in the production and distribution of wealth.

Q. Do capital and labour each deserve a certain return for their services?—A. As no one imagines the existing competitive system is founded on abstract justice, the discussion of deserts is beside the point. Capital being dead cannot serve actively—it can only be used; for allowing it

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to be used, the owners may reasonably demand compensation for their risk of losing it.

Q. Is the return for services rendered to any concern by capital and labour the profit upon the work?—A. No; part of it is wages. As "Lancastrian" gives a clear example illustrating this point, I need not reply at length.

Q. Where else but on division of profits do interest of capital and labour clash?—A On rates of wages, hours per day of work, sanitation of factories and workshops, etc.

Q. How exactly should the profits realised be divided?—A Under a system where man competes with man and company with company, the only practicable method is for each to take all he can get—which is exactly what is done. The result is conflict, strikes, lock outs, extravagant advertising, adulteration and misrepresentation of goods, and endless inefficiency. With a practical alternative of co-operative production already to hand, the competitive system stands condemned.

Q. Can capital have employment without labour?—A. No.

Q. Can labour have employment without capital?—A. Yes; but until from excess of production over consumption capital is forthcoming (in the shape, for example, of tools), the labour is inefficient.

Q. Are the men delegated to organise the working of capital the equivalent of the capitalist?—A. No; strictly speaking, the capitalist is merely the owner of capital, and the organiser or user of capital on a large scale is a worker and is in the same category as the workman who uses capital on a small scale

I should like in my turn to have asked a few questions, but perhaps we have enough to discuss at present.—Yours, etc.,

STAFFORDIAN.

GROVES'S OHMMETER.

SIR,—I am reluctant to criticise the award of prizes for replies to your question No. 1,012, but on reading the answers the following queries, among others, suggest themselves to me. Why, if Mr. Dunsheath resorted to the patent specification to obtain a diagram of the instrument concerned, did he not also get information as to its working from the same source? Why, if the "best answer" is considered worthy of a prize, are prizes also awarded to competitors giving a totally different description of the operation of the instrument? Why is the glamour of trigonometrical formulæ allowed to cover the multitude of sins in the "best answer." Why, when the operation of this simple piece of labour-saving apparatus is described in Messrs. Elliott Bros.' pamphlet, (*vide* the 5s. answer) and elsewhere, does Mr. Dunsheath go out of his way to explain how the instrument does *not* and cannot work? Why should the obvious absurdities in the "best answer" pass without a protest from—Yours, etc.,

THE PATENTEE.

[Mr. Dunsheath will be able to answer this letter best, but we wish "The Patentee" had pointed out the detailed errors he refers to.—ED., *E. E.*]

CATALOGUES.

SIR,—We should be very glad if you would give publicity to the fact that we shall be very glad to receive copies of catalogues with the best terms from the electrical manufacturers.—Yours, etc.,

ELECTRIC STORES (WOLVERHAMPTON), LIMITED.
(J. H. Whittaker, Director.)

THE RAILWAY CRISIS.

It is necessary that I should dissociate myself from the impersonal "we" in carrying on a pleasant controversy with "Staffordian," "Lancastrian," and any others who may be inclined to join in, upon a subject which, if not directly technical, is of the utmost importance in all business and commercial pursuits. My aim is first to get a common starting point where both sides are agreed, without which discussion is valueless, as it leads and can lead to nothing and nowhere. As yet we have not found that common starting point, nor do we approach it in the letters referred to or in this article, for I cannot agree to the definitions held by the writers of the letters.

Prof. Jones's book on political economy, edited by Dr. Whewell, says of "wealth," p. 6: Its original sources "no doubt are the earth and elements. From them all the material wealth which man can appropriate or fashion is originally produced. Labour was inadvertently described by Adam Smith as the source of all wealth." Again, he says:

"*Labour* is the universal instrument without which none of the productions of Nature could be appropriated by man, or made useful to him, but his labour is no more the original source of his wealth than the mouth is the original source of his food."

He goes on to elaborate the subject, while agreeing that the efficiency of labour has more to do with the actual and comparative wealth of nations than the original sources of their wealth.

Efficiency of labour depends (1) on the continuity with which it is applied (you cannot have continuity without capital); on (2) the skill with which it is directed (you cannot have skill without capital); and (3) the power by which it is aided (you cannot have machinery without capital).

If these views are correct, then you cannot have efficiency without capital, and on this ground I maintain that that which renders labour more efficient ought to participate in the results of that increased efficiency.

These remarks I hope are clear, plain, and to the point. Do "Staffordian" and "Lancastrian" dispute them? If so, in what respect? If not, we get to the common ground of agreement—that capital must as a right have a commensurate return for its use.

Capital, according to Prof. Jones, p. 35, "consists of all such commodities as are employed in producing wealth, or are advanced towards the maintenance of those who produce wealth."

Capital (John Stuart Mill in his "Principles of Political Economy," People's Edition, p. 34, says:) is "a stock *previously* accumulated of the products of *former* labour." (The italics are mine.) If these definitions are correct, and to me they are in accord, except that Mill's is more restrictive, but for my purpose now even that is enough, the bottom of "Lancastrian's" idea is knocked out. Wages are paid out of capital. His £10 worth of castings are obtained out of capital, and his stock is only possible through the aid of capital. That the capital advanced will be repaid with additions has nothing to do with this particular point. The operation could not be carried on without capital. It is a case of destruction and of construction. "Staffordian" rather grudgingly allows that capitalists "may reasonably demand compensation for their risk of losing it." I am afraid that in this form I cannot agree with "Staffordian." Capital does not desire risk—that is an accident—nor does it "demand compensation"; it claims participation in results as a right. But I would prefer for the moment leaving this to ask whether what I have said about wealth, labour, and capital is correct, and if the definitions are accepted? Granting these definitions, I shall have no difficulty in proving the right of capital to participate in the results of labour. In fact, Bastiat proved this to my mind most conclusively some 50 or more years ago.

Let us start on an agreed firm foundation.

THE WRITER ON THE CRISIS.

THE DEVELOPMENT OF TURBO-GENERATORS.*

BY DR. ROBERT POHL, ASSOCIATE MEMBER.

Through the great improvements made in late years in the construction of steam-turbines the electrical industry is confronted with the problem of designing dynamos suitable to be directly coupled to these high-speed prime movers. The inter-dependence of steam and electrical engineering, and the consequent great influence which the solution of this problem would exercise on the future of both industries, explains the untiring energy with which most of the

* Paper read before the Institution of Electrical Engineers.

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leading firms in all countries have been working at it for the last four or five years, following the lead of Messrs. Parsons and Co., of Newcastle, and Messrs. Brown, Boveri, and Co., of Baden. The difficulties of the problem are partly of a mechanical, partly of an electrical nature, and whilst the same may now be said to be satisfactorily overcome in the case of alternators, there is admittedly much room for improvement in the construction of direct-current machinery.

Several most valuable and exhaustive papers have been recently read before this and other societies dealing with turbo machines both for alternating current and direct current. In the present paper it is not intended to consider the whole of this vast subject, but it is confined to direct-current generators. The paper will deal with these only, or at least mainly, from the point of view of their electromagnetic design, in which, as is well known, the greatest obstacles to further improvement are encountered. The object is to show why certain outputs and speeds cannot at the present time be safely exceeded, to define these output limits, and, in conclusion, to discuss briefly the directions in which further improvements may be expected. In this connection one or two suggestions will be made which may possibly prove to be of interest.

In view of the desirability—from the turbine maker's point of view—of running the set with as high a speed as possible, we have first of all to answer the questions: Given a certain diameter of the armature, which will be the maximum permissible speed at which it may be run without undue stress being set up? and, secondly, What is the maximum possible output thereby obtainable, assuming the armature to be made axially as long as possible? In finding the reply to these questions, we shall arrive at a curve showing the highest possible speed for which a generator can be built as a function of its output.

In slow-speed machines the output, as is well known, is limited either by the sparking or by the heating. For the purpose of our present investigation, as may be particularly noted, we shall leave the question of temperature rise altogether out of consideration, because, though it requires the most careful attention in the design and construction, it cannot be considered as an output limit. The extremely high periodicity and consequent large iron losses with which most turbo-generators have to work, coupled with their small dimensions, necessitate in most cases the employment of artificial cooling devices. A number of systems for artificial ventilation, which allow of the regulation of the quantity of air forced through, are in use, so that the heating limit can, for our purposes, be considered as lying above the output limit as fixed by other considerations.

The mechanical or speed limit of an armature is defined by the circumferential velocity, for which the tensile stresses reach their permissible limit. In working through modern turbo-generator designs it will be found that it is invariably the stress in the end shells protecting the connections which first approaches the limiting values. If we calculate the stress, K, occurring in an ordinary unloaded ring of radius r cm., thickness δ cm., and specific weight γ, rotating with velocity v m./sec., we obtain

$$K = \frac{1}{\delta}\int_{\phi=0}^{\phi=90} \frac{r \cdot d\phi \cdot \delta\gamma}{98{\cdot}1} \times \frac{v^2}{r} \times \sin\phi = \frac{v^2 \cdot \gamma}{98{\cdot}1} \text{ kg/sq. cm.,}$$

therefore the highest permissible velocity

$$v_{perm.} = \sqrt{\frac{K_{perm.} \times 98{\cdot}1}{\gamma}} = \sim 10\sqrt{\frac{K_{perm.}}{\gamma}} \text{ m./sec.}$$

Allowing a permissible stress for ordinary bronze casting of 260 kg. per square centimetre (tenacity about 1,500), we obtain as maximum velocity for an unloaded ring 55 m/sec. Considering the additional load due to the end connections, the maximum speed will only be about 50 m/sec. In order to allow of higher circumferential velocities, special phosphor-bronze and manganese-bronze castings are generally employed for the end shells. As the permissible stress for these materials is about 600 kg. per square centimetre or even higher (tenacity about 3,500 to 4,500), the maximum velocity will be found to be 75 to 85 m./sec. under the conditions of load prevailing in such machines. If, for the purpose of our consideration, we assume 75 m./sec. to be the maximum circumferential velocity, we arrive immediately at the highest possible speed in revolutions per minute for any armature of given diameter. Let us now proceed to the purely electrical output limits.

Flash-over Limit.—While in ordinary slow-speed direct-current machinery the only electrical limit is that of sparking, in high-speed machines we have not only to deal with this factor but also with a new one, which we may term the "flash-over limit," and which requires quite as much attention as the commutation. In fact, not a few turbo-generators, in spite of their good commutating qualities, have proved to be failures on account of their tendency to arc round the whole commutator. If one were to inquire from the designers as to the cause of this trouble, they would, in most cases, attribute it to insufficient insulation of the shrinkings and of the brush gear. This may often have been the cause; so much is certain, however, that in not a few cases the real source of the trouble must be attributed to the excessive potential difference between two adjacent commutator bars. It is, of course, a matter of common experience that bad commutation, particularly in connection with a dusty commutator, can by itself be the cause of flashing over, and it is further well known that the kind of winding employed and the velocity of load fluctuations, which result in momentary increases of pressure, materially influence the phenomenon. Whilst fully recognising the importance of these subsidiary causes, it must, in the author's opinion, be admitted that the maximum voltage per segment is the most important factor, which for satisfactory performance should not exceed a certain value. This value we shall have to decide upon. In doing so, however, it must be remembered that the circumferential velocity is already fixed as not more than 75 m/sec, and that now, in limiting the voltage per segment, the highest number of lines of force which can be allowed to pass through the gap per centimetre armature circumference is at the same time settled. In other words, by limiting $e_{seg.\ max}$, the product $B_{g\ max} \times l_a$ is simultaneously limited, which practically means also the length of the armature. Experience has shown that slow-speed machines, with clean commutator and the usual thickness of mica insulation between the segments, approach their flash-over limit if the voltage per segment reaches a maximum of about 60 volts. As a safe limit in the case of turbo-generators 40 volts may be taken, the smaller figure taking into account the effect of load fluctuations, dust, etc. In testing and examining a large number of different machines, the author found this figure only once or twice slightly exceeded. From $e_{seg.\ max.} = 40$ volts and $v = 75$m./sec, the product $B_{g\ max.} \times l_a$ is found to be

$$B_{g\ max.} \times l_a = \frac{40 \times 10^8}{2 \times 75 \times 100} = 267{,}000.*$$

Assuming 25 per cent. field distortion,

$$\left(\frac{B_{g\ max.}}{B_{g\ mean}} = 1{\cdot}25\right)$$

then

$$B_{g\ mean} \times l_a = 215{,}000,$$

which for $B_{g\ mean} = 5{,}000$ corresponds to $l_a = 43$ cm. as greatest permissible length of the armature, independent of its diameter. We now arrive at the total number of lines, $p \times N$ (p = number of poles, N = flux per pole), entering or leaving the armature. Taking the ratio $\frac{\text{pole arc}}{\text{pole pitch}} = a = 0{\cdot}65$,* we find $p\ N = d_a\ \pi\ a\ B_{g\ mean}\ l_a = 0{\cdot}44\ d_a\ 10^6$ (second column of Table I.). It will thus be seen that in the design of the magnetic circuit of a turbo-generator the flash-over limit is of the utmost importance, as it restricts the number of lines allowed to enter or leave an armature of given diameter.

Commutation Limit.—The only point which now remains to be settled, before arriving at the highest possible output, is the question as to how many ampere-turns can be accommodated on the circumference of the armature, or,

* The armature winding is assumed throughout the paper to be an ordinary lap winding, for which the potential difference between two adjacent commutator bars is equal to the E.M.F. induced in two conductors in series.

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in other words, which is the highest permissible specific load A S (ampere conductors per centimetre armature circumference). The limiting factor in this case is the sparking. The quality of the commutation, of course, depends not only on the A S value of the armature, but is intimately connected with quite a number of other electric and magnetic conditions, particularly the effectiveness of the commutating poles. Last, and not least, it depends greatly on the mechanical conditions of the armature, the commutator, and the brushes. Further, in machines of large output the pressure, or better, the absolute value of the current strength, is of the greatest importance, so that for 550-volt machines A S may be considerably higher than for 240 or even 120 volt machines. Although a general fixing of A S values is, therefore, impossible, the accompanying curve (Fig. 1), applicable to well-designed 550-volt machines working with the above-stated values of v and 1_a, may be adopted as containing the limiting figures. Having thus settled upon the values of A S, $p \times N$, and the speed, the maximum possible output in kilowatts for any

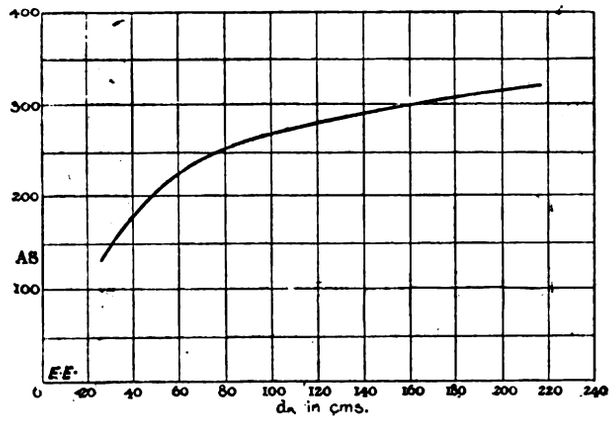


FIG. 1.

assumed diameter can now easily be deduced. As the E.M.F. produced by a generator is

$$E = p\,N \times \frac{s}{a} \times \frac{n}{60} \times 10^{-8},$$

and the current strength

$$C = A\,S \times d_a\,\pi \times \frac{a}{s},$$

the output will be

$$K.W. = \frac{E \times C}{1{,}000} = p\,N \times A\,S \times d_a\,\pi\,\frac{n}{60} \times 10^{-11}.$$

The following table, based on the above calculation, shows the maximum outputs and speeds which at the present time are obtainable in the very best designs:

TABLE I.

d_a in centimetres.	N for v = 75 m./sec.	$p\,N \times 10^{-6}$	A S.	Output in kilowatts.
30	4,780	13·1	150	148
40	3,590	17·6	185	244
50	2,870	22·0	210	347
60	2,390	26·3	230	454
80	1,800	35·1	255	670
100	1,435	44·0	270	890
120	1,195	52·9	280	1,110
140	1,020	61·5	290	1,340
160	895	70·2	300	1,585
200	720	88·0	315	2,080

(To be continued.)

NEW PUBLICATIONS.—"Frictional Pitch-Windings for Induction Motors," by C. A. Adams, W. K. Cabot, and G. E. Irving, jun. This is a reprint of a paper presented at the twenty-fourth annual convention of the American Institute of Electrical Engineers in June last.—"The Demagnetising Factors for Cylindrical Iron Rods," by C. L. B. Shuddemagen, is the title of some contributions from the Jefferson Physical Laboratory to the Harvard University to the September issue of the *Proceedings* (vol. 43, No. 6) of the American Academy of Arts and Sciences.

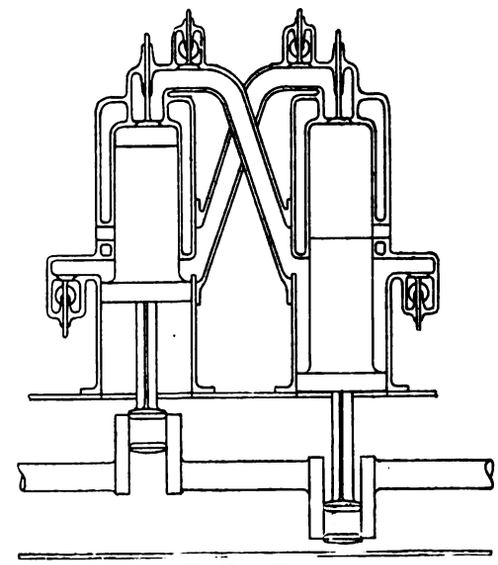
* For reasons of leakage and core density a is usually much smaller than in ordinary machines.

TWO-STROKE MOTORS.*

BY G. A. KING.

The Principle.—In a two-stroke motor there is an explosion every revolution, and so there must be some method for introducing the gas into the cylinder other than by the suction of the working piston, as is the case with a four-stroke motor. There must, therefore, be some chamber into which the gas may be drawn, compressed more or less, and then admitted into the working cylinder. There are three different methods of doing this: the first is to have a separate pump cylinder; the second and most common is to use the crank case as the gas-pump; and in the third method the gas-pump is an annular chamber formed by a piston having two diameters and working in a corresponding cylinder.

The two-stroke motor has many advantages over the four-stroke pattern. Among them the principal ones are the more uniform turning moment (especially in a double-acting engine), the simplicity of the engine, the low initial cost, and the absence of valves which have to meet hot exhaust gases. There are, however, two serious disadvantages: the loss in efficiency due to imperfect scavenging and waste of fuel through the exhaust port, and the danger of back fire into the gas-pump through the explosive charge coming in contact with the exhaust gases.



The Kelly Motor.

Several methods have been employed to increase the efficiency of the motor and to prevent back firing into the gas-pump. One very usual method is to compress pure air only, and introduce the fuel at some point on the up stroke of the piston after the exhaust port has been closed. Some of the air compressed is allowed to escape with the exhaust gases, thus ensuring very much better scavenging. Another method of getting rid of most the exhaust gases is to suck them out by a vacuum pump, as is done in the old Williams motor and in the Gothic motor.

A motor which seems to get over all these difficulties is the Kelly two-cylinder engine. The cylinders of the engine consist of two chambers of unequal diameters, the smaller being the working cylinder. In the cylinders are pistons also of unequal diameters, so that when the piston moves down an annular space is left in the bottom of the cylinder; this annular chamber forms the gas-pump. By cross-connecting the pump of one cylinder to the working cylinder of the other, crank-case compression is entirely dispensed with. The pipe from the pump enters the working cylinder at the top through an automatic valve. Close to this valve there is another automatic valve in the induction pipe which opens to the atmosphere, and there is a third automatic valve in the pipe supplying the mixture from the carburetter to the pump, so that each cylinder has three automatic valves. Now, when one piston descends a vacuum is formed in the

* Abstract of paper read before the Northampton Institute Engineering Society.

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annular chamber and two valves are opened, one admitting mixture to the pump and the other admitting air into the pipe from the pump to the cylinder. On the next stroke the mixture is compressed, and, when the pressure in the cylinder drops, is forced into the working cylinder, preceded by the air in the pipe, which drives out the remaining exhaust gases from the cylinder. Some of this scavenging air is allowed to escape, but as there is no fuel with it there is no loss in efficiency. The air, besides scavenging, provides an air buffer between the exhaust gas and the fresh charge, thus preventing back firing.

ELECTRICAL EXHIBITION, 1908, TO BE HELD IN MANCHESTER.

The various preliminary arrangements, upon which we have already reported in our columns, resulted in a meeting being convened by the Lord Mayor of Manchester and the Mayor of Salford on Sept. 24 last for municipal councils' and supply companies' representatives interested in electrical undertakings. The proceedings were opened by the Lord Mayor of Manchester, who outlined the wishes of his immediate Corporation and the neighbouring borough of Salford. The Lord Mayor then nominated Councillor Howarth, chairman of the Electricity Committee, to the chair. The general details of the scheme were discussed, and after numerous points had been raised and satisfactorily dealt with the following resolutions were arrived at: "(1) That in the opinion of the representatives of the various municipal, district, and urban councils and supply companies' authorities it is desirable that an exhibition be held in Manchester during October, 1908. (2) That as the sum of £5,000 is considered a necessary fund to be raised for the purpose of providing suitable buildings, and to ensure success to the undertaking, it was suggested that this should be raised by donations, from the above authorities, in the area affected, it being understood that tickets to the exhibition would be issued to the donors in proportion to the value of their contribution."

On the proposition of Mr. G. Wilkinson, of Harrogate, seconded by Mr. C. Furness, of Blackpool, it was agreed that the title of the exhibition should be "The Electrical Exhibition, 1908, to be held in Manchester." The following authorities were represented: Accrington, Batley, Bury, Bradford, Bolton, Blackburn, Blackpool, Colwyn Bay, Derby, Dewsbury, Elland, Harrogate, Heywood, Liverpool, Lancashire Electric Power Company, Manchester, Rochdale, Stretford, St. Helens, Salford, and undertook to give their support. Since that meeting the Corporations of Buxton and Warrington have contributed, and now that the municipal elections are over a very large number of corporations' committees have undertaken to deal with the matter.

The proposed scheme for conducting the exhibition is as follows: A meeting of the electrical trade will be convened in Manchester on Friday, Dec. 6, and in London on Dec. 11, thus giving members members of the industry an opportunity of attending whichever meeting is most convenient to them. It is fully anticipated that this being the second electrical exhibition organised by the trade itself it may reasonably be expected to be even more successful than the first: (1) on account of the general support being given by the corporations in the North; (2) by reason of Manchester being the centre of so great a number of textile, manufacturing, and mining industries; and (3) from the more complete and comprehensive nature of the exhibition. An influential president is to be elected, and a list of patrons secured. A general committee is to be appointed, consisting of: (*a*) five representatives of corporations or councils donating to the funds; (*b*) two representatives of supply companies donating to the funds; (*c*) two representatives elected by the Institution of Electrical Engineers; (*d*) one by the Municipal Electrical Association; (*e*) three representatives of the National Electrical Manufacturers' Association; (*f*) two representatives of the Electrical Contractors' Association; (*g*) five representatives from amongst the general exhibitors

From this general committee an executive or acting committee will be appointed with full powers to carry out the scheme on behalf of the main committee. Consulting engineers, Mr. S. L. Pearce, A.M.I.C.E., M.I.E.E., M.I.M.E., and Mr. V. A. H. M'Cowen, M.I.E.E., M.I.M.E.; general manager, Mr. C. S. Northcote, M.I.E.E.; organising secretary, Mr. W. Davenport. It has been arranged to allocate the profits arising out of the exhibition as follows: (1) in a percentage return to exhibitors; (2) a percentage return to donors; (3) a percentage to be contributed to charities connected with the electrical industry; (4) a surplus, if any, to be dealt with by the committee.

It may be remembered that a result of the Olympia Exhibition was that a sum of £3,793 was distributed to the benefit of the electrical industry generally, and it is hoped that the result of the forthcoming exhibition will be even more successful, quite apart from the stimulus given to the industry generally throughout a very large area.

FORTHCOMING EVENTS.

FRIDAY, NOV. 29.

Society of Arts.—At 8 p.m., "The Hygiene of Work in Compressed Air," by Dr. Scott Haldane.

Northampton Institute.—At 7 p.m., distribution of prizes by Duke of Connaught, and conversazione.

SATURDAY, NOV. 30.

Northampton Institute.—Conversazione.

MONDAY, DEC. 2.

Society of Arts.—At 8 p.m., "The Theory of the Microscope," by Conrad Beele.

TUESDAY, DEC. 3.

Institution of Electrical Engineers (Manchester Students' Section).—"The Evolution of the Modern Switchboard," by E. P. Hill.

Association of Engineers-in-Charge.—Visit to General Electric Company's Works, Birmingham.

WEDNESDAY, DEC. 4.

Society of Arts.—"Old-Age Pensions," by Sir E. W. Brabrook.

THURSDAY, DEC. 5.

Institution of Electrical Engineers.—"Automatic Cab-Signalling on Locomotives," by J. Pigg.

Civil and Mechanical Engineers' Society.—At 8 p.m., at Caxton Hall, Westminster, "Retaining Walls," by Mr. A. T. Walmisley.

I.E.E. (Manchester Local Section).—Tuesday, Dec. 10, "The Reluctance of the Air-Gap in Dynamo Machines," by Mr. Thos. F. Wall.

I.E.E. (Birmingham Local Section).—Wednesday, Dec. 11, "The Torque Conditions in Alternate-Current Motors," by Val. A. Fynn.

Society of Engineers.—Wednesday, Dec. 11, annual dinner at Hotel Cecil.

Association of Engineers-in-Charge.—Wednesday, Dec. 11, "The Province of the 'Illuminating Engineer,'" by Mr. Leon Gaster.

I.E.E. (Dublin Section).—Thursday, Dec. 12, at 8 p.m., at the Royal College of Science.

Rugby Engineering Society.—Thursday, Dec. 12, "Textile Electric Driving," by Mr. J. Shaw.

Electro-Harmonic Society.—Friday, Dec. 13, at King's Hall, Holborn Restaurant, smoking concert.

THE ELECTRICAL ENGINEERS, R.E. (VOLS.).

Orders for week ending Saturday, Dec. 7.

SATURDAY, NOV. 30.—"A" Coy.—Week-end run at Coalhouse.
"B" Coy.—Hop. Cup practice, Headquarters, 3 p.m.

MONDAY, DEC. 2.—"A" Coy.—Technical drill, 6 p.m.

TUESDAY, DEC. 3.—"B" Coy.—Recruits' infantry drill, 6 p.m.
Technical drill, 7 p.m.

WEDNESDAY, DEC. 4.—"D" Coy.—Hop. Cup practice, 7 p.m.

THURSDAY, DEC. 5.—"C" Coy.—Recruits' infantry drill, 6.30 p.m.
Technical drill, 7 p.m.

FRIDAY, DEC. 6.—"D" Coy.—Recruits' infantry drill, 6 p.m.
Technical drill, 7 p.m.

SATURDAY, DEC. 7.—"A" Coy.—Hop. Cup practice, 3 p.m.
"B" Coy.—Week-end run at Coalhouse.

(Signed) J. H. S. PHILLIPS, Captain,
Acting Adjutant.

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ELECTRICAL BILLS IN PARLIAMENT.

London Electric Supply.

Among the preliminary announcements relating to electrical Bills which are proposed to be introduced in the coming session of Parliament is one in connection with the supply of electric power in London. Power is to be sought under the Bill to appoint a joint committee, comprising representatives of the companies supplying electrical energy in London or some of them, to sell and supply electrical energy in bulk to any company or body authorised under any provisional order or Act of Parliament to supply electrical energy. The area over which it is proposed that the powers of the joint committee should extend is as follows: the administrative county of London; and in Essex—the county borough of West Ham, the borough of East Ham, and the urban districts of Barking Town, Walthamstow, and Leyton; in Kent—the borough of Bromley and the urban districts of Erith, Bexley, Foots Cray, Chislehurst, Beckenham, and Penge, and so much of the rural district of Bromley as is comprised in the parish of Mottingham; in Surrey—the county borough of Croydon, the boroughs of Kingston-upon-Thames, Richmond, and Wimbledon, the urban districts of Barnes, Ham, and The Maldens and Coombe, and so much of the rural district of Croydon as is comprised in the parish of Mitcham; in Middlesex—the borough of Hornsey, and the urban districts of Chiswick, Acton, Willesden, Hendon, Finchley, and Tottenham.

One of the most important clauses reads as follows: "The Bill may provide for the inclusion as constituents of the joint committee of any local authorities in London being undertakers for the supply of electrical energy, and may define the obligations to be undertaken by any such local authority, whether financial or relating to the receiving or giving of a supply of electrical energy, and may empower such local authority or the London County Council to contribute to the funds of the joint committee, or to guarantee the stock of the joint committee, and may provide for the raising and expenditure of money by such local authority or County Council, and charging the same upon the rate leviable by such local authority or County Council, and for altering and increasing such rate so far as may be necessary to provide for such contribution or guarantee, and for the payment and recovery of any sums payable in respect of such contribution or guarantee, and may confer or impose upon any such local authority any of the powers, rights, and duties which may by the intended Act be conferred or imposed upon the constituent companies or any of them."

Other important clauses seek to empower and require the constituent companies or any bodies represented on the committee to afford a supply of energy to the joint committee and to determine the price at which and conditions upon which such supply shall be given, and to exempt the joint committee and their undertaking from all or any of the provisions of the Electric Lighting Acts, 1882 and 1888, and in particular to provide that the provisions of the said Acts with respect to the purchase of the undertaking shall not apply to any undertaking, property, or rights of the joint committee.

The companies and bodies to whom it is intended that the provisions of the Bill should apply and who may be empowered to enter into agreements and arrangements are the 17 companies having powers within the county of London and 16 metropolitan borough councils.

LEGAL INTELLIGENCE.

SMOKE NUISANCE AT AN ELECTRIC POWER STATION.

At the Warwickshire Borough Police Court last week the Leamington and Warwick Electrical Co. were summoned by the sanitary inspector for failing to obey the order of the justices to abate the smoke nuisance at the power station, Emscote, on Oct. 8, 19, and 21.

Mr. CAMPBELL, on behalf of the Council, said that although the latter felt satisfied that some steps had been taken to abate the nuisance, yet they thought they had given the company sufficient time to find some effectual means of improving the combustion of the smoke. Moreover, constant complaint had been made about it. Of course, the Council were very averse to stopping or injuring any industry in the town, but the smoke had proved a very great nuisance to the well-to-do inhabitants of the neighbourhood, as well as a very great loss to the poor people, many of whom got their living by laundry work.

Mr. CHARLTON, the company's engineer, explained, in answer to the prosecution, that while anthracite did not smoke it was not commercially possible to burn it. They had been trying four different kinds of coal. There was a contract with a syndicate who absolutely undertook to stop the smoke with their particular kind of furnace, but the results, after considerable expense for installing the new furnace, were absolutely disappointing. The company were approached with a view to getting alterations made, with the result that regenerative arches were put in. Among other alterations was the installing of a No. 2 boiler. He promised not to spare anything reasonable to abate it. The smoke was not anything like so bad as it was a year ago.

The CHAIRMAN, while admitting that the company had tried a good deal to abate the nuisance, imposed a fine of £3. 10s., including costs.

"TAPPING" ELECTRICITY MAINS.

Luigi Armanni, an electrician, occupying basement premises in Baker-street, W., was summoned at Marylebone for fraudulently using the borough electricity.

In September last Detective Sergeant Draper, of the D Division, it was said, went to the defendant's premises to execute a search warrant, and in consequence of what he saw he communicated with the Marylebone Borough Council, and returned to the premises with two of the Council's electricians. Defendant was then out, but came in shortly afterwards, and on the officer disclosing his business under the search warrant he suggested that they should go downstairs that their conversation might not be overheard. When they reached the basement it was alleged that the defendant rushed forward and hurried at a great rate through a showroom into his workshop. The shop at that time was lighted up by a large number of electric lamps, but defendant jumped up at a cut-out in the corner of the shop, where a multitude of electric wires converged, and did something with his hand. At the same moment there was a spark, and the whole of the lights went out. In a subsequent conversation it was said defendant remarked that he did not mind "doing" the Borough Council; they owed him £80, and if they did anything it would be for revenge. The electricians then tested the lights, and discovered that the current that supplied 17 lamps in defendant's workshop, showroom, and living-room was not passing through the meter, while only three lights, which were in the office and on the staircase, were being registered.

One of the electricians said that when defendant jumped up at the cut-out he presumed that he pulled away some "tapping," but he was unable to trace anything there. Some days later, however, he made a further search, and discovered a pinhole in the live wiring under the floor-board which supplied the current from the Council's main to the meter on the first floor. Another electrician stated that, having regard to the nature of defendant's business, he should have expected him to have used a larger amount of current than he had. A third witness said that when he visited defendant's workshop he saw a temporary wire coming from the bottom of the cut-out and passing through a hole in the wall.

The magistrate found the case clearly proved, and imposed the maximum penalty of £5, with 20 guineas costs, or in default six weeks' imprisonment.

TRAMWAY RATING.

A local rating case was dealt with at the Fleetwood Sessions last week, when the Blackpool and Fleetwood Tramroad Co. were summoned by Mr. J. W. Tickle, the clerk and rate collector of the Bispham Urban Council, for the non-payment of the general district rate, amounting to £594. 10s. 6d. Attention was called to the rate-book, in which the company's waiting-rooms were rated at £30. 10s.; generating station, land, buildings, etc., were rated at £1,624; and the portion of the tramroad within the township area at £2,302; the total amount, at 3s. in the £, being £594. 10s. 6d.

After some discussion between the parties and the Bench, it was eventually agreed that the rate due on the tramroad be reduced from £345. 6s. to £86. 6s. 6d., making the total amount due from the company £335. 11s. The Bench accordingly made an order for the payment of this sum.

COMPANIES' MEETINGS AND REPORTS.

SINGAPORE ELECTRIC TRAMWAYS.

The report of the Singapore Electric Tramways Co. from the date of incorporation of the Company to Dec. 31, 1906, states that on July 11 an agreement was entered into with the East India Construction Syndicate, under which it acquired the Singapore tramways undertaking and rights. The purchase consideration was £730,000, payable as to £330,000 in debentures or cash and as to £400,000 by the allotment of shares of £1 each fully paid. In respect of the optional portion of the purchase consideration the East India Construction Syndicate procured cash subscribers for £30,000 debentures, thus enabling the Company to pay purchase consideration in cash to that extent, the balance of the £330,000—viz., £300,000—being satisfied by the allotment of debentures to that amount. Owing to negotiations with the Municipality of Singapore in respect of a bridge, the construction work was suspended on Section 6, and the completion of the purchase delayed in consequence. It was arranged that the uncompleted work should be undertaken by the Company, and the necessary material and funds were provided by the East India Construction Syndicate. The funds provided included £3,000, an agreed contribution towards the cost by the Municipality of erecting the bridge referred to, which, owing to the intention to lay a double tramway track upon it, will be wider, and, therefore, more costly than ordinary traffic would demand. It is understood that the bridge will be completed by about December, 1908, and this will enable the Company to link up Section 6 with the water-front section. The debenture portion of the purchase consideration was allotted in January and the shares in July last. The total debenture issue is £350,000. Of the balance of £20,000 not already dealt with, above £10,000 were subscribed for by the East India Construction Syndicate for working capital for this Company, and £10,000 were allotted in satisfaction of that syndicate's right to interest to Sept. 30,

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1906. There is a deficit to Dec. 31, 1906, after charging debenture interest due and writing off depreciation, of £7,623. 19s. 3d. This has resulted from abnormal expenditure incurred in the earlier months of the Company's business, in the training of the Oriental staff, and to low traffic receipts before the convenience of the tramway was appreciated by the population in Singapore. The first section of the tramway was opened on July 24, 1905, and four other sections on Sept. 9 following. All expenditure to July 23, 1905, has been charged to capital account. The traffic receipts were, generally speaking, until the following March unsatisfactory. In that month a uniform three-cent fare was introduced and the receipts immediately increased considerably, and continue to give encouraging returns. When completed the tramway system will consist of about 26¼ miles of track in 16 miles of route. The several sections are at present served by 50 cars, but owing to increasing traffic six additional cars have been ordered, and four other cars are under consideration. The Company has the right to supply electric energy for lighting and power to the Singapore Municipality. The demand at first was very small, but the monthly output of units through the municipality is gradually increasing, and considerable revenue is looked for from this source.

PROVINCIAL TRAMWAYS.

The report of the Provincial Tramways Co. for the year ended Sept. 30 last states that the net revenue received from the local companies has been £38,049, which, with £3,217 brought forward and £28 transfer fees, makes £41,294, from which has to be deducted administration expenses, £1,364; income tax, £946; interest, £6,415; preference dividend, £6,000; interim dividend on ordinary shares, £3,736; leaving £22.830. The directors have set aside for depreciation the sum of £10,000, and have set aside towards meeting the expenses of the issue of the debenture stock £3,000, leaving at the credit of net revenue account £9,830. The directors recommend a dividend on the ordinary shares of 5s. per share, making 8s. per share, free of income tax, for the year, leaving £3,602 to be carried forward. Owing to the financial conditions which have existed during the past year the directors have found it impossible to make a successful issue of debentures on the terms mentioned in last year's report, and the proposed issue has accordingly been cancelled, and in lieu thereof the directors have created £175,000 of 5 per cent. first debenture stock, which it is proposed to issue at par. The proceeds of this issue will be applied to the payment off of the liabilities of the Company, part of which are secured by deposit of debentures forming part of the existing authorised issue of £150,000 4½ per cent. debentures, and which debentures will thereupon be discharged and cancelled.

ISLE OF THANET ELECTRIC TRAMS.

The report of the Isle of Thanet Electric Tramways and Lighting Co. for the year ended Sept. 30 last states that the traffic receipts show a decrease of £336, but the lighting receipts show an increase of £692, and the balance of profit carried to appropriation account is £13,428. The balance of revenue account brought forward from last year was £376, which, with the amount transferred from the appropriation account of £4,706, makes £5,083. The directors think that in the present circumstances they would not be justified in recommending any dividend in respect of the preference shares for the past year. They also think that it is better to clear off the cost of reconstruction on Madeira-hill and the balance of the special account for reconstruction of cars at once rather than leave them a charge on future years, and they, therefore, propose to write off against the revenue balance the whole amounts for these two works—namely, £2,019 and £1,200 respectively. After these deductions there will remain £1,863, of which it is proposed to place £1,000 to reserve and to carry forward £863.

ELECTROMOBILE.

The accounts of the Electromobile Co. for the year to Aug. 31 show, after allowing for depreciation, a net profit of £4,681, converting the debit balance of £4,470 brought down into a credit balance of £210.

NEW COMPANIES REGISTERED.

Hooghly River Electric Power Co.—Registered Nov. 18. Capital, £100,000 in £1 shares. Object: to carry on in India the business of suppliers of electricity.

Automatic Weldless Chain Co., Limited.—Registered Oct. 23. Capital, £200 in £1 shares. Objects: to acquire, deal with, and turn to account an invention relating to an improved method of and apparatus for casting links in chain form, and with a view thereto to adopt an agreement with C. S. McIntire. No initial public issue. Registered without articles of association.

Interoceanic Engineering Co., Limited.—Registered Nov. 15. Capital, £15,000 in £1 shares. Objects: to adopt an agreement with J. Pettigrew, and to carry on the business of engineers, manufacturers of plant and appliances, dealers in machinery, stores, and articles used for railway and transport purposes, etc. No initial public issue. Registered without articles of association.

Waddle Patent Fan and Engineering Co., Limited.—Registered Nov. 7. Capital, £20,000 in £50 shares. Objects: to take over the business carried on at Llanelly as the Waddle Patent Fan and Engineering Co., and to carry on the business of engineers, manufacturers of ventilating fans and other machinery, electrical engineers, etc. No initial public issue. Registered office: Llanmore Works, Llanelly, Carmarthen.

Bradford Electrical Engineering Co., Limited.—Registered Oct. 30. Capital, £3,000 in £1 shares. Objects: to adopt an agreement with C. J. Casse and H. H. Casse for the acquisition of the business carried on by them at 3, Royal-arcade, Manningham-lane, Bradford, as the Bradford Electrical Engineering Co., and to carry on the business of electricians, electrical and mechanical engineers, producers of and dealers in electricity, motive power, and light, etc. No initial public issue.

Bergtheil and Young, Limited.—Registered Oct. 26. Capital, £12,000 in £1 shares. Objects: to acquire the assets and liabilities of Bergtheil and Young (incorporated in 1904); to adopt an agreement with the said old company, which is about to wind up voluntarily; and to carry on the business of importers, exporters, and manufacturers of and dealers in all kinds of electric, magnetic, galvanic, chemical, and other machinery, apparatus, and appliances, and electrical or other engineers' requisites, etc. No initial public issue. Registered office: 12, Camomile-street, E.C.

Liens Registered.

Britannia Electric Lamp Works (1905), Limited, South Tottenham, N.—Lien registered Nov. 4 for £600 second debentures. No trustees. Charged on the assests, excluding the uncalled capital.

Appliances and General Engineering Co., Limited, London, E.C.—Lien registered Nov. 11 for £500 7½ per cent. debentures, part of £2,000 authorised. No trustees. Charged on the assests and effects.

Pyrenees Electrical Society, Limited.—Particulars of £80,000 debentures, created by resolution of Nov. 1, 1907, have been filed pursuant to Section 14 (4) of the Companies Act, 1900. Property charged: the company's undertaking and assets, present and future. No trustees.

Nairobi Electric Power and Lighting Co., Limited, London, E.C.—Four mortgages and scrip certificates registered Nov. 4 for securing the sum of £5,200 6 per cent. first mortgage debenture stock, part of £6,000 authorised. The debenture stock, however, has not yet been issued. Secured by a floating charge on the assets, property, and uncalled capital, subject to certain prior charges.

Barbados Light Railway, Limited, Westminster, S.W.—Trust deed registered Nov. 12 for securing £10,000 5 per cent. debenture bonds of £50 each, and lien registered Nov. 12 for £7,750 debentures, part of the above £10,000. Trustees: C. J. P. Cave and Hon. E. A. Palk. Secured by a specific charge on all the freehold and leasehold lands and hereditaments situated in the island of Barbados, together with a floating charge on the undertaking, present and future.

Lancashire Dynamo and Motor Co., Limited, Manchester.—Lien registered Nov. 13 for £65,000 5 per cent. first mortgage debentures of £100 each, part of a total authorised series not to exceed £75,000. Trustees: E. F. Sheppard and A. Tongue. Secured by a first mortgage on certain freehold properties situated at Trafford Park, Stretford, near Manchester, together with all the fixed plant, machinery, and effects; also by a floating charge on the undertaking and all the other assets, but excluding the uncalled capital.

OPENINGS FOR CONTRACTORS.

ABERCANAID—Houses at Alexandria-place, Mr. L. Morgan.

ABERFAN—Shops and houses, Moy-road, Mr. E. Lewis; seven houses, next schools, Mr. Thomas.

ABERYSTWYTH—Four houses, Portland-street, Mr. R. Owen; houses, Ropewalk Field, Mr. T. J. Samuel.

ACOCKS GREEN—Elementary school (£13,083), Worcestershire Education Committee.

ALDERSHOT—Two houses, Holly-road, Mr. Gale; houses, Lower Farnham-road, Mr. W. Webster; hotel, Union-street, Messrs. Crowley and Co.; removal of iron church and re-erection on site of St. Augustine's, North Town, Rev. C. E. Hoyle; addition to Cawdor Villa, St. George's-road, Mr. J. Rossiter; motor shed, Church-lane, Mr. H. C. Smith.

ANERLEY—Schoolmaster's residence, North Surrey District School, Managers.

ANFIELD—Block of tenements, Irvine-place, Mr. R. Lawson.

ANNFIELD PLAIN Additions to premises, Industrial Co-operative Society. Mr. G. T. Wilson, architect.

ASHTON—Elementary school, Lamberhead Green, County Education Authority.

AUDLEY—Elementary school, Staffs County Council.

BALERNO—Presbytery house. Messrs. M'Luckie and Walker, architects.

BALLINA—Labourers' dwellings (£14,590), Rural District Council.

BARNOLDSWICK—Three houses, North-avenue, Mr. Proctor Barrett; five houses, James-street, and seven houses, Sun-street, Mr. W. J. J. MacDonald.

BARNSLEY—Houses, Kensington-road, Mr. G. H. Gray; houses, St. John's-road, Mr. S. Dryden; seven houses, Harbro' Hills-road, Messrs. Raper and Wainwright; houses, Pollitt-street, Messrs. Pollitt and Harrison; shops and dwelling-house, Shambles-street, Mr. P. A. Hinchcliff.

BATH—Working-class dwellings, Town Council.

BENFIELDSIDE—New school to accommodate 300 children; school in Derwent-street for 250; school at Medomsley Edge, to provide for 450 children, County Education Committee

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BELFAST—Buildings at Cattle Market, Oxford-street, Town Council.
BETHNAL GREEN, N.E.—Town hall (£20,000), Town Council.
BEXHILL—Enlargement of Council chamber (£250), Town Council.
BERMONDSEY, S.E.—Public-house, Dockhead, Messrs. Mann, Crossman, and Paulin.
BIRMINGHAM—Housing scheme (£4,000), Town Council.
BOSHAM—Enlargement of Council school (£530), West Sussex County Council.
BRIGHTON—Alteration, Central National Schools (£600).
BRITON FERRY—Working-class dwellings (£12,347), Urban District Council.
BUSHEY—Sub-fire station, Bushey Hall-road, Urban District Council.
BUXTON—Electric lighting (£1,800), Town Council.
CADISHEAD—Elementary school, Lancs. Education Committee.
CAERAU—Temporary school, County Council.
CAMELDALE—Enlargement of Council Schools (£1,900), West Sussex County Council.
CARSHALTON—Public offices (£1,920). Plans passed, Urban District Council.
CATHCART—Block of houses, Holmlee-road, Mr. G. Eadie, 405, Mathieson-street, Glasgow.
CAVERSHAM—Alterations to public offices, Urban District Council.
CHATTENDEN—Elementary school to accommodate 200 scholars, Kent County Council.
CHICHESTER — Secondary school (£1,800), West Sussex County Council.
CLITHEROE — Nineteen houses, Low Moor. Mr. E. T. Welch, architect.
CLOGHER—Workmen's dwellings (£10,540), Rural District Council.
COEDPOETH—Elementary school, County Education Committee.
CONNOR DOWNS—Elementary schools, Cornwall Education Committee.
COSHAM—Barrack block, War Office.
COOTEHILL—Labourers' dwellings (£15,282), Rural District Council.
COPENHAGEN—Royal residence, a Parliament house, supreme court of justice on the site of the Royal castle of Christiansborg.
COTTINGHAM—Nine houses, Cornwall-street, Mr. J. M. Blaydon; six houses, Linden-avenue, Mr. W. Sykes.
COVENTRY—Ragged school, Priory-row, Mr. H. Quick, architect; school, Leicester-causeway (£17,968); enlargement of Paradise School (£1,312), City Council.
CROMDALE—Alterations at manse. Mr. J. Whittet, architect.
CROYDON—Enlargement of Tennyson School (£1,250), Corporation.
CULLEN—Alterations and additions to the elementary school, Town Council.
CWMBRAN—Additions to plant at generating station, Electricity Co.
DARTMOUTH—Post office, adjacent to Embankment House.
DAVYHULME—Pair of semi-detached houses, Davyhulme-road, Mr. Plant.
DENTON—Elementary school (£3,440), Kent County Council.
DEWSBURY—Reconstruction of Cut End Mills, Saville Town. Messrs. C. H. Marriott, Son, and Shaw, architects.
DOVER—Houses, Mr. D. Southam; two villas, Mr. W. F. Lambe, at St. Margarets-at-Cliffe.
DROGHEDA—Extension and improvements to National School house (£345). Mr. F. H. Tallan, architect.
DUBLIN—Alterations and additions, Royal Hibernian Military School. Mr. H. William, secretary.
DUDLEY—Day training college, Education Committee.
DUMBARTON—Church, Free Church Congregation (£3,500).
DUNCHURCH—Building in connection with Dunchurch Church, Rev. McNulty.
DUNDEE—Extensions to central baths (£8,000), Town Council.
DUNDRUM—New clock, Central Lunatic Asylum. Mr. H. William, secretary.
DYFFRYN—Forty houses. Mr. H. Thomas, architect.
EARLESTOWN—Public library, Crowe-lane, Urban District Council.
EAGLESHAM—House, Glendinning-place, Mr. Wm. Rodger, Dennistown.
EGHAM—Recreation room at Egham Hythe, Mr. W. Lake.
ELAN VALLEY—New works (£30,000, Messrs. Lovatt and Son.
ELLAND—Alterations to Town Hall Hotel. Messrs. Samuel Jackson and Sons, architects.
ENNISCORTHY — Reconstruction market-house building, Technical Instruction Committee.
ERITH—Electrical installations in 48 municipal cottages, Urban District Council.
FARNHAM—Houses, Black Pond-road, Mr. Kennaird.
FARTOWN—Liberal club, Cobcroft-road. Messrs. Stokes and Sykes, architects.
FOLESHILL—Chapel and caretaker's house cemetery (£4,080).
FRODSHAM—Fire station, Main-street, Town Council.
FULHAM—Congregational church, Fulham Palace-road (£5,500).
FULMER—Elementary school, Bucks Education Committee.
GIFFNOCK—Double house in Penrith-avenue, Messrs. Dixon and Sons.
GLASGOW—Laundry, Corporation.
GLOSSOP—Mills, Messrs. Oliver and Partington.
GORGIE—Veterinary college, Town Council.
HILLMORTON—Houses, Mr. Warren.
HALIFAX—Fire Brigade station, three dwelling-houses, stables, and cart-shed, Halifax Flower Society. Mr. W. C. Williams, architect.
HAMMERSMITH, W.—Erection and equipment tramway car shed (£7,430), London County Council.
HANLEY—Mission hall, Bucknall Old-road. Mr. W. Campbell, architect.
HARROGATE—Alterations and additions to Dirlton Hotel. Mr. J. Whitehead, architect.
HEADCORN—Enlargement of Council School (£200), Kent County Council.
HERTFORD—Improvement of corn exchange (£500), Town Council.
HOOK—Elementary school, Surrey County Council.
HOWDEN-LE-WEAR—Elementary school, Durham County Education Committee.
HULL—Additions to grammar school, Leicester-street, Education Committee. Mr. J. H. Hurst, architect.
ILKLEY—School at Ben Rhydding, West Riding Education Committee.
INISHOWEN—Labourers' dwellings (£19,620), Rural District Council.
INVERURIE — Elementary school, School Board. Mr. G. Gray.
IPSWICH—Alterations and additions, secondary school, Bolton-lane, Education Committee.
KILBEGGAN — Erection of workmen's dwellings (£7,330), Rural District Council.
KILMARNOCK—Technical school, Elm Bank-drive (£16,000).
KINGSTON-ON-THAMES—Music hall (£25,000).
LAMBERHEAD—Elementary school, Lancs. Education Committee. Mr. H. Littler, architect.
LIVERPOOL—Libraries at Garston and Walton, Corporation.
LLANDDANIEL—C.M. chapel. Messrs. Davies and Son, architects.
LLANDDONA—Additions and alterations to Council school, Anglesey Education Committee.
LLANDRINDOD WELLS—Pavilion and other buildings, Urban District Council.
LLANDUDNO—Free library, Mostyn-street (£4,000), Town Council.
LLANTRISANT—Extension to engineering works, Messrs. Mountford, Phillips, and Co.
LOCHGELLY—Town house (£2,048), Town Council.
LONDON, W.C.—Alterations, Lyceum, Strand, Mr. E. Bates.
LONG LAWFORD—Houses, Mr. Newbold.
LOSTOCK HALL—New St. James's Church (£1,100).
LOUGHBOROUGH—Alterations to Hicklings School, Town Council.
LURGAN—Labourers' dwellings (£10,500), Rural District Council.
MAESTEG—Houses, Garn-road, Mr. L. Morgan; 13 houses, Margam-street, Mr. A. Yemm.
MAUD—Additions to elementary school. Mr. J. Chalmers, architect.
MERTHYR—Hall, Bethesda-street, Rev. Canon Wade; houses, Dixon, Mr. E Cleary; houses, Mount-street, Mr. J. Gillenand; additional block, workhouse infirmary (£1,900).
MILTON REGIS—Elementary school (£3,440), Kent County Council.
MIRFIELD—Elementary school, West Riding Education Committee. Mr. J. Edwards, architect.
MOUNTAIN ASH—Twelve houses, Messrs. Nixon's Navigation Co.
MOUNT BOONE—Houses, Mr. A. Arscott; villas, Mr. J. Stephens.
NEWBURN—Housing scheme (£11,300), Urban District Council.
NEWLANDS—Two double villas, Woodburn-road, Mr. G. Eadie, Glasgow.
NEWMARKET (FLINTSHIRE) — Restoration of Welsh Congregational Chapel (£300).
NEWTON ABBOT—Building, Lloyds Bank, Courtenay-street. Messrs. Rowel, Sons, and Lock, architects.
NORBITON—Repairs to St. Peter's Church (£400).
NORWICH—Wensum View Council School, City Council; new parish hall, St. Luke's (£1,700).
NOTTINGHAM—Repairs to following schools: Bulwell and Basford; Hyson Green, New Basford, and Sherwood; Eastern; Lenton and Central; Sneinton and Meadows. Mr. F. B. Lewis, architect.
ORRELL—Seven houses, City-road, Mr. Rigby; 14 houses, St. James's-road, Mr. Holt.
OTFORD—Elementary school, Dunton Green (£5,500), Kent County Council.
PARKSTONE—Shops and residences, Bournemouth-road. Messrs. Smart and Wyeth, architects.
PENWORTHAM—Weaving school, Tardygate Manufacturing Co.
PONTYPRIDD—Electricity undertaking (£3,356), Town Council.
PORTSMOUTH—Fire-escape station, North End-avenue, Town Council.
RAWTENSTALL—Lighting cables, conduits, trenching, etc., Corporation; Council day school, Board of Education.
ROTHERHAM—Girls' school, Education Committee; cookery school, Park-street (£350); cookery school and caretaker's house, Alma-road (£830); additions to Alma-road School (£2,500).
ROTHESAY—New post office (£6,000).
ROYTON—New bath (£5,000), Town Council.
RUGBY—New stores at Newbold, Rugby Portland Cement Co.
ST. ALBANS—High school (£4,500), Education Committee.
ST. ANNES—Bandstand, Urban District Council.
SALTERHEBBLE—Rebuilding All Saints' School. Messrs. Walsh and Nicholas, architects.
SILSDEN—Fire station (£1,000), Town Council.

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SCARBOROUGH—Post office, H.M. Commissioners of Public Works and Buildings.

SHARDLOW—Additions to laundry and offices at workhouse (£1,400), Guardians.

SITTINGBOURNE—Elementary school (£5,500), Kent County Council.

SKIPTON—Manse, Old Raikes-road, Rev. L. H. Gaunt; 13 houses, Weary-street, Messrs. Ward Bros.

SLIGO—Cottages for asylum attendants (£1,150).

SMETHWICK—Fire station (£780), Town Council.

SOUTHAMPTON—Alterations and additions to buildings at Warehouse Quay, Southampton Harbour Board.

SOUTHPORT—Church, Blowick End.

SOUTHWICK—Additions to town hall, Urban District Council.

STAFFORD—Elementary school, Bushbury-lane, County Council.

STIRLING—Office and stores, George-street, Mr. W. B. Elder; block of houses, Glasgow-road, Mr. W. McFarline; additions to premises, Co-operative Society, Cowane-street; elementary school, Stirling School Board.

STOCKPORT—Police buildings, Town Council.

STORNAWAY—Technical and secondary school, School Board.

STRABANE—Town hall (£3,800), Urban District Council.

STRANORLAR—Labourers' dwellings (£23,049), Rural District Council.

SURBITON—Electric lighting (£20,000), Urban District Council.

SUTTON COLDFIELD—Elementary school, Hollyfield-road, Town Council.

TAPLOW—Houses, Mr. F. Summers.

TARPORLEY—Police station (£1,930).

THORNTON—Two houses, Thornton Gate, Mr. J. Parker; house, Way Gate, Mr. G. Crossland; house, Limegrove, Mr. Foxley; two houses, Marsh-road, Mr. J. Fenton; two houses and shops, Victoria-road, Mr. T. Haworth.

TIVERTON—Public convenience, near Cynthia-road Bridge (£170), Parish Council; engineering business, Charlton-road, Enterprise Foundry Co.

TIVERTON—Higher-grade school, Education Committee.

TOWLAW—Elementary school, Durham County Education Committee.

TOOTING—Skating rink, Lessingham-avenue, Mr. E. L. Ellis.

TULLAMORE—Labourers' dwellings (£45,000), Rural District Council.

TUTBURY—Elementary school, Staffs County Council.

USWORTH—Parish electricity lighting, Parish Council.

WARRINGTON—Elementary school, Education Committee.

WESHAM—Two semi-detached houses, Old Garstang-road. Mr. Cyril J. Cross, Kirkham, architect.

WHITEFIELD—New school, Secondary School Committee.

WILLAND—Dwelling-houses, Mr. W. Barons, Tiverton.

WINDSOR—Additions to "Torwood," Mr. Rendle.

WISHAW—Fifty-two dwelling-houses (£13,000). Plans passed.

WITTON—Primitive Methodist church (£7,000).

WOLSTANTON—Fire station (£825), Town Council.

WOOD GREEN—Temporary school building, Education Committee.

WOOLWICH—Addition, Royal Assembly Rooms, Mr. G. R. Haversham.

WORTHING—Secondary school (£2,971), West Sussex County Council.

WRAYSBURY—Houses, Mr. H. W. Wright.

YIEWSLEY—Church room (£1,228). Mr. A. H. Winterbourne, architect.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Brussels.—The Belgian Telegraph Department invite tenders for telegraph material and apparatus. Tenders by Dec. 11.

Melbourne.—The Postmaster-General invites tenders for 30 metallic iron telephone switchboards. Tenders by Dec. 31.

Linz.—The Austrian Government Railways invite tenders for travelling cranes to be worked by electric motors. Tenders by Dec. 10.

New South Wales.—The Postmaster-General, Sydney, invites tenders for one branching metallic multiple magneto switchboard. Tenders by Jan. 8, 1908.

Neath.—The Urban District Council invite tenders for the annual supply of alternating current watt-hour meters and prepayment meters for the Electricity Department.

Brussels.—Tenders are invited for the electrical equipment of transformer station for the Société Nationale des Chemin de fer de l'Etat. Tenders by Dec. 11.

Pontypridd.—The Urban District Council invite tenders for the supply of one mechanical stoker to be used with a Babcock and Wilcox water-tube boiler. Tenders by Dec. 2.

Rotherham.—Tenders are invited for the conversion of three single-deck into double-deck cars with top covers. Particulars from the Tramways Managers. Tenders by Dec. 5.

Listowel.—Tenders are invited for the lighting of Listowel, Ontario, by electricity—arc and incandescent. Tenders to Mr. C. A. Lee, chairman of the Lighting Committee, Listowel.

London, S.W.—The London County Council invite tenders for the manufacture, supply, and delivery of 50 steel underframes for double-deck electric tramcar bodies. Tenders by Dec. 10.

Valencia.—Tenders are invited for the construction of electric tramways to Pueblo Novo. Particulars from the Direccion de Obras Publicas, Ministerio de Fomento, Madrid. Tenders by Dec. 5.

Trimdon Grange (Durham).—Tenders are invited for the supply of stores, including electric fittings. Tenders to Messrs. Walter Scott, Trimdon Grange Colliery, co. Durham, by Dec. 9.

Erith.—The Urban District Council invite tenders for the complete installation of electric light at 48 municipal cottages, Brook-street, Belvedere. Tenders to Mr. C. H. Fry, clerk, by Dec. 9.

Napier (New Zealand).—The Town Council invite tenders for lighting and power plant and an electric tramway equipment. Particulars from Mr. F. Bowen, town clerk. Tenders by Dec. 31.

Melbourne.—The Postmaster-General's Department invite tenders for 11 sets and a common-battery switchboard, and 3,000 subscribers telephones, etc., for the Windsor exchange. Tenders by Jan. 7.

Calcutta.—Tenders are invited for the lighting of the town by gas or electricity. Particulars from Mr. P. N. Mookerjee, secretary to the Corporation. Tenders to the Vice-Chairman by Jan. 2, 1908.

Punjab (India).—Tenders are invited for electric and pumping plant for water supply. Particulars from the Executive Engineer, Special Work Division, Patiala, Punjab. Deposit £133. 6s. 8d. Tenders by Jan. 6, 1908.

Handsworth.—Tenders are invited by the Urban District Council for the supply of steam coal at the electric generating station. Particulars from Mr. F. A. Nixon, electrical engineer. Tenders to the Clerk by Dec. 5.

Dover.—The Harbour Board invite tenders for the supply of materials during the year commencing Jan. 1, 1908, including electrical requisites. Tenders to Mr. Martyn Mowll, Castle-street, Dover, by Dec. 5.

Sydney.—The Postmaster-General invites tenders for 1,000 common-battery wall telephones and 100 portable telephones. Particulars from the Commonwealth Offices, 72, Victoria-street, Westminster. Tenders by Dec. 11.

Brisbane.—Tenders are invited for insulators, iron spindlers, and copper wire for the Postmaster-General's Department. Particulars from Captain Muirhead Collins, 72, Victoria-street, Westminster. Tenders by Dec. 16.

Buenos Ayres.—Tenders are invited for the construction of underground electric tramways. Particulars from the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London. Tenders by June 1, 1908.

Lyons.—The Corporation invite tenders for the erection of a refuse destructor, the heat to be utilised in generating steam for electric motors. Particulars from the Commercial Intelligence Branch of the Board of Trade. Tenders by Dec. 15.

Madrid.—The Post and Telegraph Department invite tenders for the construction and working of a telephone system. Deposit, 144,695 pesetas. Particulars from Direccion General de Correos y Telegrafos, 10, Carretas. Tenders by Dec. 26.

Buenos Ayres.—Tenders are invited for (1) the construction of and (2) the concession to work the two principal sections of the underground electric railway. Particulars from the Argentine Legation, 12, Rue van Moer, Brussels. Tenders by May 1, 1908.

Aberdare.—The Powell Duffryn Steam Coal Co. invite tenders for supply of stores from Jan. 1, 1908, including indiarubber and asbestos, electrical fittings, wire ropes, etc. Tenders to the Powell Duffryn Steam Coal Co., 101, Leadenhall-street, London, E.C., by Dec. 9.

Adelaide.—The Deputy Postmaster-General for Queensland invites tenders for a common battery switchboard and 3,000 subscribers' telephones. Specification No. 166. Particulars may be obtained from the Commonwealth Offices, 72, Victoria-street, London, S.W. Tenders by Jan. 8, 1908.

Belfast.—The Harbour Commissioners invite tenders for the construction of a double line of electric tramway, permanent way, electric masts, cables, wiring, lamps, etc., on the co. Down side of the harbour. Tenders to Mr. W. A. Currie, secretary, Harbour Offices, Belfast, by Dec. 28.

Victoria.—The Deputy Postmaster-General at Melbourne invites tenders for the supply and delivery at Melbourne of 11 sections of a common-battery switchboard and 3,000 subscribers' telephones and other apparatus for telephone exchange, Windsor, in accordance with Victorian specification No. 148. Tenders by Jan. 7.

Gillingham.—The Corporation invite tenders for the erection of plant capable of effectually burning a minimum of 30 tons of refuse per day of 16 hours, the heat to be utilised in a water-tube boiler for raising steam in connection with the electricity works, Windsor-road, Gillingham. Tenders to the Town Clerk by Dec. 12.

London, S.W.—Tenders are invited by the London County Council for the supply and delivery of about 1,520 tons of steel girder tramway track rails and fastenings required in connection with the construction for electric traction on the overhead trolley system of the authorised tramways from Hammersmith to Harlesden. Tenders by Dec. 10.

London, S.W.—The London County Council invite tenders for the roadwork and platelaying required for the construction for electric traction on the overhead trolley system of the authorised tramways from Hammersmith-broadway, *via* Brook Green-road, Shepherd's Bush-road, Wood-lane, and Scrubs-lane to Harlesden. Tenders to the Clerk of the London County Council, Spring-gardens, S.W., by Dec. 10.

RESULTS OF TENDERS.

Watford.—The Urban District Council have accepted the tender of Henley's Telegraph Works Co. for the supply of cable for a period of 12 months.

Bristol.—The contract of the Princess Royal Colliery Co. has been accepted for the supply of coal to the Temple Back and Avon bank electricity works.

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Moscow.—We understand that Bruce Peebles and Co., Edinburgh, have secured the contract for the electrification of the tramways at Moscow for £2,000,000.

Chelmsford.—The Town Council have accepted the tender of F. H. Dennis, of Chelmsford, for fixing the wires and bells in the houses of the members of the fire brigade, for £65.

London.—The tender of Rowley Bros., Tottenham, at £24,078, has been recommended for acceptance to the London County Council for the erection of a tramways car-shed at Mare-street, Hackney.

Dundee.—Messrs. R. M'Alpine and Sons, Glasgow, have received the contract for the construction of the foundations of the new generating station for Dundee. The cost of the work will be about £6,000.

Leeds.—The Corporation Tramways Committee have accepted the tender of the Leeds Steelworks, Hunslet, for the supply of 1,500 tons of steel rails, to be used in connection with tramway extensions recently authorised.

Bristol.—The Electrical Committee have accepted the tender of Clapham Bros., Keighley, for the supply and erection at the Avonbank Electricity Works, Feeder-road, Bristol, of three cast-iron tanks—one of 3,000 gallons, one of 4,500 gallons, and one of 16,200 gallons approximate capacity.

Kettering.—The following tenders have been accepted by the Urban District Council for the supply and erection of the following plant at the electricity generating station: W. H. Allen, Son, and Co., Queen's Engineering Works, Bedford, extension engine and dynamo (350-kw. set), with pipework connections, £2 218. 15s.; Cox-Walkers, Darlington, extension switchboard panel, £191.

Wrexham.—The following tenders have been received for a 60-kw. steam set:

Phœnix Dynamo Manufacturing Co.	£493	10	0
Morley Electrical Co.	505	12	0
Morris-Hawkins	514	0	0
Newton Electrical Works	521	10	0
General Electric Co.	542	10	0
International Electric Co.	538	0	0
Mavor and Coulson	542	10	0
Electric Construction Co.	528	0	0
Jones-Westward Electrical Manufacturing Co.	545	0	0
Lancashire Dynamo Co. (accepted)	545	15	0
British Electric Plant Co.	529	10	0
Union Electric Co.	548	0	0
P. R. Jackson and Co.	556	10	0
India Rubber and Gutta Percha Telegraph Works	557	0	0
Johnson and Phillips	557	10	0
T. W. Broadbent	573	18	0
J. H. Holmes and Co.	604	0	0
British Westinghouse Manufacturing Co.	609	10	0
T. Parker, Limited	606	0	0
Siemens Bros. Dynamo Works	585	10	0
E. Scott and Mountain	602	10	0
L. H. Hodgson and Co.	921	0	0

BUSINESS NOTES.

TRACTION.

Moscow.—Messrs. Bruce Peebles and Co., of Edinburgh, have obtained the contract for the electrification of the Moscow tramways at a cost of £2,000,000.

Scarborough.—The residents on the North Side and residents in Castle-road have presented two separate petitions to the Corporation with regard to the noise caused by the trams, and these have been referred to the Streets Sub-Committee.

New District Railway Rates.—The District Railway Co. are revising from Dec. 1 many of their rates for season tickets, and particularly those between the western suburban districts—namely, Harrow, Sudbury, Ealing, Hounslow, Acton, etc.—and London.

Erith.—At the meeting of the Council Tramways Committee the manager reported that the traffic receipts for the previous four weeks, as compared with the corresponding week of last year, were as follows: 1907, £619. 16s. 11d.; 1906, £763. 8s. 0½d.—deficit, £143. 11s. 1½d.

Buenos Ayres and Belgrano Electric Tramways Co.—Receipts for the week ending Nov. 25. 1907, converted to gold, were £3,950; corresponding week, 1906, £3,868—increase £82. Aggregate from Jan. 1, 1907, £181,482; aggregate from Jan. 1, 1906, £171,427—increase, £10,055.

Edmonton (Alberta).—The Strathcona Radial Tramway, which a short time ago secured a street railway franchise from Strathcona, has purchased a right-of-way into the business centre of this city. The company are now asking running rights over one or two streets which they have to cross to build into Edmonton.

Bermondsey.—Upon the recommendation of the General Purposes Committee, the Council have resolved to concur with the resolution adopted by the Southwark Borough Council in favour of the tramways being allowed to cross Southwark Bridge when reconstructed, and to communicate with the County Council accordingly.

Lucknow.—The work of construction of the electric tramway for Lucknow is hoped to be put in hand early next year, if not before the close of the present year. The plans sanctioning route and area were received from the Government of India on the 10th inst., and were at once dispatched to the British Eastern Electric Co., of Broad-street, London.

Hanwell.—At the last meeting of the District Council a letter was read from Sir J. Clifton Robinson, on behalf of the London United Tramways Co., saying that the cross-over points opposite the Duke of York, complained of by the Council, were in good condition, and there was no reasonable ground of complaint on the score of noise. It was decided to again approach the company, and if the result was not satisfactory to approach the Board of Trade.

Shoreditch.—An electric tramcar and a farmer's cart collided at Shoreditch on the 25th. The driver, in endeavouring to slacken speed to round the curve at the church, found that the brakes would not act. The car jumped the metals and ran into the rear of the wagon, smashing it to pieces. The car was also much damaged, and the driver and passengers were shaken. Traffic was delayed, and at one time there were no fewer than 40 cars on the line waiting to go either way.

Halifax.—The trolley of a two decker tramcar which was going down King Cross-street on the 24th inst. jumped off the overhead wire near the end of Bond-street. The trolley became entangled in the overhead equipment, and after dragging three lengths of wire from the insulators, and breaking a portion of the guard wire, fell into the street, and missed by about a foot a man who was passing. The damaged wires were repaired as quickly as possible, but the tram service on this portion of the route was interrupted for more than an hour.

Kensal Green.—The London County Council have decided to give notice to the Metropolitan Electric Tramways, requiring that company to sell to the Council, under the condition provided in the Tramways Act, 1870, that portion in London of the undertaking authorised by the Harrow-road and Paddington Tramways Act. The lines are situated in Harrow-road between a point near Kensal Green Cemetery, where the London and North-Western Railway crosses that thoroughfare, and the existing terminus at the Lock Bridge, near Amberley-road, and are worked on the overhead system of electric traction.

New Underground Station.—All the arrangements have now been completed in connection with next Saturday's opening of the Piccadilly Tube station in the Strand. The Strand has hitherto been badly served in the matter of underground lines, but in future passengers will be able to reach all parts of London quickly and cheaply from the new station. A notable feature in connection with the traffic from this station will be a special express theatre train, which will run for the benefit of theatre-goers. At 11.13 p.m. each night a through train will leave the Strand for Finsbury Park, calling only at Holborn, King's Cross, and Holloway, for the use of North London residents.

Bradford.—At a meeting of the Tramways Committee of the Corporation on the 26th, the report of a sub-committee was received with regard to the inspection of a new type of upper deck for the covered tramcars. These are so arranged that there is no standard running through the middle of the upper deck, and the roof is raised, enabling passengers to stand erect. More and improved accommodation is at the same time provided. The new kind of cover was approved, and orders were given for adapting them to 25 cars at once. Thirteen claims have been received in connection with the tramway accident which occurred at the bottom of Church Bank on July 31 last. A small sub-committee have this special business in hand, and the claims have not yet come before the whole committee.

Birmingham.—The Corporation have negotiated a loan with the Prudential Assurance Co. for £100,000 for extensions to the tramway system. Colonel von Donop, inspector of the Board of Trade, visited Birmingham on the 26th for the purpose of inspecting the tramway which runs from Rea-street along Digbeth and Moor-street, and joins the existing Bordesley Green line at the bottom of Carr's-lane. The tramway is about half a mile in length, and, connecting Bordesley with East Birmingham, will give a through service between Small Heath Park and Nechells. The inspector expressed himself satisfied with the construction of the line, and granted a speed of eight miles an hour. He also fixed the compulsory stops, and gave permission for the line to be opened for traffic as soon as convenient to the authorities.

Paddington.—The Works Committee reported to the Borough Council at the last meeting that for some time past they had been endeavouring to persuade the Metropolitan Electric Tramways, Limited, to remove the disused tramway lines from Chippenham-road, and were now in a position to report progress. A representative of the company had informed the chairman that he was prepared to take up the rails at the Harrow-road and Shirland-road ends of the road, in the event of the Council raising no objection to the company taking a horse car across the carriageway paving in Chippenham-road and Harrow-road once in every three months, in order to comply with the provisions of the Tramway Act. There was a reasonable prospect of inducing the company shortly to take up the remainder of the Chippenham-road tramway. They recommended giving the company the permission. The Council after discussion agreed with the committee.

Luton.—So rapidly has the construction of Luton's tramway system proceeded that at the present time two routes are practically finished, and on two others the work of preparation has commenced, leaving only one other to receive attention. The track has been completed between the car-shed in Park-street and the bottom of the Market-hill and between Wardown lodge gates and the Midland Railway bridge in New Bedford-road. On this portion the rails have been placed in position as far as the corner of Bute-street. The Dunstable-road section has been excavated from close to the steam laundry to the corner of Leagrave-road, while the rails have been laid within 200 yards of this point. The men commenced opening the roadway at the junction of Midland and High Town roads on the 20th inst. The George-street section will soon be completed, as the navvies are now at work between Bute-street and Cheapside. The fixing of the

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bracket arms on the London-road route is being speedily proceeded with.

Gloucester.—There was further discussion at the meeting of the Gloucester City Council on the 27th with respect to the municipal tramways. The Corporation purchased the old horse tramways about four years ago, and electrified the system. The result was very disappointing, every year showing a heavy loss. The ex-mayor and another member of the Council were several months ago appointed a special committee to make inquiries privately for the purpose of ascertaining whether it would be possible to lease the undertaking to a company on terms favourable to the city. They found that it would be possible—that they could lease and escape all danger of loss. There was an outcry against the suggestion to lease, it being urged that the first thing a company would do would be to discontinue running on some of the routes, and that the staff would be reduced. The committee was reconstituted, and on Wednesday presented a scheme which it was hoped would bring about an improvement. The trams were to cease running on two routes on which it was known they did not pay. It was estimated that nearly £700 a year will be saved in this way. The proposal gave rise to much discussion. An amendment that the scheme should be referred back was defeated, and the recommendation of the committee ultimately confirmed.

The Potteries Tramways.—On the 27th inst. Colonel Druitt, of the Board of Trade, was engaged in making an inspection of certain portions of the North Staffordshire tramway system, the licence for the electrical working of which expires on Dec. 17. The lengths of line inspected were those between Burslem, Hanley, Stoke, and Longton, upon which the old steam trams used to run. The licence for the electrical working of these lines was only granted for a certain number of years, and the Board of Trade require to be satisfied that the line is in suitable order for electric traction before they renew the licence. It will be remembered that several of the local authorities petitioned the Board of Trade some time ago not to consent to the renewal of the certificate until various causes of complaint had been remedied. Colonel Druitt commenced his inspection at 10 o'clock, when he travelled by special car over the line between Stoke and Longton. Then he journeyed by train to Burslem, and resumed his inspection by examining the line between Burslem and Hanley, arriving at Miles Bank about half-past eleven. Afterwards he inspected the line between Hanley and Stoke. He was accompanied during the various stages of his journey by the surveyors of Stoke, Fenton, Longton, Burslem, and Hanley, and by representatives of the different local authorities interested.

Bury.—The chairman, at a meeting of the Corporation Tramways Committee, reported that a deputation had waited upon him and the manager from the Bury Tradesmen's Association making further proposals for the extension of the tramway system. The only feasible scheme seemed to be the extension to Little Lever, and the Outside Authorities Sub-Committee was authorised to meet representatives of the Little Lever District Council on the matter. The manager reported that the chairman and himself had had several interviews with the Bolton authorities as to the complaints of the Bolton motormen, who thought 36 minutes were insufficient for the journey between the two towns, and it had been agreed to revert to the 42 minutes' journey. Application was received from the Unsworth Parish Council that a new 1½d. stage should be arranged between Parkhills-road and the Unsworth boundary. It is possible that at the end of the present financial year the Salford Corporation will make new arrangements in regard to their portion of the track from the Unsworth boundary to Whitefield, and the matter was left in abeyance until that time. A letter was received from the Association of Tramway and Vehicle Workers renewing the application for an advance of ½d. per hour for conductors. As several members of the committee had to leave, it was decided to adjourn the consideration of the matter until the next meeting.

Derby.—A successful trial trip was made on the 21st inst. over the Ashbourne-road new electrical tramway route at Derby and part of the Uttoxeter-road route, and the cars will probably begin running for the use of the public early next week. When these routes are opened there will be a revision in the working of several of the routes. The Uttoxeter-road cars will run through to Alvaston with a 12 minutes' service on weekdays, and the Market-place as a terminus for the Alvaston cars will be dispensed with. On Sundays the Uttoxeter-road and Burton-road routes will be combined, leaving the Alvaston cars to run through to Kedleston-road as at present. On weekdays the Burton-road town terminus will be changed from Victoria-street to the Market-place. The Ashbourne-road cars will run through to the Midland Railway Station every 10 minutes, working in with the Kedleston-road and Midland Station cars so as to still give a five minutes' service from the Royal Hotel to the Midland Station. On Sundays the Ashbourne-road cars will stop in Victoria-street until 6 p.m., and then run through to the Midland Station. For the time being the Osmaston-road cars will make the Market-place their town terminus instead of Victoria-street, but when the Nottingham-road route is open for traffic, which will be very shortly, these two routes will be combined. The other sections will remain as they are for the present. The fare on each of the new routes will be 1d.

York.—The City Council have passed the following resolution: "(1) That application be made in the present month by the Lord Mayor, aldermen, and citizens of the city of York to the Light Railway Commissioners for an order under the Light Railways Act, 1896, to authorise the following lines: route No. 1—railway station to city boundary, Tadcaster-road *via* Station-road, Queen-street Bridge, Queen-street, Blossom-street, The Mount, Mount-vale, and Tadcaster-road; route No. 1A—The Mount to Holgate-road; route No. 2—railway station to city boundary, Fulford-road *via* Station-road, Leeman-road, Tanner's Moat, Rougier-street, Tanner-row, Railway-street, Micklegate, Bridge-street, Ousebridge, Low Ousegate, Nessgate, Clifford-street, Tower-street, Castle Mills Bridge, Fishergate, and Fulford-road; route No. 2A—Station-road to Tanner's Moat; route No. 3—city boundary, Fulford, to Fulford village *via* Fulford-road; route No. 4—Blossom-street to city boundary, Acomb-road, *via* Blossom-street, Holgate-street, and Acomb-road; route No. 5—Station-road, Lendal Bridge to railway bridge, Haxby-road, *via* Station-road, Lendal Bridge approach road, Lendal Bridge, Museum-street, St. Leonard's-place, Bootham, Gillygate, Clarence-street, and Haxby-road; route No. 5A—Leeman-road to Lendal Bridge approach road." Also that the Tramways Committee and the town clerk take all necessary steps to carry the foregoing resolution into effect, and that the corporate seal be affixed to the memorial to the Light Railway Commissioners and to any other necessary documents.

Dundee.—The Town Council met on the 21st inst. to consider the question of a contract for six new electric cars. The lowest contract was one submitted by the Brush Electrical Engineering Co., Loughborough, but the question was raised as to whether the company were complying with a Corporation standing order by paying the standard rate of wages, and as a result of negotiations two representatives of the company travelled to Dundee and offered to submit the pay sheets of the company to the Tramway Committee; but the committee recommended the Council by a majority that the pay sheets be not examined, and that the next lowest offer be accepted. Mr. Alexander Speed moved the disapproval of this recommendation, and said the conditions obtaining in the establishment which had made the lowest offer were the same as those in other shops, with this difference, that they employed non-unionists as well as unionists, and he asked if the Council was to give encouragement to the idea that a man should not sell his labour in the best market. Bailie Don, in seconding, said the Council had been elected to conserve the best interests of the community, and the contractors had been unjustly treated in that their representatives who had travelled north had not been heard. By accepting the next lowest offer the town would have to pay an additional £240, and if that policy were pursued by the city or by private firms the result would be bankruptcy. After a long discussion it was agreed by 19 votes to 5 that the contract be given to a Birkenhead firm whose tender was £240 in excess of that of the other company.

LIGHTING AND GENERAL.

Cape Copper Co.—The directors have declared a dividend of 14s. per share, free from income tax, on the ordinary shares.

Whitby.—The managers of the Council schools have resolved to have the electric light installed throughout the whole of their schools.

Buxton.—A Local Government Board inquiry will be held on Dec. 4 into the Council's application for sanction to borrow £1,800 for electric lighting purposes.

Woolwich.—The London County Council have agreed to lend the Borough Council the sum of £3,000 for extensions to the electric lighting department.

Cirencester.—The Rural District Council have consented to the erection of 31 telephone poles to connect Kemble subscribers with Cirencester exchange.

Pontypridd.—The Local Government Board will hold an inquiry on Dec. 5 into the application of the Council for sanction to borrow £3,656 for the electricity undertaking

Gravesend.—The Corporation have promised to turn on the electric light in Northfleet not later than April 30. It is believed that if rapid progress is made the light may appear 29 days earlier.

Western Telegraph Co.—The directors have declared the first quarterly interim dividend of 3s. per share, free of income tax, for the year ended June 30, 1908, being at the rate of 6 per cent. per annum.

Notice of Intended Dividend.—According to the *London Gazette* the last day for receiving proofs in the estate of C. W. Stafford, electrical engineer, 59, Toll End-road, Ocker Hill, Tipton, Staffs, is Dec. 6.

Elderslie.—A branch telephone exchange of the National Telephone Co. is expected to be established in Elderslie shortly after the New Year. It is understood that the requisite number of subscribers has been secured.

Partnership.—The *London Gazette* announces that the partnership between W. R. Laidlaw and W. C. Laidlaw, carrying on business as electrical engineers at Pink Bank-lane, Longsight, Manchester, has been dissolved by mutual consent.

Knaresborough.—The National Telephone Co. have written asking the Council's permission to erect 17 poles at Beckwith Head. The surveyor having stated that the company had fulfilled the requirements of the Council, the request was acceded to.

Hamilton (Ontario).—Mr. T. W. Sotham, chief engineer of the Hydro-Electric Power Commission, has completed his specifications for the two new 6,000,000-gallon electric pumps to be installed here. He estimates the cost for installation at 30,000dol.

Brandon (Manitoba).—This city is installing an electric lighting system at the pumping station for lighting the buildings at that place, and it is quite probable that in the near future the plant may be enlarged sufficiently to do all the municipal lighting.

Harpenden.—The Council have instructed their clerk to write to the County Council asking them if they will, before giving consent to the placing of telegraph and telephone posts on the highway, confer with the local council as to the position of such posts.

Windsor.—During the visit of the German Emperor and Empress and Court at Windsor Castle the resources of the Windsor Electrical Co. were taxed to their utmost, supplemented by additional feeding from the Slough works. Over 6,000 lamps were burning at one time.

Grassington.—The future lighting of the village is a heated question just now. Many favour the new electric scheme, which it is

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understood will soon be set on foot. This new scheme will be worked by turbine on the river, and is in the hands of Messrs. Pullan, of Halifax.

Indian Order for Transformers.—The British Thomson-Houston Co. are supplying three constant-current transformers to the East Indian Railway. The machines will, it is believed, be ready for delivery in December, and will cost a sum of about £400 f.o.b. at an English port.

Sunbury.—At the last meeting of the District Council, attention was drawn to an account amounting to £15 for gas mantles. It was stated that the Council were obliged to spend from £40 to £50 per annum on mantles in order to obtain a very indifferent light, which was characterised as disgraceful by the speaker.

Wednesfield.—The District Council have instructed their clerk to write to the Willenhall Gas Co. asking by what authority the company came into the Wednesfield district with their gas-mains. The General Purposes Committee are to consider a communication from the British Electric Corporation for Power Distribution as to the lighting of a portion of the district by electricity.

Brynmawr.—Complaints are rife as to the ineffective lighting of the town, and it is evident that the supply of gas is of very poor quality. Business people in particular experience much inconvenience, the light at times failing at an unexpected moment and in a most unusual manner. The matter is certainly becoming serious enough to warrant prompt attention from the local authorities.

Battersea.—The Borough Council have decided that the insurance of the engines, turbines, and electrical machines at the central station be effected with the Municipal Mutual Insurance through the National Boiler and General Insurance Co., so as to secure payment up to £5,660 to cover the cost of any repairs, etc., owing to breakdown which may occur, at an annual premium of £278. 12s.

Newport.—The Council at their last meeting discussed the refusal of the Local Government Board to sanction the loan of £30,000 for new capital on the electricity undertaking until the Board had been definitely informed of the steps which the Town Council intended to take with a view to wiping off the deficit on the undertaking. After a long discussion it was decided to pay the deficit out of the general district rate.

Liverpool.—Mr. H. R. Hooper, M.I.C.E., an inspector under the Local Government Board, last week held an inquiry into an application by the Corporation for sanction to borrow £200,000 for purposes connected with the supply of electrical energy. Mr. Pierce, deputy town clerk, represented the Corporation. After an exhaustive statement concerning the finance of the undertaking, to which very little opposition was offered, the inquiry closed.

Dunfermline.—At a special meeting of the Town Council a committee was appointed, consisting of Provost Macbeth, Bailie Stewart, Bailie Husband, and Treasurer Harley, for the purpose of laying the divergent views of the Council before Prof. Kennedy, who is to be asked to advise the Corporation on various points, such as generating, purchasing in bulk from the Fife Electric Power Co., and handing over the provisional order to that company.

Finchley.—At a recent meeting of the District Council it was resolved to apply to Parliament for powers to extend the area of supply of electrical energy, including Torrington-park and Friern-park. Several members objected to this proposal, saying that the Council was supplying current at a loss. The Council in committee have now decided to rescind the resolution so far as it concerns the supply of electricity to Torrington-park and Friern-park.

Callan.—The project to introduce electric light into Callan, to replace the street oil lamps and also for domestic purposes, having met with a satisfactory measure of support, Mr. Haines, of Grafton-street, Dublin, has laid down a plant, the power being generated in Lynch's mill, and already the light is installed in a few houses, and it is expected that the other residents will apply for the light. We understand that the Town Commissioners and the District Council are negotiating for a loan for the purpose.

Swansea.—The accounts of the Corporation just issued by the accountant, and covering the year 1906-7, show that the total amount expended on the electric lighting undertaking to March last was £141,868. The income was £18,586, against £17,899 expended, of which £8,189 was for interest and repayment on borrowed capital. The profit on the year's working is thus £687. After deducting this from the deficit for the preceding year (£1,128) there remained a loss on the undertaking of £441, which had been carried forward to next year's account.

Ashton.—At the meeting of the Lighting Committee letters were read from the British Insulated and Helsby Cables, Limited, that as no doubt the electric current would be taken from the tramways mains, one of the conductors would be earthed; under such circumstances the earthed conductor would run underneath the other, and require for support two short bracket arms instead of one bracket arm, the extra cost of which would be 1s. 6d. per pole. The committee resolved that the extra cost be allowed, and the contractors be instructed to proceed at once to carry out the work.

Tobermory.—On Saturday and Sunday morning a most unusual number of messages were transmitted by the Marconi station at Tobermory from Lochboisdale and the Outer Isles, owing to the breakdown in the Uist and Skye cable. On Monday and Tuesday Mr. Booth, chief electrician, St Martin's, London, was busily engaged at Tobermory with experiments in long-distance telegraphing, the field of his operations embracing stations as far distant as Paris. The two stations at Tobermory and Lochboisdale have already more than realised the advantages claimed for them by the promoters.

New Issue.—The Bank of Montreal are inviting subscriptions for an issue of 2,400,000dol. 7 per cent. gold cumulative convertible preference shares of the Mexican Light and Power Co. The bank are authorised to receive applications for these shares (100dol. each) at 99 per cent. or (at par of exchange) £20. 6s. 10d. per share. The shares are entitled to a fixed cumulative preferential dividend at the rate of 7 per cent. per annum, and holders will have the option of converting them into ordinary shares (share for share) at any time before Jan. 1, 1913, or such extended date as the directors may fix.

Tighnabruaich.—At the last meeting of the Cowal District Committee a requisition to form Tighnabruaich into a special lighting district was considered, and as it was stated that the cost of an unopposed provisional order would be approximately £230, and if opposed from £250 to £400, apart from the legal charges, the proposal was sent back to the promoters for further consideration. A letter from the county clerk bearing on the subject was read, and the minutes of the special meeting of the Parish Council of Kilfinan and the promoters showed that they resolved that no provisional order be applied for.

Watford.—The report of the Electric Light Committee to the Council at their meeting showed that 13 consumers had been connected to the system during the past month, making a total of 565 connected. The committee have approved the principle of a bonus scheme, and directed the electrical engineer to make inquiries from other urban district councils, and to submit particulars to the next meeting. The Chairman, in moving the adoption of the report, stated that for the half-year ending Sept. 21 the revenue from the light increased to the extent of £762, and they sold 93,000 more units than in the corresponding half-year last year.

Heysham.—At the last meeting of the Urban Council the clerk read a letter from the Board of Trade *re* Heysham Electric Lighting Order, 1904, pointing out that it was provided in such order that certain works should be executed within a specified period and a supply of energy given throughout the area of supply, and that no steps having been taken by the Council to carry out the obligations under the order, it devolved on the Board to determine whether the order should be allowed to remain any longer in force, and asking for any representations the Council had to make on the matter. After some discussion, it was eventually decided to defer the reply to be sent until the next Council meeting.

Stock Exchange.—The Stock Exchange Committee appointed Nov. 27 a special settling day in Batu Tiga (Selangor) Rubber Co.'s 20,000 vendors' shares of £1 each fully paid, Nos. 40,001 to 60,000; and have ordered the undermentioned securities to be quoted in the official list: Hastings and District Electric Tramways Co.'s 40,000 6 per cent. cumulative preference shares of £5 each fully paid, Nos. 1 to 40,000; and Victoria Falls Power Co.'s 800,000 preference shares of £1 each full paid, Nos. 1 to 800,000. Application has been made to the committee to appoint a settling day in Imperial Ethiopian Rubber Co.'s 24,000 vendors' "A" shares of £1 each fully paid, Nos. 31,001 to 55,000, and 30,000 vendors' "B" shares of £1 each fully paid, Nos. 1 to 30,000.

St. Marylebone.—In the report of the Works Committee to the Borough Council at their last meeting, the borough surveyor having reported that the engineer of the electricity department was in the habit of breaking up streets for purposes of laying mains without making application, the Works Committee addressed a memorandum to the Electric Supply Committee stating that they were of opinion that they ought to carry out their work in this respect in the same way as any company having similar statutory rights, and requesting that they would instruct the engineer to make the necessary applications in future, as there seemed no reason why they should not be made in sufficiently good time to receive their sanction without inconvenience being caused to the department.

Leek.—At the last meeting of the Urban District Council the Electricity Committee recommended that the Council apply for power to borrow an increased sum of £1,200 in connection with the extension of plant, etc., to enable the committee to produce the whole of the gas required. It was, however, proposed that the matter be referred back to the committee, as it was not considered advisable by the mover of the resolution to convert their present engines and plant for the purpose proposed. If this were done, it would lower the horse-power working of the engines. He thought there ought to be a joint meeting of the Gas and Electricity Committees so as to devise some means of supplying gas from the works. The Chairman said it would be no use having a meeting of the two committees. The Gas Committee could not produce gas at less than 1s. 7½d. per 1,000 cubic feet, and if the electric works could produce gas at 10d. they could not possibly compete with them. The resolution of the Electricity Committee was eventually agreed to.

Holywood.—At a meeting of the Holywood Urban Council held on Nov. 21 the question of the proposed electric lighting of the town, and the establishment of the company which is to run trams from Holywood to Belfast, came up for consideration. The town clerk stated that the solicitor of the company had informed him that no hitch had occurred in the carrying out of the project. The work had been delayed, however, by the fact that the company had not been able to ascertain the amount of power which would be required from the generating station which they intended to erect in Holywood, as they had been in communication with the Belfast Corporation, to whom they had applied for permission to run on their lines. The whole scheme, however, would come before Parliament for its final sanction. In the event of the company being able to dispense with a local generating station, the idea of lighting the town by electricity would not be feasible. In the course of a discussion which ensued the members expressed themselves gratified that the company's project was being carried out with as great dispatch as possible.

Birmingham.—The Electricity Supply Committee, in their report to the City Council, record that the first equipment of the Summer-lane generating station, and of the five sub-stations situated in Parker-street, Camden-street, Scholefield-street, Upper Trinity-street, and

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Court-road, is now practically completed. The recent growth in the demand for current has compelled the committee to consider the question of further extending the generating and distributing plant. They have forecasted their requirements for the next three or four years, and ask the Council's approval to the installation of additional plant as detailed in a schedule set out in detail, and to the borrowing of the amount required for that purpose. The items of plant set out in the schedule are in most cases duplicates of the plant that has been already installed, and are summarised under the following headings: plant at Summer-lane station, £183,635; sub-stations, £14,850; Water-street station, £17,300; Dale-end station, £11,500; meters, £4,000—total, £231,285. The committee now recommend that the Finance Committee be authorised to borrow a sum of £220,000 to cover this expenditure, and prospective expenditure on the same account. The Finance Committee of the Corporation have negotiated with the Prudential Assurance Co. for a loan of £39,568 for extensions to the electricity undertaking.

PROVISIONAL PATENTS, 1907.

Nov. 18.

15100A. **Improvements in or relating to electric secondary clocks.** Arthur Charles Stray, 111, Hatton-garden, London. (Date applied for under Rule 5 of the Patents Rules, 1905, July 1, 1907.) (Complete specification.)

25478. **Improvements in electric fuse holders.** The Electric and Ordnance Accessories Company, Limited, and Robert Frederick Hall, 24, Temple-row, Birmingham.

25503. **New or improved means whereby on excess of current in an electrical circuit the same is automatically broken and completed again by another path after a predetermined interval.** Stanley Clive Midwinter, 306, High Holborn, London.

25511. **Improvements in electric portable photographic lamps.** Oscar Thomas Banks, 49, Mortimer-street, London.

25522. **Alterno-rotary motor.** Alexandre Primat, 116, High Holborn, London.

25553. **Improved process for the electric dissociation of metals by the wet method.** Alfred Levy, 31, Basinghall-street, London. (Complete specification.)

Nov. 19.

25584. **Improved electrical apparatus for the production of light.** Thomas Oliver Dunford and William Kirtley, 6, Finkle-street, Stockton-on-Tees.

25585. **Improvements in or relating to interlocked iron-clad electric switches.** Vernon Hope, Vincent Henry Sugden, and Walter Harrison Gardner, 55, Market-street, Manchester.

25607. **Improvements in and relating to electrical connections or conductors.** Robert Bittner Hutchison and William Archibald Bonnell, 18, Southampton-buildings, London. (Complete specification.)

25630. **Improvements in apparatus for controlling and operating the points of electric railways and tramways.** Henry Lawrence Turner, 8, Quality-court, Chancery-lane, London.

25649. **Improvements in and relating to electric light fittings for use on alternating current.** Edwin Rudolph Grote and the Foster Arc Lamp and Engineering Company, Limited, 40, Chancery-lane, London.

25651. **Improvements in sockets or holders for electric lamps.** Charles Clare Regnart, 29, Anson-road, Cricklewood, London.

25655. **Improvements in processes of manufacturing bodies capable of conducting electricity in a cold state.** Erich von Seemen, 111, Hatton-garden, London. (Date applied for under Patents Act, 1901, Nov. 19, 1906, being date of application in Germany.) (Complete specification.)

25663. **Improvements in suspension devices for electric conductors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.) (Complete specification.)

25664. **Improvements in suspending devices for electric conductors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.) (Complete specification.)

Nov. 20.

25666. **Improvements in electric contact breakers and trembler coils.** Arthur Wilson Metcalfe, Grove Mill, Belfast, Ireland.

25667. **Improvements in the manufacture of commutators for dynamos, electromotors, and the like.** William Porter Draper, Quilter-road, Felixstowe, Suffolk.

25669. **Improvement in electro-deposition.** Lincoln Hausmann, 37, Old Broad-street, London. (Date applied for under Patents Act, 1901, Nov. 23, 1906, being date of application in Germany.) (Complete specification.)

25688. **Improved sanding apparatus for electric train cars or the like.** James Diggle and Joseph Burrell, 13, Apsley-road, Denton, Lancs.

25709. **Improvements in switches for use in connection with intercommunication telephone systems.** John Josiah Perry, 24, Temple-row, Birmingham.

25705. **Improvements in the magnetic separation of minerals.** George Thomas Holloway, 57, Chancery-lane, London.

25716. **Improvements relating to a method of and means for controlling electric appliances in connection with electric circuits.** Robert Francis Venner and Robert Constantine Griesbach, 20, High Holborn, London.

25733. **Improvements in or relating to electric switches.** Harry Pigott Allison and Henry James Arnold, 111, Hatton-garden, London.

25740. **Improvements in electrically-operated signalling installations.** De Courcy Beamish, 6, Lord-street, Liverpool.

25744. **Improvements in means for varying the potential at two points between which an electric current passes.** Felten und Guilleaume-Lahmeyerwerke Act.-Ges., 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Nov. 26, 1906, being date of application in Germany.) (Complete specification.)

25752. **Improvements in electric cooking apparatus.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

Nov. 21.

25768. **Electrically-operated automatic steam trap.** Bernard Abbott Malkin and John Drysdale Robb, 3, Moat-street, Edinburgh.

25772. **Improved means of paralleling the motors of electric and petrol-electric cars.** William Arthur Stevens, St. Peter's-street, Maidstone.

25792. **Improvements in joint-boxes for electric cables.** John Stratton, Charles James Beaver, and Ernest Alexander Claremont, 4, Bloomsbury-square, London. (Complete specification.)

25815. **Improvements in and connected with incandescent electric lamps and their fittings.** John Hillery Collings and Hugo Hirst, 33, Cannon-street, London.

25830. **Improvements in or relating to electric switches.** Alfred Loebl and the British Ever Ready Electrical Company, Limited, 111, Hatton-garden, London. (Complete specification.)

25832. **Insulated rail joint.** Benjamin Wolhaupter, 165, Queen Victoria-street, London. (Complete specification.)

25833. **Insulated rail joint.** Benjamin Wolhaupter, 165, Queen Victoria-street, London. (Date applied for under Patents Act, 1901, Dec. 6, 1906, being date of application in United States.) (Complete specification.)

25834. **Improvements in dynamo-electric machines.** The British Thomson-Houston Company, Limited, and Frederic Horton Clough, 83, Cannon-street, London.

Nov. 22.

25842. **Improvements in the distribution of electric power by electric transformers.** John Thomas Irwin, William Edward Rotson, and James Lewis Cook, The Central Technical College, Exhibition-road, South Kensington.

25846. **Improved electrical gas lighting and extinguishing device.** John Magill Stewart and Arthur George Rendall, 100, Wellington-street, Glasgow.

25863. **Improvements in means for supporting the trolley wires or conductors of electric tramways.** George Robert Feather, 17, Hanover-street, Keighley, Yorks.

25864. **Improved device for supporting the trolley wires or conductors of electric tramways.** George Robert Feather, 17, Hanover-street, Keighley, Yorks.

25878. **Improvements in distribution of electricity.** William James Davy, 40, Chancery-lane, London.

25881. **Improvements relating to electric arc lamps.** David Suchostawer, 33, Chancery-lane, London.

25902. **Improvements in and relating to the cooling of dynamo-electric machines.** The Phœnix Dynamo Manufacturing Company, Limited, and Robert Pohl, 322, High Holborn, London.

25911. **Improvements relating to telephone circuits.** Charles Mark Jacobs, Birkbeck Bank chambers, Southampton-buildings, London.

25912. **Improvements relating to telephone circuits.** Charles Mark Jacobs, Birkbeck Bank-chambers, Southampton-buildings, London.

25919. **Improvements in and relating to electricity generators.** James Ferguson, 18, Southampton-buildings, London. (Complete specification.)

25922. **Improvements in insulated electric conductors and processes of forming the same.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

Nov. 23.

25953. **Improvements in or connected with electrical switches.** Charles James Turner, 139, Dale-street, Liverpool.

25961. **Automatic sand-valve opener for tramcars and other electrically-driven vehicles.** Frederick John Squire Hosken, 16, Blackburn-road, Darwen, Lancs.

25967. **Improvements in load equalisers for alternating-current supply circuits.** Paul Martyn Lincoln, Westinghouse Building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Dec. 3, 1906, being date of application in United States.) (Complete specification.)

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25970. Improvements in telephone receivers. Knut Eric Ericsson, 65, Chancery-lane, London.

25978. Improved cable or telegraph code. Frederick Pain, 18, Southampton-buildings, London. (Complete specification.)

25987. Improvements in connection with the brake-operating mechanism of electric lifts or hoists or the like. Felten und Guilleaume-Lahmeyerwerke Act.-Ges., 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Nov. 22, 1906, being date of application in Germany.) (Complete specification.)

25998. Improvements in electrically-operated winches. Aarhus Dynamo und Elektromotorfabrik and Soren Peter Johansen, 6, Lord-street, Liverpool.

25999. Improvements in electromotors. Aarhus Dynamo und Elektromotorfabrik and Soren Peter Johansen, 6, Lord-street, Liverpool.

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Dec. 12.)

1906.

18624. Method of and apparatus for producing electricity by steam. Fry.

23334. Manufacture of electric conductors, more especially applicable for use as incandescing bodies for electric lamps. Coolidge. (Date applied for under International Convention, May 9, 1906.)

23335. Manufacture of electric conductors, more especially applicable for use as incandescing bodies in electric lamps. Arsem. (Date applied for under International Convention, May 9, 1906.)

23336. Manufacture of electric conductors, more especially applicable for use as incandescing bodies in electric lamps. Coolidge. (Date applied for under International Convention, May 9, 1906.)

26219. Electric signalling apparatus. Schorn. (Date applied for under International Convention, Nov. 20, 1905.)

26301. Automatic telephone district system and means for use in automatic telephony. James. (Automatic Electric Company.)

26524. Time-alarm electric signalling. Maas and Gowing.

26620. Electric arc lamps. Headland and Plutte.

26872. Telephonic receivers. Graham.

26982. Electromagnetic ignition devices for internal-combustion engines. Bosch. (Date applied for under International Convention, Nov. 28, 1905.)

27726. Electric arc lamps having mutually-inclined carbon-holders. Brockie.

27762. Ventilation or cooling of dynamo-electric machines. Armistead.

28637. Electrical fittings, bottle stoppers, and the like. Waltho.

1907.

1456. Electrolytic rectifiers. De Faria.

3189. Supports and connections of electric conductors and cables. Astafieff.

4685. Aerials for wireless telegraphy and the like. Fairweather. (Brown Hoisting Machinery Company.)

5565. Alternating-current dynamo-electric machines. Mershon.

6735. Electrical accumulators or secondary batteries. Triquet.

6967. Motor-controlling rheostats. British Thomson-Houston Company. (General Electric Company.)

8474. Electro-mechanical control of hydraulic lifts and like apparatus. Smith.

8660. Electric primary batteries. Szek.

12711. Electric conductors for use in connection with installations of electric light. Davis.

13140. System of controlling and operating motors for electric railways and power plants. Sahulka.

14440. Control of electric motors. Allgemeine Elektricitäts Ges. (Date applied for under International Convention, June 23, 1906.)

15219. Driving gear of electric tramcars. Lironi.

16241. Railway point and signal apparatus. Kershaw, and Saxby and Farmer, Limited.

16301. Method of electric lighting for lighthouses, beacons, or buoys. Stevenson.

16732. Conduits, particularly conduits for electric tramways. Manders and Hodge.

18492. Means for attaching electric conductors to carbon brushes. Robertson.

18922. Production of tungsten dioxide. Westinghouse Metal-Filament Lamp Company. (Date applied for under International Convention, Nov. 23, 1906.)

19077. Apparatus for use in connection with electric wave telegraphy. Osman.

20300. Pneumatic distributing systems for electrically-propelled vehicles. Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, Sept. 12, 1906.)

21252. Wireless telegraphy and telephony. Maiche.

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £	Last price. £
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-⅝
—— Ord., 1,125 000	1 ..	⅛-¼
Aron Electricity Meter, 6 p.c Cum. Pref. Shares, 1-125,000	1 ..	19/32-23/32
—— Ordinary, Nos. 1 125,0.0	1 ..	5/32 9/32
British Aluminium Co., Ordinary, 2,001-40 000	5 ..	3½-4½
—— 7 per cent. Cum. Pref., 1-40 000	5 ..	4½-5
—— "A" 6 per cent. Cum. Pref., 1-20 000	5 ..	4½-5
—— 4 per cent. Funding Certificates, 1-20 000	h ..	3½ 4½
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	100-103
—— 5s per cent Loch Leven Deb. (Reg.) Red., 1-3 000	100 ..	96 99
British Insulated and Helsby Cables, Ord., 1-100 000	5 ..	6½-7
—— 6 per cent. Cum. Pref., 1-100 000	5 ..	5⅝-6¼
—— 4½ per cent. Mortgage Debentures	100 ..	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	85 89
British Westinghouse Elec. and Manuf. 6 per cent Pref., 275,001-375 000	3 ..	¼-1½
—— 4 per cent. Mortgage Debenture Stock	100 ..	55-65
Brush Electrical Engineering, Ordinary, Nos. 1-105 731	2 ..	0-½
—— Non. Cum., 6 per cent., Pref.	2 ..	⅜-½
—— 4½ per cent. 1st Debenture Stock	100 ..	83-86
—— 4½ per cent. 2nd Debenture Stock	100 ..	67-70
Callender's Cable, Debentures	100 ..	105½-107½
—— Ordinary	5 ..	9½-10½
—— 5 per cent. Pref.	5 ..	5¼-5⅝
Consolidated Electrical Co., Ordinary, 1-110,000	1 ..	7/16-9/16
Crompton and Co.	3 ..	1⅛-1¼
—— 5 per cent Debentures	100 ..	96-99
Dick, Kerr and Co., Ordinary, 1 250 000	1 ..	1¼-1½
—— 6 per cent. Cum. Pref., 1-305,000	1 ..	1-1¼
—— 4½ per cent. Debenture Stock, Red.	100 ..	101-104
Edison and Swan United, "A" Shares, 1-99 261	5 ..	13/16-1 1/16
—— "A" Shares, 01-017,139	5 ..	1-2½
—— 5 per cent. Debentures	100 ..	87-90
—— 4 per cent. Deb. Stock, Red.	100 ..	79-82
Electric Construction, Nos. 1 to 112 100	2 ..	1/16-3/16
—— 7 per cent. Cumulative Pref.	2 ..	¼-1
—— 4 per cent. Perp. 1st Mort. Deb	100 ..	59-64
Electrolytic Alkali Co., Ordinary, 1-202,218	1 ..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock. Red.	100 ..	—
General Electric Company (1900) 5 per cent. Cum. Pref.	10 ..	8-8½
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	89-92
W. T. Henley's Telegraph Works, Ordinary	5 ..	10½-11½
—— 4½ per cent. Preference	5 ..	5-5½
—— 4½ per cent. Debentures	100 ..	105½-107½
India Rubber, Gutta Percha, and Telegraph Works	10 ..	14½-15½
—— 4 per cent. Debentures	100 ..	96-98
National Electric Construction Co., 1-170,000	1 ..	13/16-15/16
Parker, Thos., Limited, Ordinary	10 ..	10-10½
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5 ..	—
Telegraph Construction and Maintenance	12 ..	27½-29½
—— 5 per cent. Bonds	100 ..	99½-102½
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10 ..	8¼-9¼

Electric Lighting and Supply.—

Name.	Amount paid. £	Last price. £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5 ..	4½-5
Bournemouth and Poole, Ordinary	10 ..	9½-10½
—— 4½ per cent. Cum. Pref., 7 501-15 000	10 ..	9¼-10
—— 6 per cent. Cum Second Pref., 15 001-22,500	10 ..	9¼-10⅜
—— 4½ per cent. Debenture Stock, Red.	100 ..	99½-102½
Bromley (Kent) Electric Light and Power Co	5 ..	4⅜-5¼
—— 4½ per cent. 1st Debenture Stock, Red.	100 ..	95-98
Brompton and Kensington, Ordinary	5 ..	7-8
—— 7 per cent. Preference	5 ..	7-8
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5 ..	6-7
—— Nos. 80,000-100,000	5 ..	5¾ 6¾ xd
Cambridge Electric Supply Company, £10 Ord.	8 ..	12½-13½
Canadian General Electric Co., Common Shares	$100 ..	98-102
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100 ..	98½-.01½
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5 ..	3¼-4⅜
—— 4½ per cent. Cum Pref., 1-80,000	5 ..	3⅜-4⅛
—— 4 per cent. Debenture Stock, Red.	100 ..	96-99
—— "City Undertaking," 4½ p.c Cum. Pref., 1-40,000	5 ..	3⅜-3¾
—— ditto (1903) 40,001-80,000	5 ..	3¼-4¼
Chelsea Electricity Supply	5 ..	3¼ 4¼
—— 4½ per cent. Debentures	100 ..	102-105
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000 ..	—
City of London, Ordinary	10 ..	9½-1 ⅛
—— 6 per cent. Cumulative Pref.	10 ..	1 ⅛-1⅛
—— 5 per cent. Debenture Stock	100 ..	122-126
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs (all pd.)	100 ..	95 98
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1 630	£0 ..	£0-53
Corrubbs Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100 ..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5 ..	3½-4½
—— 5 per cent. Preference, 1-50,000	5 ..	4⅜-4¾
County of London Elec. Supply, Ordinary	10 ..	6½-7½
—— 6 per cent. Cum Pref.	10 ..	10-10⅜
—— 4½ per cent. Debentures Prov. Certs. All pd., Red.	100 ..	105-108
—— 4½ per cent. 2nd Debentures Prov Certs	100 ..	9 -9⅛
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5 ..	⅜-½
—— 6 per cent. Cum. Pref.	5 ..	1- ⅜
—— 4½ per cent. First Mort. Deb	100 ..	76-81
Electrical Development Co. of Ontario 5 per cent. 1st Mort. 20-year Gold Bonds, 10,751-15,750	— ..	75-78 p.c.
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm Pf., 1-30,000	5 ..	2½-2¾
—— 5 per cent Debenture Stock, Red.	100 ..	85½-89
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red.	100 ..	94-96
Folkestone Electric Supply, Ord., Nos 1-10 000	5 ..	4⅜- ⅜
—— 5 per cent. Cum. Pref., Nos. 1-10 000	5 ..	4⅜-5⅛
—— 4½ per cent. First Deb Stock, Red.	100 ..	96-99
Hove Electric Lighting, Ord., 1-13,000	5 ..	6½-7
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100 ..	101-104
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk., Red.	100 ..	32-36
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1 ..	1/16-3/16
Kensington and Knightsbridge Elec. Lt., Ord, 1-21,000	5 ..	8-9
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100 ..	98-102
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10½

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Name.	Amount paid. £	Last price. £
London Electric, Ordinary	5	1½-1⅝
—— 6 per cent. Pref.	5	3⅜-4½
—— 4 per cent 1st Mortgage Debenture Stock, Red.	100	89-93
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100	92-95
Metropolitan Ordinary, 100,001-200,000	5	5½-5⅝
—— 4½ per cent. First Mortgage Debenture Stock	100	102 .06
—— 4½ per cent. Cum. Pref.	5	4½-5
—— 5½ per cent. Mortgage Debenture, Red	100	86 91
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds 1935, C 1-1,000 ($100), D 1-3,000 ($500), M 1-4,000 ($1 000)	—	72-74 p.c.
Mexican Light and Power Co., Capital Stock	$100	36 38
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14,000 ($1,000)	—	79-81
Midland Electric Power Dis., 4½ p.c 1st Mort. Deb	—	95½ 98½
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009	5	6¼-6⅜
—— do., 57,010-75,000	5	6¼-6⅜
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid)	5	6¼-6⅜
—— 5 per cent., Pref., 1-57,009	5	5-5½
—— do., 75,001-87,500 (issued at 10s. prem., 4s. paid)	5	5-5½
Notting Hill Electric Lighting	10	10½ 11½
—— 4 per cent. First Mort. Debs. Nos. 1 500 (Reg.)	100	95-97
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	5½ 6
—— 4 per cent. Debenture Stock	100	95-97
River Plate Electricity Co., Ord., 1-119 687 & 120,501-120 507	1	9/16-11 16
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	⅝-1
—— 5 per cent. Debenture Stock, Red	100	95-98
Rosario Electric Co., 6 per cent. Cum. Pref., 1-20 000	5	4⅜ 5½
—— 6 per cent. Cum. 2nd Pref., 1-15,000	5	4⅞ 5⅜
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	96 98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	—	99-100 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5	½ 1½
—— 4 per cent. Debenture Stock	100	71-75
South London, Ordinary	5	2-2½
South Metropolitan Electric Light and Power, Ord.	1	½-⅝
—— 7 per cent. Cum Pref.	1	15/16-1 7/16
—— 4½ per cent. 1st Mort. Deb.	100	99 102
St. James's and Pall Mall, Ordinary, 101-20,080	5	7½ 8¼
—— 7 per cent. Pref.	5	6-7
—— 3½ per cent. Deb.	100	86-91
Urban Electric Supply Co., Ordinary, 8-30,007	5	1⅜ 2½
—— 5 per cent. Cumulative Preference, 50 001 80,000	5	1⅝-2⅝
Westminster, Ordinary	5	8-9
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	4⅜-5⅛

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine, 6 per cent. Cum Pref., 1-260,007	5	5 9/16-5 13/16
—— 10 per cent. Non-Cum. 2nd Pref., 260,008-280,007	5	7¼-7⅜
—— Permanent 6 per cent Debenture Stock, 1888	100	128-131
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	102-105
Barcelona Tramways, Ord., 1-20,000	10	—
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	—
—— 5 per cent Deb., Red., 1-600	100	—
—— 4½ per cent. Red. Deb. Stock	100	—
Bath Elec Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1	11/16 13/16
—— 5 per cent. Cum. Pref. Shares, 1-75,000	1	1316/-15/16
Birmingham and Midland Trams., 4½ p. c 1st Db. Stk., Red.	100	94-97
Blackpool and Fleetwood Tramroad	10	13⅜ 1⅞
Bombay Elec. Supply and Trams Co., 6 per cent. Cum. Pref.	8	7½ 8
—— 4½ per cent. Deb. Stock, Red.	100	94-96
Brisbane Tramway Invest., Ord., 1-75,000	5	3-3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4¼-4⅜
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	96-100
British Columbia Electric Railway Co., Ord Def.	100	128-133
—— Ord. Pref.	100	110 114
—— 5 per cent. Cum. Perpetual Pref. Stock	100	99 103
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	98-101
—— 4½ per cent. Vancouver Power Deb.	100	100-103
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	1¼ 1⅜
—— 6 per cent. Cm Pf., 30,0001-60,000	10	4¼ 4½
—— 5 per cent. Perpetual Debenture Stock	100	92-95
—— 4½ per cent 2nd Deb. Stock	100	73-77
Bueno Ayres and Belgrano Trams	5	4⅜-4⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	4⅜-5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4⅜ 5⅛
—— 5 per cent. Deb. Stock, Red.	100	105-115
—— Prov. Cert., all paid	100	103-105
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100	91-96
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100	99-103
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	98-103
Buenos Ayres Lacrcze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	91-94
Calcutta Tramways, 1-105,000	5	6⅛-7¼
—— 105,001-137,610	5	5 5½
—— 4½ per cent. 1st Deb. Stock, Red.	100	100 104
Cape Electric Tramways, Nos. 1-480,000	1	¼-⅜
City of Birmingham Tramways, 5 per cent. Cum Pref.	5	4¼-4⅜
—— 4 per cent 1st Mortgage Deb., 1-3 000 (1917)	100	96-99
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	4⅜-4¼ xd
—— 4 per cent. Deb. Stock, Red. 1985	100	98-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	93-97
Cork Electric Tramway and Lighting Co., Ordinary	10	13-14
—— 6 per cent. Cum. Pref.	10	12½-13⅜
—— 4 per cent. Debentures	100	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12½-13¼
—— 6 per cent. Pref., Nos. within 1-60,000	10	12⅜-13⅜
—— 3½ per cent. Mort. Debs., 1-3,000 Red	100	90-95
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100	97-100
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1,000	83 88
Imperial Tramways, Ordinary	all	18-19
—— 6 per cent. Cum. Pref.	all	14-14½
—— 4½ per cent. Deb. Stock	100	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30 001-60,000	5	⅝ 1⅜
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100	66-71
Kalgoorlie Electric Tramways, 1-250,000	1	1/16-⅛
—— 5 per cent. "A" Deb. Stock	100	89-93
—— 6 per cent. "B" Deb. Stock	100	74-78
Kidderminster and District Lighting and Traction, Pref.	5	10-10½
Lancashire United Tramways, Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	94-97
—— £296 500 2nd Mort. Deb. Stock	—	—
—— £83,330 Deferred Deb. Stock (all fully paid)	—	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1	¼-1¼
—— 6 per cent. Cum. Pref., Nos. 1-425 553	1	¼-1¼
—— 5 per cent. Mort Deb., 1-5,000 Red.	100	92-97
London (United Trys. (1901), 5 per cent. Cum. Pref.	10	7¼-8¼
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100	80-85

Name.	Amount paid. £	Last price. £
Madras Elec Trams. (1904) 5 per cent. Deb. Stk., Red.	100	96-99
Manila Elec. R.R. and Lightg. Corp., 5 p.c. 1st Lien and Coll Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000	88-92
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 201-21,625 and 23,436-25,000	—	4½ 5
—— 4½ per cent 1st Mort. Deb Stock, Red.	100	96-99
Metropolitan Elec Trams., Defd., 1 000,001-1 314 016	1	1/16 3/16
—— 5 per cent. Cum Pref., 500,001-1,000 000	1	13/16-15/16
—— 4½ per cent. Deb. Stock, Red.	100	93-96
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	—	79-81 p.c.
Milwaukee Electric Rail and Light, 5 per cent. 20-yr. Con. Mort Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 601-2,000 1922	100	101-103
New General Traction, 6 per cent. Cum. Pref., 1-10 000 and 34 001-74,000	5	¾-1⅛
Oldham, Ashton, and Hyde Tramway, Ordinary	10	2
—— 5 per cent. Cum. Pref.	10	8¾-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100	89-103
Potteries Electric Traction, Ordinary, 1-245.000	1	5/16-9/16
—— 5 per cent Cum Pref., 300,001-545 000	1	⅛-¾
—— 4½ per cent. Debenture Stock	100	93-96 xd
Provincial Tramways Co., Ordinary, 1-24,912	10	5-5½
—— 6 per cent. Cum. Pref., 1-10,000	10	10¼-11¼
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum Pref., 1-20,000	5	5-5½
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	97-99
Sao Paulo Tramway, Light, and Power Co.	$100	103-107
—— 5 per cent. 1st Mort. Deb., Red. 1929, 1-11,000	$500	91-93 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1	⅝-1⅛
—— 4 per cent. Deb Stock, Red. 1940	100	80-84
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs., Red., 1-1 600	100	84-88
Yorkshire (West Riding) Elec Tram. Co., Ord., 70,001-110,000	5	1-1¼
—— 6 per cent. Cum. Pref., 1-46,261	5	3⅛ 3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	84-87

Electric Railways.—

Name.	Amount paid £	Last price. £
Central London, Ordinary	100	57-60
—— 4 per cent. Pref.	100	83-85
—— " " deferred	100	4 -43
—— 4 p c Deb. Stock (Prov. Script Certs., fully paid)	100	101-104
City and South London, Consolidated Ordinary	100	43-45
—— 4 per cent Debenture Stock	100	100-103
—— 5 per cent. Pref. Stock '91	100	116-119
—— " " " '96	100	115-116
—— " " " '01	100	113-116
—— " " " '05	100	108-111
Liverpool Overhead, 5 per cent. Pref	10	10-10½
—— Ordinary, 1-50,000	10	3¼-4⅛
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	34-38

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price. £
Amazon Telegraph Co., 1-25,000	10	2½-3½
—— 5 per cent. Debs., Red., within 1-1,069	100	85-88
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78 000	$1 000	89 91
Anglo-American Telegraph Co., Ordinary	100	54-57
—— 6 per cent. Preferred Ordinary	100	96-98
—— Deferred Ordinary	100	14-14½
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100	99-102
Chili Telephone Co., 1-44,000	5	6⅞ 7¼
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100	85-87
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	6-7 xd
—— 10 per cent Preference, 1-6 000	10	15-16 xd
Direct Spanish Telegraph Co., Ordinary	5	3¼-3½
—— 10 per cent. Cum. Preference	5	8¼-8½
—— 4½ per cent. Debs., 1-600	50	98-101
Direct United States Cable Co.	20	13-13½
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100	100-102
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100	97½-100½
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8 000, 1913	25	98-100
Eastern Extension, Australasia and China, 1-200,000	10	12-12¼
—— 4 per cent. Mort. Deb. Stock. Perp.	100	98-102
Eastern Telegraph Co., Ordinary Stock	100	128-130
—— 3½ per cent. Preference Stock	100	88-89
—— 4 per cent. Mortgage Debenture Stock	100	98-101
Great Northern Telegraph Co. (of Copenhagen)	10	30½-32½
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1,200, Red.	100	99-10
Indo-European Telegraph Co.	25	52-55
Marconi's Wireless Telegraph Co., Nos. 255,128-284,190	1	⅜-½
Monte Video Telephone Co., Ordinary, 1-72,680	1	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492	—	¼-1
National Telephone, Preferred	100	106-108
—— Deferred Stock	100	103-105
—— 6 per cent. Cum. First Pref.	10	10½-12½
—— 6 per cent Cum. Second Pref.	10	10-12
—— 5 per cent. Non. Cum. Third Pref.	5	5¼-5⅜
—— 3½ per cent. Deb. Stock, Red.	100	96-98
—— 4 per cent. Deb. Stock, Red.	100	98½-100½
Oriental Telephone and Electric Company	1	1⅛-1⅛
—— 6 per cent. Cum. Pref.	1	1⅛-1⅛
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100	97-100
United River Plate Tele. Co., Ordinary, 1-100,000	5	7-8
—— 5 per cent. Cum. Pref., 1-40,000	5	5-5½
—— 5 per cent. Debenture Stock, Red.	100	—
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	98-101
West African Telegraph Co.	10	10-10½
West Coast of America, 1-30 000 and 53 001-53,008	2½	1¼-1⅜
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100	97 100
West India and Panama Telegraph Co., Ordinary	10	7/16-9/16
—— 6 per cent. Cum. 1st Preference	10	7-7½ xd
—— 6 per cent. Cum. 2nd Preference	10	6¾-7⅛
—— 5 per cent. Debs., Red., 1-800	100	99-102
Western Telegraph Co., 1-207,930	10	12⅜-12⅝
—— 4 per cent. Debenture Stock, Red.	100	98½-101½

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.							Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1907.	1906.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Nov. 20	1,135	1,140	- 4	— h	25½	25	May 31	64,071	15,530,351	1,379.723	0·98	11·14	2,512	6·45
Ayr Corporation	,, 17	1,019	965	+ 53	- 176	8	8	,, 15	14,528	3,316,380	353,945	1	9·71	1,830	5·16
Baker Street and Waterloo Ry.	,, 23	2 795	2,055	+ 740	+ 18,285	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 24	976	986	- 10	- 180	23·53	21·53	March 31	55,025	11,145,531	1,309,903	1·18	10·08	2,338b	6·03
Birmingham Corporation	,, 23	6 131	—	—	—	56½	—	,, 31	17,133	4,709,798	266,526	·86	14·5	8,866	—
Blackburn Corporation	,, 13	1,091	980	+ 110	+ 2,487	24	24	,, 25	48,875	8,661,720	986,953	1·35	11·89	2,036	7·44
Blackpool Corporation	,, 21	348	330	+ 13	- 1,315	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	Oct. 26	311	279	+ 32	- 1,139	16½	16½	Dec. 31	31,846	2,525,677	579,264	3·28	13 19	—	7·27
Bolton Corporation	Nov. 24	2 074	2,027	+ 47	+ 4,796	42	40	March 31	95 766	20,205,196	2,161,130	1·13	10·63	2,394	6·14
Bournemouth Corporation	,, 20	1,287	1,226	+ 61	+ 1,151	17·41	16·82	,, 31	55,276	10,058,288	1,121,623	1·32	11 83	3,22	7·19
Bradford Corporation	,, 23	4,114	4 147	- 33	+ 3,127	95	95	,, 31	230,085	47,108,000	5,053,392	1·172	10 927	2,396	—
Brighton Corporation	,, 21	687	753	- 66	- 2,972	9½	9½	,, 31	50,339	11,321,160	1,152,82	1·06	10·48	,914·8	8·0·4
Bristol Tramway Company	,, 22	4 559	4,656	- 97	—	51½	51½	Dec. 31	259,799	45,312,373	6,127,135	--	—	—	—
Burnley Corporation	,, 23	1,127	1,108	+ 19	—	40	40	March 31	57,992	11,092,704	1,197,772	1·31	11·61	5,388	8·17
Burton Corporation	,, 24	237	255	- 18	- 486	8½	8½	,, 31	17,950	3,878,269	454,082	1·07	9·21	2,0t 8	6·76
Cardiff Corporation	—	—	—	—	—	32·62	†32·26	,, 31	112,209	24,134,363	2,770,049	1·12	9·72	3,782	9·44
Carlisle Tramways Company	,, 23	153	153	+ 1	- 533	8·5	8·5	Dec. 31	10 713	2,935 002	359,756	—	7·14	—	5.18
Central London Railway	,, 23	5,901	6,825	- 924	- 16,878	6	6	,, 31	347,588	4,875,547	1,281,214	1·86	65·10	57,931	35·80
Charing X, Euston, & Hamp. Ry	,, 23	2,865	—	—	—	8	—	—	—	—	—	—	—		—
City and South London Railway	,, 24	3,325	2,914	+ 411	+ 9,194	6½	6½	,, 31	—	—	—	—	—		
Colchester Corporation	,, 6	191	191	1	--	8	8	March 31	10,588	2.457.553	220,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	,, 21	396	396	—	- 804	15½	15½	Dec 31	24,895	5,814,376	882,256	1·01	6·64	—	4·69
Croydon Corporation	,, 24	1,448	—	—	—	12 c	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 22	238	232	+ 6	- 11	7 23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	,, 23	158	183	- 25	- 1,095	4½	4½	,, 31	11,250	2 853,200	284,343	·94	9·49	2,500	—
Dublin and Lucan Electric Ry.	,, 22	89	92	- 3	+ 238h	6½	6½	Dec 31	6,358	402,511	113,738	3·79	13·78	942	7·33
Dublin U.T.	,, 22	4 675	4,591	+ 84	+ 30 930	48½	48½	,, 31	267,489	50,050,949	7,077,372	1·28	9 07	691	5 55
Dundee City Tramways	,, 20	1,095	—	—	—	22	22	May 15	52,154	13,086,396	1,005,911	·906	11·96	2,180	7·42
East Ham Corporation	,, 23	739	785	+ 14	- 90	14	14	March 31	56,652	3,689,658	863,816	·64	10 18	2,994	6 79
Glasgow Corporation	,, 16	17,248	16,243	+1,005	+12,605h	79½	79½	May 31	756,430	195,767,519	17,945,595	—	10·12	—	—
Gloucester Corporation	,, 20	225	229	- 4	—	15	15	March 31	15,465	3,902,077	563,595	·80	6·58	999	5·32
G.N., Piccadilly and Brompton	,, 23	1 885	—	—	—	9	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	37	37	,, 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 23	1 474	1,475	- 1	+ 2,613	35	35	,, 31	69,938	12,838,150	1.665,262	1·24	9·71	1,923	—
Hull Corporation	,, 23	2,459	2,318	+ 141	+ 1,388	26	26	,, 31	112,651	27,102,921	2,910,698	1	9·29		—
Ilford Corporation	—	—	—	—	—	10½	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 20	127	117	+ 10	+ 285	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	11,586	3,626,656	419,800	·737	6·62	1,480	5·22
Lancashire United Tramways	,, 20	1,178	959	+ 209	+ 13,859	39	38	—	—	—	—	—	—	—	—
Leeds Corporation	,, 16	6,354	6,074	+ 360	+ 9,413	89½	89½	March 25	298,233	64,223,666	7,121,038	1 10	10·02	351	—
Leicester Corporation	,, 23	2,024	2,067	- 43	—	42	42	Dec. 31	26,011	12 039,252	1,229,507	1	9·79	—	4 82
Liverpool Corporation	,, 16	10,781	10,428	+ 353	+ 8,458	104	104	,, 31	547 625	116,642 663	12,166 419	—	—	—	—
Liverpool Overhead Railway	,, 25	1,395	1,402	- 7	+ 1,777h	6·65	6·65	June 30	81,302	11.171,865	1,024,275	—	—	—	—
London County Council	,, 16	30 237	24,800	+5,437	+175,029	98	98	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 23	166	154	+ 10	- 33	6	6	Sept. 30	14,511	3,128,867	359,435	1·08	9·68	2,630	6·48
Maidstone Corporation	—	—	—	—	—	2	2	March 31	4,740	850,121	112,227	1·33	10 13	2,370	
Manchester Corporation	,, 23	13,657	13 347	+ 310	+503 273	149	149	,, 31	631,956	126,900,875	14,123,124	1·19	10·73	4,299	6·39
Metropolitan District Railway	,, 16	3,724	3,618	+ 106	- 331	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 21	15,627	15,571	+ 56	+ 6,019	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 23	127	129	- 2	- 18	2¾	2¾	,, 31	6,159	1,992,647	206,358	82	7 14	2,239	—
Newcastle-on-Tyne Corporation	,, 23	3,893	3,941	- 49	+ 634	50	50	,, 31	197,849	43,061,934	4,326,152	1·07	10·98	3,957	7·0
Newport (Mon.) Corporation	,, 23	611	522	- 29	+ 1,831	15½	15½	,, 31	30,356	7,252,535	783 435	—	9 29	—	6·4
Oldham Corporation	—	—	—	—	—	34	34	,, 25	65 553	13,466,245	1,504,740	1 16	10·45	1,886	—
Portsmouth Corporation	May 21	2,330	1 578	+ 752	+ 632	28½	28½	,, 31	95,702	19,625,329	197,499	1·17	11·63	—	—
Reading Corporation	Nov. 21	553	578	- 25	- 777	33½	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	11·29	21·29	,, 31	14,881	2,837,110	386,547	1·24	9·24	1,102	7·98
Rotherham Corporation	—	—	—	—	—	9½	9½	,, 31	23,569	5,251,472	593,054	1 07	9·53	2,612	7·49
Salford Corporation	,, 25	4,556	4,724	- 168	+ 4,405	70¾	70¾	,, 31	214,111	39,213,560	4,884,590	1·28	10·29	—	—
Scarborough Tramways Co.	—	—	—	—	—	4½	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 24	5,347	5,351	- 3	+ 9,132	35¾	35¾	,, 25	230,545	63 952,283	,049,899	·903	9 543	3,653	5·94
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,365	9 294,771	1,108,369	1·27	11·02	—	7 85
Southend-on-Sea Corporation	,, 20	264	252	+ 12	- 49	9	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	,, 31	39,550	6,766,031	1,027,730	—	9 23	—	4·75
Sunderland Corporation	,, 24	1,137	1,290	- 153	- 922	20	20	,, 31	64,858	15,364 463	1,495,685	1·004	10·36	—	6 37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	4,937	1,315,757	102,751	0·87	11 53	1,371	—
Torquay Tramways	Nov. 14	154	—	—	—	5 16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 23	712	755	- 43	+ 747	12 68	12·43	,, 31	43,607	7,995,451	862,12	9·27	12·14	3,13	7·50
Warrington Corporation	—	—	—	—	—	9	9	,, 31	17,0 7	4,418 225	403 363	—	9·85	—	6·33
West Ham Corporation	,, 14	2,085	2,090	- 5	+ 1,451	14·7	14 7	,, 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	,, 20	773	787	- 14	+ 256	20	20	,, 31	41,905	8,847,066	950,338	—	10·583	2,0	6·1o

† And 98 miles of interlacing track. a Train mile. b Per mile of single track. c Miles of route. h Half-year's figure k Double track.

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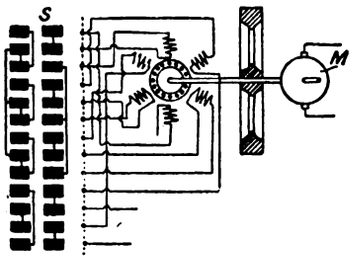
NOTES.

Private Bills in Parliament.—By last Saturday night, when the period for depositing at the House of Commons plans relating to private Bills to be promoted in Parliament in the session 1908 expired, 133 Bills had been deposited, divided as follows: railways, 14; tramways, 8; provisional orders, 65; miscellaneous, 46. Last year there were plans for 18 railway Bills, 9 tramway Bills, 43 miscellaneous Bills, and 88 provisional orders—making a total of 158.

Control of Transformers. — The Felten und Guilleaume-Lahmeyerwerke A.G., of Frankfort-on-Main, have introduced a device for controlling the motors of transformers consisting of combined dynamos and motors. In dynamo-electric flywheel machines, particularly motor-generators supplying current to motors for operating hauling and hoisting apparatus, the loss of energy due to the weight of the flywheel is considerably reduced, when operating at "no load," by running the motor of the motor-generator at a low speed, the motor being so constructed that it can be run at speeds varying greatly from one another. As shown in the figure, the speed of the motor is varied by altering the number of poles by means of the switch, S, the motor being run at the low speed



when the load on the generator, M, is light. The invention is applicable to buffer machines and the like.

Physical Society Exhibition.—At the exhibition to be held by the Physical Society on Friday evening, Dec. 13, from 7 to 10 p.m., at the Royal College of Science, South Kensington, the following firms will be exhibiting: Messrs. R. and J. Beck, Limited; Cambridge Scientific Instrument Company, Limited; Casella and Co.; A. C. Cossor; Crompton and Co.; Elliott Bros.; Everett, Edgcumbe, and Co.; Evershed and Vignoles, Limited; Clark Fisher and Wadsworth; Gambrell Bros.; J. J. Griffin and Sons; A. Hilger, Limited; Leslie Miller; Nalder Bros. and Co.; Nalder Bros. and Thompson, Limited; Newton and Co.; R. W. Paul; James Pitkin and Co.; Ross, Limited; Alexander Wright and Co.; and also the Meteorological Office. From the programme, of which we have received an advance proof, there appears to be many items of considerable interest to both physicists and electrical engineers. We understand that invitations have been given to the Institution of Electrical Engineers, the Faraday Society, the Optical Society, and the Röntgen Society. Admission, however, except to Fellows of the Physical Society, will be by ticket only, and, therefore, members of the societies just mentioned desiring to attend the exhibition should apply to the secretary of the society to which they belong.

Platinum in the United States.—From statistics of the platinum industry in 1906 presented by Dr. D. T. Day, of the United States Geological Survey, we gather that the production of platinum in the United States in 1904 was 200oz., valued at £832; in 1905 the production was 318oz., valued at £1,064; in 1906 the platinum production of the country amounted to 1,439oz., valued at £9,038—a fourfold increase in quantity and more than eightfold increase in value over the figures for 1905. Dr. Day calls special attention to the platinum placers of the South American Republic of Colombia, which, next to Russia, is the most important producer of the mineral. During 1906 a new concentrating apparatus to use the black sands was installed for the placer interests near Cariboo, Canada, and it is probable, he says, that this plant will yield a considerable output in 1907. The occurrence of platinum in copper-nickel ores in South-Western Utah and Eastern Nevada has also been reported, and two companies have begun development work on low-grade copper-nickel ores in the north-eastern part of Lincoln County, Nev. It is interesting to note that the imports for consumption of platinum into the United States during the calendar year 1906 were valued at £757,752, as against £434,725 in 1905, distributed as follows: unmanufactured, 1,267lb., valued at £78,198; ingots, bars, sheets, and wire, 10,227lb., valued at £642,026; vases, retorts, and other apparatus, vessels and parts thereof for chemical uses, £37,279; manufactures of, not specially provided for, £248.

Electrically-Operated Turntables.—The importance of the quick and reliable operation of the turntables in large stations has led to the frequent application of electrical driving to them in Germany, and some examples, constructed by the Lahmeyer Company, are described in a recent number of *Elektrische Kraftbetriebe und Bahnen*. In the case of small tables the motors are arranged to drive one of the travelling wheels through worm and spur gears, and if the table has been previously worked by hand gear this is usually left intact as a stand-by. In this way practically no interruption of the working of the table is necessary while installing the electrical gear. For the larger tables a small motor carriage is provided running on the outer rail of the turntable, and dragging the table round after it. The motor (about 8-h.p.) is enclosed in a watertight case, and is operated by a small reversing hand controller. A small electromagnetic brake, which comes into operation as soon as the motor is switched off, serves to bring the table to rest at any desired point. The most troublesome part of the electrical installation is the arrangement for leading the current in and out. A simple arrangement sometimes adopted consists in tapping off two overhead wires from the nearest arc lamp post, and carrying them to a revolving terminal support carried on a light girder erection over the centre of the turntable. The terminals are mounted on ball bearings, so that they turn readily as the turntable moves round, and do not attempt to drag the wires round. Sliding contact is made between the terminals and the turntable by means of two small collector rings. These rings are suitably protected against the smoke from the locomotives. In many cases underground mains are used, and then the connection between the supply and the turntable is made by means of two fixed slip-rings on which brushes, attached to the underside of the turntable, rub.

London County Council Tramways.—Among the Bills to be deposited in the coming Parliament is the London County Council (Tramways and Improvements) Bill, 1908. The proposals of this Bill have already appeared in detail in these columns, but we may repeat that they provide for the construction of about 4 miles 2½ furlongs of new tramways, of which about 2 miles 1 furlong will be double and 2 mile 1½ furlongs single lines. Certain street works, necessitated by the proposed tramways, are also to be carried out. As our readers will remember, many of the proposed new tramway routes are intended to connect up existing routes. It is, nevertheless, interesting to note that the present Council continues the policy of its predecessors in seeking to link up the tramways around

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the county boundaries. For example, the tramways ending at Hammersmith-broadway are to be extended to the county boundary at Harlesden on the overhead system, for which purpose the Highways Committee are recommending an expenditure of £20,500 (cable ducts and cable, £13,500; sub-station plant and equipment, £7,000) in order that a supply of energy may be obtained from the Greenwich generating station. Again, the Council propose to extend (on the overhead trolley system) the tramways from Wickham-lane, Plumstead, to the county boundary at Abbey Wood, in order to connect the County Council's tramways in that part of London with those of the Bexley Council. The cost of this latter work is estimated at £19,460, which includes £13,580 for trackwork, etc., £2,750 for overhead electrical equipment, and £3,130 for cables and cable ducts. Just outside the south-eastern boundary of London separate tramway systems are worked by the Dartford, Erith, and Bexley Councils, whose lines are adjacent, but between which there is no physical junction, thus preventing through communication. It is to be hoped that the extension of the London County Council tramways in that neighbourhood will help to foster a more conciliatory spirit among the neighbouring authorities, and hasten the establishment of mutual intercommunication.

Peak Load Difficulties.—Our New York contemporary, the *Electrical World*, draws attention to one of the many remedies which have been suggested for keeping down central-station peak loads. It has been suggested, says our contemporary, that illuminating engineering furnishes an admirable means towards this end. It is one of the fundamental principles of sound central-station business policy that the ratio of the peak to the average load be kept as low as possible; or, in other words, that the load factor be kept high. Certain classes of business which use energy many hours per day yield enough revenue to the central-station company to pay for operating expenses and the fixed charges on the investment necessary to serve them. Customers using energy only a short time per day are an unprofitable class, provided their demand comes at the time of peak load. In order to keep down the demand of this unprofitable class of business, which comprises mainly stores and offices which close early, it is proposed that the central-station company shall attempt to undertake such customers' installations so that they will get satisfactory lighting with the smallest possible demands, thus aiding to keep down the unprofitable portion of the central-station company's investment. Commenting upon this rather finely spun theory, the *Electrical World* considers that "it undoubtedly indicates a wise line of policy for a central-station company to pursue. It is not to be expected that the pursuance of such a policy will work any great changes in the company's load factor for several years, but the load factor of every central-station company certainly needs helping; and it is only by combining all the slight possible improvements that any change worth while can be accomplished." There is much difference of opinion as to the wisdom of such a policy on the part of electrical undertakers, and, on our part, we have our doubts whether in the present undeveloped state of illuminating engineering, in this country, at any rate, the appropriation of the business of electrical contractors by central stations will give any decided advantages. Nevertheless, some means of combination and mutual understandings between central stations and electrical contractors, aided by effective publicity work, might have the desired effect.

Royal Institution.—A general monthly meeting of the members of the Royal Institution was held on the 2nd inst., Sir James Crichton-Browne, treasurer and vice-president, in the chair. Miss Joyce Burton Buckley, Dr. L. Gottschalk, Mrs. Robert Home, Dr. D. G. Johnstone, Sir Edwin Ray Lankester, K.C.B, Mr. S. F. G. Osborne, and Miss E. A. Stoney, M.A., were elected members. Prof. L. J. Troost, Prof. A. Haller, and Prof. W. Victor were elected honorary members. The special thanks of the members were returned to Lord Sanderson for his donation of five guineas to the fund for the promotion of experimental research at low temperatures. The following are the lecture arrangements before Easter: Sir David Gill, a Christmas course of six illustrated lectures on "Astronomy, Old and New," adapted to a juvenile auditory; Dr. A. A. Gray, two lectures on "The Internal Ear of Different Animals"; Prof. F. J. Haverfield, two lectures on "Roman Britain—(*a*) Its Frontiers and Garrison, (*b*) Its Interior Civilisation"; Prof. W. Stirling, six lectures on "Membranes—Their Structure, Uses, and Products"; Dr. E. A. Wallis Budge, three lectures on "The Egyptian Sudan — Its History, Monuments, and Peoples, Past and Present"; Prof. W. W. Watts, two lectures on "(1) The Building of Britain, (2) Recent Light on Ancient Physiographies"; Major Martin Hume, three lectures on "The Story of the Spanish Armada"; Prof. W. Somerville, two lectures on "Wood, Its Botanical and Technical Aspects"; Prof. Sir John Rhys, two lectures on "Celtic"; Mr. R. T. Glazebrook, two lectures on "Physics"; Mr. R. Lydekker, two lectures on "(1) "The Animals of Africa," "(2) The Animals of South America"; Prof. Gisbert Kapp, "The Electrification of Railways"; Mr. Lionel Cust, two lectures on "Anthony Van Dyck"; Mr. Selwyn Brinton, three lectures on the "Art of Florence"; and Prof. J. J. Thomson, six lectures on "Electric Discharges through Gases." The Friday evening meetings will commence on Jan. 17, when Prof. T. E. Thorpe will deliver a discourse on "The Centenary of Davy's Discovery of the Metals of the Alkalis." Succeeding discourses will probably be given by Colonel David Bruce, Prof. E. Rutherford, Mr. Humphry Ward, Dr. C. W. Saleeby, Sir Oliver Lodge, Prof. W. A. Bone, Prof. J. Milne, Prof. A. E. H. Love, the Hon. R. J. Strutt, Lord Montagu of Beaulieu, Prof. J. J. Thomson, and other gentlemen.

Royal Society.—The anniversary meeting of the Royal Society was held last Saturday. Lord Rayleigh, O.M. (the president), in presenting his report, remarked that the work of the National Physical Laboratory had grown greatly during the year. The addition to the engineering building and the new building for metallurgical chemistry were completed and now occupied. A new 100-ton testing machine, one of Messrs. Buckton's latest patterns, had been installed, and the increased accommodation in the engineering laboratory enabled the work there to proceed more easily and rapidly. The completion of the work on the electrical units would be satisfactory to those who had been interested in this question. At the time of his own researches about 25 years ago, the ohm and the ampere were uncertain to 2 or 3 per cent., and he then scarcely hoped to get nearer than one part in a thousand. The recent work carried on at Bushey would seem to indicate that an accuracy of one part in 10,000 might have been attained. The Copley medal was awarded to Prof. Albert Abraham Michelson (foreign member) on the ground of his experimental investigations in optics. One of the Royal medals had been awarded, with the approval of his Majesty, to Dr. E. W. Hobson for his eminent contributions to mathematics and mathematical physics. The Davy medal was awarded to Prof. E. W. Morley for his work in the application of optical interferences and other physical phenomena to increase the accuracy of measure-

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ment. Prof. Wilhelm Wirtinger, of Vienna, was the recipient of the Sylvester medal. He was distinguished for the importance and wide scope of his contributions to the general theory of functions. The Hughes medal was awarded to Principal E. H. Griffiths, who, said the president, had conferred great benefit on physical science by his series of measurements of fundamental constants, mainly in the domain of thermal and electric energy. The Buchanan medal was awarded to Mr. W. H. Power for his services to hygienic science and practice. The following is a list of the Fellows elected into the council of the Royal Society for the ensuing year: president, Lord Rayleigh; treasurer, Mr. A. B. Kempe; secretaries, Prof. J. Larmor and Sir A. Geikie; foreign secretary, Prof. J. R. Bradford. Other members of the council: Dr. H. F. Baker, the Right Hon. A. J. Balfour, Sir William Crookes, Mr. F. Darwin, Sir G. H. Darwin, Prof. J. C. Ewart, Prof. D. Ferrier, Mr. C. T. Heycock, Prof. S. J. Hickson, Prof. J. Joly, the Hon. C. A. Parsons, Dr. A. Scott, Mr. A. C. Seward, Prof. F. T. Trouton, Dr. A. D. Waller, and Mr. W. Whitaker.

Units of Electricity.—A long research has been conducted at the Bureau of Standards, Washington, by Dr. E. B. Rosa and Mr. N. E. Dorsey, for redetermining the ratio of the electromagnetic to the electrostatic units of electricity. In an abstract of the results of this research the *Electrical Review* of New York states that in their report the authors discuss the comparative advantages of the various methods of determining this ratio which are available. A report on this matter, presented to the British Association in 1863 by Maxwell and Jenkins, says that there are five available methods. The first is by a common measure of quantity—that is, the measurement of the charge of a condenser and of a flowing current; the second by a comparison of the measure of E.M.F. produced by a battery; the third by common measure of resistance; the fourth by a comparison of currents, and the fifth by a comparison of capacity. The first method was used by Weber and Kohlrausch and Rowland. It does not involve the use of a resistance as do the other four, but the method is difficult and complicated. In the E.M.F. method no condenser need be employed. It has been used by a number of observers, and it is doubtful whether any great improvement can be made in the determination through this method. It requires, however, the knowledge of the unit of resistance, and it is difficult to measure accurately the electrostatic potential. The whole problem in the resistance methods lies in measuring the resistance in electrostatic units, and the difficulties are very great. The current method mentioned should really come under the capacity method, since it requires the determination of the capacity of a condenser. This method may be dismissed. The best of all the methods is the method of capacities. There are several ways of determining the capacity—by a ballistic galvanometer, by the steady deflection of a galvanometer, by the Maxwell bridge, by the differential galvanometer, and others. The conclusions the authors reach are, briefly, as follows: Of the four methods available, the quantity method is the most complicated and the least accurate. The E.M.F. method is better, but is likely to be more useful in determining the absolute value of the standard cell when the ratio of the units is taken as known. The resistance method is roundabout, and cannot be expected to give results as accurate as the remaining capacity method. Of the various ways of conducting tests by the latter, the Maxwell bridge and the differential galvanometer are the best; and by the use of several different forms of absolute condensers it is thought that thoroughly reliable results may be obtained without further use of the less direct and more difficult methods.

Electrical Speed Measurement on Motorcars. The introduction of electrical methods of speed measurement on motorcars has become very general, and a large number of different instruments has been tried. The indication must be that of the instantaneous speed, because the speed not only varies widely in amount, but does so within very short time intervals. The problem is further complicated by the excessive vibration to which the instrument is subject. Of the electrical methods employed, the earliest consists in generating a direct or alternating voltage proportional to the speed, and measuring this voltage on a suitable voltmeter calibrated to read speeds directly. In the more recent forms the functions of the generator and

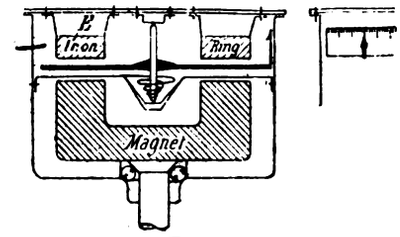

FIG. 1.

of the meter are combined in a single apparatus. An instrument of this type is described in *Elektrotechnik und Maschinenbau*, and shown in Fig. 1. It consists of a magnet rotated from the machine whose speed is to be indicated by a flexible shaft or other means. Above the magnet an iron ring is fixed, and between the two a thin metal disc is supported provided with a pointer and controlled by a spiral spring. When the magnet rotates eddy currents are set up in the disc and a torque is exerted on the latter, which consequently deflects the pointer against the action of the spring. In this way all current-carrying rubbing contacts are avoided, and the deflection of the pointer on a suitably calibrated scale gives the speed directly. The Deutsche Tachometer-Werke, Berlin, put a somewhat similar apparatus on the market.

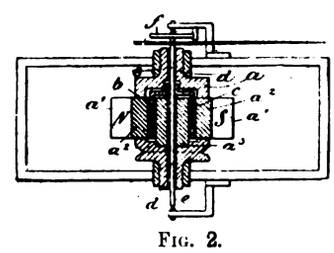

FIG. 2.

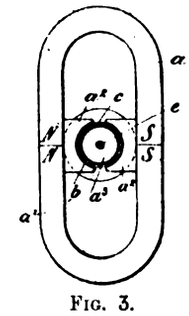

FIG. 3.

If consists, as shown in Figs. 2 and 3, of a horseshoe magnet, a_1, which is rotated together with an internal iron armature, a_3, and in the gap between the two a hollow metal body, C, is suspended. This body tends to rotate with the magnet owing to the induced eddy currents, and this motion is opposed by the spiral spring, f, so that for each speed a definite position is taken up by the pointer on the scale. The shape of the body, c, is such that practically the whole flux of the magnet is cut, thus giving a high torque, whilst hysteresis effects are avoided by rotating all the iron. The variable drag due to friction is avoided by suspending c by centres fixed independently of the rotating portion.

Northampton Polytechnic Instituto.—The annual prize distribution took place last Friday night in the presence of a large and distinguished gathering. The proceedings were presided over by Mr. L. B. Sebastian, chairman of the governing body of the institute, and the prizes and certificates were distributed by the Duke of

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Connaught. His Royal Highness remarked in his address that he could not help thinking that there was much truth in the statement often made that we were behind foreign competitors in technical education, but at present, he said, everybody was recognising that something ought to be done. The Northampton Institute appeared to him to be working on thoroughly sound lines, and he rejoiced to hear of the large number of students who came forward to take advantage of the opportunities given to learn their occupations on scientific lines and turn them to remunerative success. The Principal (Dr. R. Mullineux Walmsley) in his report pointed out that on the educational side the chief development of the 1906-7 session was the transfer of the technical optics department to the rooms of the British Horological Institute in Northampton-square, which had the double effect of increasing the accommodation for the technical optics department and also of relieving the pressure, by further increased accommodation, in the electrical engineering department. He referred again this year to the pressing need of increased accommodation, and explained that the instalments made in past years towards this end had been utilised: (1) For the establishment of an intermediate electrical engineering laboratory into which the students are drafted on leaving the junior laboratory before being admitted to the senior. The establishment of such a laboratory is believed to be unique in electrical engineering education (2) For extension of the instrument workshop, the size of which has been increased 50 per cent. (3) For the establishment of a standards and research laboratory in which the highest work of the electrical engineering department is carried on, and from which some important researches have already been issued. As regards enrolments of students, there was an increase to a total of 2,100, or over 6 per cent., in the individual day and evening students, and of 9 per cent. in the class entries of evening students, the total being 5,440. The increase was particularly marked in the engineering day courses. The student hours, upon which the maintenance grant of the London County Council is based, increased to 126,163, being an average of nearly 65 hours per student on the whole of the evening students enrolled, although these student hours only include the records of those students who have made not less than 20 hours' attendance during the session. The number of apprentices admitted constitutes over 36 per cent. of the total technical students, the figure being a minimum, as many students join without claiming the reduced fee to which they are entitled as apprentices, and, therefore, are not reckoned as such in the above figures.

The Diesel Engine.—In a paper recently read before the Rugby Engineering Society, Mr. A. E. Thompson dealt with the Diesel oil-engine, tracing the developments that have taken place in connection with it during the past 16 years, and winding up with some convincing figures relative to the economy of this form of prime mover, obtained from actual working experience. Mr. Thompson pointed to the facility and certainty with which the Diesel engine is started, and its ever readiness for duty, thus obviating stand-by losses. He compared the fuel consumption of a 140-kw. Diesel at full, three-quarter, and half loads with a 700-b.h.p. Nürnberg gas-engine, a 3,500-kw. Parsons steam-turbine, and a 250-i.h.p. high-speed double-acting steam-engine, which showed the Diesel to have a great advantage in the way of economy, it being (and according to the figures given by Mr. Thompson) 30 per cent. better than the gas-engine and producer, and 87½ per cent. ahead of the steam-turbine and boiler at full load, while at lower loads it still maintained its supremacy. Where the call for power is very varying—*e.g.*, in an electric lighting or tramway station—the efficiency of the Diesel engine asserts itself. Mr. Thompson quoted the economy obtained at the generating station—Yardley—of the City of Birmingham Tramways Company, Limited. The installation there consists of four 100-kw. double-cylinder Diesel engines direct-coupled to Brush generators. The equipment has been in use for more than three years, and the cost of fuel for generating one Board of Trade unit is 0·18d. Inclusive of all such items as works management, wages, depreciation, rent, etc., the cost is 0·362d., and this with a load factor as low as 33 per cent. At Sunderland, a 240-b.h.p. engine has been running for about three years driving a ropery. The actual figures taken over six months representing 1,201 working hours is 2s. 3d. per hour, and, owing to the exceptionally heavy freight charges, the fuel reaches a high figure per ton. That the owner of this engine is satisfied with its performance is instanced by the fact of his giving an order for another of 500 b.h.p. In order to illustrate the economy effected by the use of the Diesel engine, Mr. Thompson set out the comparative running costs for power installations of 35 b.h.p. and 100 b.h.p. respectively, working on several well-known systems. These figures cover a year's working and were based on 50 weeks of 54 hours each. They may be summarised as follows: (1) Electric motor, taking current from public mains at 1d. per Board of Trade unit—annual cost of running, 35 b.h.p., £300. 16s.; 100 b.h.p., £855. (2) High-speed non-condensing steam-engine and boiler, working with steam coal at 12s. per ton—35 h.p., £181. 13s.; 100 h.p., £358. 5s. (3) Gas-engines working on coal-gas at 2s. per 1,000 cubic feet—35 h.p., £175. 4s.; 100 h.p., £460. (4) Gas-engine working on producer gas, the raw fuel costing 30s. per ton—35 h.p., £119; 100 h.p., £294. 5s. (5) Diesel engine, using crude oil at 42s. per ton—35 h.p., £97. 4s.; 100 h.p., £247. 14s. When reckoning the power of Diesel engines it is assumed they will work at or about sea-level. To emphasise the importance of this point Mr. Thompson mentioned that an engine installed at 5,000ft. above sea-level had its power reduced about 20 per cent., while at 12,000ft. 50 per cent. Diesel engines, he said, would take an overload of 10 per cent. for many hours, and one of 20 per cent. for short periods. A recent test gave an oil consumption at full load of 0·38lb. per brake horse-power developed, and a mechanical efficiency of 80 per cent

Publications Received.—"Handbuch der Elektrischen Beleuchtung," by Josef Herzog and Prof. Clarence Feldmann (Berlin, N. Julius Springer, Monbijonplatz 3 Price, 20 marks). This useful handbook has now reached its third edition, and has been brought up to date by the incorporation of all the most important developments in electric lighting that have taken place within the last six years, the date when the second edition of the work was published.—Four books have recently been published by Messrs. Archibald Constable and Co., Limited, 10, Orange-street, Leicester-square, W.C., in their well-known "Westminster Series." These are "Liquid and Gaseous Fuels," by Prof. Vivian B. Lewes; "Town Gas and its Uses," by W. H. Y. Webber; "Coal," by James Tonge; "Electric Traction and Power," by F. H. Davies. With regard to the latter, the author explains in his preface that the book is intended to apply to members of such trades and callings to whom some knowledge of applied electrical engineering is desirable, if not strictly essential. It may also be useful to students, as it covers, with but small exception, purely practical ground. The book contains a glossary of electrical terms which will be useful to readers, as it explains concisely many technical terms and expressions as may reasonably be expected to be outside the sphere of such readers for whom the book is particularly intended. Each

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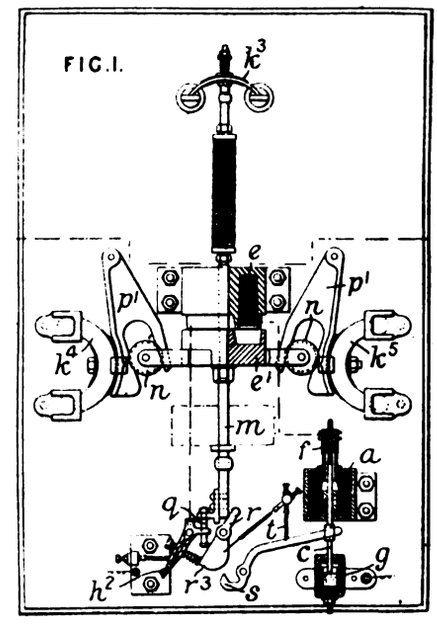
of the above-mentioned four volumes is published at 6s.—The November issues of *Science Abstracts* (Section A, Physics; Section B, Electrical Engineering) have just come to hand from the Institution of Electrical Engineers. Messrs E. and F. N. Spon, Limited, 57, Haymarket, S.W., are the publishers of this work, the price of which is 1s. 6d. net per section.—In the section devoted to mining and metallurgy of the November issue of the *Journal* of the Franklin Institute (Philadelphia), there appears an article on "Deflocculated Graphite," by Mr. E. J. Acheson. Among the other items of interest contained in the same issue is the report of the Committee of Science and Arts on the "Parker Steam Generator."—The following communications appear in the October issue of the *Transactions* of the Faraday Society, vol. iii., part 2 (published by the society at 82, Victoria-street, London, S.W. Price 10s. 6d.): "Contributions to the Chemistry of Gold," by F. H. Campbell, M.Sc.; "Reduction of Oxides, Sulphides, etc., by Metallic Calcium," by F. Mollwo Perkin, Ph.D.; "A New Pattern of Thermostat designed to Supply a Rapid Stream of Water Heated to a Constant Temperature," by T. Martin Lowry, D.Sc.; general discussion on "Hydrates in Solution": Mr. W. R. Bousfield, M.A., K.C., and Dr. T. Martin Lowry on "The Thermochemistry of Electrolytes in Relation to the Hydrate Theory of Ionisation"; Dr. James C. Philip on "Influence of Non-Electrolytes and Electrolytes on the Solubility of Gases in Water: the Question of Hydrates in Solution"; Dr. George Senter on "Discussion of Methods suggested for Determining Degree of Hydration"; Dr. Alex. Findlay on "The Stability of Hydrates as indicated by Equilibrium Curves"; discussion (Prof. W. A. Tilden, F.R.S., Mr. R. J. Caldwell, Prof. S. P. U. Pickering, F.R.S., Dr. H. Borns, Dr. H. J. H. Fenton, F.R.S., Mr. W. A. Davis). "On the Electrolysis of Salt Solutions in Liquefied Sulphur Dioxide at Low Temperatures," by Bertram D. Steele, D.Sc.—*Proceedings* of the American Institute of Electrical Engineers (No. 10, vol. 26. Price 50 cents) include papers on "The Comparative Performance of Steam and Electric Locomotives," by Albert H. Armstrong, and on "Constants of Cables and Magnetic Conductors," by Ernst J. Berg; also discussions on "Light from Gaseous Conductors within Glass Tubes—the Moore Light;" "Motor-Generators *v.* Synchronous Converters, with special reference to Operation on Long-Distance Transmission Lines;" "The Practicability of Large Generators wound for 22,000 Volts."

Switching Apparatus.—There is disclosed in a recently-issued patent specification a description of a switch invented by Mr. Geo. Wilkinson, Beech Mount, Harrogate, for putting transformers into and out of action in an electric distribution system according to the variations of the load. Switches putting the main transformers into full action close by gravity when the load increases sufficiently, and open by the pull of an electromagnet when the load decreases. For this purpose use is made of an ammeter and a controlling electromagnet which is energised by the ammeter, and in turn energises the main magnet. The controlling electromagnet also operates a latching lever for holding the switches in their open position. In the arrangement shown in Fig. 2 a supplementary transformer, 7, 8, in series with the main transformer, 5, 6, is normally held out of action by means of switches, k^3, k^4, which short-circuit its secondary and primary windings respectively. An ammeter or relay, 11^a, in the secondary circuit, 1, allows a weighted switch lever, 9, to make a circuit at 13 when the load decreases sufficiently. A small current is thus sent through a solenoid, *a* (Figs. 1 and 2), which draws down its hollow core, *f*, and makes contact at a mercury cup, *g*, completing a shunt circuit through the coils of a magnet, *e*, by which the switches are directly operated. Both the contact rod, *c*, and the mercury cup, *g*, are susceptible of independent adjustment relative to their mountings. The upward movement of the armature, e^1, of the main magnet, *e*, opens, by means of rollers, *n*, and slotted links, p^1, a double-pole switch, k^4, k^5, in the primary circuit, and, by lifting a bridging contact, k^3, open the secondary circuit also. When the armature, e^1, reaches the top of its stroke, a rigidly-attached shaft, *m*, which may carry a weight as shown in the dotted lines, acts by means of a



tail-piece, *q*, to open a switch, h^2, in circuit with its own actuating coils, *e*. Just before the current is cut off, a latch, *r*, falls automatically into place below the end of the rod, *m*, and is prevented from being forced aside under the weight of the released armature by the entry of a hook, *s*, into a notch, r^3, of the latch. The hook, *s*, is moved by the downward stroke of the core of the solenoid, *a*. At the close of these operations the parts assume the positions shown in Fig. 1. If the current through the ammeter, 11^a, subsequently increases sufficiently, the circuit of the solenoid, *a*, is broken, the hook, *s*, removed from its notch, r^3, by the action of a spring, *t*, the latch, *r*, freed, and the

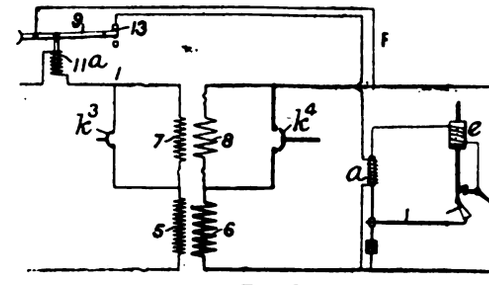


FIG. 2.

armature, e^1, thus allowed to drop. The switch h^2 closes immediately, but the circuit of the magnet, *e*, is kept open by the separation of the contacts, *c*, *g*. The fall of the armature, e^1, recloses the switches k^3, k^4, k^5, putting the transformer, 7, 8, out of action. The switching means may be utilised in other ways for controlling transformers in supply systems of the type described in this specification, as by switching transformers completely into and out of circuit. A three-wire distribution circuit may be controlled by the arrangement of switches shown in Fig. 2. The blowing of a fuse in the circuit of the primary of the supplementary transformer may be made to open the circuit of the solenoid, *a*, and cause the windings to be short-circuited.

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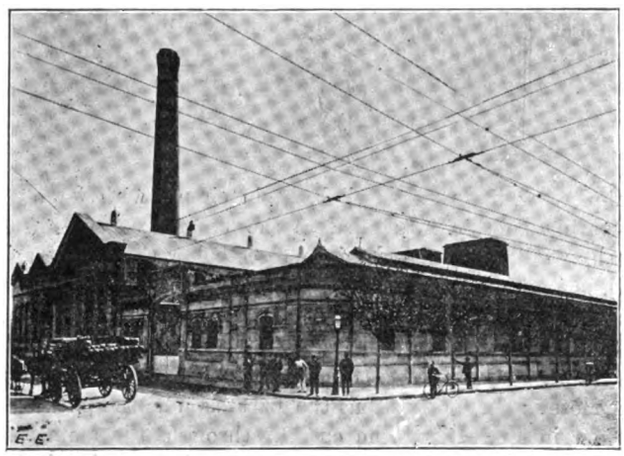
BUENOS AYRES TRAMWAYS.

The Lacroze System.

Buenos Ayres, which was founded in 1535, had in the year 1870 a population of some 180,000 inhabitants. To-day, according to official statistics, the population within the city limits exceeds 1,100,000. The rate of increase, due to natural causes and to immigration, amounts to doubling every 13 years. In a period of five years the increase is equivalent to the whole of the population of a large capital like Lima. Like most cities of relatively recent creation in South America, Buenos Ayres has had the advantage over older historical European cities, inasmuch as it has benefited, free of all experimental costs, by the latest improved inventions connected with public works.

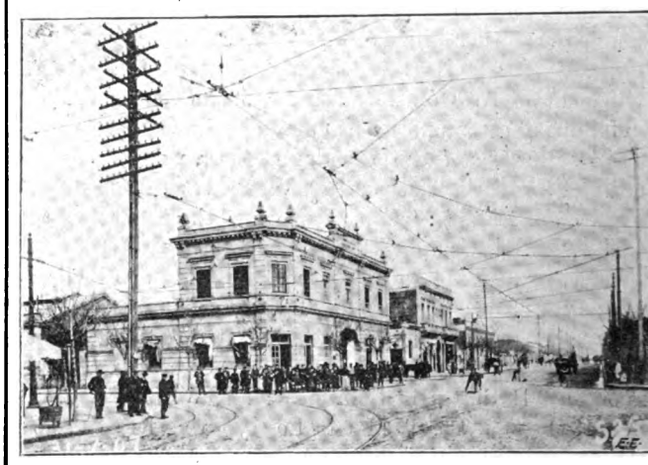
Among the public works of note may be mentioned the port with its four large docks for Transatlantic steamers, thoroughly up-to-date drainage and water-supply systems, and extensive railway networks connecting the capital with the fertile plains of Argentine and with the seashore, and interconnecting the eastern part of Argentine by intercontinental routes with Chile, Bolivia, and Paraguay. In addition, there is a large development in electric lighting and electric tramway undertakings. In fact, one of the greatest difficulties has been the meeting of the constantly-increasing requirements of the rapidly-growing country



Station at Cuyo and Medrano.

and capital for all kinds of public services. For instance, the port works, which were built but a few years ago, and were considered at that time amply large for many years to come, have been so congested of late that many hundreds of thousands of pounds have been lost to shippers and to the trade in general. However, at the present time a new scheme for considerable enlargements, involving an outlay of £5,000,000, is being actively pushed forward. Furthermore, the building of new approaches for the railways and of new stations, the paving of considerable extensions of new streets, the supply of drainage and water for large new areas, the increase of electric lighting, and the development of the telephone systems, are all now in full swing. The transportation of the populace within the city, and from the city to the suburbs, is also meeting with due recognition. That the traffic within the city itself is of great magnitude is proved by the returns of last year, which show a movement of over 200,000,000 passengers by the tramways alone. This great movement is explained by the considerable area covered by the city, which is equivalent to not less than two-thirds of that of London, and, consequently, greater than that of large cities like Paris, Berlin, Glasgow, Hamburg, Genoa, and Vienna. Due to this great extension, to the warm climate, and to the fact that the population prefers to ride even for very short distances, the needs of adequate transportation facilities have been particularly great. Even some years ago the horse tramway system was very considerably developed, amounting to some 280 miles. Owing to the disposition of the streets, which are on the American chessboard system, and to their narrowness, the tramway lines have been distributed all over the town in such a manner that practically not a single important street is without its line. In order to avoid congestion, the tramway traffic, as a rule, moves in one direction only. Every line, therefore, uses certain streets on its way out and different streets on the return journey.

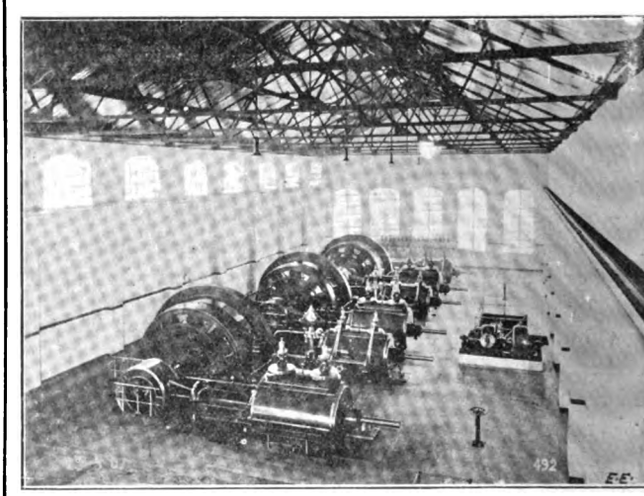
In the early nineties it was evident to the tramway owners that horse lines were no longer capable of meeting the demands made upon them, and accordingly the first



Lacroze Tramway Station at Medrano and Corrientes.

section of electric tramways was laid in 1897. Since that time practically all of the lines have been converted by various companies, mostly formed by English enterprise. The increased facilities afforded by electrification have, however, as usual, not diminished but increased the congestion. The Municipality, in order to ameliorate the conditions under which transportation is carried on, has decided to construct a vast system of diagonal avenues and of street widenings, for the planning of which the services of the eminent French architect of the city of Paris, M. Bouvard, have been requisitioned. This scheme when carried out will cost many millions of pounds, and will change the whole aspect of the city.

Among the various tramway systems of Buenos Ayres one of the most interesting is that of the Buenos Ayres Lacroze Tramway Company, the only native Argentine tramway company in the city, and the only line running a high-speed suburban service on American lines, with private



View of the Engine Ro m at the Tramway Station.

right-of-way and cars equipped for a maximum speed of 50 miles per hour. In 1905 a contract was placed with Messrs. J. G. White and Co. for the reconstruction and electrification of the old city lines under the name of the Buenos Ayres Lacroze Tramways. Being laid in the new portions of the city, the streets are wide enough to accommodate a double track. The work was commenced in March, 1906, and before the end of that year the new power-house, with a capacity of 2,250 kw., was in running order—an achievement which, considering the labour

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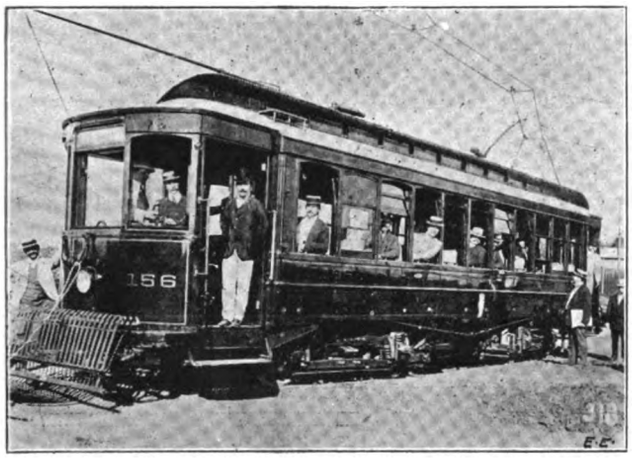
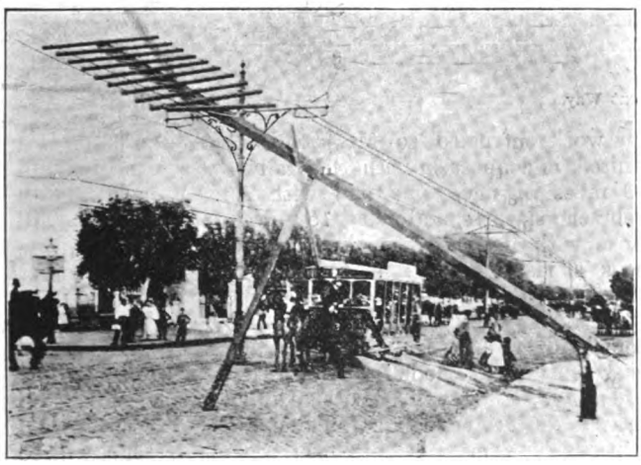
troubles and the port congestion, may well be considered a record for rapid construction. Part of the lines were opened formally to public traffic on March 10, 1907, and since that time the traffic receipts have increased beyond all expectation. The original lines consisted of 40 km. of track owned by the company and 10 km. held jointly with other companies and on lease. Messrs. J. G. White and Co. are now engaged in extending these lines a further 40 km., the franchise for which was granted by the Buenos



One of the Cars with Four-Motor Equipment.

Ayres Municipality in December, 1905, and for the purpose of serving these new lines another 750-kw. set is being added to the station.

In the track construction all the lines are laid to a gauge of 4ft. 8½in. The rails, manufactured by the German Steelworks Agency, Phœnix Mill, and the Société Anonyme des Acieries d'Angleur, of Belgium, weigh 87lb. per yard, and have the following specified chemical composition: carbon, from 0 45 to 0·55 per cent.; manganese, from 0 70 to 1·00 per cent.; silicon, not to exceed 0·10 per cent.; phosphorus, not to exceed 0·10 per cent.; sulphur, not to exceed 0 10 per cent. A test piece, having a sectional area equal approximately to half square inch, and with a length of 2in. between test gauge points, was prepared and tested. The ultimate tensile strength was not less than 40 tons per square inch, with an elongation of not less than 12 per cent. on a length of 2in. The tiebar holes were punched, and all other holes were drilled. The rails are laid on concrete

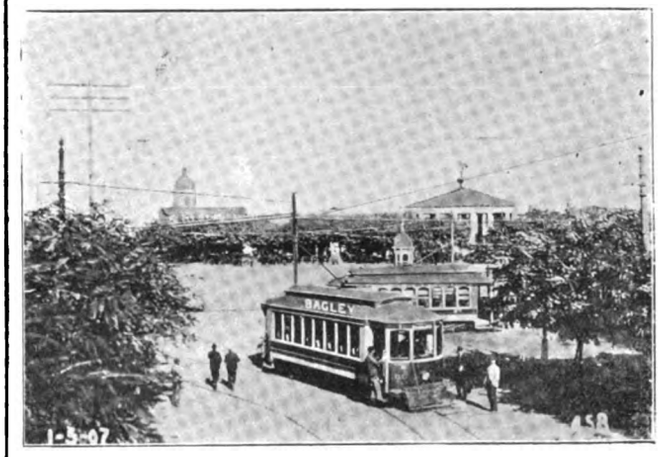


View showing Effect of a Storm.

stringers. The depth of the stringer is 6in. and the width 16in. The greater part of the paving has been executed with granite setts. The tiebars are of the Bayliss, Jones, and Bayliss pattern type, 2in. by ¼in., spaced at intervals of 3ft. 9in. Continuous joints, supplied by the Continuous Rail Joint Company of Great Britain, Limited, were used, 24in. long, weighing 77lb. per pair. All the special work for the track was supplied by Messrs. Hadfield's Steelfoundry Company, Limited, and the United States Steel Products Export Company. The rails are bonded by two concealed bonds, 4/0 B. & S. gauge. The gradients offer no difficulties, since the track is practically all laid on the level. The radius of the sharpest curve is 45ft.

The overhead equipment consists of side poles with span-wire construction, centre poles, side-pole construction with bracket arms, and a few rosettes. The poles are made, to the British standard specification, of steel, 30ft. in length, in three sizes, and were supplied by Messrs. Stewarts and Lloyds, Limited. The trolley wire is 2/0 B. & S. gauge copper, with a height of 20ft. 6in. from the ground, and was supplied by Messrs. Edward Le Bas and Co. The section boxes were supplied by Messrs. Estler Bros.

The power-house is situated at the corner of Medrano and Cuyo, the building being of massive brick construction with an exterior plastering usual to the country. The buildings comprise an engine-room, 58m. by 17m.; a boiler-house, 40m. by 9½m.; and a coal storage of the same size, representing a total area of 1,806m., and with room for considerable extensions. A massive brick chimney has been built, its height being 47·50m. In the engine-room are installed three 1,100 i.h.p. horizontal, cross-compound engines by Carels Frères, Belgium, constructed after the Sulzer patent. These each drive direct a 750-kw. compound-wound, direct-current generator by the General Electric Company, New York, U.S.A., giving 550 volts at 115 r.p.m. The consumption of the engines averages 22lb. of steam per kilowatt-hour, with a load factor approximately 40 per cent. Each engine has its own condenser,



One of the City Cars.

of the "Contraflo" type, by Richardsons, Westgarth, and Co. The air-pumps are of the Edwards type, independently driven by steam-engines supplied by Allen and Co. Worthington centrifugals are used for circulating pumps, each being capable of dealing with 1,000 gallons per minute, and are driven direct by Brown-Boveri motors. The switchboard is located at the end of the engine-room, facing Cuyo, and is of the railway type by the British Westinghouse Company, and at the present time consists of 14 panels, which comprise three generator, three negative booster, six feeder, a Board of Trade, and a lighting panel, the panels being of marble, and are equipped with all the necessary instruments for a safe and rapid handling of a large traction load. At the present time one 60-kw. negative booster by the Electric Construction Company is installed. A 25-ton crane by Carrick and Ritchie traverses the engine-room. The water for condensing purposes is cooled by two natural-draught cooling towers, which are wood, the interiors being supplied by Richardson, Westgarth, and Co., whereas the materials for the shells were procured locally, each tower being capable of cooling 66,000 gallons per hour.

In the boiler-house are installed, with room for extensions, five marine-type boilers by Babcock and Wilcox. These are fitted with their well-known superheaters, having a heating surface of 630 square feet. Each boiler is capable of evaporating 12,000lb. of water per hour, the grate area and heating surface being 49 square feet and 2,480 square feet respectively. The three feed pumps installed are of the Worthington duplex type. A Wheeler feed-water heater capable of utilising all the steam from the auxiliary

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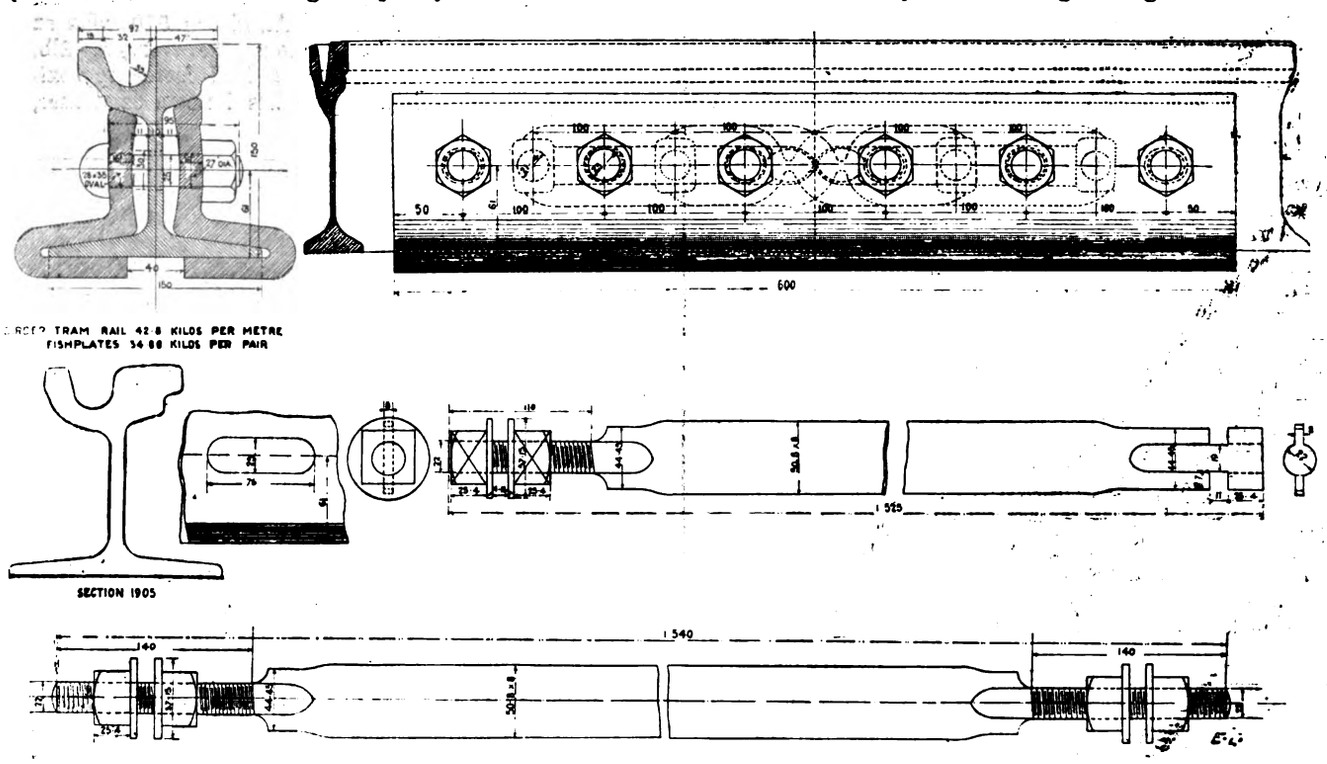
plant is installed, and there are also a Paterson condensation water purifier and grease eliminator. In the coal store an electrically-operated overhead Temperley transporter with a Hone's grab has been fitted, and in the power-house yard there is an Avery 20-ton weighbridge for coal weighing purposes. The water supply is taken from a well on the premises by a treble-barrelled deep-well pump, electrically driven, by Hayward-Tyler and Co. A supplementary supply can also be taken from the city supply.

The feeders have been supplied by Callender's Cable and Construction Company, Limited, and are paper-insulated, lead-covered, and are drawn into Sykes's patent stoneware conduits. There are three car-sheds — one being at Medrano, alongside the power-house; the other two are respectively at Chacarita and Palermo.

The rolling-stock for city purposes will consist of 140 cars of the semi-convertible type, the cars being supplied by the J. G. Brill Company. Their construction allows the car to be completely shut in during bad weather, whilst at other times it is practically an open car. There is seating accommodation for 32 persons; the seats are upholstered in cane. The tops of the windows on each side of the car are made in accordance with the Brill patent. The glass of the windows is of good quality and set in rubber.



Details of Permanent Way.

The car doors are of the mutually operating double sliding type. The platform at each end of the car can be entirely closed if desired; it is in the form of a vestibule, having three drop windows in front and two-leaf folding doors on either side, as well as a sliding metal gate. The roof is of the monitor deck pattern, with eight ventilator sashes on each side, and operated by four ventilator openers, one in each corner of the car. Two electric fans are also fitted, and the cars are well lighted. The wood employed inside for the doors, linings, and mouldings is mahogany, while the ceiling is decorated with three-ply birch veneer. The cars are tastefully painted cream and green outside with trimmings of solid bronze. The electrical equipment comprises two 40-h.p. motors, supplied by the British Westinghouse Company, capable of maintaining a speed of 15 miles per hour.

In addition to the city cars, there will be at first 10 interurban cars, the only difference being that these are larger, seating 44 people, and that the electric equipment comprises four 50-h.p. motors. With these it will be possible to maintain a speed of 40 miles per hour. These cars will operate on the city lines, passing on to the steam line at Chacarita, and running through Lynch to the important suburb of San Martin. Electric locomotives will also be used in connection with the heavy goods department—a large and increasing business. Dick, Kerr, and Co., Limited, are supplying the locomotives, the type used being the central cab, mounted on two four-wheeled bogies, the electrical equipment comprising four 50-h.p. motors, capable of hauling a train of 50 tons at 20 miles per hour. These locomotives will haul the freight trains of the Ferro-Carril Central de Buenos Aires and the Entre Rios Railway from Chacarita to the goods station at Once and to the market. Mr. C. E. d'Ornellas acted as superintendent in charge of the above work for Messrs. J. G. White and Co., Limited.

Partly as an outgrowth of the electrification of the Lacroze city tramways, the Ferro-Carril Central de Buenos Aires (formerly the Tramway Rural à Vapor) is reconstructing its short branch to the large suburb of San Martin, and is equipping the entire line from San Martin to Chacarita terminal (about 11 km. of double track) for a high-speed electric service, which will be operated by the tramways company. By a contract with the Lacroze Tramways Company, dated March 29, 1906, running powers were granted over the lines of the latter company from the Chacarita Station to the goods station at the Once, and to the Mercado de Abasto Proveedor, the Covent Garden of Buenos Ayres. The engineering and construction work entrusted to Messrs. J. G. White and Co., Limited, in connection with this railway consists of about 100 miles of main line laid with 70lb. Vignole rail on quebracho sleepers, and about 16 miles of sidings and yard tracks with lighter rails, also the necessary waiting and goods sheds and stations to be erected. The longest bridge is 60m. in three spans—two of 10m. and one of 40m. The Lynch repair shops, situated at Lynch, about midway between Chacarita and San Martin, are being entirely remodelled and fitted with up-to-date machinery. They will consist mainly of a machine and erecting shop, a smithy, a foundry, and a carpentry and paint shop. Complete buildings for general stores will be erected, as well as the necessary storage accommodation for locomotives and rolling-stock, distributing yards, etc.

The Ferro-Carril Central de Buenos Aires has secured from the National Congress a concession for a further extension from Rojas north-westwards to Villa Maria, about 300 km., and a further application has been made for a concession to build a small port at Zarate.

Melbourne (Australia).—Plans are being matured for the electrification of several of the suburban railways of Melbourne. These are State lines having a large passenger business.

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LEEDS ELECTRICITY SUPPLY AND TRAMWAYS.

The question of combining the electricity supply and tramway departments in Leeds is very acute at the present time. The proposal to join these two large undertakings under one committee and one management was broached when the new committees had to be appointed in the middle of November. The following report of the proceedings appeared in the *Bradford Observer*:

The Labour Party and the Committees.

Considerable time was spent in the appointment of these committees. Alderman Sir JOHN WARD moved the election of a Tramways and Electricity Committee. Hitherto the tramways and the electric lighting undertaking had been controlled by two committees, and Sir John explained that the proposed combination was in the interests of the city.

Labour members, in objecting, remarked that the alteration should not have been made without the Council being consulted.

Mr. BADLAY urged that the resolution could not be put, as no notice had been given of the appointment of two separate committees, and the contention was upheld by the town clerk.

In answer to Alderman Kinder, the TOWN CLERK said that the gentlemen elected on the Tramways Committee could also be chosen on the Electricity Committee, and this advice was followed at a later stage of the proceedings.

Alderman BUCKLE considered that the Labour party had been snubbed in not having been consulted in regard to the constitution of the committees.

Alderman E. MATHESON hoped the Electricity Committee would not be regarded as a sub-committee of the tramways.

Mr. R. A. SMITHSON replied that there was not the slightest intention of losing the services of the members of the Electricity Committee, and especially those of Alderman Matheson, whose work on that committee they all appreciated, but that it was thought desirable, in the interests of the city, to amalgamate two committees which were dealing with the supply of electricity. Any proposed changes of management which might or might not emanate from the joint committee would have to come before the Council.

Alderman C. H. WILSON said that the Conservatives had not received a single request from the Labour party as to the constitution of the committees. There was nothing in the complaint—the speeches of "indignation" were so many appeals to the gallery. The friction between the Tramways and the Electricity Committees had been a crying evil, and the proposed amalgamation was a proposal in the interests of the city as a whole.

Mr. CONNELLAN considered that the control of the tramways was quite sufficient for one committee without taking on the work of the electricity department.

Alderman KINDER mentioned that on the last budget day he foreshadowed some such change as has been proposed. It had been fairly obvious to every member of the Council except the Labour party that there were great advantages to be gained from amalgamation of the two committees. For instance, a cable was required from Leeds to Bramley for lighting purposes, and another for tramway purposes. Certain members said one cable would do for both and others that it would not, and the two committees had been warring with each other on the point. "We say," said Mr. Kinder, "that the same gentlemen shall settle this matter. It is an instance of how from £16,000 to £20,000 can be saved to the city."

Sir JOHN WARD was satisfied that amalgamation would mean a great saving, and said other cities and towns had seen the wisdom of making a similar change.

The motion for the appointment of a Tramways Committee was carried.

The opinions of Alderman Matheson, the chairman of the Electricity Committee, on this subject are contained in the following letter:

LEEDS ELECTRICITY AND TRAMWAYS DEPARTMENTS.—THE PROPOSED AMALGAMATION.

To the Editor of the *Yorkshire Post*.

Sir,—The attention of your readers may have been drawn to this subject by the extract given in the *Yorkshire Evening Post* of the 28th ult., from a protest made by an engineering journal against the amalgamation of the two committees. In view more particularly of the editorial statement that such amalgamation is to "put an end to the constant friction which has taken place between the two committees," I, who have occupied the position of chairman of the Electricity Committee for the last three years, feel constrained to lay the position before the Leeds ratepayers in the baldest possible outline, so that they may judge of the situation.

There was in Leeds, before my advent on the scene, a difference of opinion between the two committees as to which of them should supply the high-tension energy for certain of the outlying districts of the city. The Electricity Committee claimed that as there was already existing in the city a large and quite modern high-tension system—viz., that at Whitehall-road—it was very undesirable, from the city's point of view, as well as for financial and engineering reasons, that a second high-tension system should be started. This view, backed up by all engineering experience, was contested by the Tramways Committee, who proceeded to lay down the nucleus of a second high-tension system of a different kind at their Crown Point works, involving considerable expenditure.

This plant was necessarily of a character suitable for tramway purposes, but cannot be adapted for lighting and power purposes except by means of a costly method of transformation. Indeed, it may be likened to establishing a new gauge of railway or tramway, involving costly transhipment where the two lines come in contact. There was an arrangement come to which the Electricity Committee claim was not carried out. This, then, in a few words, has been the matter of difference between the two committees. How has such friction been dealt with? After a number of joint meetings of representatives of each committee, it was finally suggested by the Electricity Committee that a convenient and short way out of this difference of opinion would be the nomination of some outside expert who should give the Corporation an independent opinion on the whole subject. To ensure an impartial expert, it was suggested that he be chosen, not by anyone in Leeds, but by the president of the Institution of Civil Engineers, and the proposal of the Engineering Committee in this regard appeared on the summons for the Council meeting of June last. However, on representation being made that the intervention of an outsider was undesirable, and that an amicable settlement could be otherwise obtained, a definite agreement was reached, which was confirmed in writing by myself and the chairman of the Tramways Committee, that, taking into account that the tramways had, wisely or unwisely, installed the second plant above referred to, that each department should do its own work—viz., that the Electricity Committee should supply entirely the requirements for lighting and power, and the tramways department the requirements for tramways in these outlying districts. On this condition, I accordingly withdrew my resolution for an independent expert.

I ask any business man to imagine my feelings when at the following Council meeting the whole question was opened up afresh, supported by the very chairman of the Tramways Committee who a week or two earlier had agreed on the matter with me, and by whose agreement with me the resolution for an expert was got out of the way. It was again proposed that the tramways should impose their undesirable and unsuitable system on the electricity department. The next step was the proposal for the amalgamation of the two committees, which was arrived at, be it noted, unknown to myself till the evening of the day preceding the Council meeting of Nov. 9, and, so far as I am aware, unknown to my deputy chairman or the members of the Electricity Committee until the last moment.

In such indecent haste was this matter sprung on the Council that, on its being shown that the requisite notice had not been given, the resolution could not be submitted, but instead two committees, consisting of the same members for each, were appointed, as a tentative method of ensuring the amalgamation, having as chairman and deputy chairman of each the same gentlemen who were respectively chairman and deputy chairman of the late Tramways Committee!

Following on this a meeting is officially summoned of the Electricity Committee, which is styled "Tramways Sub (Electricity)," an action which, in view of the Council having appointed the Electricity Committee as a separate entity, is surely a high-handed proceeding in anticipating a change which, though eagerly desired by the Tramways Committee, is not yet authorised. The late Tramways Committee, that had opposed the proposal for an expert, treated as waste paper their own chairman's written agreement as to each committee doing its own work, yet, as though to insult my late committee, the strange and, to my mind, un-English method is resorted to of appointing as chairman and deputy chairman of the Electricity Committee the very gentlemen with whom we differed, and who are at the same time chairman and deputy-chairman of the two committees! In regard to the assertion that there is friction between the two committees, I would have the ratepayers know that no desire for friction has been shown by the electricity department, who sought only the best method of serving the financial interests of the city, and I would ask them to closely follow a movement which has advanced step by step during the last few months, and which has evidently necessitated a haste that is unusual and improper, and the full object of which, whatever it may be, is not yet entirely disclosed.—

Yours, etc.,
EWING MATHESON.

Leeds, Dec. 2.

In view of this radical change at Leeds, we thought it worth while to make a special visit to the city and to ascertain first hand the history of both the electricity

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and tramway undertakings. Through the courtesy of the officials in charge, we were given every facility for our inquiries, and we found that both the undertakings were in a flourishing condition, due to the energy of Mr. Harold Dickinson and Mr. J. B. Hamilton respectively.

Electricity Undertaking.

The Yorkshire House-to-House Electricity Supply Company started the undertaking for the distribution of electrical energy in Leeds which is now owned by the Corporation. The company was bought out in 1898, and since then has been considerably extended. The system of supply has been altered by Mr. Dickinson from single-phase to two-phase alternating, with satisfactory results. For instance, the load factor has been increased from 11·28 per cent. in 1900 to 17·37 per cent. last year. With this improvement in load factor and increase in the output from the works, there has been a large decrease both in the cost of production and in the price charged. In order to show how Leeds stands with respect to other large towns in the consumption of electricity we have prepared the following Table II., which shows the electricity used last year for other than tramway purposes. Leeds with its 24·6 units per head of population stands well up in the list.

TABLE II.

Town.	Population.	Units sold deducting tramway load.	Units per head of population.
Bradford	288,500	6,756,000	23·4
Edinburgh ...	336,600	12,914,119	38·5
Glasgow	800,000	21,536,425	28·2
Leeds	465,500	11,368,956	24·6
Liverpool.....	704,100	11,722,011	16·7
Manchester...	698,300	25,400,438	36·4
Salford.....	221,000	3,122,831	14·1

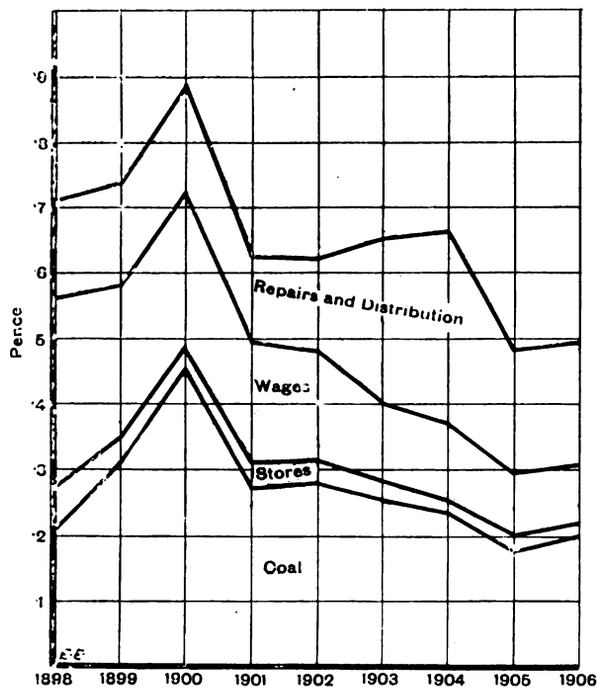

FIG. 1.—Curves showing the Costs per Unit Sold in the Leeds Corporation Electricity Works for the last nine years.

The figures showing the cost of production per unit sold are given in Fig. 1. From these curves the various details, such as coal, stores, wages, and repairs, can be seen, and, as is well known, Mr. Dickinson has frequently secured the blue ribbon amongst station engineers for his economic production of electricity.

In Fig. 2 the progress of the undertaking can be followed in curve form much more readily than if long extracts were reproduced from the annual balance-sheets. The increase in the units sold shown in this diagram indicates that the department has been pushed commercially, and that Mr. Dickinson's energies have not been confined to the central station. The reduction in the average price obtained shows that the consumers, indeed, have been always given reductions in the charges immediately they have been warranted. The annual profits have been small. Thus, in 1901 the surplus was £3,170; in 1902, £1,383; in 1903, £3,430; in 1904, only £282; in 1905, £3,527; and last year, £3,407. The Leeds Corporation ends its financial year in March, but we in all the curves for both

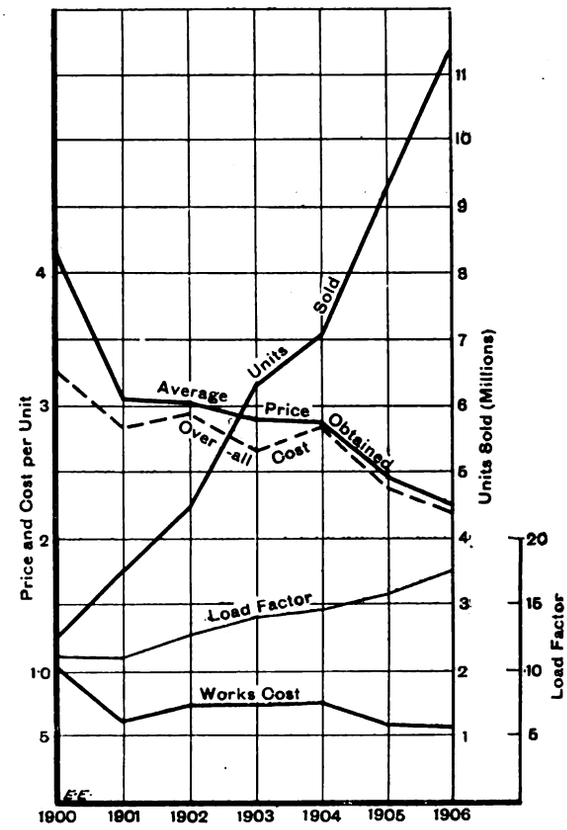

FIG 2.—Progress Diagram of the Leeds Electricity Supp'y Undertaking. The curve for works cost includes rent and rates.

undertakings put the figures for the year ending March, 1907, under 1906.

In Fig. 3 the curves show the policy of the Leeds Electricity Committee for the past seven years. This has been to give electricity to the inhabitants at so little over

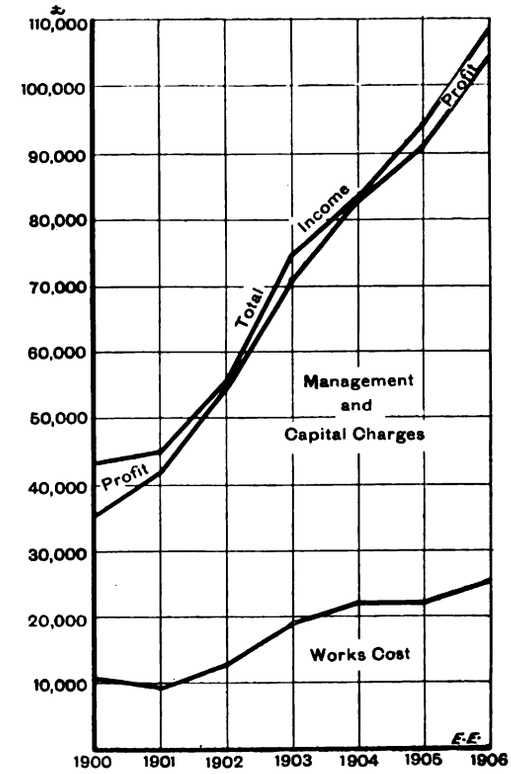

FIG. 3.—Income and Costs Curves for the Leeds Corporation Electricity Works.

cost price that the department is assured against loss, but makes no appreciable profit. Again, to still further improve the stability of the undertaking, the committee during the last year spent £14,272 out of revenue on what they termed extraordinary renewals. For this sum they

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replaced three engines and dynamos by larger and up-to-date plant. In the previous year one 200-kw. engine was replaced at a cost of £3,494. These figures and curves show that the policy of the committee has been that which we have always laid down as the correct guide for municipal trading—*i.e.*, that the supply should be at cost, and that the undertaking should not be used to relieve rates.

Tramway Undertaking.

The tramways at Leeds were owned by the Corporation before the electrical supply undertaking was purchased, and when the electrification of the trams was decided on the Corporation put down a power station to supply the tramways with direct current. This current could not have been obtained from the then House-to-House Company without the interposition of transforming apparatus to convert single-phase alternating-current electricity into continuous current. Mr. J. Burbridge was the first tramway manager, and the electrification of the lines was carried out under the advice of Messrs. Hopkinson and Talbot as consulting engineers. Mr. J. B. Hamilton was appointed general manager of the undertaking in 1902, and the accompanying curves show that under him the undertaking has flourished exceedingly.

Curve Fig. 4 shows the cost per unit of generating electricity at the tramway power-house. In comparing this curve with the similar one for the electric lighting station, it must be remembered that the tramway power-house costs

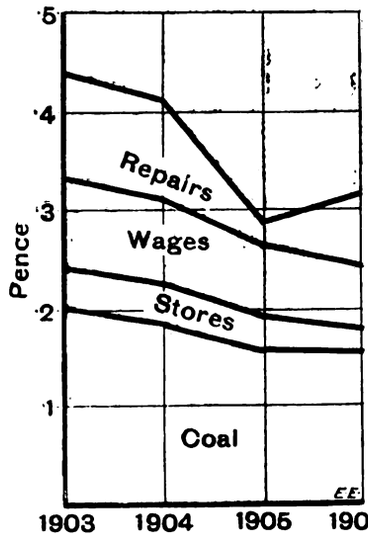

FIG. 4.—Details of Cost per Unit Generated at the Tramway Power House.

are per unit generated and those for Mr. Dickinson's station per unit sold. Hence these curves, from the published records, do not afford a proper basis of comparison, for the very good reason that these records are not compiled on identical lines, and that the two works are run under vastly different conditions of load factor. The electric lighting works have quite a modest "supply" load factor of no more than 17 per cent., which in their case is equivalent to a "generating" load factor of 23 per cent. On the other hand, the tramway station has a "generating" load factor of 37 per cent. A high load factor is a very important accessory to economical working, and its influence is felt on all the items of cost.

Then, again, the costs of the electric lighting department are determined by the number of units delivered to the consumers after deducting all losses in transmission, transformation, and distribution, whereas the costs of the tramway station are on units generated. An equitable comparison, therefore, demands the calculation of the costs on generated units in both cases. The generated output in the case of the tramway station is as under: for traction, etc., purposes, 12,750,319 units; for other purposes (depôt lighting, etc.), 497,462 units—total, 13,247,781 units. The traction maximum load was 4,070 kw., so that the generating load factor works out at 37 per cent. The generated output of the electric lighting works may be calculated on the basis of a 75 per cent. efficiency—that is, allowing 25 per cent. for high-pressure transmission, transformation, and distribution—thus the figure becomes

$$11{,}368{,}956 \text{ units sold} \times \frac{100}{75} = 15{,}158{,}600 \text{ units.}$$

The lighting maximum load was 7,470 kw., so that the generating load factor is fixed at 23 per cent. A further adjustment is demanded by the fact that the electric lighting accounts cover the distribution costs, which are known to be a pretty substantial item in electric supply, and these, of course, find no place in tramway generating records, the only items of expense in this direction being feeder and sub-station maintenance. The official accounts of the two departments, however, enable these adjustments to be easily made. We have made these adjustments, and our view of the comparative values of the generating costs of the two departments is expressed by the subjoined table:

GENERATING COSTS AT LEEDS.

Item.	Electric lighting works.	Tramway works.
Coal	£9,638 = ·15d.	£3,728 = ·16d.
Oil and stores	795 = ·01d.	1,135 = ·02d.
Wages	3,635 = ·06d.	3,352 = ·06d.
Repairs	3,351 = ·05d.	2,376 = ·04d.
Total	£17,419 = ·27d.	£15,591 = ·28d.
Units generated	15,158,608	13,247,781
Generating load factor	23 per cent.	37 per cent.

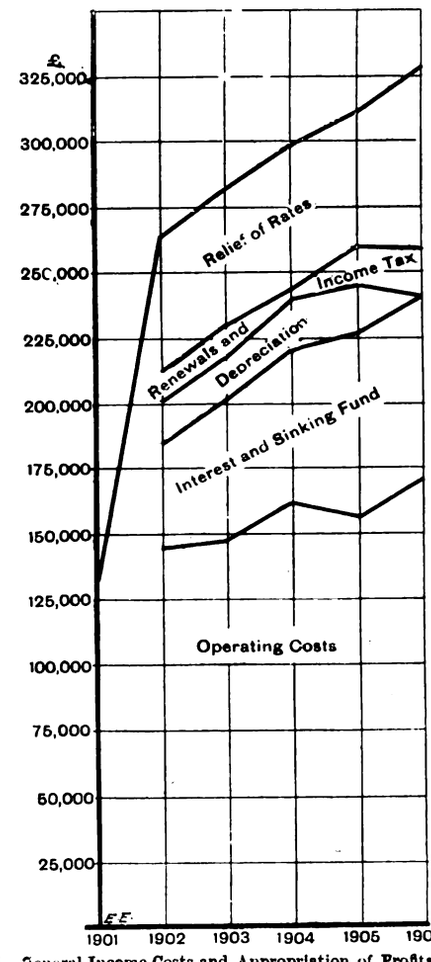

FIG. 5.—General Income Costs and Appropriation of Profits Curves for the Leeds Tramways Department.

These figures show that the electric lighting department on a much less favourable load factor is able to claim the attainment of the better generating costs. The figures in the case of the lighting department are for the year ended March, 1907; those for the tramway department for the year ended March, 1906.

The curve Fig. 5 is more or less comparable with that for the lighting station (Fig. 1). It shows the policy of the Tramways Committee, which, in our opinion, is unsound, and will lead to a crisis in the course of four or five years. Thus, while the electricity supply is given at practically cost price, the tramway department has contributed large sums for the past five years to the relief of the rates. The whole amount so contributed amounts to over £275,000, and the inhabitants using the trams have contributed this amount, which has relieved those ratepayers who do not need to go to business each day on the public cars. The Corporation's policy in this respect is

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TABLE I.—FIGURES FOR STATIONS PROVIDING OVER 10,000,000 UNITS PER ANNUM.

Town.	Units sold.	Load factor.	Works costs.	Total costs.	Capital cost per kw.	Price obtained. Total.	Price obtained. Private supply.	Price obtained. Traction supply
Bradford	13,984,054	25·06	·50	·73	82	1·56	2·49	1·00
Edinburgh	14,257,848	16·23	·51	·89	73	2·01	2·13	—
Glasgow	26,332,998	15·30	·57	·89	58	2·06	2·01	—
Leeds	11,368,956	17·37	·49	·69	80·5	2·28	2·37	—
Liverpool	33,234,103	22·68	·49	·73	67·4	1·83	3·04	1·11
Manchester	47,564,903	21·56	·54	·73	69·2	1·73	2·25	1·26
Salford	12,567,343	25·82	·41	·62	87	1·61	1·59	1·35

TABLE III.—APPROPRIATION OF GROSS PROFITS OF ELECTRIC TRAMWAYS.

Year ended March 31, 1907.	Glasgow. Amount.	Glasgow. Per cent. to capital.	Leeds. Amount.	Leeds. Per cent. to capital.	Salford. Amount.	Salford. Per cent. to capital.
Interest on loans, lease, rentals, etc.	£87,121	2·8	£37.813	2·9	£44,129	7·7
Loan repayment	49,777	1·6	38,029	2·9	18,690	3·2
Depreciation, renewals, and reserve	238,687	7·7	11,481	·9	14,890	2·6
Contribution to rates	35,000	1·1	69,262	5·3	13,000	2·3
Gross profits	£410,585	13·2	£156,585	12·0	£90,709	15·8

TABLE IV.

Town.	Maximum lighting load. Kw.	Maximum traction load. Kw.	Total kw.	Maximum combined load. Kw.	Difference.	33 per cent. spare plant.	Plant saved by combination.	Cost per kw.	Capital saving.
Halifax	1,250	1,990	3,240	2,462	778	259	1,037	30	31,110
Bradford	4,152	3,671	7,823	5,780	2,043	680	2,723	39	77,967
Blackburn	1,100	1,160	2,260	1,461	799	266	1,065	30	31,950
Bury	656	884	1,540	1,148	392	130	522	31	16,182
Rochdale	524	1,238	1,760	1,450	312	104	416	27·5	11,440

directly opposed to municipal trading. Expressed in simple form, this contribution, which last year amounted to £69,262, means that every traveller paying one penny for the tramways contributes one-sixth of a penny to the rates. Thus the working-man using the tramway night and morning pays 9s. a year more rates than he should do.

There is a stronger objection, however, to the policy of the Tramway Committee as shown in their accounts. The contributions to reserve or depreciation have been almost wholly transferred to "aid of rates," and last year none whatever was allowed, the whole amount left standing at the figure £33,000 In the case of Leeds the sinking fund charges per annum only amount to about 3 per cent. of the total capital employed. There is no track renewal fund, although the permanent way cost £563,422 out of a total capital expenditure of £1,303,815. The life of a tramway track is about 12 years, and the Leeds track has already been in use between five and six years. When extensive renewals of track are needed, the Corporation will have to pay for the same out of revenue. To show what other towns do in this respect we would mention the following.

The Glasgow Tramways Committee set aside annually £500 per mile of single track for renewals of the permanent way alone (in addition to doing the ordinary repairs), and last year the sum of £83,760 was provided in this way for track renewals. The Glasgow system at present has a track renewal fund of £329,656, which is equal to one-third of the capital expenditure on the permanent way. In addition to this, Glasgow system has other reserve and depreciation funds amounting to £792,447, making a total for renewals, depreciation, and reserve of £1,122,103, or 36 per cent. on the capital outlay of £3,104,061.

Now what is the position of the Leeds tramways in these respects? The Leeds system has no special fund at all for track renewals. The Leeds system has a total reserve and depreciation fund of only £33,270, or a mere $2\frac{1}{2}$ per cent. of its capital outlay of £1,303,815. It will be seen that in comparison with the Glasgow figures the Leeds records on renewals and depreciation are hopelessly weak. And this position the Leeds system has reached by its policy of giving large sums to the rates.

Let us see how the Leeds Tramways Committee dealt with its obligations to tramway users last year as indicated by the official accounts. The net revenue, after deducting interest payments, tax, etc., and loan redemption charges, amounted to £80,743. If the whole of this had been set aside for renewals and reserve, it would not have been too much—in fact, it would have been much below Glasgow's actual rate. But what did the Leeds Tramways Committee do? They dropped depreciation provision entirely: they provided a beggarly £11,481 for renewals (but they had actually spent during the year on track renewals a sum of £11,704, so that the result is that the contribution for renewals last year was a *negative* sum of £223). And they handed over to the rates £69,262!

And that is not all. To bolster up the tramways as a rate-aider a sum of no less than £85,000 was abstracted from the already small renewals fund and passed over to the rates—a procedure that deserves the greatest condemnation, as it leaves the renewals fund with a paltry balance to its credit of only £33,270.

Coming now to the amalgamation of the two undertakings, out of the 75 corporations or municipal authorities owning tramway and electricity supply undertakings in this country, only eight have separate generating stations for the tramways. In the remaining 67 cases the electricity is supplied from the stations which generate the lighting and power current for other purposes. These eight towns in which the generating of electricity is divided up are Birkenhead, Glasgow, Huddersfield, Hull, Leeds, Leicester, Portsmouth, and Sheffield. The reasons for starting the separate generating stations are various, and we give our own opinions as follows: In Huddersfield, Hull, Leeds, Leicester, Portsmouth, and Sheffield the current generated at the electricity works could not be used for tramway purposes without conversion of some sort. In Birkenhead this did not apply, and we know of no reason for the second station, although a perfectly valid reason may exist. In Glasgow the separate station at Pinkston was put up because Mr. John Young, the energetic and able manager of the tramways in that city, believed it to be economical to keep the whole undertaking under one management. The net result has been a splendid paying system, which is, perhaps, the best example of municipal enterprise in the United Kingdom. Thus, when Chicago wanted to know what could be done in this way by a corporation, they obtained advice from the Glasgow tramway manager, Mr.

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Dalrymple. Still, the electricity supply station at Pinkston cannot be justified. It was always too large. It is too costly, and it is placed so near the Port Dundas electricity works of the Corporation that there is no excuse for the short distance separating them. Again, while the cost per unit generated at Pinkston appears low, the cost of the current, including the capital charges, is very high for the large output and the load factor of the supply. We believe the cost per unit for tramway current, including capital charges, is in Glasgow 1·07d. per unit.

Now, it is worth considering the gain which other towns have found from the joint station for producing electricity for light, power, and tramway purposes. Take the typical figures as given in Table IV. This table shows that in these five towns the combined electricity generating station for tramways and other purposes has saved 5,763 kw. of p'ant and a corresponding capital outlay of £168,649.

Our conclusions on this matter will be found somewhat at length in this week's leading article.

THE DEVELOPMENT OF TURBO-GENERATORS.*

BY DR. ROBERT POHL, ASSOCIATE MEMBER.

(*Concluded from page 780.*)

In Fig. 2 the output figures are plotted as function of the speed, and at the same time the respective curve of the Parsons turbine, as usually constructed, is indicated by a

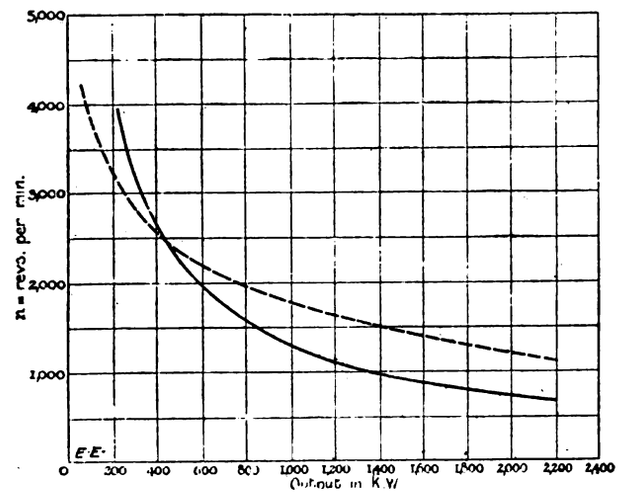

FIG. 2.

dotted line. The comparison is of interest, as it shows that up to about 500 kw. the dynamo can be built to the requirements, whilst for outputs above 500 kw.—the proper domain of the steam-turbine—it is no more possible to construct direct-current generators running at so high a speed as the equivalent turbine demands. There are two ways of overcoming the discrepancy. The one consists in artificially reducing the speed of the steam-turbine, which, however, is connected with increased cost and steam consumption. The second is the tandem arrangement of two dynamos coupled to one turbine, the capacity of each being one-half of the turbine output. The latter method obviously brings the dynamo well within the above calculated limits, and it also has certain practical advantages. It adds, however, considerably to the cost of the set, involves further expenses in foundations, bearings, etc., and increases the floor space required. Both methods can, therefore, only be considered as temporary measures. Considering further the growing demand for large units, the endeavour of all manufacturers of turbo-generators to extend the output limits appears to be fully justified. In fact, the problem is, perhaps, even more important, as it might appear from the above considerations, seeing that the successful production of direct-current turbo-generators suitable for much higher speeds than was hitherto possible would further reduce the steam consumption and considerably lower the output, for which the turbine becomes superior in performance and in first cost to the reciprocating engine. It would also exercise great influence on the choice of a system for central stations and power transmission schemes. Let us consider in which directions such further improvements may possibly be accomplished.

Homopolar Machines.—Refore dealing with methods for the reduction of the electrical difficulties in commutating machines, it will be of interest to consider the prospects of the now well known homopolar type of direct-current dynamo. Though historically the oldest electromagnetic generator, this type had been almost forgotten, until in 1904 the publication of the test results and of the construction of a 300-kw. homopolar turbo-dynamo built by the General Electric Company, U.S.A., directed the universal interest again to the same. Since that time, however, so far as the author is aware, no further experimental results of homopolar machines have been published, although the patent records indicate considerable activity in the direction. The main and somewhat threadbare objection cited against the homopolar principle is the difficulty of obtaining sufficiently high voltages. The author ventures to suggest, however, that this is not the most important one, but that the excessive weight of active material, which these machines require, is, from a commercial point of view, practically prohibitive. Returning, however, first of all to the production of high voltages, the belief has often been expressed that the development of high-speed prime movers would greatly facilitate the intro-

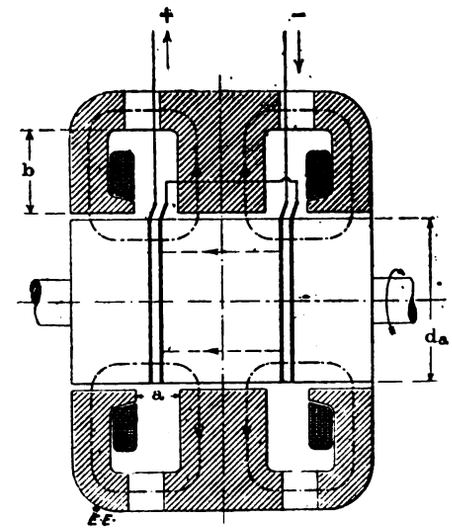

FIG. 3.

duction of homopolar machines on the ground that turbo speeds would remove the long-standing objection against this type. It may be pointed out that this argument must be taken with great reserve. In fact, it is easy to show that exactly the opposite is the case, provided that in all cases the same circumferential velocity of the armature is allowed. Taking the arrangement shown in Fig. 3, which is the most suitable one for producing high voltages, and assuming the whole cross-section of the armature to be magnetically effective, the maximum possible number of useful lines will be

$$N_{max.} = 2\, d_a^2 \frac{\pi}{4} B_{a\,max.},$$

where $B_{a\,max.}$ is about 20,000. The highest possible voltage obtainable per conductor

$$e_{max.} = N_{max.} \times \frac{n}{60} \times 10^{-8}.$$

Now, for certain circumferential velocity we have

$$v = \frac{d_a}{100}\, \pi\, \frac{n}{60}\ \text{m./sec.},$$

$$d_a = \frac{6{,}000\, v}{\pi\, n}.$$

Inserting the expressions for $N_{max.}$ and d_a into the equation for $e_{max.}$, we find

$$e_{max.} = 19\, \frac{v^2}{n}.$$

In other words, the maximum possible voltage per con-

* Paper read before the Institution of Electrical Engineers.

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ductor is inversely proportional to the number of revolutions per minute, taking v as being constant. Thus, if a number of conductors are connected in series for the purpose of obtaining a certain pressure, the number of insulated conductors and slip-rings required increases directly with the speed (revolutions per minute) of the prime mover. Increase in pressure per conductor is only obtainable by allowing higher circumferential velocities. Let us now further consider the question of utilisation of material. It will be found that quite an extraordinary apparatus of brushes and slip-rings is required when working with as low a specific load as 30 ampere conductors per centimetre of armature circumference. Let us for our purpose assume A S = 32. We then find the current which may be taken out of a simple cylinder, $e = d_a \times \pi \times 32 = \sim 100\, d_a$, and as for $B_a = 20{,}000$, e can be written $e = \frac{d_a v}{100}$, we obtain the output in kilowatt output $= \frac{e \times c}{1{,}000} = \frac{d_a^2 v}{1{,}000}$ kw. (see columns 3, 4, 5, 7, 8, and 9 of Table II.). In order to obtain a further approximate idea as to the weight of steel required, a simple formula may be propounded for the same. Taking, again, $B_a = 20{,}000$, further B gap = 10,000, B pole = B yoke = 15,000 (without leakage), $a = 20$cm., and $b = \frac{1}{2} d_a$,* the weight of steel will found to be

$$W = 7\,8\,(5{\cdot}8\, d_a^3 + 74\, d_a^2)\, 10^{-6} \text{ tons.}$$

From this a table can be immediately drawn up showing the weights of steel of homopolar machines, and the possible outputs as functions of the diameter. This is done in Table II. both for 100 and for 200 m./secs. circumferential velocity. It appears that for $v = 100$ m./sec., for instance, a 1,000-kw. generator could be built for 600 volts, obtained by means of twice six slip-rings connected in series. The speed of 1,900 r.p.m. would be quite convenient. The weight of steel, however, is not less than 51 tons, as compared with approximately five tons magnetic material for a commutating machine of similar output. This comparison will suffice to show that at present it is out of the question to commercially obtain satisfactory results with homopolar machines. At the same time the fact must not be lost sight of that the 12 slip-rings for 1,670 amperes each, which are not easily accessible and rotating at very high speed, will most likely require as much attention as a turbo-commutator. The extraordinary increase in steel weight as compared with the steel required for commutating machines cannot by any means be compensated for by a slight saving in copper which may possibly be effected.

TABLE II.

d_a in cm.	v = 100 m./sec.				v = 200 m./sec.				Weight of steel in tons.
	Revs. per min.	Volts.	Amps.	Kw.	Revs. per min.	Volts.	Amps.	Kw.	
20	9 550	20	2,000	40	19,100	40	2,000	80	0·6
40	4,775	40	4,000	160	9,550	80	4,000	320	3 8
60	3,180	60	6,000	360	6 360	120	6,000	720	11·6
80	2,390	80	8,000	640	4,780	160	8,000	1,280	26·8
100	1,910	100	10,000	1,000	3,820	200	10,000	2,000	51
150	1,270	150	15,000	2,250	2,540	300	15,000	4,500	166
200	955	200	20,000	4,000	1,910	400	20,000	8,000	384
300	635	300	30,000	9,000	1,270	600	30,000	18,000	1,280

Considering the last table for 200 m./sec., the generators contained therein would, perhaps, be suitable for direct coupling to De Laval turbines. It would, however, hardly be possible to have insulated conductors and slip-rings rotating at so high a circumferential velocity. But for a simple homogeneous cylinder, as Table II. shows, the pressure obtained would be too small for ordinary purposes unless one goes at the same time to extremely large outputs. Even then the weight will be prohibitive. If it were possible to employ as high a velocity as 400 m./sec.—which, as De Laval turbines prove, is quite feasible from a mechanical point of view—one would arrive at generators the speed of which is far higher than that of any known prime mover. The poor utilisation of the material in homopolar machines is mainly due to the low A S values, which are approximately only one-tenth of those employed in large commutating machines. We necessarily arrive, therefore, at approximately 10 times the weight of magnetic material. Seeing that the A S value is limited by the brush apparatus, the problem of building a commercially successful homopolar machine appears to be identical with the problem of constructing a reliable apparatus for taking current out of a cylinder rotating at very high velocity with a current density corresponding to about 200 to 300 amperes per centimetre circumference. So long as this problem remains unsolved the homopolar machine seems to be only suitable for such outputs and such low pressures for which a commutating machine is practically impossible. The solution of the problem, however, is, perhaps, connected with even greater difficulties than those involved in the further improvement of commutating machines.

Means for the Improvement and Increase of Output of Commutating Machines.—Such means must have for their object the further extension of the above-discussed two limits—namely, the sparking and the flash-over limit. This can be accomplished, first, by working with a higher circumferential velocity of the armature. Considering two machines of equal output and speed, of which the one has the armature diameter D, the other the diameter 2 D, the length of the armature of the second will be only a quarter of that of the first, whilst for the same pressure the number of conductors and segments will be doubled. The voltage per segment, and approximately also the reactance voltage, will therefore only be one-half of the respective values of the first machine. These two voltages may be taken as being approximately inversely proportional to the circumferential velocity employed. Now 75 m./sec. cannot very well be exceeded with ordinary manganese, bronze, or phosphor-bronze castings for the end shields. By employing, however, certain steel alloys of very low magnetic conductivity and high tensile strength, further progress in this direction appears to be possible. The difficulties connected with balancing, which rapidly increase with increase of circumferential velocity, must, however, not be disregarded. Even more important than the first balancing is the steady running and maintenance of balance under continuous work. It is, therefore, infinitely preferable to aim at such further improvements which do not entail any further increase in the velocity. Directing our attention to the permissible A S values, a further possibility seems to lie in the careful adjustment of the commutating field. This would have for its object the extension of the A S line without exceeding the sparking limit. As is well known, in machines with artificial commutation additional short-circuit currents and sparking can only occur if the E.M.F. induced by the commutating field is different from the reactance voltage. Now, as the latter increases exactly in proportion to the armature current, the characteristic of the commutating field should be exactly a straight line. Unfortunately, this is not the case, and, in fact, it is mainly the deviation from this straight line which ultimately causes sparking and limits the permissible A S. Even for the very low saturations obtaining in the commutating poles of turbo-generators the characteristic of the commutating field is slightly convex instead of being exactly straight. The author has found that the following method allows an adjustment of the form of the characteristic. A shunt parallel to the commutating poles is employed, the resistance of which increases rapidly with increasing load. Iron resistances of the kind used for Nernst lamps are particularly suitable, although thin copper wires may also be employed, for which without enclosure in an airtight bulb high temperatures may be permitted. As will easily be seen, the ampere-turns of the commutating poles as a function of the load will now rise according to a concave curve, thus compensating for the curvature of the characteristic. Experiments have shown that almost exact straight line relationship between the intensity of the commutating field and the load is thus obtainable within very wide limits.

Coming, finally, to the flash-over limit, the possibility might be suggested of improving the commutator construction with a view of preventing flashing over. This would permit of a higher voltage per segment, and would enable us to work with a larger magnetic flux, and thus to

* This assumption is somewhat unfavourable in the case of larger sizes.

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increase the output. It must not be forgotten, however, that even if this were possible, an increase of the output by means of larger flux is, in principle, connected with a lengthening of the armature, and means, therefore, at the same time an increase of the reactance voltage and of the commutation difficulties. Thus, what might be gained in flux would at least partly be lost in A S. This is no likelihood of decided improvements in the direction of increased flux unless means are found which would enable the armature to be lengthened without exceeding the flash-over limit, and simultaneously without increasing the reactance voltage. This can only be accomplished, it seems, by a suitable armature winding, and the author believes that it is in this direction that important developments must be looked for A brief description of a new winding which has the above aim for its object may be permitted, although no experimental results can as yet be communicated. In machines working in the near proximity of the above calculated limit the number of commutator segments is in most cases extremely small, and the width great. Leaving out of consideration multiple windings, which in practice have proved unreliable, it is impossible to increase the number of segments, as this would cause a proportionate rise of A S and of the reactance voltage. It has been repeatedly proposed to adopt additional segments connected to suitable points of the armature coils, and to increase thereby the number of bars without increasing at the same time the A S value. The intention is to commutate each coil step by step and to obtain a reduction of both the reactance voltage and of the voltage per segment. Fig. 4 shows diagrammatically

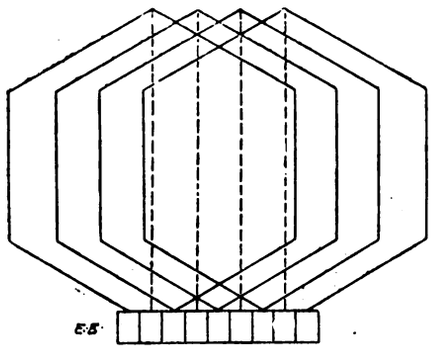

FIG. 4.

such a winding, in which in this manner the number of commutator bars is doubled. There is no doubt that the voltage per segment is actually halved. As regards the commutation, however, it will be found on closer examination that the reactance voltage is by no means necessarily reduced, because the self-induction of the connecting wires always adds itself to that of the conductors undergoing commutation. In practice the connectors will be necessarily arranged in holes in the armature iron. They are surrounded entirely by magnetic material, and the self-induction of a connecting wire will most likely be far higher than that of a conductor. Assume, for sake of argument, that practically no current at all would pass through the connecting wires to the commutator, owing to their very high self-induction. Then the reactance voltage would be twice as great as in an ordinary winding, as the time of commutation would be reduced to a half. If, on the other hand, the resistance and the self-induction of the connecting wires would be similar to that of the ordinary commutator lugs, the reactance voltage would be halved. From this it is seen that whether the auxiliary segments improve the commutation or otherwise depends entirely on the self-induction of the connectors. Now, there is a simple way for the neutralisation of their self-induction. If they are arranged in groups in such a way as to have connectors of opposite polarity always in close proximity to each other, so that the number of ampere conductors in every one of these groups is always zero, practically no lines of force will then be interlinked with any such group. Their self-induction is thus eliminated. This will be more clearly understood by considering a bipolar machine in which all the connectors are arranged in one group—for instance, in a hollow shaft. At any instant the connecting wires will carry exactly the same amount of current in both directions, so that no change of magnetic flux can take place. Fig. 5 will make the arrangement clear. In the practical construction of this winding it is by no means necessary to make the number of groups equal to the number of pairs of poles, although in four and six polar machines this does not create any great difficulty. The number of groups may be made as large as convenient if only care be taken to have in each group wires which are displaced by 180 electrical degrees. The objection could be made that there will always be irregularities in the distribution of the current and induction effects due to the same. To prevent irregularities as completely as possible, the connectors are joined to the equalising rings at the back of the armature, and, furthermore, they are arranged in copper tubes through the armature core, which would exercise a very strong damping effect on any remaining magnetic oscillations. The connectors are made of considerable size, so as to keep the ohmic resistance as low as that of the ordinary commutator lugs. Satisfactory running machines of twice the present armature length, and of twice the output at present obtainable, appears to be within the possibilities of this winding. The necessity of arranging two machines in tandem would thereby be removed, and even for such outputs and speeds which at present can be obtained by means of one machine only the application of the new winding should mean a very great margin of safety as to sparking and flashing over. Such results, however, would, probably, by no means form the limit of what may be expected from the future as regards direct-current turbo-generators. We are only in the very beginning of their history, and, in spite of some reverses, the great progress made during the last few years justify

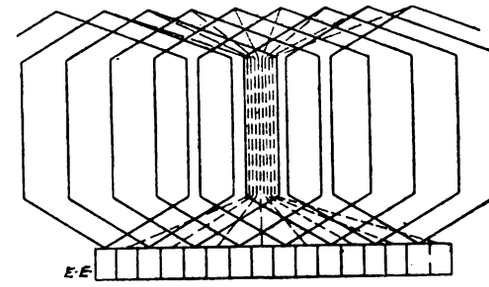

FIG. 5.

the confident expectation of much more important developments.

DISCUSSION.

MR. GERALD G. STONEY (Messrs. C. A. Parsons and Co.), in opening the discussion, pointed out that the paper contained a deal of information respecting turbo-generators which had not hitherto been published. He did not agree with the author's statement that in slow-speed machines with clean commutators the flash-over limit is reached if the voltage per segment reaches a maximum of about 60 volts. He could not trace a maximum voltage per segment such as this in modern slow-speed dynamos. In Silvanus Thompson's "Dynamo-Electric Machinery" there are a large number given, but the highest there is about 34 and the next highest 21 volts. He agreed with Dr. Pohl that the safe limit in the case of turbo-generators is about 40 volts, provided the mica is thin, but if, as in modern turbo-generators, the commutator is built with rather thick mica, the higher limit is quite safe. His company had made several two-pole machines for 550 volts, with a maximum of 49 volts per segment, which had been perfectly satisfactory. The curve ampere conductors per centimetre of armature circumference, or, what is the same thing, which is often taken in this country as ampere-turns per 1in. diameter, seemed to be approximately correct, but rather on the low side. He had found from his experience that even allowing a turbo-generator to carry 50 per cent. without serious sparking, and to be able to be varied from no load to 25 per cent. overload without sparking or shifting the brushes, considerably higher figures could be taken with surface-wound armatures, which to his (the speaker's) mind were much preferable to sunk-wound, whereas in turbo-generators the very best conditions of commutation were requisite to get the best results. He mentioned that Messrs. Parsons had obtained much better results with two-pole machines than with four-pole, there never having been a case of flashing over with a two-pole machine with their compensated winding, or of injurious sparking, and the cost of two-

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pole machines had been found not to exceed that of four-pole machines. Two-pole machines were now being built up to outputs of 1,000 kw., and Messrs. Parsons were prepared to build them up to 1,500 kw. in single dynamos. They had made several 750-kw. running at 1,800 r.p.m., and 1,000-kw. running at 1,500 r.p.m., which was exactly the same speed as of 1,000-kw. 50-period four-pole alternator, and, as was well known, turbines of this size and speed gave most economical results. Similarly, as the ampere-turns per 1in. diameter go up rather with size, a 1,500-kw. would run at about 1,100 r.p.m. or 1,200 r.p.m., and he said this was quite in accordance with modern practice in Parsons turbines. It was thus seen that at present the limit is somewhere about 1,500 kw., but it is quite certain, he added, that with the steady improvement in the design of turbines and generators, this limit would very soon be as much out of date as the man who said in the early sixties that it would be neither safe nor advisable to cross the Atlantic faster than 12 knots an hour. The whole thing depended on the struggle that has always been going on between the turbine people and the dynamo people for the turbine people to lower their speeds and the dynamo people to increase theirs for any given size. With reference to Dr. Pohl's remarks on homopolar machines, Mr. Stoney said that Messrs. Parsons had come to the conclusion that they were not practicable. The author's method of doubling the number of commutator segments, if it proved satisfactory, would be very valuable. But he doubted whether it would be found possible in practice to equalise the self-induction of the conductors which were connected to the commutator by the outside and by the inside of the armature, and unless the self-induction of these two was absolutely the same, it was obvious that there would be more tendency to spark at certain segments than at others, and thus the commutation would rapidly become uneven. They had found in their practice that, unless the winding of the armature was absolutely symmetrical, sparking at certain segments took place, and this was found to be especially the case in some machines in which the conductors were grouped slightly closer together at one part than another to provide extra ventilation.

Mr. E. J. Fox (Messrs. Willans and Robinson, Limited), speaking from the steam-turbine manufacturer's point of view, said he was glad that the Phœnix Dynamo Company were taking up the manufacture of dynamos suitable for running with turbines. He expressed the opinion that the absence of a continuous-current dynamo suitable for this purpose had kept back the employment of turbine-driven sets in this country. On the Continent it was the universal practice to have slow-speed direct-current turbine sets, and until recently we had to look to the Continent for this type of plant. Until the last year or two his firm had kept clear of the direct-current dynamo, because they did not think it would be satisfactory, and it was only after carefully inspecting the large direct-current sets on the Continent that they had decided to go in for it. He believed that for satisfactory running it was essential to use a slotted-core armature with carbon brushes, and he doubted whether it would be possible to get satisfaction out of the machine without carbon brushes. He recently inspected a 1,000-kw. set running at Salford, and the performance of the machine was in every way satisfactory. With regard to the question of speed, he was of opinion that there was a tendency to overdo this; competition was tending to increase the speed of dynamos in order to bring about some reduction in their first cost, with the result that satisfactory running was being sacrificed for some slight saving in first cost.

Mr. Miles Walker said Dr. Pohl's paper was particularly interesting at a time when the direct-current turbo was struggling to oust the big engine-type generator. Speaking from the user's point of view, Mr. Walker said a direct-current machine should have all the good qualities of the massive engine-type. The turbo-generator, if it was to oust the latter, must have carbon brushes. He admitted that metal-brush machines were made to operate fairly satisfactorily in the hands of careful attendants, but if the brushes were left without attention they soon wore so as to cover the wrong arc, and began sparking and burning. The wear of brushes filled the air with fine copper dust, which settled on insulating surfaces, and was often the cause of breakdowns. Carbon brushes could be made which would run for years without renewal, always occupying the same arc, and giving to the commutator a bright gloss, so that after years of running only the slightest gloss could be detected. Electrical engineers owed a great deal to the makers of carbon brushes for the way in which they had solved the problem of brush manufacture, and given such excellent brushes. He thought it would be a pity to throw away all the advantages of carbon brushes and go back to metal brushes. Another of the advantages of the carbon brush was that it did not require such a fine adjustment on the commutating pole. Discussing the question of the maintenance and balance, Mr. Walker said it was very important that a turbo-machine should compare favourably with the engine type in this matter. The going out of balance had been a troublesome defect with turbo-machines in the past, but it has been cured with better design. If carbon brushes were used, the arrangements must be such that even if the balance was bad, the brushes would not leave the commutator. This difficulty had been completely overcome. The row of exposed shrink rings on a direct-current turbo-generator was an objectionable feature, which did not appear on the engine type machine. While admitting that many commutators with shrink rings were running satisfactorily, he said that if he had to bend over a commutator to attend to brushes, he would feel very much safer without those rings. With regard to the question of voltage between commutator segments, he said that, from a user's point of view, he should prefer 20 volts per segment instead of 40 volts mentioned by Dr. Pohl. With good engine-type generators, the best practice was to have as many as 48 commutator bars per pole for a 550-volt machine, giving a mean pressure of 11½ volts, or a maximum of 17 volts between bars. The high number of bars made the engine-type machine comparatively free from flash-overs, even when abnormal rises in pressure occurred. If he were a user of a direct-current turbo—say for traction work at 550 volts—he should insist on as many as 48 bars per pole with a fair uniformity of distribution of potential, allowing about 20 volts per bar as a maximum. From the designer's point of view, this meant a more expensive machine. Ease of repair was an important characteristic which was apt to be lost sight of in the many difficulties with turbo-generators. The method of reducing the voltage per bar shown by Dr. Pohl in Fig. 4, had been employed by the American Westinghouse Company for a number of years, with good results. It was rather difficult to support the connectors running through the spider in a satisfactory way, and either a gunmetal spider should be employed or another circuit for mutual induction provided to kill the self-induction. The method shown in Fig. 5 was good, but still involved an awkward mechanical construction, and would be difficult to repair.

Prof. S. P. Thompson said that Dr. Pohl had pointed out a limitation which, though known, had never been put forward before as a definite limit for the rating of a machine—*i.e.*, the flash-over limit. He said that for a long time there had been a double rating. An international committee was now discussing the question of limitation, and in one of the documents which was presented before it as evidence the temperature limit of rating was recommended, to which Dr. Thompson objected. He said the flash-over limit was a real thing when we came to high-speed machines. Commutating high-speed turbine-driven machines were not suitable for low voltages, but, on the other hand, homopolar machines appeared to be very well adapted for low voltages. In certain machines of Continental build, in order to avoid flash-over, the commutator was long, and was divided in the middle by a shrunk-on ring, and, instead of the top brushes going right across the commutator, they were placed on the top of one half, and the bottom brushes were placed on the other half of the commutator. This had obvious disadvantages, but it prevented the flash-over from going right across, as the brushes were not over. He thought the flash-over could be prevented by abandoning reliance on the strip of mica under the shrunk-on ring; he thought it preferable to place a disc of mica against the shrunk ring instead. He suggested the use of silver for making the commutator, in order to reduce friction, and asked if anyone had tried making a silver commutator instead of a copper commutator?

Mr. A. C. Eborall (Messrs. Brown, Boveri, and Co.) discussed a few general matters suggested by Dr. Pohl's interesting paper. In the first place, it was absolutely necessary to make a good mechanical job, as half of the troubles in the past had been due to the poor mechanical construction. It was of the greatest importance to have cool and smooth running of the commutator, in order to avoid brush troubles. Variation in the balance of the machine, due to the conductors moving, was a cause of the commutation becoming bad. He insisted that low temperature rise was not so important as equable temperature. Mr. Eborall then described the machines with which he was most familiar, saying that by using a combination of metallic and carbon brushes the machines in question were freed from flash-over troubles, and did not suffer from accumulations of copper dust. His firm had built 1½-million horse-power generators, and in only one case was "flash-over" experienced, that being in a machine of 750 kw. built three years ago. A feature of their machines lay in the fact that they provided direct-coupled exciters to secure excitation in the coils irrespective of what might happen in the circuits. As to the wear of brushes, etc., they had nothing to grumble at, but their experience was that the negative brushes work quicker than positive; they had their own idea as to why this was so, but he did not think that the Institution was the place where to express them. For the rest, Mr. Eborall left the paper severely alone, confining his remarks to the machines of his own firm.

Dr. Gisbert Kapp said they had been carried away from the legitimate discussion by the previous speaker. Dr. Pohl, he said, had made a successful attempt to give in a broad way the limit of output for turbo-generators. The author's views were based on the belief that the commutation was entirely by resist-

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ance of the brushes, or was assisted by commutating poles. But Dr. Kapp expressed the opinion that a machine with commutating poles would not be satisfactory for commutating at overload. Such a machine would be of no use for a tramway load, owing to sudden variations in the load. Mr. G. Stoney had found a way out of the difficulty, and he added that Mr. Stoney's method of a compensating winding gave every satisfaction. A machine fitted with Mr. Stoney's commutating device could be overloaded to about twice its normal full load.

Mr. S. EVERSHED (Messrs. Evershed and Vignoles) said Dr. Thompson's suggestion as to using a silver commutator would work admirably when silver was about half its present price. The coefficient of friction for silver was about the same as for copper—viz., ·15.

Mr. A. J. ELLIS said the paper emphasised the fact that high speeds were not desirable for the driving of continuous-current machines. The many difficulties referred to in the paper showed that the additional devices for which provision had to be made tended to complicate rather than simplify the construction, and at the same time increased the cost of manufacture. Although for a considerable range of outputs the standard speeds of steam-turbines permitted of more or less satisfactory dynamo designs, it was not the case that the turbine speed corresponded to the most economical design consistent with good operating quality that could be obtained for a given output. The most economical designs were obtained at speeds considerably lower than the steam-turbine speeds. He showed a series of curves for speed and output of steam-turbines and continuous-current generators which showed that, if maximum economy were the deciding factor, the Curtis turbine was more suitable for continuous-current machines than the Parsons turbine. The chief point suggested by his curves was that the continuous-current machines are not inherently high-speed machines. In spite of this, fast machines had to be built to meet the speeds employed by steam-turbine makers, and among the latter there was a tendency towards even higher speeds than the present standards on account of the increased economy at the steam-turbine end of the generating set. It was interesting to note, he said, how the coming of high-speed prime movers had compelled dynamo makers to go in for forced-draught ventilation. This system of cooling has led to a much finer degree of subdivision of the parts of the machine to enable the air to circulate freely throughout the interior. In this way the temperature throughout the machine was much more uniform than hitherto. In older machines there existed temperatures at certain parts considerably higher than the mean temperature of the hottest accessible part. The thorough ventilation gave a greater degree of safety from breakdown of the insulation due to local overheating, and it might be worth considering whether a higher standard of temperature rise might not gradually come to be permissible in such machines on this account. He asked the author to give more information as to why the homopolar machines required so much as ten times as much steel as an ordinary machine.

Mr. VAL. A. FYNN inquired about the new winding described at the end of the paper. He thought that the arrangement would be equivalent to doubling the number of segments and leaving the segments unconnected. If that was so, the reactance voltage would not be twice, but four times as great with the winding described by Dr. Pohl as it would be with the ordinary winding.

Dr. POHL replied very briefly to certain points raised in the discussion, and decided to defer his further remarks for publication in the *Journal*. He agreed with Mr. Fox and Mr. Walker as to the preference for carbon brushes. The mica disc mentioned by Dr. Thompson had been adopted, and he agreed with Mr. Eborall that temperature rise in all parts of the machine should be uniform. He also regarded Mr. Stoney's compensating winding mentioned by Dr. Kapp as a good one.

On the motion of the CHAIRMAN (Mr. C. P. Sparks), the meeting accorded a hearty vote of thanks to Dr. Pohl.

INSTITUTION OF ELECTRICAL ENGINEERS.

At an ordinary general meeting held on Nov. 28, Mr. C. P. Sparks, vice-president, in the chair, the following were elected to the Institution:

Associate Members.—H. Doboll, Poldhu Wireless Station, Cornwall; A. H. Ellis, London Electric Supply Corporation, Limited, 25A, Cockspur-street, S.W.; J. L. Forsyth, West Rand Mines, Krugersdorp, South Africa; W. W. S. Ibbetson, 8, Eastmount-terrace, Darlington; J. A. W. Kerr, P.O. Box 312, Johannesburg, Transvaal; R. T. McArthur, Natal Government Telegraphs, Pietermaritzburg; W. H. Mahon, 64, Castelnau, Barnes, S.W.; G. A. Mennie, Messrs. Reunert and Lenz, P.O. Box 92, Johannesburg, Transvaal; A. Richardson, Corporation Power Station, Manors, Newcastle-on-Tyne; B. A. Stoker, Borough Electrical Engineer's Office, Durban, Natal.

Associates.—W. L. Johnson, Messrs. Bell Bros., Limited, Clarence Ironworks, Middlesbrough; C. B. Lessner, Carril Electromagnetic Separation Works, Carril, Spain; F. R. Simms, Kimberley-road, Willesden-lane, Kilburn, N.W.

Students.—W. R. Abram, 380, Hungerford-road, Crewe; T. G. S. Babb, Henley Villa, Minehead; D. R. Cooper, Chotani-building, Grant-road, Bombay; P. R. Fortin, 23, Hilldrop-road, N.; G. Hartley, Weston-road, Crewe; G. F. Hilton, Heath Bank, Marple Bridge, near Stockport; J. W. G. Meaby, Oaklands Freshfield, near Liverpool; A. L. Paramor, 6, Clifton-gardens, Folkestone; C. Redman, 15, Delamere-street, Paddington, W.; M. Roy, Arcadia, Byculla, Bombay; C. M. Simpson, 41, Ferncroft-avenue, Hampstead, N.W.; A. Southall, 20, Etnam-street, Leominster, Herefordshire; F. C. Topham, 15, Mortlake-road, Kew, Surrey; G. D. Villares, Avenida Paulista, 191, Sao Paulo, Brazil; E. L. Walton, Elton Banks, Edenfield, near Manchester.

FORTHCOMING EVENTS.

FRIDAY, DEC. 6.

Institution of Electrical Engineers.—At 2.30 p.m., students' visit to Board of Trade Laboratory, Whitehall.

Northampton Institute Engineering Society.—At 5.45 p.m., "Carburettors and Vaporisers," by Mr. A. G. Elliott.

Institution of Civil Engineers.—At 8 p.m., at Great George-street, S.W., students' meeting, "Methods of Vaporising Liquid Fuels, used with Internal-Combustion Engines, as applied to Road Vehicles," by Mr. R. T. Deane.

Manchester Electrical Exhibition.—At 4 p.m., meeting at 44, Mosley-street, Manchester.

MONDAY, DEC. 9.

Institution of Mechanical Engineers.—At 8 p.m., graduates' meeting, "Types of Boilers," by Mr. R. J. P. Briggs.

Society of Arts.—At 8 p.m., at John-street, Adelphi, London, W.C., Cantor lecture, "The Theory of the Microscope," by Mr. Conrad Beck. (Lecture III.)

Institution of Electrical Engineers (Newcastle Local Section).—At 8 p.m., at the Armstrong College, Newcastle-on-Tyne, "Automatic Cab-Signalling on Locomotives," by Mr. James Pigg

TUESDAY, DEC. 10.

London Chamber of Commerce.—At 2.30 p.m., at Oxford-court, Cannon-street, E.C., "The Franco-British Exhibition of 1908," by Mr. C. Charleton.

Institution of Electrical Engineers (Glasgow Local Section).—At 8 p.m., meeting at James Watt Laboratory.

Institution of Electrical Engineers (Manchester Local Section). At 7.30 p.m., at the University (Physical Laboratory), "The Reluctance of the Air-Gap in Dynamo Machines," by Mr. Thos. F. Wall.

Junior Institution of Engineers.—At 8 p.m., at the Society of Arts, "Arc Lighting," by Mr. W. Krause.

Institution of Civil Engineers.—At 8 p.m., "The Predetermination of Train Resistance," by Prof. C. A. Carus-Wilson.

WEDNESDAY, DEC. 11.

Institution of Civil Engineers.—Students' visit to the motor works of Messrs. Clement Talbot, Limited, Barlby-road, North Kensington, W.

Association of Engineers-in-Charge.—At 7.30 p.m., at St. Bride's Institute, Fleet-street, "The Province of the 'Illuminating Engineer,'" by Mr. Leon Gaster.

Society of Arts.—At 8 p.m. "Radioactive Phenomena," by Sir William Ramsay (Aldred Lecture).

Institution of Electrical Engineers (Birmingham Local Section). At 7.30 p.m., at the University, Edmund-street, "The Torque Conditions in Alternate-Current Motors," by Mr. Val. A. Fynn.

Society of Engineers.—Annual dinner at Hotel Cecil.

THURSDAY, DEC. 12.

Institution Electrical Engineers (Dublin Section).—At 8 p.m., meeting at the Royal College of Science, Dublin.

Rugby Engineering Society.—"Textile Electric Driving," by Mr. J. Shaw.

Borough Polytechnic Institute.—At 8 p.m., at 103, Borough-road, London, S.E., distribution of prizes by Sir E. H. Carson, K.C., M.P.

Manchester Exhibition.—At 4 p.m., meeting of electrical trades (Sir W. H. Preece in chair), Hotel Cecil, London, W.C.

FRIDAY, DEC. 13.

Electro-Harmonic Society.—At 8 p.m., at King's Hall, Holborn Restaurant, smoking concert.

Physical Society.—At 7 p.m., exhibition at South Kensington.

SATURDAY, DEC. 14.

Junior Institution of Engineers.—At 3 p.m., visit the Franco-British Exhibition Buildings, etc., the exhibition extension works of the Central London Railway, and Central London Railway power house at Shepherd's Bush.

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THE

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TO CORRESPONDENTS.

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LEEDS CORPORATION MISMANAGEMENT.

Leeds has been noted for years for the multiplicity of watertight compartments into which the Corporation divides its permanent officials. An attempt to rectify this has been made since the last elections at the instigation of the Tramways Committee, and on lines which would nullify any advantage from the proposed combination of the tramways and electricity departments. This committee holds a strong position in Leeds because it contributes annually large sums to the relief of rates. The tramway manager, Mr. Hamilton, has raised his department into a leading position among the tramway undertakings in the kingdom. This will not last unless the unsound policy of the committee be changed. After examining the tramway accounts on the spot and interviewing the various gentlemen concerned, we bring and can prove the following accusations against the Leeds Tramways Committee: (1) the profits are too large, and hence the fares charged too high; (2) no adequate depreciation is allowed for out of these profits, and hence the undertaking is unstable financially, as the annual repayments of loans do not cover the cost of track renewals in this case; (3) the high-tension plant laid down in the tramways station in order to supply two sub-stations in Bramley and Kirkstall should never have been ordered. It has necessitated an expenditure on generating plant three times larger than would have been needed if the power for these sub-stations had been taken from the existing high-tension electricity works of the Corporation. In fact, in this instance the Tramways Committee treated another department of the Leeds Corporation as if they had been the Yorkshire Power Company. The policy showed that money would be wasted freely rather than acknowledge the existence of the Electricity Committee and its station. Still, the Tramway Committee were powerful, and the last elections confirmed their desire to control the electricity supply department. Alderman Matheson in his letter to the *Yorkshire Post*, which we reproduce elsewhere, exposes the contemptible way in which they lobbied to this end. We believe that the proposed amalgamation might be made beneficial to the town, although it should have been arranged before the Tramway Committee wasted money on redundant high-tension generating plant. The accounts of the tramways show that their generating costs are much higher than they should be. In fact, the costs of producing electricity with a load factor of 37 per cent. are practically the same as those in Mr. Dickinson's high-tension station with a load factor of only 23 per cent. Hence this official should be given control of the whole of the electricity-producing works in the town. His previous records justify the promotion, and the city of Leeds will gain from the change. This will leave Mr. Hamilton more free to manage the tramways, in which work he has no equal. He does not, we believe, claim to be an electrical expert, and hence should be relieved of the responsibility of managing a power station. Reverting to the accounts of the tramway department—the balance-sheet for the year ending March 31, 1907—the accumulated reserve and renewals fund accounts at the beginning of that year stood at £118,493. 9s. 9d. During the year the amount set aside for the fund was £0. 0s. 0d., but £85,000 was transferred from the accumulated funds in "relief of rates," so in the year the rates were subsidised by this amount from the reserve fund and by £69,362. 9s. 7d. out of the profits for the year. We suppose the committee have some reason for the course adopted, but it is not referred to in the annual report of the general manager. In conclusion, we would say that we have no personal interest either way in this question, and we trust that the Corporation members will put the

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city's interest before the personal aggrandisement of any committee.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

RE QUESTION 1,012.

SIR,—Along with you, I wish "The Patentee" in his letter last week had pointed out a few of the "multitude of sins" and "obvious absurdities" in my answer It is rather a difficult matter to reply to such a general denunciation, but I have gone through my answer and have come to the conclusion that probably he takes exception to Figs. 2 and 4, showing minor details. In that case I would call his attention to the wording of the question, which simply asked for the working principles, and not for a detailed advertising pamphlet.

Fig. 5 and the little deduction in trigonometry appear to trouble "The Patentee," but as most engineers nowadays know at least enough mathematics to melt away the glamour of ignorance, it seems a pity to take up further space in your columns on this point. I am sorry to have brought disappointment to "The Patentee's" friend, the 5s. man, but possibly there will be another question soon to which he can send the best answer.—Yours, etc,

PERCY DUNSHEATH.

Sheffield, Dec. 4, 1907.

MUSSOORIE HYDRO-ELECTRIC SCHEME.

An interesting function was celebrated on Oct. 4 last, when the foundation stone of the new power-house for the hydro-electric scheme in progress at Mussoorie, Upper Punjab, was laid in the presence of a distinguished company of military and civil residents. The stone was suspended from the centre of a structure resembling an old battlemented keep, beautifully decorated with evergreens and ferns, and emblazoned with the motto "Success to the Mussoorie Hydro-Electric Scheme," and the lowering tackle was so arranged that it could be set in motion by pulling a red, white, and blue ribbon. Before this was done, however, an illuminated parchment scroll, signed by all present, was sealed and deposited, along with specimens of current coinage, local newspapers, etc., in a prepared cavity below the stone. The Hon. H. W. Reynolds, commissioner for the Meerut division, then spread the mortar with a silver trowel—a replica of the trowels used by native workmen—and lowered the stone into position.

After an interlude for photographs, the company inspected the works under the guidance of Mr. J. S. Pitkeathly, the representative of Messrs. Bruce Peebles and Co., Limited, of Edinburgh, who are the main contractors for the undertaking. The primary object of the scheme is to provide a plentiful and reliable water supply for the "station." Springs which can be depended on for a quarter of a million gallons per day have been acquired by the Municipality itself, but these are located at a level of 1,500ft. below Mussoorie itself, so that a powerful pumping plant was required. Owing to the abundance of water power in the district, a hydro-electric scheme was the obvious inference, and the contract was awarded to Messrs. Bruce Peebles and Co. about a year ago. A stream known as the Rhatta is being dammed, and a duplicate pipe line 4,500ft. long runs down the hill to the power-house, supplying water to the three 300-b.p. Pelton wheels under 990ft. head. The pipe line and Pelton wheels were supplied by Messrs James Gordon, of London, as sub-contractors to Bruce Peebles and Co, Limited. Each Pelton wheel is direct-coupled to a Peebles 150-kw. high-tension alternator, the combination running at 500 r.p.m. Current is to be transmitted at 6,600 volts by two overhead transmission lines, one running to the pumping station direct and the other to the town of Mussoorie and then on to the pumping station, thus providing a loop system. The pumping station is being equipped with two 150-h.p. high-lift pumps, each driven by a Peebles induction motor, and either unit being sufficient for the work, the second being a stand-by. The remainder of the load which the station can carry will be furnished by public and private lighting and motor applications The public lighting, by means of arc lamps in the main streets and incandescent elsewhere, is already arranged, and there is no doubt that the remainder of the available power will early be taken up for private use. There is ample scope for further developments.

After the inspection of the works the visitors were entertained to lunch by Messrs. Bruce Peebles and Co., for whom Mr. J. S. Pitkeathly did the honours. Speculation was rife among the guests with regard to the identity of the caterer, and it ultimately transpired that Mr. Pitkeathly was himself responsible, having built a model kitchen specially for the occasion.

ELECTRIC TRAMS AND THE WORKING CLASSES.

With the beginning of December the Newcastle-upon-Tyne Corporation tramways department is commencing an experiment which will be of particular interest, as it introduces the principle of differentiation between ordinary passengers and workmen. The practice of using workmen's tickets has, of course, been in vogue for many years on the railways, but, as far as we are aware, there has not been any very great attempt at meeting the same problem on tramlines within a city boundary which workmen must use in travelling to and from their work. The new departure is the issue of weekly coupon tickets to male and female clerks, shop assistants, apprentices, warehouse employés, and those in other occupations which can conveniently be classed as workpeople. The limit of wages in the case of men is 25s. per week and for women 15s.

An office will be opened at the central part of the town near to Earl Grey's monument, where five or six tram routes converge, and from Monday, Dec. 2, these weekly coupon tickets will be issued over the counter any weekday, from nine in the morning till eight in the evening, and these tickets will be accepted by the conductors in lieu of cash The applicants are required to fill in a form stating wages and other particulars, which must be certified by their employers, and any attempt at misuse or fraud will be proceeded against under the by-laws of the Corporation. All applications in the first instance have to be made personally, but arrangements can afterwards be made for any other person deputed by the applicant to receive a weekly supply of tickets, provided that such deputed person produces the certificate which has been issued to the privileged passenger.

At any time during the issue of the weekly coupon tickets to passengers the Corporation reserves the right to require any person to fill up further forms relating to wages, etc., as circumstances appear to warrant such inquiry, and any person making a false declaration upon the forms provided will be prosecuted under the by-laws. Moreover, the Corporation reserves the right to make inquiries from any employer respecting the wages, etc., received by any person using these privilege tickets. Any person disregarding the regulations and instructions relating to the use of such weekly coupon tickets would have the privilege withdrawn, and no application for these tickets can be entertained if such application is sent through the post. The tickets will only be issued at the above-mentioned tramway office on presentation of the holder's certificate, which will have a registered number placed on it, and these certificates must be renewed during the first week in March in each year, during which time they must be presented at this office together with a further certificate on the standard forms provided, giving details of wages, etc., at that time and certified by the holder's employer.

The tickets are not available for travelling on Sundays or in any of the special cars provided during the period of the race week for the accommodation of passengers to the racecourse. The tickets will be sold in bundles, only one week's supply being issued to any person at any one time,

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and they must be used in consecutive order. Moreover, the ticket for each journey must be taken off from the bundle in the presence of the tram conductor, otherwise this official has authority to refuse such a ticket, and to demand the whole ordinary fare for the journey. Any ticket inspector or other tramway official may at any time demand to inspect the balance of the tickets in the packet.

The tickets enable any privileged person to travel twice or four times a day, according to the value of the ticket purchased, and at any time during the day suitable to themselves. The following schedule gives an idea of the concessions made in point of price: For 1d. fares passengers can travel twice a day for six days per week at 10d. per set per week; this is a reduction of 2d. per week per passenger. For 1d. fares for passengers travelling four times per ordinary weekday and twice on Saturday—that is to say, for a full fare of 1s. 10d.—the set for the week can be purchased for 1s. 6d. In the case of 1½d. fares, passengers travelling twice per day for six days per week—that is to say, taking a full fare of 1s. 6d.—the set of coupon tickets costs 1s. 3½. Passengers travelling four times per ordinary weekday and twice on Saturday—that is to say, spending 2s. 9d. in full fares—the coupon tickets will cost 2s. 3d. per week. For 2d. fares the reduction per week for passengers travelling twice per day and four times per ordinary weekday and twice on Saturday, is 4d. and 8d. per set respectively, on the same basis as above.

As, of course, these weekly coupon tickets represent money taken by the conductor, and, therefore, have to be at the head office, it is essential that passengers should keep the same in a fresh and clean condition, owing to the difficulty of recognition of tickets in a dirty and mutilated state. For this reason such soiled tickets will be refused by tram conductors, and the passengers presenting them will be obliged to pay the full fare for that journey.

It will be seen from the above arrangements that the scheme has been very thoroughly and carefully gone into, and it is to be hoped that the arrangement—which is to be on trial for a period of six months—will prove so satisfactory that they will be continued for a further period. Newcastle-upon-Tyne has been the pioneer in a good many improvements in the electrical world, and it is to be hoped that this latest progressive step on the part of the tramway officials will meet with the success which a broad-minded policy such as this deserves.

METALLIC-FILAMENT LAMPS.—HOW WILL THEY AFFECT ELECTRICITY UNDERTAKINGS?

BY A LAMP MAKER.

It is evident to all that the carbon-filament lamp with its low efficiency is doomed. For a few months, it may be a year or so, it will still be used by those who are slow to change. But the metallic filament lamp has taken its place, and it is well to consider its effect on the station. It has been argued that a loss of revenue might be expected, and these arguments have been met by the statement that decreased revenue would be balanced by increased use. It seems on examination that this idea is a chimera, and that it can be demonstrated that sufficient new customers can neither be obtained nor connected at a profit unless radical innovations in systems of charging and connecting are inaugurated. It is said that the coming of the 8-c.p., 8-watt lamp of high voltage—a lamp which I can assure my readers is coming—will be welcomed by the majority of engineers much as the coming of King Stork was welcomed after King Log. One very eminent authority, I understand, is looking forward to a large increase in the light unit used by the householder, foreshadowing huge 70-c.p. lamps, and plenty of them, as I take it. Another suggests that less care will be taken as regards switching off lights not required, and that less care will be taken to prevent a too liberal and, indeed, generous use of electricity. This seems a delicately expressed hope that the station may make its profit out of wasted current, paying expenses out of that which is used, much as fortunes are, as we are told, made out of the mustard which philanthropic diners leave on their plates.

As regards the first point, I can assure the critics that the householder is not going to use any more light than he needs in order to help electric light stations to make a profit. He knows the amount of illumination that he requires, and if he finds that the cost is extremely low he will chuckle, and consider that he is merely being recompensed for the heavy bills he has had to meet in the past.

I am afraid that there is nothing to be looked forward to in the matter of raising the light unit. The high candle-power gas mantle failed to do so, and I do not for one moment believe that this will be accomplished by the metallic-filament lamp. Why should it? The very expression of the hope seems the despairing cry of one on the brink of argumentative bankruptcy. Let us follow the idea to a logical conclusion. We desire to connect to our mains certain customers who have hitherto held aloof. Their reason for so doing was that it would have cost them, let us say, £5 per annum for electricity—an amount which they felt they could not afford. We told them that for that sum they could have so many candle-power for so many hours. They replied that the cost was too great, and they would continue to use gas giving an equal light for so much less. Are we likely to attract them by saying that we can now give double the light for the same money? If we made the offer, they would reply that they did not need the extra light, but they felt they did need the money they were saving. When people have all the light they require, they do not care about incurring a greater cost than they at present pay for an extra amount of light which they do not need. As a matter of fact, the light unit is now quite as high as the present standard of domestic comfort desires, and although in time it may increase somewhat, it will not do so to any appreciable extent. So we must not look for help from an increased unit of light, and the only argument to fall back upon to prove the falsity of the contention that the coming of the metal filament will be disastrous to the station unless we introduce radical innovations into our systems of distribution and charging, is to show that the increase in consumers attracted by the new lamps will provide sufficient revenue to balance the reduction in the income derived from existing users. Can this be shown? I am of opinion that not only is it impossible to do so, but that, on the other hand, it can be shown that with existing methods it will be financially disastrous to couple up the additional customers.

Let us first see what effect the hypothetical one-watt-per-candle-power lamp will have on present connections. The rooms already wired will be fitted with metal-filament lamps, with the result that the revenue derived from this part of the installation will fall to less than one-quarter of the original sum received. To some extent additional lamps in rooms hitherto lighted by gas may be fixed, but these will in hardly any case be in places where a long-hour remunerative load may be expected. The electric light will be extended to bedrooms, passages, etc., but the hours of burning will be so few that the income will be almost negligible. So that it would appear that to secure the necessary increased use we must open up new districts and secure new customers.

For many years station men have endeavoured to get small customers coupled up, and although these individually could never be very profitable, it was felt that in the aggregate they might be very valuable, especially in the cases of small residences and public-houses. The inclusion of small early-closing shops would be, of course, extremely undesirable, but most premises would be long-hour consumers, and consequently to be encouraged. It has always been admitted that the ultimate benefit, taking everything into consideration, would not be inordinately large; but be that as it may, station engineers in the past have wooed these clients, and are now apparently determining to have them by force, if necessary, in order to obtain that increased use they require to balance the decreased specific consumption with which they are threatened. My part is merely to show that if they are connected, and the new lamps which we have foreshadowed are used, the station engineer will find that he has discovered a more speedy way of losing money than any he has hitherto come across.

The reason I am going into this so insistently is that I see a great danger lying ahead in the shape of those who,

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as far as can be seen without reason, cry that all is well, and look to this chimera of "increased use" as something that will cause all troubles to come right in the end. Many who would otherwise begin to put their house in order are being lulled into a false security as the result of this cry, instead of going into matters thoroughly with the idea of finding some means of reducing the cost of connection. But I believe that the majority of station engineers realise in their inmost heart that the station revenue will be reduced, and sincerely hope, although they have no sound ground to work upon, that they will be able, owing to the cheapness of electric lighting—with which nothing could compete except oil—to connect up a number of new customers, and so make up on the swings what they will lose on the roundabouts. They have had but little or no experience with the class of customers they desire to exploit, and—in making this next remark I do not wish to be misunderstood—it is not their own money they are risking, but that of the ratepayers' or shareholders'. This has been responsible for much waste of money in the past, and it is time that all commercial men entered an emphatic protest against any further increase in capital expenditure, unless it can be clearly shown that the results will justify the outlay, and that one part of the district will not have to be taxed in order to make the extension seem profitable. These new districts are generally some distance from the station, and for some reason or other it was not considered advisable when the plant was laid down to incur the expense of running mains, nor up to the present has it appeared likely to be profitable so to do.

Now, owing to the threatened reduction in revenue, it is felt that it is of paramount necessity to open up these new districts, and unless engineers radically alter their methods, thus at once admitting my case, they will have to run their mains and couple up their new customers by the same methods adopted in other parts of the area. This course is practically an attempt to show that a profit can be made with a low revenue, out of a locality which it had been previously decided would be unremunerative with a fairly high charge. Still, it will be answered, it is hoped that considerably more customers will be connected at the low rate than the high—a case which seems, after all, like the old story that a profit could be made out of selling matchboxes ½d. under cost if only sufficient were sold.

It has been estimated that in a new district containing, say, 4,000 inhabitants we might expect by the end of two years, according to present averages, to have connected some 2,800 lights of 8-c.p., of present-day efficiency, at a lighting rate of 4½d. per unit, including town lighting. From this we should receive an estimated revenue of some £330 odd from sale of current, £40 odd from street-lighting, and, say, £20 from meter rents and sundries. This would thus amount to £390 in revenue, and the capital expenditure incurred would probably amount to some £5,350, including proportion of costs of generating works, high-tension feeder cables, sub-station transformers, distributing cables, services and meters and street lights, the revenue thus representing some 7⅓ per cent. on this sum. On such a total the interest and sinking fund charges should be taken at 6 per cent.—a total of £321—leaving £69 to pay for costs, excluding capital charges. The costs of generating 2,000 units at the low estimate of 1d. would amount to £83, so that even at 4½d. per unit, with lamps at their present efficiency, the loss on the extension would be £14 per annum! And nothing whatever is provided towards depreciation!

It seems opportune here to point out that my authority for the above figures of costs and revenue suggests supplying such a district by overhead mains, and he further estimates that the adoption of these would cut down the capital expenditure to some £4,300. The capital charges on this would total £258, and thus leave a sum of £132 for works costs and profit. Taking the costs as before, we get, then, a sum of £49, just over 1 per cent., available for profit. It is doubtful, however, whether the extra clerical labour, inspection, etc., necessitated would not bring this down to vanishing point. So that we again reach the conclusion that was apparently arrived at in the first place, which was that such outlying districts as the one we have instanced do not pay for connection.

Let us go further into this investigation, and taking our lamp basis as correct, and reducing our revenue of £390 in direct proportion, we find that our hypothetical one-watt-per-candle-power lamp will reduce this to about £86. Now, our capital charges remain the same, but our generating costs will be reduced in direct ratio. To the estimate based on underground mains we add the reduced generating costs of, say, this time, £19, to our capital charges of £321, making a total of £340, and are at once face to face with a deficit of £254! And in this typical district of 4,000 people, wherein one of the best-known station engineers in England estimates gaining a total of 80 customers and some street-lighting in two years, is it likely that we are going to find 288 additional customers in time to save our financial reputation? And with overhead mains it is very little better.

Nor is this all. The above figures in the estimate of capital charges estimate the sum of £1,600 as cost of overhead distributing mains, meters, services, etc., for 80 customers and 40 street lamps. The requisite 288 new customers, taken at the same average, will cost, for the same items, an additional £5,760. These new connections raise the capital charges to £10,060. To pay interest and sinking fund on this at 6 per cent. will take £603 odd, so on capital charges alone we face a deficit of £213, as well as supplying current for nothing. And I shall be glad if some of my anticipated critics will show me how many more customers with metallic-filament lamps are to be connected, on the above basis, before a profit is shown—unless certain radical changes in methods are carried into effect.

I may be again met with the statement that I am dealing only with hypothetical cases, and so it may be well to look at some results actually obtained in cases where attempts have been made to induce customers of a poorer class to use electricity. There has always been in the minds of certain engineers—perhaps first implanted by the fallacious but much quoted remark, that "electricity is the poor man's light"—an idea that working-class districts would prove veritable golcondas if only the cost of current could be reduced, and some cheaper method devised of wiring the houses. I have no hesitation in saying that with present methods this idea is incorrect. With certain innovations and alterations in systems of charging it might be profitable, but, after all, the whole question of electricity supply is about to undergo so great a change that, strange to say, the question of whether a profit is made in lighting, or whether it merely pays legitimate expenses, will have very little effect on the station.

I am well acquainted with a neighbourhood, not by any means a working-class district, but one where the houses let at rentals of from £28 to £36 per annum (not including rates), and where the houses were wired *en bloc* during erection, and are served through slot meters. For each house a separate connection has been made, necessitating at least 15 yards of armoured main laid in the ground, cast-iron double-pole cut-out, and Geipel and Lange meter. The cost of this, including labour, may be easily calculated by optimists who wish to extend their mains into new districts. The price obtained averages slightly under 5d. per unit. From the *Electrical Times* tables of costs I see that from the units sold throughout the area these houses should average a consumption of 90 units per annum. I gather from inquiries made on the spot that the customers in this district do actually use from 70 to 100 units per annum, the average being about 75, which means a revenue of, say, 31s. per annum per house. The total costs in the whole area, which is a prosperous business centre as well as a good class residential neighbourhood, are over 2d. Taking this average consumption, and deducting the works costs, which we take at 1⅓d., or 11s. 8d., we have 19s. 4d. to cover interest, sinking fund, cost of connection, depreciation, labour in meter reading, and general attention, and the risk of the property falling empty or the tenant reverting to the use of oil. In one street of 40 houses it is no uncommon thing to see half a dozen or more empty houses, whilst an evening stroll reveals the fact that several tenants are using paraffin throughout. This amount, therefore, does not show a large margin of profit.

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Now, let us imagine that in this district metallic-filament lamps are installed, as they certainly will be in the near future. The reduction in current used would not have an undue effect on the costs of the station, but we may imagine, in order to represent the case as fairly as possible, that by dint of strenuous effort the works costs are brought down to 1½d. per unit. Now, our installation with 4½-watt lamps has averaged 75 units. With our suggested lamp, and allowing for a due proportion of increased use, this average will fall to 18 units. The revenue would be, therefore, 7s. 6d. per annum. Our total costs on this are at least 3s. (although with a reduction of output the total costs would rise considerably, as the standing charges would remain the same. We are, however, not concerned with this aspect at present, although obviously it would help our case considerably), leaving 4s. available for other purposes. But to pay a fair rate of interest, and to allow for a sinking fund on the cost of connection on each house, would require from 10s. to 15s, and as I imagine that the periodic visits of inspectors and meter readers and a due share of accountancy charges alone would swallow up a considerable portion of this 4s. balance, what follows? It seems to me that it would tax even municipal book-keeping to find this a profitable transaction. But the installations cited above are not, as I said, in a working-class district, and it will be well to look into some previous attempts to connect such areas and see whether they have been uniformly successful. For I cannot see how, if they are not so at present, they can possibly be made to pay since the introduction of metallic-filament lamps.

A certain supply company near Manchester some years ago considered it advisable to open up such a district. A block of nine houses was connected to the mains at one end, and a cheap looping-out system of distribution was adopted to carry the current into the separate premises. I understand that no meter was fixed, and the tenants were charged the exceedingly low flat rate of 5d. per week. It will be seen that the methods adopted were very different from those used to-day, and were, in fact, a great advance towards the common-sense distribution of electricity; but even so, the plan was unprofitable. Owing to most of the tenants preferring oil rather than pay the low weekly charge, the block was disconnected, and it would seem that this shows that, even at so low a rate, electricity is not a popular illuminant; nor, if one can judge from this example, does this class of property seem ever likely to repay the cost of connection, however cheaply this is done. I understand that Mr. Slevin, in the Pemberton district, has experimented with cottage property. He has used a very cheap system of wiring, and has endeavoured to reduce costs wherever possible. Even at the rate he charges—which is 8d. per week for four lights up to 1s. 9d. per week for 18 lights—he finds it is not a lucrative investment. And I have no doubt but that again it is the capital charges that kill the enterprise.

Manchester has had a considerable amount of experience in supplying outlying districts, as several orders were taken over some years ago, with the result that it was found that the capital expenditure on the four that are now incorporated into the city was so high that two other orders have not been put in force, as it has been found that these districts can never hope to show any return. At Birkenhead an outlying district supplied some years ago proved a loss until 1904, although an extra penny per unit was charged and the undertaking managed with the utmost care. Imagine the financial result had this district in the first place been fitted up with 8-c.p, 8-watt metallic-filament lamps! At Eastbourne the capital charges were so high that the supply authorities would not undertake the work until they had a guarantee of a certain minimum demand for three years. Northampton, one of the soundest companies in the kingdom, is particularly careful over extensions of mains, and has adopted a very conservative policy in connection with customers which has borne good financial fruit. But these sound business methods would be of little avail were the revenue, due to the changing to metallic-filament lamps, to fall by seven-ninths. Already at Northampton the effect of the new lamps is being felt. At their meeting it was announced that the immediate effect of the introduction of the new high-efficiency lamps was to retard appreciably the growth of output and to injuriously affect the revenue. And there are only a few lamps connected to-day, comparatively speaking, and those of a considerably lower efficiency than may be shortly expected! What will be the effect of the low candle-power metallic-filament lamp when in use throughout the system?

It may be said that I have hitherto been speaking in generalities, and that in dealing with small bulk supplies and the like, and in instancing estimated returns on estimated capital charges, I have been dealing with my case on a broad theoretical basis that is likely to prove inexact when narrowed down to individual cases. So I will go further still, and, taking figures prepared by a well-known station engineer, show that in no case can small property be connected at a profit where our hypothetical lamps are installed and present method of distribution and connection are used. Lest it be held that I have chosen estimates to suit my case, I may say that, so far from this being so, they are considered by most station engineers to whom they have been submitted to be unduly optimistic from a revenue-earning point of view; but first a little digression.

It has been suggested—and frequently the suggestions have been acted upon—that the class of property to which the station engineers are looking for salvation from the metallic-filament lamp could be reached by a system of free wiring combined with slot meters. In spite of the utter failure of free-wiring experiments, due in every case to the high capital expenditure combined with the uncertainty of tenancy, the idea has a certain fascination to many, and in connection with it some very elaborate and carefully-worked-out estimates of costs and revenue have been worked out, and it is on these that I have based the following deductions, having purposely selected those least favourable to my case. We may say that the property that it is desired to reach consists of small residences of the lower-middle and working class, together with the small shops always associated with such districts. The occupiers are at present using gas or oil, the majority being oil users, and very few of them could afford the expense of wiring their premises. They rent the houses weekly, and are peripatetic, and of uncertain credit. A station engineer has described the class as consisting of the better-class artisan, small shopkeeper, and clerk down to the labourer earning £1 per week. The houses are not large, either as regards size or number of rooms, and the average lights would be of the equivalent of six of 8 c.p., placed as follows: hall, one 8-c.p. metallic-filament; front room, one 16-c.p. metallic-filament; back room, one 16-c.p. metallic-filament; kitchen, or scullery where back room is used as a living-room, one 8-c.p. metallic-filament. All these lamps would probably be fitted with some form of holophane or similar reflector. It would be useless to have the bedrooms or upstairs landing wired, as the lights would be used only for short and unremunerative periods. In the above table it is certain that more than half the lights would be only used at extremely irregular intervals, and as a matter of fact the only light—and this is a point almost always overlooked by those who clamour for the connecting of this class of property—in regular use would be the kitchen or living-room lamp. At the most favourable average, allowing for lodgers, houses with two families, etc., we could not estimate an average use of more than two 8-c.p. equivalents per installation throughout the area, and our revenue would be that derived from the use of 16 watts per hour, or one unit in 62 hours, say 18 units per annum, which, with electricity at, say, average 5d., amounts to about 7s. 6d. As a matter of fact, this is really too high an estimate. We will leave out of our calculations the cost of wiring the premises, as at present we are not concerned with that question. Nor need we consider who should carry out this work, whether the supply company or the landlord. It appears certain that it will not be done by the tenant, and that is all that at the moment is of interest. Incidentally it may be mentioned that the cost of wiring such premises would be about 42s. complete at the lowest estimate. Personally, I should not care to undertake the work at anything near that price, but the estimate considered gives it at about that figure.

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In considering the next question, which is the cost of connection, we will suppose that out of existing methods the system of charging by prepayment meters is adopted. By ordinary meters a risk would be run of incurring bad debts, as well as of constant disputes and loss of custom. Obviously, also slot meters will be most convenient for the client as well as most safe for the station. The estimate of cost considered includes service cable, allowing an average of 12 yards of $^3/_{20}$ vulcanised indiarubber, and the cost of this, together with the joint-box, house terminal box, meter board, meter, and men's time fixing, is found to average £4. 19s. 3d. For the sake of round numbers I am taking this at £5. The interest and sinking fund on this we may take as 6s. The total costs of the generating station work out, let us say, 2d. (although 2¾d. appears to be more nearly correct in the case under discussion), or 3s. for our average consumption. It is evident that a further sum must be charged for the visits of meter-readers, inspectors, cash collectors, and accountants' work, and to cover empty houses, and the risk of reverting tenants, and I do not see that this should be taken at any less than 5 per cent. on the outlay, or 6s. We have now a total cost of 15s, and we have allowed nothing for the cost of mains. In opening up this district a considerable amount of cable would be necessary, and, although in view of the high efficiency of our lamps, there would be no need to run very heavy cables, yet the cost of mainlaying with any system at present in use would not be less than from 5s. to 6s. per yard, and it is doubtful whether, taking everything into consideration, this would not amount to about 8s. per yard throughout. So that allowing nothing for mains and mainlaying, and assuming that our house remains tenanted, and the light used for one year, we have a revenue which I estimate at 7s. 6d. towards an expenditure of 15s.

But there is a further allowance to be made for lamp renewals, as no tenant will replace these himself, neither will he pay for any repair to the installation (and at a price of about 7s. per point for wiring and fittings I can imagine a good number of repairs being necessary before the place finally burnt down), and it may be taken as a fact based on a lengthy experience that at the least failure the tenant would revert to oil. Few who know and appreciate the electric light have any conception of the unpopularity of electricity with the class we are desiring to reach. Oil is, and I fear will be for some time, the favourite illuminant, and although it will be discarded when the metallic filament arrives and philanthropists have wired cheap houses, thereby committing financial suicide, at the first failure, or request for out-of-the-way payment, back the tenant will go to oil, until the supply man, cap in hand, and abjectly apologetic, begs him to resume his use of the installation which has been overhauled or fitted with new lamps at the ratepayers' or shareholders' expense!

This is the point! The metallic-filament lamp has come to stay, and radical alterations in systems of connection and charging are necessary unless disastrous results are invited. And when the coupling up of small consumers without such alterations is suggested as a sound method of meeting the new condition of affairs, may we be reminded, always and ever, of the fact that those whom the gods would destroy they first make mad!

THE PRODUCTION OF POWER FROM PEAT.*

BY T. TOMLINSON, B.A.I., M.I.E.E., M.I.C.E.I., CHAIRMAN.

Successive failures in attempts to deal with peat as fuel on a commercial scale have so discredited peat as a fuel that there is great danger that Irish engineers and capitalists—remembering these failures and not inquiring into the causes—may allow the exploitation of our great industrial asset to pass into the hands of outsiders—to their profit and not to our credit—through not taking note of the advances made, because not interested in the matter, and through not remembering how rapid in this century is the advance in science and engineering, and that what may be looked upon as impossible one year is shown to be feasible next year, and in 10 years or less is done. To emphasise this latter point, let me remind you, though it is scarcely necessary, that only nine years elapsed between the wireless message from the Kish to Kingstown and the opening of wireless communication between Port Morein and Clifden, and that the magnificent performances of the "Lusitania" and "Mauretania" are made possible through the steam-turbine, which less than 20 years ago was a laboratory experiment, and, I believe, unsuccessful at that. Do not hastily draw the conclusion that, because to emphasise a point, I instance two recent engineering triumphs which could only have been carried through to a successful issue by men as exceptionally gifted as Parsons or Marconi, with those rare combined gifts of scientific insight, self-confidence, and iron resolution with which Nature has to dower a man when she has new and difficult work to be done.

The problem to which I direct your attention to-night is not of this sort. I am firmly persuaded, and I hope to show you, that through work already done and advances already made it is a very ordinary bit of engineering journey-work—that the thing is perfectly feasible to-day on sound commercial lines, and that it can be undertaken whenever the capitalists will find the money. Lest you should suppose that this is an over-statement, let me put the matter before you in a way which will appeal to you as engineers. On May 17, 1907, *Engineering* had an article on a recent test of a peat-gas and ammonia-recovery plant, the gas being used to drive a gas-engine. The account of the trial is as follows: "The method adopted in the experiments at Winnington was Dr. Caro's process for the gasification of inferior fuels by means of air and superheated steam. The experiments were made in the Mond gas plant, and the resulting gas utilised in the gas engines; the superintending engineer was not informed that he was burning a special mixture, and he did not notice any difference. The peat came from Italy, the special machinery having been constructed for that country. Altogether 650 tons of this peat were gasified. The peat contained about 40 per cent. of water—the percentage varied—and in the dry state 15·2 per cent. of ashes, volatile substances 43·8 per cent., nitrogen 1·6 per cent., and 34 per cent. of carbon. A ton of dry peat yielded 1,780 cubic metres of gas of 1,360 large calories (about 150 B.Th.U. per cubic foot), and 55 kg. (118lb.) of ammonium sulphate; this amount of ammonia was really obtained, and not only calculated. The gas generated was partly utilised for raising the steam required for the process, and also for evaporating the ammonium sulphate, and it gave, in addition, 480 horse-power hours in the internal-combustion engine—that is to say, the ton of dry peat yielded 480 horse-power hours, in addition to 66 per cent. of its contents of nitrogen as ammonium sulphate. An estimate of the cost shows that under such conditions peat and producer gas has a good prospect of being financially successful. Not reckoning the value of the ammonium sulphate, the horse-power hour cost less than 0·5 pfennig (0·06d)."

Now, I think you will agree with me this far, at any rate, that a test like that raises the problem out of the experimental stage, and brings the matter within the sphere of practical engineering. It has, at any rate, done so in the case of certain foreign capitalists and engineers, for in *Engineering* of May 31, 1907, Mr. Mond wrote, referring to the above quoted article: "These were carried out solely by my company at its engineering works at Stockton-on-Tees, where the Mond plant is manufactured, and it is quite correct that the peat gas was turned into the gas-engine driving the works by ordinary Mond gas without the change being noticed by those in charge of the engines. In consequence of this, we have now concluded a contract with the Società per l'Utilizzazione dei Combustibili Italiana, Milan, for a 2,000-h.p. ammonia-recovery peat gas plant for a central electrical distribution station to be driven by gas engines consuming peat gas. This plant is now being constructed at our works, and we expect that it will be operating at the end of this year. We have also utilised successfully Swedish and other peats."

As "La Società per l'Utilizzazione dei Combustibili Italiana" has got to work, one may hope for "An Kunroo dhun dhane-toosh nah Monah nah harean," which is the

* Opening address delivered before the Dublin Local Section of the Institution of Electrical Engineers, Nov. 21.

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same thing in Irish. You will, I hope, pardon alike my Italian and my Irish for the sake of the sentiment. Assuming that the generating station of the Italian company is at the bogside and that the waste heat is utilised to dry the peat, then we may take it that there is now in progress of erection in Italy a plant embodying that solution of our problem which I resolved to make the subject of this address when you did me the honour to elect me chairman. I am glad to be able to quote the action of "La Società" to help convince you, but I should have preferred "An Kunroo" to have got in advance of "La Società," and to that extent I regret the precipitancy of the Italian gentlemen. As Prof. Townsend once put it, "The worst plagiarists are those who anticipate us," which is at the same time a designedly delicious Irish bull and a profound truth. It does not appear from the extract (which is all the information I have) that the waste heat is to be utilised in the Italian case to dry the peat, and under the climatic conditions of Italy this may not be necessary; but I am perfectly satisfied that it cannot be relied on in Ireland, where Nature, in a jesting mood, gave us 2,500 millions tons of easily accessible fuel, but waterlogged it to the extent of 90 per cent., and, to crown the jest, gave us one of the dampest climates in Europe.

The one thing which distinguishes the scheme of utilisation which we are considering from all others tried here, of which I have any knowledge, is this, that it makes available for the absolutely necessary drying 60 per cent. of the total heat value of the peat—this makes the thing possible from an engineering point of view. After it has thus been made possible, the recovery of the sulphate of ammonia makes it profitable as a commercial undertaking, or perhaps it would be more accurate to say that the value of the sulphate of ammonia per ton of dry peat covers, and, in my opinion, more than covers, the cost of getting the peat and reducing it to such a state of dryness as enables the rest of the drying process to be carried out in the producer. Let us first consider the question of the value of the sulphate of ammonia per ton of dry peat, which, it is scarcely necessary to say, is recovered by passing the gas through sulphuric acid. On this point there is a fair agreement.

Engineering, in the extract quoted, gives 118lb. "really obtained and not only calculated." Mr. Rigby, in a paper read in March, 1906, before the Engineering and Scientific Association of Ireland, gave 130lb., and I have a recent analysis of peat samples, taken by myself from three different levels in an Irish bog, from which an expert in producer plant states 85lb. per ton of dry peat is recoverable; the figure varies according to the percentage of nitrogen in the peat and the manner of working the plant. Taking the last figure, we have one ton of sulphate of ammonia for every 26 5 tons of dry peat. Now, a ton of sulphate of ammonia is worth £12 and the sulphuric acid is worth about £1. 10s., leaving a net value (exclusive of labour, interest, and depreciation of plant) of £10. 10s., or 7s 11d. per ton dry peat—say, 7s. Now 7s. per ton of dry peat is 3s. per ton of peat containing 40 per cent. of moisture (air-dried peat), so that virtually the problem of peat utilisation is narrowed down to the getting of peat equal to air-dried at a cost as near 3s. per ton as possible. If you can get it at that price you have fuel free.

Lest you should think I overstate the case in stating free fuel as possible, let me read you an extract from the *Engineer* of June 29, 1906. At the launch of H.M.S. "Agamemnon," Mr. Beardmore, the chairman of the Naval Construction Works, Dalmuir, is reported to have said: "The yard was also unique in this respect—that it was the first establishment of such proportions in which steam as a motive power had been entirely discarded. All the machines were driven by electric motors, and those motors were worked by electricity generated by internal-combustion gas-engines. There was not a steam-boiler in the whole place. In this he thought they might claim that they had done something wholly new. The gas they used for power purposes they first of all chemically treated so as to extract from it the nitrogen, which was of no use for heating purposes, but was of great value for fertilising purposes. The result was that by taking from the gas that nitrogen, and forming it into sulphate of ammonia, they found that when they came to square their accounts that their coal bill was entirely paid by the money received for sulphate of ammonia." From that coal 85lb. to 90lb. of sulphate of ammonia was recovered—precisely the quantity recoverable from the peat samples I have alluded to, and considerably less than that actually recovered from peat in the test above given.

It is not possible in this country to get air-dried peat at 3s. per ton with manual labour and open-air drying, as is the universal practice in Ireland; but there is no reason why it should not be got and dried at this price if machine getting and drying by waste heat be adopted. Of machine getting and treatment we know nothing in this country, where the cheapness of seaborne English coal makes peat valueless except to supply local requirements, but in other countries where fuel is dearer machinery is extensively used. Of machines and systems there is no end, and I do not propose to weary you by describing them. I shall confine myself to giving you cost of their operation, which is the important point. The first (Brosowsky) is a simple hand-operated machine, of which 1,300 were made for Pomerania and Mecklenberg during the first five years of its introduction. It is also the simplest. With this machine the yield, reduced to dry peat, is said to be two tons cut and laid to dry per man per day, and the cost for labour would, therefore, be 1s. 6d. per ton of dry peat. A much more elaborate Swedish machine (the "Anrep") is stated to deal with the equivalent of 24 tons of dry peat per day of 10 hours at a cost of 3s. 4d. per ton of dry peat, and takes as power 10 brake horse-power hours per ton of dry peat, which seems a very excessive allowance. A still more elaborate German machine, the Schlickeysen, or Dolberg, is said to do only 3·8 tons of dry peat in a 10 hours' day, at a cost, inclusive of hand digging of peat, of 2s. 6d. per ton of dry peat, with an expenditure of 5 b.h.p. per ton of dry peat The first machine gives peat in sods of the wetness of the bog (say 90 per cent.), and it would probably be used for getting a summer harvest of air-dried peat when the season favoured, for no man wants to do by machinery and artificial heat what Nature, when in the mood, can do more cheaply. The second machine is one of a very numerous class in which the peat is macerated, forced through nozzles, and cut into briquettes. The briquettes contain about 80 per cent. moisture. The third employs maceration and pressing in a modified sewage sludge press; it delivers the peat with 50 to 60 per cent. moisture. It is then most effective, but it is slow, and the necessity of using bags to contain the peat during compression, which appears to be absolutely necessary where a high degree of compression is attained, is not desirable; but, on the other hand, it is effective in the extraction of moisture, it necessitates no atmospheric drying—with the inevitable handling—it delivers the peat in a suitable form for artificial drying, and its stated cost of operation is well within our requirements.

That the work can be done at or about this price of 2s. 6d. per ton of dry peat I have been assured by Mr. Lennox, an engineer and expert in this matter of peat getting and drying, and the inventor of drying apparatus now in successful operation, to whom within this past week I submitted the problem with a statement of the waste heat available.

(To be concluded.)

THE ELECTRICAL ENGINEERS, R.E. (VOLS.).

Orders for week ending Saturday, Dec. 14.

MONDAY, DEC. 9.—"A" Coy.—Hop. Cup Competition, 7 p.m.

TUESDAY, DEC. 10.—"B" Coy.—Hop. Cup Competition, 7 p.m.

THURSDAY, DEC. 12.—"C" Coy.—Hop. Cup Competition, 7 p.m.

FRIDAY, DEC. 13.—"D" Coy.—Hop. Cup Competition, 7 p.m.

SATURDAY, DEC. 14.—Corps dinner, 7.30 p.m., at the Cafe Monico (International Hall), uniform, mess, or evening dress.

(Signed) J. H. S. PHILLIPS, Captain,
Acting Adjutant.

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LEGAL INTELLIGENCE.

RE S. G. BROWN'S PATENTS.

This case came on for hearing in the Court of Appeal, consisting of the Lord Chief Justice, Lord Justice Buckley, and Lord Justice Kennedy, on Wednesday, the 4th inst., on the appeal of the petitioners from the judgment of Mr. Justice Neville in the Chancery Division on March 11.

In this case the petitioners petitioned for the revocation of the letters patent in question on the ground of want of novelty, utility, and subject-matter. The letters patent were granted to Mr. S. G. Brown "for improvements in telegraph apparatus," the invention consisting in a relay for retransmitting messages received through cables and an apparatus used therewith. In May, 1906, A. Muirhead and Muirhead and Co. presented a petition for revocation of the patent, which was served on the owners of the patent and their licensees, the Commercial Cable Co. The usual grounds of invalidity were alleged at the trial, and a number of prior publications were discussed, and evidence was also given as to common knowledge.

Mr. Justice Neville, after a nine days' hearing, on March 11 last held that the petitioners had failed to establish any of their objections to the patent, and dismissed the petition, with costs. Hence the present appeal of the petitioners.

Sir Robert Finlay, K.C., Mr. Cripps, K.C., Mr. A. J. Walter, K.C., and Mr. F. Sinclair (instructed by Mr. Alfred Withers) appeared for the appellants; Mr. Bousfield, K.C., and Mr. J. C Graham, K.C. (instructed by Messrs. Trinder, Capron, and Co.), were for the respondents on the appeal; and Mr. E. Russell Clarke (instructed by Messrs. Budd, Johnson, and Jackes) appeared for the Commercial Cable Co.

INSTALLING ELECTRIC BELLS.

A sequel to the fire which occurred at the Duke of Grafton's country mansion, Euston Hall, near Thetford, Suffolk, some time ago, was heard at the Brompton County Court last week, when Mr. George W. Henley, an electrician, of Oxberry-avenue, Fulham, sued Mr. Thomas Heath, builder, of South Eaton-place, S.W., for £34. 11s. 8d. in respect of work done. Mr. Heath counterclaimed for £91. 10s. 3d for damages for breach of contract over an electric bell installation at the Duke's mansion after the fire. The plaintiff's claim was admitted, and after judgment had been given the counterclaim alone remained to be dealt with.

Mr. BALL, counsel for Mr. Heath, said his client's claim was in respect of inferior material used by Mr. Henley in putting in the installation at his Grace's country seat, and the estimated cost of putting the installation right. Mr. Henley undertook to fit an electric bell installation in the new wing of the Duke's mansion which Heath rebuilt for his Grace to replace the portion which had been burnt down some time before. The estimate for £28 was accepted with the proviso that only the best material should be used in the work. The order specified the number of bell pushes to be put in the rooms, the fixing of indicators, and a provision as to the tones of the bells on each floor being different. A man named Dewhurst, who was a third party in the action, was sent by Mr. Henley and did the work. Up to July, 1906—the work was carried out in 1905—the Duke of Grafton was not in residence, but about that time his Grace went home with the view of holding shooting parties in the autumn, and it was found that the installation would not work at all and there were numerous faults, and that many of the bells would not ring, and that the pushes when they were pressed in did not come out again. The batteries were found to be run down, although up to that time they had naturally been used very little, as nobody but servants were in the domicile. Counsel added that Heath wrote to the plaintiff and asked him to remedy the faults, telling him that, contrary to the agreement, he had put in very inferior materials and workmanship, but plaintiff did not send, although defendant told him that he was getting into a lot of trouble in the matter. Finding that the plaintiff would not send a man, defendant sent an electrician himself, and it was found that, instead of the best materials and work which had been specified for as fit for a very high-class residence, the material was very inferior, and the bells of the very cheapest quality. In the places where the wires should have been run through pipes they were simply fastened down with staples, which had corroded, and the insulation had disappeared, leaving the wires naked. Under the flooring the wires had been stretched tightly over the concrete. There were several short-circuits. Owing to plaintiff's refusal to put it right another had been employed to do so, but, unfortunately, the family and guests being in residence, and the carpets down in many of the rooms, it was impossible to make as good a job of it as was wished. An expert would be called before his Honour.

Judge SELFE: Not for me to hear. A judge is supposed to know something about law, but he can't be expected to know anything about electric bell installations.

In the end his Honour referred the matter to Mr. Prestwick, an electrical engineer, as arbitrator.

GAWLEY v. BELFAST CORPORATION.

The hearing took place last week in the Court of Appeal, Dublin, of the arguments on this appeal, which was brought by Mrs. Gawley against a decision of the King's Bench Division that her action was barred by the Public Authorities' Protection Act, 1904, as not having been commenced within six months of the cause of action. Her husband was injured on June, 13, 1906, having been knocked down by a Corporation tramcar in Belfast. On July 30 he sued the Corporation for damages for personal injuries, and on Feb. 28 of the present year, before the action was tried, he died, and with him the action. His wife then brought an action under Lord Campbell's Act, claiming damages for his death. This action the Court held on demurrer to be barred.

The LORD CHANCELLOR intimated that he need not discuss the question as to whether the Corporation came within the Public Authorities' Protection Act. The real contention was whether the cause of action ran from the death of Bernard Gawley or from the date of the accident.

At the close of the arguments, the LORD CHANCELLOR delivered judgment. He said the facts were these: Bernard Gawley brought an action against the Belfast Corporation founded on personal injuries, which he attributed to the negligent management of their tramcars. The writ was issued in July, 1906. He died before the action was tried, and consequently the action died too. His widow brought a new action under the Fatal Accidents Act in April of this year. Thus this action was brought within six months after the death, but after six months had elapsed following the alleged negligence. The Corporation had moved the King's Bench to dismiss her action on that ground, but as it was brought after the lapse of more than six months from the occurrence of the alleged negligence, the plaintiff's case was barred by the Public Authorities' Protection Act of 1903. The Court of King's Bench had taken this view, and had dismissed the action with costs. The appeal was heard on two grounds—first, that the real cause of action was her husband's death, and that the six months ran from that date, and not from the date of the injury; second, that the Belfast Corporation were voluntarily engaged in running trams as an ordinary company, that they were under no legal duty to do so, and that they were not public authorities entitled to the protection of the Public Authorities' Protection Act. With regard to the first ground, the Court was of opinion that the death was only the occasion of the widow's right to sue, and was not in itself the real cause of action. By a careful examination of the Fatal Accidents Act, 1846, it was clear that the Legislature intended to give the widow a right to bring an action which her husband could have brought had he been alive, and it had been decided in a long series of cases that the defendants could, as against the widow, rely on every defence which they could have raised against the husband if he had brought the present action. If the husband had issued this writ, the action was clearly barred by the Act of 1903, and the wife's action must also be barred. The Court of Appeal in England, in the case of Williams *v.* Mersey Docks Board, had under a similar state of facts taken this view, and they saw no reason to differ from them. With regard to the second question—namely, were the defendants, having voluntarily undertaken to run trams and carry passengers, entitled to claim the protection of the Act—he said that this question had not been raised in the Divisional Court. However, it was a question of law which they were prepared to decide. In their opinion the Corporation, having obtained the authority of Parliament to run trams, became bound as a duty to the public to do so. The whole scheme of the local Act of 1904 showed that the Corporation was acting as a public authority, and performing "duties" to the public, and, therefore, they were of opinion that this point also failed. The appeal must, therefore, be dismissed, with costs.

Lords Justices FITZGIBBON and HOLMES concurred.

BAKEWELL v. GEORGE SHAW AND SONS.

At the Sheffield Assizes last week Mr. Justice Channell heard a case in which Mr. William Bakewell, an electrical engineer of Sheffield, sued Messrs. George Shaw and Sons, of Holmes Pottery, Rotherham, for £257. 7s. 8d. for electrical apparatus supplied and work done. The defendants contended that the materials supplied were not of the nature stipulated for in the contract, and counterclaimed £224. 10s. 2d., the sum expended in making the work in accord with the terms of the contract. The chief point in the case was the construction to be placed on certain terms in the contract and upon terms and expressions used in other documents.

Ultimately the case was settled on terms which were not announced.

COMPANIES' MEETINGS AND REPORTS.

SINGAPORE ELECTRIC TRAMWAYS.

The ordinary general meeting of the Singapore Electric Tramways was held on Tuesday in London, Sir Frank A. Swettenham, the chairman, presiding.

In moving the adoption of the report, the CHAIRMAN explained that although the Company was incorporated in March, 1905, the five sections of the tramways at present in use were not passed by the authorities and certified for traffic until September of that year, except in the case of one section only, which was opened on July 24, 1905. The accounts were made up only to Dec. 31, 1906, and the net result, which on the profit and loss account showed a loss of £7,623. 19s. 3d., could not be regarded as any indication of the future prospects of the Company. For some months after the opening of the tramways traffic receipts were exceedingly low; considerable expenditure, out of proportion to revenue, had been incurred in the early days in trainng the native staff, and a large undertaking such as theirs could not be expected immediately it was set in operation to be earning a profit on £750,000, and the directors considered it satisfactory that the traffic receipts had already so increased that the payment of interest on the £350,000 debentures was well assured. In referring to the possibilities of the undertaking, he mentioned that an important section of the tramway was still incomplete. That was known as No. 6, and would run from a point near the Tank-road Station of the Singapore-Kranji Railway down to the mouth of the Singapore River. The completion of this section had been delayed

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from several causes, principally pending negotiations and agreement with the Municipality as to the contribution to be borne by the tramway company towards the cost of building a new bridge over the Singapore River wide enough and strong enough to admit of a double tramway track, and, therefore, of greater width than would otherwise be necessary for the public convenience, and also to the fact that over a considerable portion of the section the Municipality found it desirable to remove their water-mains and to relay them in another part of the road, and until that removal work was completed and the ground fairly settled, it was not desirable that the track should be laid in those roads. They were pushing on with the work from its northern end down to the Dalhousie Monument, about 200 yards from the approach to the proposed bridge. When they got to that point they would have to wait until the bridge was ready to receive their rails. The intention was so soon as the track was completed to the Dalhousie Monument to put cars upon this section, and considerable extra revenue was looked for from that portion of the system. That section, it was anticipated, would be of much greater value to the Company when it could be carried over the bridge, as it would then link up with the tramway to the west of the river and so make complete and continuous their water-front lines, which, with the important dock extension work, should contribute largely to the traffic receipts. The Chairman added that the percentage of increase in the number of passengers carried was greater than the percentage of increase in receipts, and was attributable to the reduction of fares in March, 1906. The passengers carried per car mile worked out at 3·06, 6·49, and 7·12 respectively during the three periods (one of nine months and two of eight months each). Here also there was a substantial increase. In determining the routes and extent of the tramway consideration was given to the probable growth of Singapore, and to the traffic which might be expected therefrom. At present, at the extremities of the system, the cars were not so fully employed as they should like, but, on the other hand, the cars on the central portions of the system were very often carrying more passengers than they had seats for. Earnings per car mile in the three periods stood at 5·34d., 6·83d., and 7·48d., and it was satisfactory to note that the expenses per car mile had steadily gone down from 4·45d. to 4·38d., and for the third period to 4·03d. The average fare per passenger for the first period (before reduction of fares) was 1·72d. During the last two periods it had stood at 1·03d. The average weekly receipts over the three periods were £580, £940, and £1,117.

Sir Charles Petrie seconded the motion, which was carried unanimously.

PROVINCIAL TRAMWAYS.

The ordinary general meeting of the Provincial Tramways Co. was held on the 29th ult. at Moorgate-street-chambers, E.C.

Mr. Andrew Beattie presided, and stated that the Company had never had a better year than the one under review. In the early part of the year they had to meet the effects of inclement weather, but, notwithstanding this, the receipts were £38,046, an increase over those for the previous year of £7,055, or nearly 22 per cent. During the last few years they had been making great progress, and the figures for the current year since Oct. 1 showed a still further increase in revenue. Owing to the conditions prevailing in the money market, the directors had found it impossible to make a successful issue of the 4½ per cent. debentures which were authorised last year, and in lieu of this they proposed to issue £175,000 of 5 per cent. debentures, which would be underwritten.

The report was adopted.

ISLE OF THANET ELECTRIC TRAMS.

The ordinary general meeting of the Isle of Thanet Electric Tramways and Lighting Co. was held last week, Lord Arthur Butler presiding.

In moving the adoption of the report, the Chairman stated that the property and assets had been increased by a sum of £1,912. 12s. 4d., the cost of installing a gas generating plant of 100 kw. capacity, while additional cables and house connections for electric light extensions during the year had increased the item under the head of electric light installation by £450. Turning to the liability side of the balance sheet, the loans secured on deposit of debenture stock had been decreased by £2,000, but the sundry creditors were increased by £2,019. Dealing with the revenue account, he stated that the traffic receipts had decreased by £336, and they might consider themselves very fortunate that they did not suffer a much greater loss under this head, taking into consideration the very inclement weather they experienced during the period of the year on which they counted for making their largest receipts, particularly during the months of July and August. September improved matters very considerably, but the loss of traffic at Thanet in a wet July and August could not be compensated even by a fine September. It was a matter of regret to the directors to find that, notwithstanding the excellent tram service which was maintained throughout the busy season, the traffic receipts were practically stagnant, and they were considering whether a small increase in fares during the busiest months would be desirable. The fares at present charged were below the statutory powers of the Company, and the system of increasing them during the rush of traffic in places of summer resort was one that had been adopted with success in some other pleasure districts in England. The carrying on of this class of traffic involved more expenditure for the services rendered than in cases where the traffic was fairly steady throughout the year, as considerable loss was incurred each year in training a large number of additional hands to conduct the traffic for a few months only. While the traffic receipts were unsatisfactory, he was glad to say that the sale of electricity showed a steady improvement, amounting to an increase of £700, or more than 20 per cent. advance upon the receipts of the previous year. The total connections at the close of the financial year were equal to 21,048 8-c.p. lamps, as against 18,640 in 1906 and 13,800 in 1905. Lighting revenue under energetic management was always progressive, and in combination with traction business could be profitably carried on. He had considerable hopes from this source of revenue in future, but there was one feature connected with it which required attention—viz., the necessity of providing an extension of the mains, and for additional plant at the generating station to meet the increased load. Expenditure under these two heads would have to be faced from time to time, but the investment was sure to be attended with substantial profits w here the lighting business was capable of being developed.

The report was adopted.

ARON ELECTRICITY METER.

The report of the Aron Electricity Meter for the year ended Sept. 30 last, to be submitted to the meeting on the 10th inst., states that the profit and loss account for the year, after providing for general charges and depreciation, shows a net profit of £20,052, making, with the balance brought forward, £6,417, a total available profits of £26,469. The directors distributed in April last a dividend of 3 per cent. on the preference shares, and they now recommend a further dividend of 6 per cent. on the preference shares, transferring to reserve towards goodwill and patents £9,000, leaving to be carried forward £6,228. The directors are pleased to record a satisfactory progress of trade in all the Company's branches. The factories continue to be fully employed, and have again been added to in order to cope with the increased business. For the greater convenience of the business of the Company, the directors propose in future to close the annual accounts on March 31 in each year instead of Sept. 30 as hitherto. The next financial period will, therefore, be for six months only, ending March 31, 1908. The question of outstanding dividends due to preference shareholders has again had the careful consideration of the Board, who hope to further reduce the arrears by a distribution after stocktaking on March 31 next, provided business continues as at present.

NEW COMPANIES REGISTERED.

London Electric Supply (Joint Committee), Limited.—Registered Nov. 29. Capital, £10,000 in £1 shares. Objects: to promote a Bill or Bills in Parliament (*a*) making further provisions for the supply of electrical energy in the county of London and in the surrounding districts in Kent, Surrey, Middlesex, and Essex; (*b*) providing for the incorporation of a joint committee and defining its constitution, powers, and obligations; and (*c*) altering, modifying, or revising the existing statutory provisions applicable to the companies or local authorities empowered to supply electrical energy within the said area, and conferring other powers on them, etc.

PERSONAL.

The Preston Town Council have increased the salary of Mr. J. F. Simpson, the electrical engineer and tramways manager, by £50 per annum.

The Rugby Urban District Council have increased the salary of Mr. Shenton. the engineer and manager of the electricity works, from £165 to £180 per annum.

At York, Mr. G. H. Holmes was last week presented with a case of silver teaspoons and sugar tongs by Mr. Hame, the city electrical engineer, on behalf of the staff and employés, on the occasion of his marriage.

The A.C. Electrical Co. have opened works and showrooms at Aberystwyth, Wales, under the style of Addinell, Humphreys, and Co. Works: Eagle Works, Great Darkhouse-street; and showrooms, St. James's-square.

Messrs. Crosby Lockwood and Son announce that they are about to open at 121A, Victoria-street, Westminster, a West-end branch of their business, where a selection of new and standard technical publications will be kept on show.

Mr. A. L. Boyle, who recently completed his engagement as electrical engineer to the Caucasus Copper Co., and was formerly with Thornycroft and Co. and with Ferranti, Limited, has been appointed to the post of chief assistant on the staff of May and Hawes, consulting engineers, of Caxton House, Westminster.

Mr. Cecil J. Grimes, resident engineer at Devonport for Messrs. Preece and Cardew, consulting engineers to the Admiralty in the electrification of the naval establishment at that port, has just received an important Government appointment under the Commissioners of the port of Calcutta, and sails for India this week.

We are informed that Messrs. Heenan and Froude have opened offices at 56, Victoria-street, S.W., London, under the control of Mr. Robert H. Hammersley Heenan, M.I.C.E., M.I.E.E., who recently retired from the position of general manager and engineer-in-chief, Table Bay Harbour and Docks, under the Cape Government. Messrs. J. B. Corrie and Co., of Queen Anne's-mansions, Westminster, will continue to act as their agents in London for South America and other foreign countries.

With reference to the meetings in connection with the Manchester Electrical Exhibition announced in our last issue, the president of the Manchester Chamber of Commerce (Mr. E. H. Langdon) will take the chair at the meeting to be held in Manchester to-day, and Sir William Preece, president of the electrical exhibition

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held at Olympia in 1905, will take the chair at the trade meeting convened in London on Thursday, Dec. 12, which will be held at 4 p.m. at the Hotel Cecil.

OPENINGS FOR CONTRACTORS.

ABBOTS LANGLEY—House, Hamilton-road, Mr. Tiffen.

ACTON—Central fire station (£1,830), Town Council.

ALDENHAM—Four houses, the Crosspath, Mr. J. G. Bayes.

ALDERSHOT—Extensions to the army veterinary department, South Camp. Mr. H. B. Measures, architect.

AINSDALE—Alterations to L. and Y. Railway Station.

ALNMOUTH—Golf house. Mr. W. Robson, architect.

ANNERLEY—School house, North Surrey District School. Mr. G. A. Sharp, architect.

ARDWICK—Temporary school, West Riding Education Committee.

ASPULL—Elementary school, District Education Committee.

AUCHTERDERRAN—Infants' school, south side of the village, Education Authority.

BACUP—Elementary school, Town Council.

BALBRIGGAN—Labourers' dwellings, Rural District Council.

BALBY — Additional accommodation to the new school (£745), Education Committee.

BALLYBOGHILL—Labourers' dwellings, Rural District Council.

BALROTHERY—Workmen's dwellings (£42,780), Rural District Council.

BALSCADDEN—Labourers' dwellings, Rural District Council.

BAMFORD—Houses, Main-road, Mr. Easton.

BARNSLEY—Grammar school, West Riding Education Committee.

BASFORD—Church, parish of St. Mark (£9,000).

BEDFORD—Six houses, Sidney-road, Mr. R. Jeakings; alterations to premises, Charity Organisation Society; nine houses, Pembroke-street, Mr. H. Jones; houses, Old Ford-road, Mr. A. Henman; four houses, Honey Hill-road, Mr. J. Smith; houses, Whitbread-avenue, Messrs. Jones Bros.; six houses, Dudley-street, Messrs. Dawes and Bowler.

BELFAST—Construction of electric tramway, Belfast Harbour Commissioners.

BERMONDSEY, S.E.—Enlargement of special school (£1,892), London County Council.

BERWICK—Elementary school (£8,000), Northumberland Education Committee.

BIRMINGHAM — Enlargement of Foundry-road School (£800), Handsworth New-road School (£600), City Education Committee.

BISPHAM—Additions to Norbreck Hall, Mr. Hardman.

BITTON—Elementary school, Gloucester Education Committee.

BLACKPOOL—Four houses, Devonshire-road, Mr. Robt. Fenton; four houses, Wilford-street, Mr. Jas. Ward; one house, Alfred-street, Mr. Eli Entwistle; two houses, Mere-road, Messrs. Parker Bros.; 16 houses and shop, Central-drive, Mr. Amos Atherton; four houses, Braithwaite-street, Mr. J. E. W. Dugdale; two houses, Hawes Side-lane, Mr. Wm. Dewhurst; two houses, Peddar's-lane, Mr. Rd. Sanderson; six houses, Cunliffe-road, Mr. J. Cunliffe; two houses, Warley-road, Mr. John Fish; house, Warbreck-road, Mr. John Fish; four houses, Claremont Park Estate, Mr. John Fish; two houses, Read's-road, Mr. Thos. Hartley; nine houses, Ash-grove and Hornby-road, Mr. W. B. Holt; two houses, Waterloo-road, Mr. Geo. Swarbrick; 24 houses, Ormond-avenue, Mr. Stephen Orme; two houses off Warley-road, Mr. John Fish.

BLYTH—Elementary school (£9,000), Northumberland Education Committee.

BOYLE—Erection of workmen's dwelling (£45,487), Rural District Council.

BRACEWELL—Elementary school (£900), Education Committee.

BRADFIELD—Elementary school (£1,400), Education Committee.

BRADFORD—Public baths (£500), Town Council.

BRAYBROOKE — Elementary school (£830), Northampton County Council

BRIDGWORTH—Secondary school, Salop County Council.

BRIGHTLINGSEA—Police station (£2,598). Mr. F. Whitmore, architect.

BROADSTAIRS—Ten houses, Magdala-road, Mr. A. Foster.

BUCKHAVEN—Buildings, Co-operative Society. Mr. H. Tarbolton, architect.

BUNDORAN—Orphanage (£3,595). Mr. W. A. Scott, architect.

BUSHBURY—Elementary school, Staffs Education Committee.

BUXTON (PLYMOUTH)—Alterations and additions to elementary schools. Messrs. King and Lister, architects.

CAMBERWELL, S.E.—Parochial hall, Townley-road, Mr. W. G. King.

CANNONLEY—Elementary school, County Education Committee.

CANTERBURY—Extension of school of art, Corporation.

CARDIFF—Goods shed and offices, Great Western Railway Co. Mr. G. K. Mills, secretary, Paddington.

CARSHALTON—New offices, Board-room, and a fire station (£2,100), Urban District Council.

CATTAL — Additions to inebriates' reformatory. Mr. J. Vickers Edwards, architect, Wakefield.

CAWDOR—Church and manse on the Cawdor Estate, Cawdor United Free Church Congregation.

CARMARTHEN—Additions to police station (£659), Town Council.

CHELMSFORD—Fixing wires and bells at houses of the members of the fire brigade, Town Council.

CHINLEY—Houses, Green-lane, Mr. J. Waterhouse.

CLECKHEATON—Additional accommodation at the technical institute, Education Authority.

CLIFTON—Wesleyan church, Burton Stone-lane (£9,000).

CLONMETHEN—Labourers' dwellings, Rural District Council.

COCKFIELD—Temperance institute. Mr. J. Howe, architect.

COLNE—Public baths (£7,400), Town Council.

COLWALL—Church and institute.

COVENTRY—Central stores, Holmsdale-road, Industrial Co-operative Society. Messrs. G. and J. Steane, architects. Conversion post office premises to corn exchange (£7,000).

COWDENBEATH—Theatre, High-street. Messrs. J. D. Swanston and Syme, Kirkcaldy, architects.

CROXTON—Additions to elementary school, Staffs Education Committee.

CROYDON—Enlargement of public baths (£8,000), Town Council.

CUMBERLAND—Enlargement of infirmary (£20,000). Mr. J. J. Burnet, architect.

DALTON—Additions to chapel, Crossley-street, Askam, trustees of the Church of Christ.

DARTMOUTH—Houses at Tounstal. Mr. E. H. Back, architect.

DARWEN—Pattern store at Atlas Foundry, Messrs. Pickup and Kelly; 19 houses in Marsh House-lane and Naples-street, Mr. John Pilkington; rebuilding shop in Bolton road, Mr. James Cocker; extension to school at Hollins-grove for the trustees of Hollins-grove Chapel; alterations at Robert-street Foundry, Messrs. H. J. and A. Coulthurst; extension to the golf pavilion for the Darwen Golf Club; warehouse in Campbell-street, Messrs. Harwood Bros.; two houses in Earnsdale-avenue, Messrs. Marsden and Yates; stable and coach house in Back Harwood-street. Mr. James Hodgkinson; plan for extension at the Anaglypta Works for the Wall Paper Manufacturers; alterations and additions at Plantation Cottage, Mr. John Lomax.

DENBEATH—Elementary school, Wemyss School Board.

DEWSBURY—Dwelling-houses, Leeds-road. Messrs. Kirk and Sons, architects.

DOVER—Shelter on sea-front, Town Council.

DOWLAIS—Renovating hotel, Mr. C. M. Davies, 112, High-street, Merthyr.

DRAX—Additions to grammar school (£3,408), West Riding Education Committee.

DULWICH, S.E.—Parochial hall, Townley-road. Mr. W. G. King, architect.

EAST HAM—Mission church (£1,700), parish of St. Paul.

EDMONTON—Infirmary, Board of Guardians.

EGLWYSWRW—Alterations to Council school, Pembrokeshire Education Authority.

FAKENHAM—Memorial church. Mr. A. F. Scott, architect.

FALMOUTH—Baptistery and additions to St. Mary's Catholic Church. Messrs. Scoles and Raymond, architects.

FARNWORTH—Secondary school, Education Committee.

FELIXSTOWE—Public convenience, Urban District Council.

FLINT—Elementary school, Flintshire Education Committee.

FRASERBURGH — Elementary school (£4,500); higher-grade schoo (£7,000), School Board.

GARRISTOWN—Labourers' dwellings, Rural District Council.

GLANDWR—Elementary school, Pembrokeshire Education Authority.

GOOLE—Secondary school, Governors of Secondary College.

GORTON—Thornwood-avenue Council School and an instruction centre (£13,080), Education Committee.

GOUROCK—Church hall (£1,000), St. John's United Methodist Free Church.

GRANGE MOOR—Houses. Mr. J. H. Hall, architect.

GREENOCK—Two semi-detached houses, Prospecthill-place, Industrial Building Co.

GRANTOWN—Alteration to manse. Mr. J. Wittet, architect.

HALSTEAD—Elementary school, Essex Education Committee.

HAMMERSMITH, W.—Baths and wash-houses (£1,500), Borough Council.

HAMPHOLE—Elementary school, West Riding Education Committee.

HANLEY—Official premises for Pottery Workers' Society, Oldhall-street.

HARBY—Elementary school, Notts Education Committee.

HARLOW—Police station (£3,650). Mr. F. Whitmore, architect.

HERMON—Alterations to Council school, Pembrokeshire Education Authority.

HEXHAM—Elementary school (£12,000), Northumberland Education Committee.

HEYWOOD—Day school, Hopwood (£8,595), Education Committee.

HILLSBOROUGH—Fifty-nine cottages, Rural District Council.

HOLLOWAY, N.—Convalescent home (£10,000), trustees of Great Northern Hospital.

HOLLYWOOD—Labourers' dwellings, Rural District Council.

HOLMPATRICK—Labourers' dwellings, Rural District Council

HOOLE—Elementary school, Chester Education Committee.

HORNSEY—Workmen's dwellings (£39,690), Borough Council.

HULL—Pavilion, Hull Education Committee.

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INGATESTONE—Rebuilding Anchor Inn. Messrs. C. and W. Pertwee, Chelmsford, architects.
ISLEWORTH—Extension of Council school (£3,755). Mr. H. G. Crothall, architect.
ITCHINGFIELD—Enlargement of Council school (£1,250), West Sussex County Council.
KILCOCK—Erection of workmen's dwelling, Rural District Council.
KILKENNY—Public library. Messrs. Lowrey and Son, architects.
KINSALE—Labourers' dwellings, Rural District Council.
KILSALLAGHAN—Labourers' dwellings, Rural District Council.
KINGUSSIE—Church and hall. Mr. A. Cattanach, architect.
KIRKBY—Elementary school, Notts Education Committee.
LANGLEY PARK—Additions to premises, Annfield Plain, Industrial Co-operative Society.
LANNER—Alterations to United Methodist Free Church.
LEAVESDEN—Alterations to asylum (£1,300), Metropolitan Asylums Board.
LEEDS—Alterations to Park Temperance Hotel. Messrs. Fossett and Son, architects.
LEISTON—Elementary school (£6,000), East Suffolk County Council.
LEVEN—Council school, County Education Authority.
LEWISHAM, S.E.—Fourteen houses, Girton-road. Messrs. Eastman Bros.; six houses, Ardgowan-road, Messrs. Norfolk and Prior; 14 houses, Muirkirk-road, Messrs. Norfolk and Prior; two houses, Micheldever-road, Mr. J. Fox; five houses and one shop, Levendale-road, Messrs. Norfolk and Prior.
LINTON—Administrative block at hospital, Maidstone Rural District Council.
LIVERPOOL—Electrical supply (£200,000), Corporation.
LONG EATON—Elementary school, Derbyshire County Council.
LUSK—Labourers' dwellings, Rural District Council.
MAIDENHEAD—Secondary school, Berkshire Education Committee.
MALAHIDE—Labourers' dwellings, Rural District Council.
MALTON—Conversion of shop into bank for the Union of London and Smith's, Limited.
MANSTON—Anglican church, churchwardens.
MAYFAIR—Enlargement of Western District Parcel Office and Telephone Exchange, H.M. Office of Works.
MERTHYR—Alterations at Penydarren Council schools, Merthyr Tydfil Education Committee.
MILFORD HAVEN—Sailors' home and Bethel. Messrs. Wood and Gaskell, architects.
MIRFIELD—Elementary school, West Riding Education Committee.
MOHILL—Workmen's dwellings (£24,000), Rural District Council.
MOIRA—Fifty-one houses (£10,500), Rural District Council.
MORPETH—Elementary school (£4,000), Northumberland Education Committee.
NEWARK—Secondary school. Messrs. Shepherd and Lockton, architects.
NEWTONSAVILLE—Additions to premises, Co-operative Dairy Society.
NORTHUMBERLAND—Five schools (£42,000), Northumberland Education Committee.
NORWOOD—Houses, Norwood-road and Trinity-road, Mr. S. W. Pearce.
NORWICH—Mission room, St. Martin-at-Palace. Messrs. Lacey and Upcher, architects.
PANT—Alterations to Council school, Merthyr Tydfil Education Committee.
PENZANCE—Shops at the quay, Borough Council.
PONJGERAVAH—Alterations to Council school, Cornwall Education Committee. Mr. S. Hill, architect.
POPLAR, E.—Electric light extensions (£4,372), Borough Council.
RAGLAN—Elementary school, Monmouthshire Education Committee.
RAYLEIGH—Elementary school, Essex Education Committee.
READING—School (£5,500), Education Committee.
RHYL—Pavilion, etc. (£14,000), District Council.
RIPON—Secondary school. Messrs. Connon and Chorley, architects.
ROSCOMMON—Workmen's dwellings (£74,795), Rural District Council.
ROSS—Secondary school, Herefordshire County Council.
RUSHDEN—Council school (£3,890). Messrs. Sharman and Archer, architects.
RUSH—Labourers' dwellings, Rural District Council.
ST. DOGMAELS—Enlargement of Council schools (£1,300), Pembrokeshire Education Authority.
ST. MELLION—Additions to church. Mr. E. Sedding, architect.
SALFORD—Nurses' home and alterations to hospital. Mr. J. Ely, architect.
SELBRIDGE—Erection of workmen's dwelling, Rural District Council.
SCHOLES—Elementary schools, West Riding Education Committee.
SKERRIES—Labourers' dwellings, Rural District Council.
SKIPTON—Elementary school, West Riding Education Committee.
SILKSTONE—Elementary school, West Riding Education Committee.
SOUTH DUBLIN—Workmen's dwellings (£58,000), Rural District Council.
SOUTH SHIELDS—Wiring of municipal buildings, town hall.
STAFFORD—Elementary school, Staffs Education Committee.
STANLEY—Elementary school, West Riding Education Authority.
STAPLETON—Extensions to a lunatic asylum, Bristol Asylum Commissioners.
STOURTON—Elementary school, West Riding Education Committee.
SWANSEA—300 houses for Council housing scheme.
SWINDON—Church, South Brook-street (£1,300).
SWORDS—Labourers' dwellings, Rural District Council.
TADCASTER—Conversion of grammar school to police station, West Riding County Council.
TEUCHAR—Houses at Meadow Bank. Mr. G. Gray, architect.
THUNDERSLEY—Elementary school, Essex Education Committee.
TREDEGAR—Houses at Cwmsifiog. Mr. J. S. George, architect.
TODMORDEN—Extension of workhouse, Board of Guardians.
TORQUAY—Post office, Commissioners of Public Works.
TWICKENHAM—Elementary schools (£12,483), Middlesex County Council.
WALLINGFORD—Fire station (£300), Town Council.
WALLSEND—Elementary school (£9,000), Northumberland Education Committee.
WANDSWORTH, S.W.—Church presbytery, Ellison-road. Mr. J. H. Beart-Foss, architect.
WELLBRAEHEAD—Extensions of school, Forfar School Board.
WESTCLIFF—Police quarters (£1,998). Mr. F. Whitmore, architect.
WEST HAM—Houses, Bushey-road, Mr. F. Hamlett; additions to nurses' home, Howards road, Messrs. C. Stoner and Sons; additions to offices, Union-street, West Ham Gas Co.
WHITECHAPEL — Re-erection of Alma Brewery, Spelman-street. Mr. W. Stewart, architect.
WIRKSWORTH—Grammar school (£4,500). Mr. G. H. Widows, architect.
WITHINGTON—Public baths, Manchester Town Council.
WOMBWELL—New school (£5,040), West Riding Education Committee.
WOOLWICH—Additions to electric lighting undertaking (£3,000), Borough Council.
WORTHAM—Alterations to Long Green School, East Suffolk County Council.
YARDLEY—Extension of isolation hospital, Rural District Council.
YORK—Secondary school, City Council.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Hull.—Tenders are invited for telephone cable and telephone instruments. Tenders to the Town Clerk by Dec. 11.

Montreal.—Tenders are invited for a bulk supply of gas and electricity to the Municipality. Tenders by Dec. 16.

Brussels.—The Belgian Telegraph Department invite tenders for telegraph material and apparatus. Tenders by Dec. 11.

Perth (Australia).—The Postmaster-General invites tenders for accumulators for telegraph purposes. Tenders by Dec. 16.

Melbourne.—The Postmaster-General invites tenders for 30 metallic iron telephone switchboards. Tenders by Dec. 31.

Dartford.—The Urban District Council invite tenders for two pumps together with electric motors. Tenders to the Clerk by Dec. 18

Nymwegen.—The Municipality invite tenders for about 35,000 kilos of copper wire for overhead electric tramways equipment. Tenders by Dec. 10.

Brussels.—The Post and Telegraph Department invite tenders for the supply of telegraph and telephone material and appliances. Tenders by Dec. 18.

Lancaster.—Tenders are invited for the supply of uniforms, etc. for the Tramways Committee. Tenders to Mr. T. Cann Hughes, town clerk, by Dec. 9.

New South Wales.—The Postmaster-General, Sydney, invites tenders for one branching metallic multiple magneto switchboard. Tenders by Jan. 8, 1908.

Madrid.—Tenders are invited for the construction and working of the North-West interurban service. Deposit, 181,675 pesetas (about £6,375). Tenders by Dec. 18.

Madrid.—Tenders are invited for the construction and working of the South interurban service. Deposit, 150,500 pesetas (about £5,281). Tenders by Jan. 11.

Brussels.—Tenders are invited for the electrical equipment of transformer station for the Société Nationale des Chemin de fer de l'Etat. Tenders by Dec. 11.

Bootle.—The Corporation invite tenders for the supply of coal fo use at the electric light station for six months ending July 1 Tenders to the Town Clerk by Dec. 14.

Rathdown.—Tenders are invited by the No. 2 Rural District Council for the lighting of Greystone, co. Wicklow, by electricity or other illuminant. Tenders by Dec. 11.

London, S.W.—The London County Council invite tenders for the manufacture, supply, and delivery of 50 steel underframes for double-deck electric tramcar bodies. Tenders by Dec. 10.

Trimdon Grange (Durham).—Tenders are invited for the supply of stores, including electric fittings. Tenders to Messrs. Walter Scott, Trimdon Grange Colliery, co. Durham, by Dec. 9.

Erith.—The Urban District Council invite tenders for the complete installation of electric light at 48 municipal cottages, Brook-street, Belvedere. Tenders to Mr. C. H. Fry, clerk, by Dec. 9.

Napier (New Zealand).—The Town Council invite tenders for lighting and power plant and an electric tramway equipment. Particulars from Mr. F. Bowen, town clerk. Tenders by Dec. 31.

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Madrid.—The Post and Telegraph Department invites tenders for the construction and working of the South-East interurban service. Deposit, 144,695 pesetas (about £5,077). Tenders by Dec. 26.

Melbourne.—The Postmaster-General's Department invite tenders for 11 sets and a common-battery switchboard, and 3,000 subscribers telephones, etc., for the Windsor exchange. Tenders by Jan. 7.

Calcutta.—Tenders are invited for the lighting of the town by gas or electricity. Particulars from Mr. P. N. Mookerjee, secretary to the Corporation. Tenders to the Vice-Chairman by Jan. 2. 1908.

Punjab (India).—Tenders are invited for electric and pumping plant for water supply. Particulars from the Executive Engineer, Special Work Division, Patiala, Punjab. Deposit £133. 6s. 8d. Tenders by Jan. 6, 1908.

Buenos Ayres.—Tenders are invited for the construction of underground electric tramways. Particulars from the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London. Tenders by June 1, 1908.

Darlington.—The Corporation invite tenders for the supply of tramway uniforms and caps. Specification, etc., from the General Manager, Electricity Works, Haughton-road, Darlington. Tenders to the Town Clerk by Dec. 9.

Lyons.—The Corporation invite tenders for the erection of a refuse destructor, the heat to be utilised in generating steam for electric motors. Particulars from the Commercial Intelligence Branch of the Board of Trade. Tenders by Dec. 15.

Buenos Ayres.—Tenders are invited for (1) the construction of and (2) the concession to work the two principal sections of the underground electric railway. Particulars from the Argentine Legation, 12, Rue van Moer, Brussels. Tenders by May 1, 1908.

Aberdare.—The Powell Duffryn Steam Coal Co. invite tenders for supply of stores from Jan. 1, 1908, including indiarubber and asbestos, electrical fittings, wire ropes, etc. Tenders to the Powell Duffryn Steam Coal Co., 101, Leadenhall-street, London, E.C., by Dec. 9.

Shildon.—Tenders are invited for the erection of hydraulic power house at Shildon Wagon Works, for the North-Eastern Railway Co. Plans and specification may be seen upon application to Mr. William Bell, the company's architect, at York. Tenders to the Secretary by Dec. 11.

Adelaide.—The Deputy Postmaster-General for Queensland invites tenders for a common battery switchboard and 3,000 subscribers' telephones. Specification No. 166. Particulars may be obtained from the Commonwealth Offices, 72, Victoria-street, London, S.W. Tenders by Jan. 8, 1908.

Belfast.—The Harbour Commissioners invite tenders for the construction of a double line of electric tramway, permanent way, electric masts, cables, wiring, lamps, etc., on the co. Down side of the harbour. Tenders to Mr. W. A. Currie, secretary, Harbour Offices, Belfast, by Dec. 28.

Madrid.—Tenders are invited for the construction of an international telephone system with France, and for the working of the interurban service of the North-East. Deposit, 120,000 pesetas (about £4,211). Tenders will be received at the Registro de la dirección general de correos y telegrafos, Madrid, by Jan. 3.

Victoria.—The Deputy Postmaster-General at Melbourne invites tenders for the supply and delivery at Melbourne of 11 sections of a common-battery switchboard and 3,000 subscribers' telephones and other apparatus for telephone exchange, Windsor, in accordance with Victorian specification No. 148. Tenders by Jan. 7.

Gillingham.—The Corporation invite tenders for the erection of plant capable of effectually burning a minimum of 30 tons of refuse per day of 16 hours, the heat to be utilised in a water-tube boiler for raising steam in connection with the electricity works, Windsor-road, Gillingham. Tenders to the Town Clerk by Dec. 12.

Stockport.—The Electricity Committee invite tenders for the supply of one 140-kw. 430-volt shunt-wound generator, direct-coupled to a Willans and Robinson triple-expansion engine suitable for a working pressure of 200lb. Particulars from Mr. R. Lomax, borough electrical engineer, Electricity Supply Works, Millgate, Stockport.

London, S.W.—Tenders are invited by the London County Council for the supply and delivery of about 1,520 tons of steel girder tramway track rails and fastenings required in connection with the construction for electric traction on the overhead trolley system of the authorised tramways from Hammersmith to Harlesden. Tenders by Dec. 10.

London, S.W.—The London County Council invite tenders for the roadwork and platelaying required for the construction for electric traction on the overhead trolley system of the authorised tramways from Hammersmith-broadway, *via* Brook Green-road, Shepherd's Bush-road, Wood-lane, and Scrubs-lane to Harlesden. Tenders to the Clerk of the London County Council, Spring-gardens, S.W., by Dec. 10.

RESULTS OF TENDERS.

Neath.—The Rural District Council have placed an order for the supply of cables with Messrs. Johnson and Phillips.

Erith.—The Urban District Council have placed an order with Messrs. Johnson and Phillips for overhead transmission line.

Luton.—The Town Council have accepted the tender of Messrs. J. G. White and Co. for paving work in connection with the tramways.

Eccles.—The tender of Messrs. Korting Bros. for the supply of a motor-driven centrifugal pump and switchgear for £189 has been accepted.

"Cryselco" Lamps.—Cryselco Co. have recently received an order for their lamps for his Majesty's the King's new yacht, "Alexandra."

Bermondsey.—The Electricity Department have accepted the tender of Messrs. Johnson and Phillips for the supply of 2,360 yards of triple-concentric cable.

South Shields.—The Corporation have accepted the tender of Messrs. W. J. Fryer and Co., Bravington-road, Paddington, London, for the wiring of the municipal buildings.

Stoke.—The Town Council have accepted the tender of the Callender Cable Co., amounting to £4,775, for supplying and laying cables and accessories throughout the compulsory area in the district of Fenton.

Stepney.—The Electricity Supply Committee recommend the acceptance of the tender, amounting to £28,140, of Messrs. Willans and Robinson for the complete equipment of the electrical generating portion of the station plant.

St. Marylebone.—The Electric Supply Committee recommend the acceptance of the tender of the Union Electric Co. for the supply of flame arc lamp carbons; Messrs. Craig, Sharp, and Co., compound, £22 per ton; British Electrical Trades and Bitumen Supply Co., pitch, £2. 5s. per ton; Messrs. Willcox and Co., grease, £2 per ton.

Hankow.—The Hankow Waterworks and Electric Lighting Co., of Hankow, China, have placed an important order with Messrs. Johnson and Phillips, of Charlton, for the supply and erection of a complete equipment of a generating station of 1,500 kw. capacity. Messrs. Johnson and Phillips have also received the order from the same company for the outside mains and supplies. The amount of the two contracts is approximately £50,000.

BUSINESS NOTES.

TRACTION.

Merthyr.—The electric traction company are proposing to fix overhead lighting mains from the Bush Hotel to Swan-street.

Hull.—The Hull Tramways Sub-Committee have agreed to meet a deputation of the Stoneferry Ratepayers' Association with a view to extending the tramway system.

Madras Electric Tramways (1904).—The receipts for the fortnight ending Nov. 30 totalled Rs.16,203, an increase of 16 per cent. The gross receipts from Jan. 1 totalled Rs.378,117, an increase of 19·8 per cent.

Brisbane Electric Tramways Investment Co.—The traffic receipts of the Brisbane tramways for the month of November amounted to £13,570; corresponding month last year, £11,836—increase, £1,734.

Milan.—The great electrical strike of employés of the Edison Co., which has kept Milan without trams for 10 days, has ended with a total increase in wages to the men of £24,000, the Mayor of Milan to arbitrate on lesser details.

Wigan.—The Tramways Committee have decided to extend the 1½d. stage in Wigan-lane from Spencer-road to Brook Mill-lane, and on the Worsley Mesnes route to extend the 1½d. stage from St. James's School to Fairbrother House.

Vienna.—The Vienna General Omnibus Co., which was started in 1881 with British capital, has gone into bankruptcy with liabilities estimated at £125,000. The failure is mainly due to the competition of the municipal electric tramways.

South Norwood.—At a public meeting of residents the Croydon Borough Council were urged not to delay any longer the scheme for extending the tramways from Addiscombe through Woodside to South Norwood, for which parliamentary powers were obtained in 1905.

Kirkcaldy.—A through service from Leven to Kirkcaldy has been commenced by the railway company in agreement with the Kirkcaldy Corporation. Cars are run every 20 minutes from Mondays to Fridays, and every 10 minutes on Saturdays. An accelerated service is promised on Sundays.

Belfast.—Another deputation representing the village of Ligoniel waited upon the City Council at its last meeting for the purpose of urging the necessity of proceeding with the proposed extension. The Council decided to acquire the Cavehill and Whitewell tramway system for the sum of £60,000.

Sneinton.—At a public meeting of inhabitants the recent abolition of the circular route between Sneinton and the Nottingham Market-place, on account of the loss experienced on its working, was the subject of a resolution, which was one protesting against the action of the Tramways Committee in depriving the locality of the route.

Nottingham.—A child named Ethel Briggs, between two and three years old, was crossing Radford-road, Nottingham, on the 30th ult. with an elder companion, when a heavy bogie car knocked her down, dashing out her brains. The motorman did his best to avoid the accident, but the incline and the fog-greased metals prevented the car from pulling up.

Fulham.—The Works Committee of the Council have considered the proposal of the County Council to install tramways in the Fulham Palace-road with the overhead system. It was decided that unless the County Council was prepared to proceed with the original conduit scheme, the Fulham Council decline to further negotiate with regard to the matter.

Lewisham.—The Borough Council are asking the London County Council to receive a joint deputation from the Council and the Sydenham, Forest Hill, and District Tradesmen's Protection Association to urge upon the Council the need of at once proceeding with the construction of the two authorised tramways from Lordship-lane to Forest Hill and from Lewisham High-road to Forest Hill.

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Bexhill.—The tramway service between Bexhill and Hastings has been greatly improved by the running of through cars, which obviates the changing by passengers at West Marina. Cars have now been fitted so as to work on the trolley system which exists at Bexhill and on the surface-contact system on the Hastings front.

Bristol.—An application has been made by the Bristol Tramways Co. for power to increase the maximum speed of electric cars at present sanctioned by the Board of Trade. The company is satisfied that in several parts of its lines cars may safely travel at 16 miles per hour. They are at present restricted to 12 miles per hour, and, of course, in congested thoroughfares the maximum speed is much lower.

Peckham-Dulwich.—After some delays the new tramway service to Peckham rye, a branch of the existing London County Council Dulwich system, about a mile in length, was opened on the 28th ult. It connects with the Lordship-lane line at East Dulwich-green, and, crossing the Rye, terminates at the Newlands. There are now 56 cars on the Dulwich route, and these give a frequent service to Victoria, the Embankment, Waterloo, and Blackfriars.

Newcastle-on-Tyne.—A deputation, headed by Mr. John Tate, of the Newcastle Tramworkers' Union, have waited upon the Tramway Committee with a request that ex-motorman Pitts, who was discharged by the general manager on the morning following the Pilgrim-street tram accident, a few days ago, should be reinstated; and also that the brakes of the trams might be examined. The deputation were informed that the matter would receive the attention of the committee.

Hatfield (Yorks).—It is stated that the contract for the construction of a line from Epworth towards Hatfield, about five miles in length, has been let to Mr. J. Moffatt, St. Mary's-gate, Manchester. It is expected that the work of construction will be commenced immediately. The country is fairly level, and it is, therefore, expected that the line will be completed in about 12 months. The promoters are the N.E. and L. and Y. joint companies, and this will be worked in connection with the Axholme joint railway.

Halifax.—The Halifax Tramways Committee have adopted in their entirety important recommendations for the reorganisation of the tramways staff, consequent upon the resignation of the general manager and the rolling-stock superintendent, contained in a report submitted by a sub-committee. The general recommendations are that the office of general manager of the tramways department should be combined with that of the electrical engineer, and that a traffic superintendent and a rolling-stock superintendent should be appointed.

Birmingham.—The Corporation Tramway Committee have come to the conclusion, after making various experiments, that the watering of street curves on the tramway system is the most satisfactory method of overcoming the screeching difficulty. In order to reduce expense the committee have now decided to lay water connections from the mains to all the curves, the connections being so arranged as to allow a constant trickle of water to run in the groove of the rails. In this way it is hoped that the screeching noise will be done away with almost entirely.

Glasgow.—Intimation has been received by the general manager of the tramways that the Board of Trade inspector will be in Glasgow next week, and arrangements are being made to open the tramway extension to Hyndland for traffic. The extension branches off the existing line in Byres-road at Highburgh-road, and proceeds *via* Highburgh-road and Hyndland-road, terminating opposite the top of Clarence-drive. The distance between Lawrence-street and Hyndland terminus will form a ½d. stage. The cars will run between Langside terminus and Hyndland.

Greenwich.—At the last meeting of the Council it was reported that a committee had considered a letter from the London County Council as to the suggested widening of Woolwich-road, between Coombedale-road and Rainton-road, in connection with the proposal to reconstruct the tramways for electric traction from the existing horse tramways. It was stated that the widening would cost £9,200, and the London County Council asked the Borough Council to contribute one third. The Council decided to signify their consent to the reconstruction of the tramways, but deferred the question of contribution for further consideration.

London.—The Parliamentary Committee of the London County Council report that they have prepared the London County Council (Tramways and Improvements) Bill, which contains proposals for the construction of some 4½ miles of tramways, and for the carrying out of improvements in connection therewith. Among these new tramways are: double line from existing tramway in Blackfriars-road, along Southwark-street, terminating by a junction with the existing tramway in that street; double junction line between existing tramway in Mitcham-road and existing tramway in Tooting High-street; partly double and partly single line from existing tramway terminus at Streatham *via* Streatham High-road to the county boundary at Norbury.

Birkenhead.—The Town Council have decided not to apply for a provisional order for powers, previously obtained and allowed to lapse, to extend the Higher Tranmere tramways route along Bebington-road to Dacre-hill. The proposal of the Tramways Committee was to extend the line with a single track, with passing places, approximately 964 yards of single line and 385 yards of double line, at a cost of £8,060, but their intention at present was to extend the line to Albany-road only—two furlongs—at a cost of £2,500. The feeling of the Council generally, however, was that sufficient revenue would not be obtained from the extension to justify the outlay, and that the extension might be postponed till a larger scheme of tramway extension was taken in hand.

Torquay.—The Doltor Tramways Co. have sent a copy of the Board of Trade certificate in respect of the recently-opened Babbacombe section of the tramways to the Council, and, claiming that these were giving every satisfaction, have asked for permission for the construction of the proposed line along the Torbay-road. The company has already spent £4,000 on wood paving out of the £6,500 agreed upon. They also ask for a cheque for the amount due in respect of the widenings already made, and which had been very costly to the company, the expenditure far exceeding the estimate. The matter was referred to the Tramway Committee, with power to grant the company's application if they were satisfied that the terms of the agreement between the Corporation and the tramway company were being fulfilled.

Guiseley.—At the last meeting of the Guiseley District Council the seal of the Council was affixed to the agreement which has been entered into by the three authorities of Guiseley, Yeadon, and Rawdon with the Leeds Corporation concerning the extension of the latter's tramways from the present terminus at Horsforth through Rawdon and Yeadon to the Station Hotel at Guiseley. The seals of the Yeadon and Rawdon Councils had been previously affixed. Under the agreement the Leeds Corporation bind themselves to complete the extension within 12 months from the date of the Royal assent being given to the parliamentary Bill now being promoted by the Corporation; to only levy tolls and charges in proportion to those levied generally through the city of Leeds, having regard to the traffic; and to run such a service of cars as they deem sufficient for the traffic. The agreement also stipulates that the three Councils shall not enforce Section 43 of the Tramways Act—the purchase clause—and disputes, if any arise, are to be settled under the terms of Section 43 of the Act of 1870. The three Councils pledge themselves, jointly and separately, to contribute to the Leeds Corporation the sum of £400 per annum for a period of 11 years, the amount for each township being apportioned as follows: Rawdon, £145; Yeadon, £185; and Guiseley, £70.

Wolverhampton.—At the last meeting of the Town Council, the Town Clerk explained that the meeting was called to consider the provisions of a draft Bill which it was proposed to promote in the next session of Parliament. The Bill was prepared for the purpose of securing an extension of time for the construction of tramways and the widening of a certain bridge mentioned in the Bill. Some time ago a deputation from the Wolverhampton Corporation visited the President of the Local Government Board in the hope of obtaining some assistance in the way of the issue of a provisional order enabling the Corporation Tramways Act to be so altered as to give the necessary time for the construction of other tramway lines in the borough. The President said that if the Corporation found that their local Acts required amendment, and would make suggestions, the Board might possibly consider the matter from the whole standpoint. Certain amendments were sent to the Board, but something like five weeks elapsed before a reply was received. The Town Clerk said when the communication was received by him it stated that, as the tramways and other matters incidental thereto were not within the jurisdiction of the Local Government Board, they were unable to issue a provisional order, and, as regarded the other matters, the Board did not offer any observations in regard to them. There was only a week in which to consider what should be included in the Bill in addition to the special object mentioned. It was entirely a matter for the Council whether they accepted the provisions in their entirety. Finally, the draft of the Bill was approved by the Council, with the exception of certain clauses which were deleted or amended.

Edinburgh.—The Tramways Committee of the Edinburgh Town Council had before them at their meeting on the 27th ult. an exhibition of models illustrating a new tramway system, which, it is urged, would suit Edinburgh admirably. It is a shallow-conduit system, and the inventor and patentee, Mr. William Cope, Birmingham, claims that it possesses all the advantages of the overhead trolley system and the conduit system, with none of their disadvantages, while the cost is something like £1,000 a mile cheaper than the overhead, which has, until now, been the cheapest to construct. Mr. Cope's device does away with the trolley boom, but the principle is, to some extent, similar to that of the overhead. The rail on the driver's right hand is slotted, so that no centre rail is required. Between the two wheels on the right of the car a small trolley carriage runs on the line on two wheels, and the electric circuit is formed through this, the feeder wire being placed underneath the lip of the slotted rail. This wire, which is of copper, has been tested to 2,000 volts, four times the strength usually required. An objection to underground electric tramways has been that the culverts become flooded in wet weather, but Mr. Cope's system provides against disorganisation in this respect. The slotted rail, being on the crown of the road, admits only surface water, and as the slot is ¼in. wide, and is much narrower, of course, than the interior, it is impossible for the water to gather in such quantity as to fill the culvert. At intervals there would be drains by which the water could escape. Mr. Cope informed the committee that he considered the system quite adaptable to the Edinburgh cable lines. In Edinburgh he would put the wire under the rim of the centre rail, and make the trolley carriage run beneath the middle of the car instead of between the right wheels. The weight of the apparatus for each car is 14lb., compared with 3cwt. for the overhead and 2cwt. for the ordinary electric underground. An attachment in the form of a brush can be made to the carriage, and this would keep the culvert free of mud, etc., which would be taken out at intervals on the route. The committee came to no resolution on the subject.

LIGHTING AND GENERAL.

Yarmouth.—The Education Committee have decided to install electric light throughout Runham School.

Worksop.—The Urban District Council have arranged to borrow £1,700 for extensions to the electricity plant.

Poplar.—The London County Council have agreed to lend £4,372 to the Borough Council for electricity extensions.

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Barking.—Application is to be made by the Urban District Council for sanction to the borrowing of £2,000 for electricity purposes.

Newcastle-Emlyn.—The Urban District Council have decided to write to both the gas and electric lighting companies asking for schemes for lighting the district.

Brighouse.—The Town Council have decided to make application to the Local Government Board for sanction to the borrowing of £3.624 for electric supply purposes.

Export of Cable.—Messrs. Johnson and Phillips's new cable works are now in full working order, and have recently shipped some 170 tons of cable to China as well as a large quantity of association cable to Germany.

Ticehurst.—Last Saturday week a failure in the gas supply was experienced, and this was repeated the next day, when services in several churches had to be cancelled and the residents were generally inconvenienced.

Walton-on-Naze.—The Urban District Council have agreed to allow the postal authorities to fix overhead wires on condition that the telegraph and telephone poles are painted with luminous paint, in the interests of public safety.

Birmingham.—The City Council have decided to provide additional plant for the purpose of the electricity undertaking at an estimated cost of £231,285, and have authorised the Finance Committee to borrow that sum.

Wimbledon.—In order to cope with the demand made upon the Corporation's electricity works, the committee have recommended the Council to apply to the Local Government Board for sanction to borrow £14,000 for additional plant.

Bridlington.—The Electric Light Committee have decided to reduce the charge for electric current for outside lamps used for advertising purposes to 4d. per unit, and to improve the street lighting by the addition of 140 new tantalum lights.

Liquidation.—The *London Gazette* announces that a general meeting of the members of the P. M. Electric Manufacturing Co. will be held at 79, Mark-lane, E.C., at 2 p.m. on Jan. 4, 1908, for the purpose of receiving the liquidator's report.

Johnstone.—The Strathclyde Electricity Supply Co. have intimated to the Town Council their intention to apply to the Board of Trade for a provisional order to permit them to provide electrical supply to Johnstone for lighting and power.

Gas Explosion.—An explosion occurred at the Linacre works of the Liverpool United Gas Co. recently. Some men were engaged in cleaning out a hydraulic main when the explosion took place, and six of them were burned about the hands and face.

Grassington.—The electric lighting scheme, which has been settled about three months, is in the hands of Messrs. Pullan, Bradford, to carry out. All preliminaries have been arranged, and the work is to be put in hand immediately after the Christmas holidays.

Cryselco, Limited.—Amongst the numerous orders which this company have recently received is one for the lamps for his Majesty the King's new yacht "Alexandra." We understand the factory is working overtime in order to cope with the ever-increasing demand for the "Cryselco" lamp.

Rugby.—The Electric Light Committee reported to the Council their approval of the draft agreement with the British Thomson-Houston Co. for an extension of the period of supply of electrical energy to Oct. 28, 1913, and recommended that the same be sealed. This the Council agreed to do.

Australia and Wireless Telegraphy.—The Postmaster-General has announced a decision to call for tenders for wireless installations at some half-dozen places round Australia. Tenderers are to sell their Australian rights to the Commonwealth. Parliament has decided not to allow, directly or indirectly, the establishment of a private monopoly.

Mansfield Woodhouse.—The Urban District Council have passed a resolution of protest against being compelled to put up with an insufficient supply of gas from the Mansfield Corporation. Although the mains have been enlarged the supply is most indifferent, tradesmen and others being compelled to augment the gas lighting by the use of candles.

Ipswich.—A concert was given in the lecture hall, Tower-street, last Friday, in aid of the fund for electric lighting of St. Pancras Roman Catholic Church. Judging from the attendance, and the number of ladies and gentlemen who volunteered their services in connection with a charmingly diversified programme, the project was a highly popular one.

Guildford.—The Woking Electric Supply Co. have written the Guildford Rural District Council asking them to pass a resolution consenting to the granting of a provisional order to the company, authorising them to supply electricity for public and private purposes in the parishes of Send and Ripley, Ockham, Wisley, and Pirbright. The resolution has been agreed to.

Royton.—The clerk reported at the last meeting of the Council that he had carried out the instructions of the Council and applied to the Board of Trade to borrow money in respect of the cost of the Electric Lighting Order, 1901. In reply, he had received a letter to the effect that the Board had no power to sanction the application. No further action was taken by the Council.

Melbourne.—A fire broke out in the centre of the city on Saturday night last. Clarke's warehouse, a Government store containing 7,000 telephones belonging to the Commonwealth Government, and other buildings were destroyed, while many other houses were damaged. The Money Order Office and hospital were for some time in danger. The damage is estimated at £150,000.

Buxton.—The Local Government Board have held an inquiry into the application of the Urban District Council for sanction to the borrowing of £1,800 for purposes of electric lighting. The Clerk stated that the amounts previously borrowed with the sanction of the Local Government Board totalled £44,914, and the outstanding debt now was £34,551. 19s. 6d. There was no opposition.

Croydon.—The report of the Lighting and Electricity Committee to the last meeting of the County Council showed that the current delivered to the mains from Oct. 17 to Nov. 14 was—for private lighting, 266,982 units; public lighting, 64,951 units; traction, 218,234 units; against 282 157 units, 64,158 units, 163,124 units respectively for the corresponding period of last year.

Yardley.—The District Council are dissatisfied with the gas supply to the district provided by the Birmingham Corporation. The surveyor reported to the last meeting that the tendency of the light to "jump," particularly in private houses, was dangerous. It was stated that the district got a good supply for two or three days and then the gas went off in quality. It was decided to communicate with the Corporation.

Electric Hogging Brush.—The Admiralty have had brought to their notice a means for keeping ships' keels free from fouling. The new invention is an electric hogging brush, which, fixed on a frame, is hauled up and down underneath the ship. The trials on Home Fleet ships have shown that the electrical current causes the brush to adhere to the bottom of the ship, and the pulling motion strips all fouling off the plates.

Stevenage.—An inquiry was made at the last meeting of the Council as to what was being done with regard to the introduction of electric light in Stevenage. The Council had made a contract some time ago with Mr. Crompton, and since then the firm had been turned into a company. The clerk said they must fulfil the contract, and it was directed to write to the company informing them that the Council wished the work to commence.

Brumby and Frodingham.—At the last meeting of the Urban District Council a letter was read from the Board of Trade asking what steps the Council were taking under the electric lighting order. The Clerk said the order was renewed for a year, and it was doubtful if it would be further extended. It was decided to write saying the Council had under serious consideration the question of lighting, and asking for a renewal of the order for another year.

Twickenham.—The resident engineer of the Twickenham and Teddington Electric Supply Co. has applied for the consent of the Council to the erection of a temporary corrugated iron building to be used for new condensing plant at the company's works. The Council have given the necessary consent, subject to an agreement to remove such building before the expiration of six months or to renew the application in the event of its being required for a longer period.

Bermondsey.—The offer of the Borough Council to supply electrical energy for working the pumps at Rotherhithe Tunnel at the rate of ·9d. per unit and as a stand-by for the lighting at the rate of ·9d. per unit after 300 hours' use a year of a maximum demand at ·6d., with a minimum charge of £52 a year, has been accepted by the London County Council. The Council have decided to have two feeder boosters rewound as compound machines at an estimated cost of £82.

Rochdale.—The Building and Sites Sub-Committee of the Council Education Committee have received a letter from the borough electrical engineer with reference to the supply of electric current to the Oakenrod, Spotland, and Castlemere Council Schools. They recommend that application be made to the Electricity Committee for current to be supplied to the Oakenrod new Council School, and that the Lighting and Heating Sectional Committee be asked to reconsider the lighting of the Castlemere and Spotland Schools.

Hammersmith.—The Borough Electricity Committee have had two motor converters inspected which they propose to purchase for the sum of £600 for use in connection with the electric supply to the Franco-British Exhibition. The test having proved satisfactory, the committee have agreed upon the purchase of the converters. Since the last meeting 42 additional consumers, representing a maximum of 4,223 8-c.p. lamps, have been connected to the mains, the present number of consumers taking current being 2,071.

Anglo-German Electric Lamp Factory.—The shareholders in the German Incandescent Gaslight Co., of Berlin, have just sanctioned an increase in the share capital for the purpose, among others, of participating in an English lamp factory for the manufacture of Osram metallic-filament electric lamps. It was stated at the meeting that the sum of £50,000 would be required for this particular purpose, and that the English concern interested in the factory is Robertson's Electric Lamps, Limited, which is associated with the General Electric Co. It was also mentioned that the latter company would undertake the sale of lamps in England and the British colonies.

Halifax.—The Local Government Board, in sanctioning a loan by the Halifax Corporation for the purposes of their electric lighting undertaking, have deducted £1,019 in respect of wages of workmen in the regular employment of the Corporation, paid out of loans previously sanctioned by the Board, such payments, they state, not being a proper subject for the borrowing of money. The town clerk has been instructed by the Tramways and Electricity Committee to ask the borough members of Parliament to see the President of the Board with a view to the deduction being withdrawn, on the ground that the action of the Board with regard to such workmen has not been uniform.

British Guiana.—The Government of British Guiana has accepted the offer of the West India and Panama Telegraph Co. to install a system of wireless telegraphy between Georgetown, British Guiana, and Port-of-Spain, Trinidad, as a supplementary service to the present cable system, which is rendered very unreliable owing to the unsuitable nature of the sea bed for submarine cables between Trinidad and British Guina. The undertaking is an experiment on the part of the

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West India and Panama Telegraph Co., and will be undertaken without extra cost to the Government beyond the giving of a guarantee to continue to pay the present subsidy of £3,000 a year for five years. This has been given.

Rugby Engineering Society.—An excursion to Park Royal generating station and Hammersmith car-sheds has been arranged to take place on Saturday next, and will leave Rugby (L. and N.W. Railway) Station by the 12 42 p.m. luncheon express for Willesden, the railway tickets being the ordinary half-day (3s. 9d.) and week-ends (7s.) to Euston, and will be available for returning from Euston. The party will walk from Willesden to the Park Royal generating station (about one mile away), arriving at the latter station about 2 45 p.m., and after vising this generating station the party will travel by a special rail motorcar to Westbourne Park, where it will be necessary to change, and go on to the Hammersmith car-sheds by the ordinary electric service.

Dundalk.—A meeting of the Council has been held to consider matters in connection with the electric lighting scheme, town hall, and other business of the Council. Letters were read from Messrs. Miller, Wilson, and Pegg enclosing tracing of the town showing position in which they purpose placing the arc and incandescent lamps and giving other information as to the overhead and underground cables. After considering the matter fully the committee recommended that 18 additional arc lamps be erected, which will extinguish about 10) incandescent lamps at the various points marked, and, therefore, be an improvement in the public lighting; the surveyor to return the tracing showing the position of the new lamps to Mr. Pegg and have his opinion thereon.

Lancaster.—Moving the proceedings of the Electricity Committee at the Town Council. the chairman said that hitherto the minimum annual charge for electricity to consumers had been 30s. That was based on the cost of meters, connections, and average annual cost of maintenance. During recent years, and especially in the last 12 months, the cost of meters had been considerably reduced. and the cost of maintenance was also less than formerly, principally because the whole system was in better condition, and efforts had been made to keep the repairs up to the mark. As a result, the committee recommended that the minimum annual charge should be reduced from 30s. to 15s. Less than that they did not think would be profitable to the undertaking. and they hoped this reduction would induce a large number of people to become consumers.

Huddersfield.—Huddersfield has for a considerable number of years found a great variety of matters of complaint over the telephones. At one time the tension was such that a municipal telephone service was suggested, and a scheme was put into shape before the Town Council. This was vetoed on the ground of expense. Then the Chamber of Commerce and Town Council had a protracted correspondence with the National Telephone Co on the question of delays and the babels of voices when subscribers made their calls. All this, it was said, could be remedied by the laying of the wires underground. This desirable improvement has been practically completed. A further grievance has, however, now arisen. Huddersfield, like other towns, objects to the new system of measured rates, and the matter has been fully discussed at the Chamber of Commerce.

Dundee.—A start has been made with the scheme of electrical development in Dundee, which has for its centre the new generating station to be erected at Carolina Port. In the first instance the distributing system is being proceeded with. Current will be generated and distributed on the three-phase alternating high-tension system, and that at a pressure of 6 600 volts. The contract for cable laying is in the hands of the British Insulated and Helsby Cables. Prescot, Lancashire. Under the charge of their superintendent, Mr. T. Nelson, operations have been begun with the present generating station at Dudhope-crescent-road as centre. From this point tracks are being laid as follows: to Lochee, 2 200 yards; to Market-street, 2,300 yards; from Market-street to Carolina Port, 1.200 yards; and from Carolina Port to Clepington-road, 1.500 yards—in all, as near as may be, 4¼ miles.

Wrexham.—The electrical engineer's report to the Council committee for last month included the following statement: Used for tramways, 13,433 units; used for lighting, etc., 44,714 units; total units generated, 58,147; new consumers connected, 7; 8-c.p. equivalent of additions to connections, 400; total number of consumers, 265; total of 8 c.p. equivalent for private supply, 18,943. (The public public lighting is not included in the above totals of 8-c.p lamps.) The electrical engineer asked for instructions to proceed with the laying of foundations for the new steam dynamo. It has been resolved that the electrical engineer be authorised to invite tenders for the work, and that the chairman and he be authorised to accept a tender. The Local Government Board will hold an inquiry on Dec. 12 into the Council's application for sanction to borrow £575 for electric lighting purposes.

Edinburgh.—The questions raised by Councillor Chisholm recently in Edinburgh Town Council regarding the Telephone Co. were brought up at a meeting of the Law Committee. The questions were as to whether there was any warrant in the agreement between the Corporation and the National Telephone Co., first for the Telephone Co. requiring six months' notice prior to the end of a year before allowing a subscriber to exercise the option of changing from the unlimited service to the toll service, or *vice versa*; and, second, whether in making it a condition of the toll service that subscribers should guarantee penny calls to the extent of £2. 10s. per annum. The town clerk reported that in his opinion both of these conditions were illegal, and the Law Committee agreed to advise the Town Council to make representations to the Telephone Co. requiring them to adhere to the terms of the Act.

West Ham.—The Electric Lighting and Tramways Committee reported at the last Council meeting that, having regard to all the circumstances, it was unnecessary to call a conference of the authorities concerned with regard to the reintroduction of the Board of Trade's Supply of Electricity Bill, and that all that was required was that memorials under the seal of the Council should be forwarded to the Prime Minister and to the Board of Trade. The Chairman of the committee said he would like to add that a copy of the resolution be sent to the borough members of Parliament, and that they be asked to give their support to the memorials in question; also that copies of the resolution be sent to the metropolitan and extra-metropolitan councils supplying electricity, with a request that they should pass similar resolutions supporting the Council in the action they were taking. The report was adopted.

Hampstead.—At the Borough Council meeting the Finance Committee presented an interesting report (prepared by a sub-committee) upon the subject of the amount set aside for depreciation and reserve in respect of the electric lighting undertaking. Based upon reports from the borough accountant and the electrical engineer, and other evidence which had been placed before them, the committee had prepared a table showing the periods of years which might reasonably be taken as the useful life of the plant, and the total amount which, on this basis, should have been set aside for depreciation up to March 31, 1907. The table showed that the hypothetical provision for depreciation should have been £138 013, and in another table the committee showed that the actual provision for depreciation had been £141,125. The sub-committee were, therefore, of opinion that the provision for depreciation in the past had been adequate.

Oldham.—At the fortnightly meeting of the members of the Oldham Electricity Committee it was reported that the number of arc lamps connected up to previous meeting was 640 and 23,488 incandescent. During the fortnight there was an increase in arc lamps of one and 59 incandescent, the total connected up to date being 641 arc lamps and 23,547 incandescent lamps. Councillor Wardle raised a question about new consumers taking an electric supply. He asked if they had any guarantors. The Chairman remarked that they had no guarantors; they trusted them. He thought that a month's notice on either side was the time stipulated in the Act. Eventually the Act was looked up, and it appeared that two years was the time that consumers should really have the supply for at least, and it was thought that if they applied for power and it was granted them they ought to have it for at least two years or else pay the cost of the outlay.

Cheltenham.—The last monthly report of the electrical engineer presented to the committee showed there were 935 consumers with the equivalent of 62,967 8-c.p. lamps connected to the private supply mains, the corresponding figures for last year being 893 and 60 035 respectively. An application was received from the trustees of Wesley Chapel, St. George's-street, for a supply of electricity for lighting. The estimated cost of the necessary extension of main was £45, and the applicants were willing to enter into the usual agreement guaranteeing an annual return of 20 per cent. on the cost for three years. The electrical engineer reported that practically the whole of the plant for the extensions had now been delivered and was in course of erection. He reported the result of his visit to Newcastle in connection with the new turbo-generator and the arrangements he had made with Messrs. Parsons and Co. It has been resolved that the arrangements made be approved.

Aberdeen.—At the last meeting of the Council the Electricity Committee recommended that the Council grant the requisite authority for the completion of the transfer of the Deeside and District Electric Supply Co.'s undertaking in terms of and subject to the provisions of the Aberdeen Corporation Electricity Act, 1907; and instruct the electrical engineer to make inquiry and report as to the probable demands for electric current in the Deeside and Donside area of supply, the extension of mains and plant required, and the estimated cost. Subject to the provisions of the Act. the date of transfer of the company's undertaking to the Corporation is Jan. 1, 1908. The Council, however, have referred the report back to the committee with instructions to report upon the actual sum expended by the Deeside Co. upon its undertaking; the annual net profits obtained by the company without allowing for depreciation, or sinking fund, or reserve fund; and how far it is compulsory on the Corporation to carry out the provisions contained in the Electricity Act of last session.

Stock Exchange.—The Stock Exchange Committee has appointed Dec. 12 special settling day in Hampden Cloncurry Copper Mines' further issue of 10,000 shares of £1 each, fully paid, Nos. 200,001 to 210,000; and the Imperial Ethiopian Rubber Co.'s 24.000 vendors' "A" shares of £1 each, fully paid, Nos. 31,001 to 55,000, and 30 000 vendors' "B" shares of £1 each, fully paid, Nos. 1 to 30,000. Applications have been made to the Stock Exchange Committee to appoint a special settling day in the Boston Consolidated Copper and Gold Mining Co.'s further issue of 17,060 shares of £1 each, fully paid, Nos. 607,941 to 625,000; the Kapar Para Rubber Estates Co.'s 17,257 shares of £1 each, fully paid, Nos. 23.001 to 40,257, and a further issue of 9.743 shares of £1 each, 10s. paid. Nos. 40,258 to 50,000; the Oklahoma Copper Co.'s 900,000 shares of 1dol. each, fully paid, Nos. 1,100,001 to 2,000,000; and the Rosehaugh Tea and Rubber Co.'s 79 900 ordinary shares of £1 each (issued at £1. 4s. per share), 6s. paid (2s. capital and 4s. premium), Nos. 1 to 7 and 224.108 to 304,000, 224.100 ordinary shares of £1 each, fully paid, Nos. 8 to 224,107, and 180.000 6 per cent. cumulative preference shares of £1 each, fully paid, Nos. 1 to 180,000.

Trade Information.—The Society of Motor Manufacturers and Traders, which is the official body of the motor industry in the United Kingdom, and which organises the Olympia motor exhibitions, is taking an important step for the development of the trade by the organisation of its trade information department, so as to be capable of dealing promptly with any inquiries with regard to motor goods. It must often happen that the names and addresses of makers of certain

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classes of motorcars (especially for commercial purposes), motor agricultural machines, fire-engines, stationary machinery, boats, component parts, and accessories of all kinds, or the makers of, or agents for, some particular type or brand of motor goods are not known to those desiring to purchase or obtain particulars of same. In all such cases it is now only necessary for the inquirer to notify his requirements to the society, Maxwell House, Arundel-street, Strand, London, W.C., when same will be circulated to the traders manufacturing or dealing in the articles in question.

Bridgend.—At the fortnightly meeting of the Urban District Council the electrician reported that he had fitted Osram lamps to 11 pillars. He regarded the light given by these lamps as satisfactory. On the recommendation of the Lighting Committee the electrician was instructed to prepare an estimate of the cost of removing the lamp pillar at the top of Caroline-street, which was considered to be in a dangerous position. The chairman, pursuant to notice, formally proposed a resolution authorising the application to the Board of Trade for a provisional order under the Electric Lighting Acts, 1882 and 1888, to alter and amend the Bridgend Electric Lighting Order, 1893, by extending the powers and provisions of the order for the supply of electricity and otherwise to those portions of the Bridgend urban district which formerly constituted parts of the parishes of Coity Lower and Daudy, in the rural district of Penybont, and also throughout the parishes of Newcastle Higher, St. Bride's Minor, and Ewenny. Mr. Morgan Stradling seconded the motion, which was passed unanimously.

Aberdeen.—At a meeting of the Electricity Committee of Town Council the question of arrangements for supplying electricity beyond the city boundaries was discussed, in view of the provisions in the recently obtained Act requiring certain works to be accomplished within two years. The electrical engineer was instructed to prepare a report as to what demand was likely to be put forward in the Deeside and Donside districts, and to report as to the necessary arrangements to be made—in the event of the County Council not taking over the Deeside undertaking—for a continuance of a supply from the Deeside station at Cults, pending a direct supply from the Aberdeen Corporation's electricity works at Dee Village.—The employés of the Corporation tramways held a concert in aid of the funds of the social and recreation club in the music hall on Wednesday of last week. There was a large audience, numbering about 2,600, and the concert was one of unqualified success. Most of the magistrates and town councillors were present, and the chair was occupied by Councillor Taggart, convener of the Tramways Committee.

Derby.—The Parliamentary and General Purposes Committee of the Derby Corporation, having regard to the fact that the National Telephone Co. are introducing a measured tariff of charges for telephone service, in a report to the Town Council are reminding that body of the terms of the agreement entered into with the company on March 4, 1904. By this agreement the company were permitted to lay their wires underground, and as a part of the consideration they agreed that the charges then made to existing subscribers should not be increased so long as they remained subscribers; that the charges for a telephone service between an exchange and premises situated within the borough, and the transmission of an unlimited number of calls to any premises within the company's Derby exchange area, should not be increased beyond the following amounts—viz.: (*a*) where the premises are within one mile of the exchange, for the first connection £10 per annum, and for each additional connection £8. 10s. per annum; (*b*) where the premises are more than one mile from the exchange, for every additional quarter-mile or part of a quarter-mile £1. 5s. per annum, and that any burgess shall have the right to demand a telephone service upon those terms.

Macclesfield.—At a meeting of the Lands, Railways, and Town Development Committee of the Council the town clerk submitted correspondence from the Board of Trade inquiring what steps had been taken by the Corporation to discharge their obligations under the Macclesfield Electric Lighting Order, 1901, and also reported the result of a conference with Sir William H. Vaudrey, the solicitor for the tramways company, stating that the company proposed to abandon the tramways in the borough, and suggesting that the Corporation should make application to the Board of Trade during the ensuing session for a provisional order to amend the present order, and also authorise the transfer of the order to a limited company. After discussion it was resolved that the Council be recommended to make application to the Board of Trade in the ensuing session for a provisional order under the Electric Lighting Acts, 1882 and 1888, to amend Section 6 of the Macclesfield Electric Lighting Order, 1901, and the provisions of the Electric Lighting (Clauses) Act, 1899, referred to in that section, by extending the time within which distributing mains are to be laid down; also to transfer and assign all or any of their powers under the above order to a limited company, and to divest the Corporation of any legal powers imposed upon them by the order of 1901, and that the steps already taken by the town clerk for that purpose be adopted and confirmed. It was also resolved that the town clerk be instructed to prepare the necessary memorial to the Board of Trade, and to take such further steps as may be necessary to carry out the above resolution, and that the mayor be authorised to affix the corporate seal to such memorial.

PROVISIONAL PATENTS, 1907.

Nov. 25.

24448A./06. **Improvements in and relating to the control of electric motors.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.) (Date applied for under Rule 5 of the Patents Rules, 1905, Nov. 1, 1906.)

26048. **Improvements in commutating devices for electrical machines.** Ernst Windrath, Thanet House, Temple Bar, London. (Complete specification.)

26049. **Improved method of driving motor vehicles by means of electric transmission of power.** Siemens-Schuckertwerke, G. m. b. H., 231, Strand, London. (Date applied for under Patents Act, 1901, Nov. 27, 1906, being date of application in Germany.) (Complete specification.)

26055. **Device for separating iron particles from chaff and the like by means of magnets.** Joseph Hagmüller, 116, High Holborn, London. (Complete specification.)

26081. **Electric meter for direct current having a permanent magnet and an armature oscillatory in the field thereof.** Wilhelm Meyerling, 27, Chancery-lane, London. (Date applied for under Patents Act, 1901, Nov. 23, 1906, being date of application in Germany.) (Complete specification.)

26084. **Electric meter for continuous current provided with a permanent magnet and an armature arranged in the field thereof.** Wilhelm Meyerling, 27, Chancery-lane, London. (Date applied for under Patents Act, 1901, Nov. 23, 1906, being date of application in Germany.) (Complete specification.)

Nov. 26.

26089. **Improved current collector for use in electric traction systems.** Allen West, 118, Queen Victoria-street, London.

26108. **Improvements in electrical advertising devices.** George Henry Clark and William Henry Whittaker, 3, Brown-street, Market-street, Manchester.

26118. **Improved electric lamp adaptors.** George Wallace, 2, Pearman-street, Lambeth, London.

26130. **Improvements in electric furnaces.** Griffith Brewer, 33, Chancery-lane, London. (Edward Randolph Taylor, United States.) (Complete specification.)

26134. **Improvements in rotors of alternating-current machines.** Siemens Bros. Dynamo Works, Limited, and Jacob Birrer, Queen Anne's-chambers, Broadway, Westminster. (Complete specification.)

26135. **Improvements in enclosed arc electric lamps.** George Washington Farthing and Thomas Knight Steanes, 77, Chancery-lane, London.

26143. **Improvements in lifting-magnets.** Arthur Clarke Eastwood, 1, Queen Victoria-street, London. (Complete specification.)

26144. **Improvements in lifting-magnets.** Arthur Clarke Eastwood, 1, Queen Victoria-street, London. (Complete specification.)

26145. **Improvements in apparatus for breaking and transporting iron products.** Arthur Clarke Eastwood, 1, Queen Victoria-street, London. (Complete specification.)

26147. **Improvements in electrical fuse boxes.** Ernest Alfred Whitney, 110, Strand, London.

26179. **Improvements in the manufacture of hollow metal filaments for incandescent electric lamps.** Frederick William Le Tall, 2, Norfolk-street, Strand, London. (Anton Lederer, Austria.)

Nov. 27.

26207. **Improvements in small electromagnetic machines.** Fred Burks, 3, Brown-street, Market-street, Manchester.

26228. **Improvements in and relating to controlling gear for electric motors.** Crompton and Co., Limited, and Claude Crompton, Arc Works, Chelmsford.

26229. **Improvements in and relating to starting and regulating switchgear for electric motors.** Crompton and Co., Limited, and Claud Crompton, Arc Works, Chelmsford.

26251. **Improvements in telephone systems.** August Alvin Monson, Fife House, Kingston-on-Thames. (Date applied for under Patents Act, 1901, Nov. 27, 1906, being date of application in United States.) (Complete specification.)

Nov. 28.

26281. **Improvements in flexible couplings.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.) (Complete specification.)

26294. **Means of supporting filaments in incandescent electric lamps.** Francis Harrison, 16, Ossian-road, Stroud Green, London.

26296. **Apparatus to register telephone calls automatically and simultaneously at the subscriber's instrument and at the exchange and the like.** Aimée Horner, 2, Charles-street, Berkeley-square, London.

26313. **Life-guard for electric tramcars, motorcars, motor omnibuses, and other power-propelled vehicles.** Peter Bisset, 67, Powis-place, Aberdeen. (Complete specification.)

26352. **Improvements in and connected with brush-holders for electrical machines.** John Harold Woolliscroft, 6, Lord-street, Liverpool.

26354. **Improvements in electric welding machines.** Michael Bartholomew Ryan, 46, Lincoln's-inn-fields, London. (Complete specification.)

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Nov. 29.

26371. Improvements in conductors and cables for telegraphic, telephonic, or other electrical transmission. Henry Hartnell, 9, Napier-avenue, Hurlingham, London.

26381. Improvements in electric accumulator sub-stations. Alfred Mills Taylor, "Avondale," Ashfield-road, King's Heath.

26404. Improvements in or relating to speed-controlling apparatus for electric motors. Siemens Bros. Dynamo Works, Limited, 139, Queen Victoria-street, London. (Siemens-Schuckertwerke, G. m. b. H., Germany.) (Complete specification.)

26417. Improved method and means for heating by electricity. James Edward Rosenthal, 55, Chancery-lane, London.

26418. Improvements in and relating to the transmission of a series of electric impulses along land lines or cables. Axel Oerling, Thomas Inkersole, and Ernest Oldenbourg, 22, Southampton-buildings, London.

26420. Method of extinguishing electric arc lamps. Beck Flame Lamp, Limited, 27, Chancery-lane, London. (Deutsche Beck Bogenlampen, G. m. b. H., Germany.) (Complete specificatiou.)

26435. Improvements in electrical ignition apparatus for internal-combustion engines. Robert Bosch, trading as the firm of Robert Bosch, Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Feb. 7, 1907, being date of application in Germany.) (Complete specification.)

26436. Improvements in sparking plugs for internal-combustion engines. Robert Bosche, trading as the firm of Robert Bosche, Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Dec. 7, 1906, being date of application in Germany.) (Complete specification.)

26440. Improvements in electrical fire-alarms especially applicable to fire-hydrants. Stanley Charles Lambert, 18, Southampton-buildings, London.

Nov. 30.

26530. Improved system of radio-telephony. Gesellschaft für drahtlose Telegraphie m. b. H., 6, Lord-street, Liverpool. (Date applied for under Patents Act, 1901, Dec. 19, 1906, being date of application in Germany.) (Complete specification.)

26531. Improved receiver arrangement for wireless telegraphy. Gesellschaft für drahtlose Telegraphie m. b. H., 6, Lord-street, Liverpool. (Date applied for under Patents Act, 1901, Dec. 3, 1906, being date of application in Germany.) (Complete specification.

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Dec. 19.)

1906.

23286. Electric arc lamps. Jones.

23889. Means for the regulation of the speed and power of electric shocks. Leitner.

25810. Conduits for laying electric cables. Warne.

27006. Apparatus for producing oxides of nitrogen by electric process. Moscicki. (Date applied for under International Convention, Aug. 8, 1906.)

27302. Electric distribution systems, especially applicable to electric railways. British Thomson-Houston Company and Woodbridge.

27330. Application of protective devices to electrical transforming machinery. Sayers.

27421. Electrical heating apparatus. Reynolds.

27556. Electric lamp plug. Chouler.

27569. Electric arc lamps. Gross.

23680. Manufacture of incandescence electric lamps. Stearne and Topham.

1907.

1061. Telegraph systems. McKenzie and Mackenzie.

3935. Telephone systems. Graham.

3963. Device for working electric alarms in use with doors, drawers, and the like. Ives.

5826. Switches for electric lighting, heating, and the like. Lunberg, Lundberg, and Lundberg.

6912. Apparatus and means for securing incandescent electric lamp-holders and other apparatus to the leads or mains. Beattie and Barnes.

8761. Arrangement of the filament of a high-voltage electric lamp of small energy consumption. Glogan.

10328. Method of and apparatus for determining the position of an object or the like which has been detected with aid of Rontgen rays. Gillet. (Date applied for under International Convention, May 4, 1906.)

15418. Electric current distributing systems. Siemens-Schuckertwerke Ges. (Date applied for under International Convention, July 5, 1906.)

18513. Ash-tray for electric arc lamp globes. Davy.

18833. Motor controllers. Siemens Bros. Dynamo Works, Limited. (Siemens-Schuckertwerke Ges.)

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £		Last price. £
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70 000	1	..	½-⅝
—— Ord., 1,125 000	1	..	⅛-¼
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125.000	1	..	½-¾
—— Ordinary, Nos. 1 125,000	1	..	5/32-9/32
British Aluminium Co., Ordinary, 2.001-40 000	5	..	3¼-4¼
—— 7 per cent. Cum. Pref., 1-40 000	5	..	4½-5
—— "A" 6 per cent. Cum. Pref., 1-20 000	5	..	4½-4⅝
—— 4 per cent. Funding Certificates, 1-20 000	5	..	3⅝-4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	100-103
—— 5 per cent Loch Leven Deb. (Reg.) Red., 1-3 000	100	..	94-97
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6½-7
—— 6 per cent. Cum. Pref., 1-100 000	5	..	5⅞-6¼
—— 4½ per cent. Mortgage Debentures	100	..	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	85-89
British Westinghouse Elec. and Manuf. 6 per cent Pref., 275,001-375 000	3	..	¼-1¼
—— 4 per cent. Mortgage Debenture Stock	100	..	55-65
Brush Electrical Engineering, Ordinary, Nos. 1-105 731	2	..	0-½
—— Non. Cum., 6 per cent., Pref.	2	..	⅜-⅝
—— 4½ per cent. 1st Debenture Stock	100	..	85-86
—— 4½ per cent. 2nd Debenture Stock	100	..	67-70
Callender's Cable, Debentures	100	..	105½-107½
—— Ordinary	5	..	9½-10½
—— 5 per cent. Pref.	5	..	5½-6
Consolidated Electrical Co., Ordinary, 1-110,000	1	..	7/16-9/16
Crompton and Co.	3	..	1¼-1⅞
—— 5 per cent Debentures	100	..	96-99
Dick, Kerr and Co., Ordinary, 1 260 000	1	..	1⅛-1⅜
—— 6 per cent. Cum. Pref., 1-305,000	1	..	1-1½
—— 4½ per cent. Debenture Stock. Red.	100	..	101 104
Edison and Swan United, "A" Shares, 1-9 261	3	..	13-16-1 1/16
—— "A" Shares 01-017,133	5	..	1½-2¼
—— 5 per cent. Debentures	100	..	87-90
—— 4 per cent. Deb. Stock, Red.	100	..	79-82
Electric Construction, Nos. 1 to 112 100	2	..	5/32-9/32
—— 7 per cent. Cumulative Pref.	2	..	½-1
—— 4 per cent. Perp. 1st Mort. Deb	100	..	59-64
Electrolytic Alkali Co., Ordinary, 1-202,218	1	..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock. Red	100	..	—
General Electric Company (1900) 5 per cent. Cum. Pref.	10	..	8-8½
—— 4 per cent. 1st Mort. Deb Stock	100	..	89-92
W. T. Henley's Telegraph Works, Ordinary	5	..	10½-11½
—— 4½ per cent. Preference	5	..	5-⅛
—— 4½ per cent. Debentures	100	..	104-106 xd
India Rubber, Gutta Percha, and Telegraph Works	10	..	14½-15½
—— 4 per cent. Debentures	100	..	96-98
National Electric Construction Co., 1-170,000	1	..	13/16-15/16
Parker, Thos., Limited, Ordinary	10	..	10-10½
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-30,000	5	..	—
Telegraph Construction and Maintenance	12	..	28-30
—— 5 per cent. Bonds	100	..	100-103
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	..	8½-9½

Electric Lighting and Supply.—

Name.	Amount paid. £		Last price. £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5	..	4½-5
Bournemouth and Poole, Ordinary	10	..	9½-10½
—— 4½ per cent. Cum. Pref., 7 501-15 000	10	..	9½-10
—— 6 per cent. Cum. Second Pref., 15 001-22,500	10	..	9⅞-10⅜
—— 4½ per cent. Debenture Stock, Red.	100	..	100-103
Bromley (Kent) Electric Light and Power Co	5	..	4⅜-5½
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	96-98
Brompton and Kensington, Ordinary	5	..	7-8
—— 7 per cent. Preference	5	..	7-8
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	..	5½-6½
—— Nos. 80,000-100,000	5	..	5⅞-6⅜ xd
Cambridge Electric Supply Company. £10 Ord.	8	..	12½-13½
Canadian General Electric Co., Common Shares	$100	..	105-103
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	..	96-99 xd
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	..	3½-4⅜
—— 4½ per cent. Cum. Pref., 1-80 000	5	..	3⅜-4½
—— 4 per cent. Debenture Stock, Red.	100	..	96-99
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	3⅜-4¼
—— ditto (1905) 40,001-80 000	5	..	3¼-4¼
Chelsea Electricity Supply	5	..	3¼-4¼
—— 4½ per cent Debentures	100	..	102-105
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000	..	—
City of London, Ordinary	10	..	9½-10½
—— 6 per cent. Cumulative Pref	10	..	1 ⅜-1⅜
—— 5 per cent. Debenture Stock	100	..	122-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	95-98
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1 630	£0	..	50-53
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100	..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5	..	3½-4½
—— 5 per cent. Preference, 1-50,000	5	..	4⅜-4⅞
County of London Elec. Supply, Ordinary	10	..	6½-7½
—— 6 per cent. Cum. Pref.	10	..	10-10½
—— 4½ per cent. Debentures Prov. Certs. All pd., Red.	100	..	105-108
—— 4½ per cent. 2nd Debentures Prov. Certs	100	..	94-97
Edmundson's Electricity Corporation, Ordinary, 1-50 000	5	..	¼-¾
—— 6 per cent. Cum. Pref.	5	..	1-1½
—— 4½ per cent. First Mort. Deb.	100	..	76-81
Electrical Development Co. of Ontario 5 per cent. 1st Mort. 30-year Gold Bonds, 10 751-15 750	—	..	74-77 p.c.
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5	..	2½-2¾
—— 5 per cent Debenture stock, Red.	100	..	85½-89
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red.	100	..	94-96
Folkestone Electric Supply, Ord., Nos. 1-10 000	5	..	4½-5
—— 5 per cent. Cum. Pref., Nos. 1-10 000	5	..	4⅞-5⅛
—— 4½ per cent. First Deb. Stock, Red.	100	..	96-99
Hove Electric Lighting, Ord., 1-13 000	5	..	6½-7
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100	..	101-104
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk., Red.	100	..	92-95
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	..	1/16-3/16
Kensington and Knightsbridge Elec. Lt., Ord., 1-21.000	5	..	8-9
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100	..	98-102
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9½-10½

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Name.	Amount paid. £	Last price. £
London Electric, Ordinary	3	1¼-1⅜
—— 6 per cent. Pref.	5	3⅜-4¼
—— 4 per cent 1st Mortgage Debenture Stock, Red.	100	89-93
Madras Electric Supply Corporation 5 per cent. Construction Deb. stock, Red (Prov. Certs.), all paid	100	92-95
Metropolitan Ordinary, 100,001-.00,000	5	5¼-5⅜
—— 4½ per cent. First Mortgage Debenture Stock	100	102-.06
—— 4½ per cent. Cum. Pref.	5	4¼-5
—— 5½ per cent. Mortgage Debenture, Red.	100	16 91
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds 1935, C 1-1,000 ($100), D 1-5,000 ($500), M 1 4,400 ($1,000)	—	74¼-76½ p.c.
Mexican Light and Power Co., Capital stock	$100	42-44
—— 5 per cent 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14 000 ($1,000)	—	82-84
Midland Electric Power Dis., 4½ p.c 1st Mort. Deb.	—	96 99
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009	5	6¼-6⅜
—— do., 57,010-75,000	5	6¼-6⅜
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid)	5	6¼-6⅜
—— 5 per cent., Pref., 1-57,009	5	5-5½
—— do., 75,001-87,500 (issued at 10s. prem., 4s paid)	5	5-5½
Notting Hill Electric Lighting	10	10¼ 11½
—— 4 per cent. First Mort. Debs. Nos. 1 500 (Reg.)	100	95-97
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	5¼ 6
—— 4 per cent. Debenture Stock	100	96-97
River Plate Electricity Co., Ord., 1-119 687 & 120,501-120 507	1	9/16-11/16
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	¼-1
—— 5 per cent. Debenture Stock, Red	100	95 98
Rosario Electric Co., 6 per cent. Cum. Pref., 1-20 000	5	4¾ 5¼
—— 6 per cent. Cum 2nd Pref., 1-15,000	5	4¾ 5⅜
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	96 98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	—	98-100 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5	¼ 1½
—— 4 per cent. Debenture Stock	100	71-75
South London Ordinary	5	2-2½
South Metropolitan Electric Light and Power, Ord.	1	¼-¾
—— 7 per cent Cum Pref.	1	15/16-1 3/16
—— 4½ per cent. 1st Mort. Deb.	100	98 102
St. James's and Pall Mall, Ordinary, 101-20,080	5	7¼ 8¼
—— 7 per cent. Pref.	5	6-7
—— 3½ per cent. Deb.	100	86-91
Urban Electric Supply Co., Ordinary, 8-30 007	5	1⅜ 2¼
—— 5 per cent. Cumulative Preference, 50 001 80,000	5	1⅝-2¼
Westminster, Ordinary	5	8-9
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	4¾-5¼

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine, 6 per cent. Cum Pref., 1-260.007	5	5¼-5⅝
—— 10 per cent. Non-Cum 2nd Pref., 2-0 008-280,007	5	7¼- ⅜
—— Permanent 6 per cent Debenture Stock, 1888	100	128-131
Auckland Elec Trams., 5 p.c. 1s Mor. Deb. Stk., Red.	100	102-105
Barcelona Tramways, Ord., 1-20 000	10	—
—— 5 per cent. Cum. Pref shares, 1-10 000	10	—
—— 5 per cent Deb., Red., 1 000	100	—
—— 4½ per cent. Red. Deb Stock	100	—
Bath Elec Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1	11/16 13/16
—— 5 per cent. Cum. Pref. Shares, 1-75 000	1	1316/-15/16
Birmingham and Midland Trams., 4½ p. c 1st Db. Stk., Red.	100	94-97
Blackpool and Fleetwood Tramroad	10	13⅜ 1'⅜
Bombay Elec. Supply and Trams Co., 6 per cent. Cum. Pref.	8	7¼-7⅞
—— 4½ per cent. Deb. Stock, Red.	100	94-96
Brisbane Tramway Invest., Ord., 1-75.000	5	3-3⅛
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4¼-4⅜
—— 4½ per cent. Deb. Stk., Red., Prov Certs. all pd	100	96-100
British Columbia Electric Railway Co., Old Def.	100	123-128 xd
—— Ord. Pref.	100	104 108 xd
—— 5 per cent. Cum. Perpetual Pref. Stock	100	99 103
—— 4½ per cent. 1st Mt. Debs., Nos. 1 6,250, of £40 each	40	98-101
—— 4½ per cent. Vancouver Power Deb.	100	100-105
British Electric Traction, Ord. 1-300 000 & 60,001-90 000	10	1¼ 2
—— 6 per cent. Cm Pf., 30,0001-60 000	10	4¼ 5
—— 5 per cent. Perpetual Debenture stock	100	92-95
—— 4½ per cent 2nd Deb. Stock	100	73-77
Bueno Ayres and Belgrano Trams	5	4⅜-4⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	4¾-5¼
—— "B" 6 per cent Cm. Pf., 1-27 500	5	4⅜ 5¼
—— 5 per cent. Deb. Stock, Red.	100	105-115
—— Prov. Cert., all paid	100	103-105
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100	91-96
Buenos Ayres Gd Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100	99-103
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	98-103
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	91-94
Calcutta Tramways, Ord., Nos 1-137,610	5	6⅜-6⅝
—— 5 per cent. Cum. Pref., Nos. 1 20,000	5	5 5¼
—— 4½ per cent. 1st Deb. Stock, Red.	100	100 104
Cape Electric Tramways, Nos. 1-480,000	1	⅛-⅜
City of Birmingham Tramways, 5 per cent. Cum Pref.	5	4¼-4⅜
—— 4 per cent 1st Mortgage Deb., 1-3 000 (1917)	100	96-99
City of Buenos Ayres Trams. Co. (1 04), 1-248,000	5	4⅛-5¼ xd
—— 4 per cent. Deb. Stock, Red. 1985	100	98-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	93-97
Cork Electric Tramway and Lighting Co., Ordinary	10	13-14
—— 6 per cent. Cum. Pref.	10	12¾-13⅜
—— 4 per cent. Debentures	100	90-95
Dublin United Tramways (1896), Ord., Nos 1-60 000	10	12¼-13½
—— 6 per cent. Pref., Nos. within 1-60 000	10	12¾-13¾
—— 3½ per cent. Mort. Debs., 1-3,000 Red	100	90-95
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100	97-100
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1,000	83-87
Imperial Tramways, Ordinary	all	18-19
—— 6 per cent. Cum. Pref.	all	14-14¼
—— 4½ per cent. Deb. Stock	100	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30 001-60.000	5	¼-1⅛
—— 4 per cent. 1st. Mt. Db Stock, Red.	100	66-71
Kalgoorlie Electric Tramways, 1-250,000	1	1/16-¼
—— 5 per cent "A" Deb. Stock	100	89-93
—— 6 per cent. "B" Deb. Stock	100	74-78
Kidderminster and District Lighting and Traction, Pref.	5	10-10½
Lancashire United Tramways, Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	94-97
—— £296 500 2nd Mort. Deb. Stock	—	—
—— £83,'30 Deferred Deb. Stock (all fully paid)	—	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1	¼-1⅛
—— 6 per cent. Cum. Pref., Nos 1-425.553	1	¼-1⅛
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100	92-97
London United Trys. (1901), 5 per cent. Cum. Pref.	10	7¼-8¼
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100	81-86
Madras Elec Trams. (1904) 5 per cent. Deb. Stk., Red.	100	96-99
Manila Elec. R.R. and Lightg. Corp., 5 p.c. 1st Lien and Coll Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-1,635	$1,000	88-92
Manx Elec Railway Co., 5½ p.c. Cum. Pref., 201-21,635 and 23,436 25 000	—	4½-5
—— 4½ per cent 1st Mort. Deb Stock, Red.	100	96-99
Metropolitan Elec Trams., Defd., 1 000.001-1 314 016	1	1/16 3/16
—— 5 per cent. Cum Pref. 500,001-1,000 000	1	13/16- 5/16
—— 4½ per cent. Deb. Stock, Red.	100	93-96
Mexico Trams. Co, Gen. Cons. 1st Mort 50-year 5 per cent. Gold Bonds	—	80-82 p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con. Mort Bonds, 1926 1-5,500 and 7,001-8,000	$1,000	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., £01-2,000 1922	100	101-103
New General Traction, 6 per cent. Cum Pref., 1-10 000 and 34 001-74 000	5	¾-1⅛
Oldham, Ashton, and Hyde Tramway, Ordinary	10	2
—— 5 per cent. Cum. Pref.	10	8¾-9
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk.	100	99-103
Potteries Electric Traction, Ordinary, 1-245.000	1	5/16-9/16
—— 5 per cent Cum Pref., 300,001-545 000	1	¼-⅜
—— 4½ per cent Debenture Stock	100	93-96
Provincial Tramways Co., Ordinary, 1-24 912	10	5-5½
—— 6 per cent. Cum. Pref., 1-10.000	10	10¼-11½
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-30,000	5	5-5½
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100	97-99
Sao Paulo Tramway, Light, and Power Co.	$100	110-115
—— 5 per cent. 1st Mort Deb., Red. 1929. 1-11,000	$500	91-93 p.c. xd
South Metropolitan Electric Tramways and Lighting Co., 6 per cent. Cum. Pref., 19,571-169.570, Prov. Certs.	1	¼-1⅛
—— 4 per cent. Deb St ck. Red. 1-40.	100	80-84
Sunderland District Electric Tramways, 5 p.c 1st Mort. Pens, Red., 1-1 600	100	84-88
Yorkshire (West Riding) Elec Tram. Co., Ord., 70 001-110,000	5	1-1½
—— 6 per cent. Cum Pref., 1-46,261	5	3¼ 3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	84-87

Electric Railways.—

Name.	Amount paid £	Last price. £
Central London, Ordinary	100	62-65
—— 4 per cent. Pref.	100	83-85
—— " " deferred	100	41-44
—— 4 p c Deb. Stock (Prov. Script Certs., fully paid)	100	101-104
City and South London, Consolidated Ordinary	100	43-45
—— 4 per cent Debenture Stock	100	100-103
—— 5 per cent. Pref. Stock '91	100	116-119
—— " " " '96	100	113-116
—— " " " '01	100	113-116
—— " " " '03	100	108-111
Liverpool Overhead, 5 per cent. Pref	10	10-10¼
—— Ordinary, 1-50 000	10	3¾-4¼
—— 4 per cent. Mortgage Debentures, Red., 1-1 700	—	94-96
Underground Electric Railways of London, 5 per cent. Profit-sharing Secured Notes	—	35-39 xd

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price. £
Amazon Telegraph Co., 1-25,000	10	2½-3½
—— 5 per cent. Debs., Red., within 1-1,069	100	85-88
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28 000 and 53 001-78 000	$1 000	88-90
Anglo-American Telegraph Co., Ordinary	100	55-58
—— 6 per cent. Preferred Ordinary	100	98¼-100½
—— Deferred Ordinary	100	14¾-15¼
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100	99-102
Chili Telephone Co., 1-44 000	5	6¾ 7¼
Commercial Cable Co., Stock, 500-year 4 p.c. Deb. Stk., Red.	100	83-87
Cuba Submarine Telegraph Co., Ordinary, 1-16 000	10	6-7
—— 10 per cent Preference, 1-6 000	10	15-16
Direct Spanish Telegraph Co., Ordinary	5	3¼-3⅜
—— 10 per cent. Cum. Preference	5	8¼-8⅜
—— 4½ per cent Debs., 1-500	50	58-101
Direct United States Cable Co.	20	13¼-13⅜
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100	100-102
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100	98 101
—— 4 per cent. Reg. Mort. Debs. (Mauritius subsidy), 1-8 000. 1913	25	98¼-100½
Eastern Extension, Australasia and China, 1-300 000	10	12⅜-12⅝
—— 4 per cent. Mort. Deb. Stock. Perp.	100	98-102
Eastern Telegraph Co., Ordinary Stock	100	128-133
—— 3½ per cent. Preference Stock	100	82-85
—— 4 per cent. Mortgage Debenture Stock	100	98½-101
Great Northern Telegraph Co. (of Copenhagen)	10	30½-32½
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1,200, Red.	100	99-10.
Indo-European Telegraph Co.	25	52-55
Marconi's Wireless Telegraph Co., Nos. 255,128-284,190	1	11/16-13/16
Monte Video Telephone Co., Ordinary, 1-72,680	1	15/16-1 1/16
—— 6 per cent. Preference, 1-86,492	—	¼-1
National Telephone, Preferred	100	106½-108½
—— Deferred Stock	100	104½-106½
—— 6 per cent Cum. First Pref.	10	10½-12½
—— 6 per cent Cum. Second Pref.	10	10-12
—— 5 per cent Non Cum. Third Pref.	5	5¼-5⅝
—— 3½ per cent. Deb. Stock, Red.	100	96½-98½
—— 4 per cent Deb. Stock, Red.	100	98½-100¼
Oriental Telephone and Electric Company	1	1⅛-1⅜
—— 6 per cent. Cum. Pref	1	1 1/16-1 3/16
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100	97-100
United River Plate Tele. Co., Ordinary, 1-100.000	5	6¾-7¼
—— 6 per cent. Cum. Pref., 1-40,000	5	4¾-5⅛
—— 5 per cent. Debenture Stock, Red.	100	—
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	98-101
West African Telegraph Co.	10	10-10¼
West Coast of America, 1-50 000 and 53 001-53,008	2½	1¼-1⅜
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100	97 100
West India and Panama Telegraph Co., Ordinary	10	7/16-9/16
—— 6 per cent. Cum. 1st Preference	10	7-7½
—— 6 per cent. Cum 2nd Preference	10	6¼-6⅞
—— 5 per cent. Debs., Red., 1-800	100	98-102
Western Telegraph Co., 1-207,930	10	12¾-13½
—— 4 per cent. Debenture Stock, Red.	100	98¼-101½

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.							Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1907.	1906.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Mile of track. Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Nov. 27	1,232	1,200	+ 32	— h	25½	25	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	,, 17	1,019	966	+ 53	− 176	8	8	,, 15	14,328	3,316,380	353,945	1	9·71	1,830	5·16
Baker Street and Waterloo Ry.	,, 30	2 890	2,020	+ 870	+19,155	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	Dec. 1	1,112	965	+ 147	− 34	23·53	21·53	March 31	55,025	11,145,531	1,309,903	1·18	10·08	2,338b	6·03
Birmingham Corporation	Nov. 23	6,131	—	—	—	56½	—	,, 31	17,133	4,709,798	266,526	·86	14·5	8,866	—
Blackburn Corporation	,, 27	981	998	− 17	+ 2,618	24	24	,, 25	48,875	8,661,720	986 953	1·35	11·89	2,036	7·44
Blackpool Corporation	,, 28	320	321	− 1	− 1,315	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	Oct. 26	311	279	+ 32	− 1,139	16½	16½	Dec. 31	31,846	2,325,677	579,264	3·28	13 19	—	7·27
Bolton Corporation	Dec. 1	2 048	1,995	+ 52	+ 4,848	42	40	March 31	95 766	20,205 196	2,161,130	1·13	10·63	2,39	6·14
Bournemouth Corporation	Nov 27	1,2·6	1,292	− 46	+ 1,085	17·41	16·82	,, 31	55,276	10,058,288	1,121,623	1·32	11 83	3,22	7·19
Bradford Corporation	,, 30	4,233	4,292	+ 1	+ 3,130	95	95	,, 31	230,085	47,108,000	5,053,392	1·172	10 927	2,396	—
Brighton Corporation	Dec. 1	677	722	− 45	− 3,017	9½	9½	,, 31	50,339	11,321,160	1,152,82	1·06	10·48	,814·8	8·014
Bristol Tramway Company	Nov. 29	4 568	4,764	− 196	—	51½	51½	Dec. 31	259,799	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	,, 30	1,180	1,181	− 1	—	40	40	March 31	67,982	11,092,704	1,197,772	1·31	11·61	5,388	8 17
Burton Corporation	Dec. 1	240	—	− 14	− 500	8½	8½	,, 31	17 950	3,878,269	454,082	1 07	9·21	2,06	6·76
Cardiff Corporation	—	—	—	—	—	32·62	†32·26	,, 31	112,209	24,134,363	2,770,049	1·12	9·72	3,782	9·44
Carlisle Tramways Company	Nov. 30	153	163	− 10	− 543	8·5	8·5	Dec. 31	10,713	2,935 002	359,756	—	7·14	—	5 18
Central London Railway	,, 30	5,931	6,666	− 735	−17,613	6	6	,, 31	347,588	4,875,547	1,281,214	1·86	65·10	57,931	35·60
Charing X, Euston, & Hamp. Ry.	,, 30	2,915	—	—	—	8	—	—	—	—	—	—	—	—	—
City and South London Railway	Dec. 1	3,553	3,016	+ 543	+ 9,737	6½	6½	,, 31	—	—	—	—	—	—	—
Colchester Corporation	Nov. 6	191	194	− 1	—	8	8	March 31	10,588	2,457,553	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	,, 23	399	428	− 39	− 844	15½	15½	Dec 31	24,895	5,814,376	882,256	1·01	6·64	—	4·68
Croydon Corporation	,, 29	1,224	—	− 50	− 2,008	12 c	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 29	250	254	− 24	− 35	7 23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	,, 30	165	183	− 18	− 1,114	4½	4½	,, 31	11,250	2,853,200	284,343	·94	9·49	2,500	
Dublin and Lucan Electric Ry.	,, 29	88	100	− 2	+ 226h	6½	6½	Dec 31	6 358	402,511	110,738	3·79	13·78	942	7 33
Dublin U.T.	,, 29	4,704	4,770	− 66	+30 855	48½	48½	,, 31	267,489	50,050,949	7,077,372	1·28	9 07	691	5 55
Dundee City Tramways	,, 27	1,090	1,051	+ 39	+ 941	22	22	May 15	30,154	13,086 396	1,005 911	·906	11·96	2,180	7·42
East Ham Corporation	,, 30	849	782	+ 47	− 44	14	14	March 31	36,652	3,689,658	863,816	·64	10·18	2,994	6 79
Glasgow Corporation	,, 30	16,236	16,776	− 480	+12,798h	79½	79½	May 31	756,490	195,767,519	17,945,595	—	10·12	—	—
Gloucester Corporation	,, 27	231	233	− 2	—	15	15	March 31	15,466	3,902,077	563,595	·90	6·58	999	5·32
G.N., Piccadilly and Brompton.	,, 30	4,930	—	—	—	9	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	37	37	,, 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 23	1 474	1,475	− 1	+ 2,643	35	35	,, 31	69,938	12,838,150	1,665,262	1·24	9·71	1,823	—
Hull Corporation	,, 30	2,605	2,307	+ 296	+ 4,648	26	26	,, 31	112,651	27,102,921	2,910,698	1	9·29	—	—
Ilford Corporation	—	—	—	—	—	10½	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 20	127	117	+ 10	+ 285	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	11,586	3,626,656	419,800	·737	6·62	1,480	5·22
Lancashire United Tramways	,, 27	1,092	1,058	+ 34	+ 13,899	39	38	—	—	—	—	—	—	—	—
Leeds Corporation	,, 30	6,089	6,136	− 47	+ 9,410	89½	89½	March 25	298,233	64,223 666	7,121,038	1 10	10·02	351	—
Leicester Corporation	,, 30	2,101	2 083	+ 17	—	42	42	Dec. 31	26,011	12 039,252	1,229,507	1	9·79	—	4 82
Liverpool Corporation	,, 23	10,200	10.586	− 386	+ 8 070	104	104	,, 31	547 625	116,642 663	12.166 419	—	—	—	—
Liverpool Overhead Railway	Dec. 1	1,326	1,386	− 60	+ 1,717h	6·65	6·65	June 30	81,302	11,171,865	1,024,275	—	—	—	—
London County Council	Nov. 23	29,544	25,616	+3,978	+178,957	98	98	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 30	163	152	+ 11	− 22	6	6	Sept. 30	14,511	3,128.867	359,435	1 08	9·68	630	6·48
Maidstone Corporation	—	—	—	—	—	2	2	March 31	4,740	850 121	112,227	1·33	10 13	2,370	—
Manchester Corporation	,, 30	13,302	13 522	− 220	+ 35 816	149	149	,, 31	631,956	126,900,875	14,123,124	1·19	10·73	4,299	6·89
Metropolitan District Railway	,, 30	8,513	8,157	+ 356	− 29	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	Dec. 1	15,436	15.327	+ 109	+ 6,128	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	Nov. 30	125	131	− 6	− 24	2½	2½	,, 31	6.159	1,992,647	206,358	82	7·14	2,239	—
Newcastle-on-Tyne Corporation	,, 30	3,898	4,012	− 114	+ 519	50	50	,, 31	197,849	43,06 ,934	4,326,152	1·07	10·98	3,967	7·0
Newport (Mon.) Corporation	,, 30	596	603	− 7	+ 1,824	15½	15½	,, 31	30,356	7,252.535	783 435	—	9 29	—	6·4
Oldham Corporation	—	—	—	—	—	34	34	,, 25	65,553	13,466,245	1,504,740	1·16	10·45	1,886	—
Portsmouth Corporation	May 25	2,330	1.578	+ 752	+ 632	28½	28½	,, 31	95,702	19,625,329	197,499	1·17	11·63	—	—
Reading Corporation	Nov. 28	560	595	− 25	− 801	33½	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	11·29	21·29	,, 31	14,881	2,837,110	386,547	1·24	9·24	1,102	7·92
Rotherham Corporation	—	—	—	—	—	9½	9½	,, 31	23,569	5,251,472	593,054	1 07	9·53	2,612	7·49
Salford Corporation	Dec. 2	4,136	4,259	− 123	+ 4,282	70¾	70¾	,, 31	214.111	39,213,560	4,894,580	1·28	10·29	—	—
Scarborough Tramways Co.	—	—	—	—	—	4½	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 1	5,510	5,323	+ 188	+ 9 320	35¾	35¾	,, 25	240.565	63 952,283	,049,899	·903	9 543	3,653	5·94
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,365	9.294,771	1,108,369	1·27	11·02	—	7·86
Southend-on-Sea Corporation	Nov. 27	252	257	− 5	− 54	9	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	,, 31	39,550	6,766,031	1,027,730	—	9 23	—	4·75
Sunderland Corporation	Dec. 1	1,182	1,250	− 68	− 991	20	20	,, 31	64,858	15.364 463	1.495,685	1·004	10·36	—	6 37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	4,937	1,315,757	102,751	0·87	11 53	1,37	—
Torquay Tramways	Nov. 28	188	—	—	—	5·16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 30	692	733	− 41	+ 705	12 68	12·43	,, 31	43,607	7,995,451	862,12	9·27	12·14	3,13	7·5
Warrington Corporation	—	—	—	—	—	9	9	,, 31	17,057	4,418 225	403 363	—	9 85	—	6·33
West Ham Corporation	,, 28	2,087	2,118	− 31	+ 1,464	14·7	14·7	,, 31	—	16,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	,, 27	772	797	− 25	+ 232	20	20	,, 31	41,905	8,847,066	950,338	—	10 588	2,0	6·15

† And 98 miles of interlacing track. a Train mile. b Per mile of single track. c Miles of route. h Half-year's figure k Double tra

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NOTES.

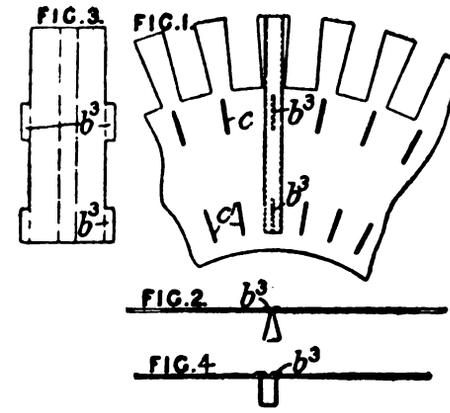
Public Lighting Charges.—The following are the charges for public lighting by electricity adopted in the metropolitan borough of Hackney: for 10-ampere lamps the charge is £13. 10s. per lamp per annum, and for seven-ampere lamps, £11 per lamp per annum. These charges include the supply of energy, the trimming, carboning, cleaning and maintenance of the lamps, the provision for interest and repayments on proportion of capital on generating works, and special and general mains for public lighting, the provision for depreciation, and the general charges for testing, supervision, and administration of stores, etc. It is left to the Finance Committee to arrange the further charges to be made for interest and repayments on loans for lamps and pillars, which approximately amount to £2. 10s. per annum in case of the 10-ampere lamps, and £2 per annum in the case of the seven-ampere arc lamps.

Reported Tube Combine.—There have been various rumours about for some time past respecting a combination of metal tube makers. These have now given way to a rumour to the effect that an agreement has been drawn up and approved by all parties for a working agreement between tube makers of America, Germany, and Great Britain in order to avoid the serious loss now resulting from international competition. A contemporary has been making inquiries in the Glasgow district as to the reliability of the rumour, and is informed by its local correspondent "that the Glasgow tube makers say they have not been asked to join the rumoured working agreement. Stewarts and Lloyds, Limited, the leading makers, have not been approached, but at the same time," adds our contemporary, "all would gladly welcome a trade understanding which would remove the present ruinous competition in neutral markets."

Scholarship Fund.—Mr. W. H. Dugdale, in the course of his presidential address to the North-East Coast Institution of Engineers and Shipbuilders, called attention to the scholarship fund promoted by the institution. That fund now amounts to £1,500, and next September it is hoped to offer a scholarship of £50, tenable at the option of the Council, for two years to some deserving student desirous of obtaining his degree in engineering or naval architecture. The first scholarship will be open to the student who obtains the best marks, irrespective of district, on the North-East Coast, and whether he be engaged in engineering or shipbuilding. After that the scholarship will be awarded bi-annually until the institution has sufficient funds to grant one annually, and will be awarded to students in engineering and naval architecture alternatively, and also in rotation in the various districts on the North-East Coast as far as practicable. This admirable method of encouraging deserving students should prove an incentive to apprentices to qualify themselves for the higher positions which their profession has to offer.

Royal Institution.—The programme of lectures arranged to be delivered at the Royal Institution of Great Britain before Easter, 1908, has now been issued. The Friday evening meetings commence on Jan. 17, and among the discourses promised are the following: Jan. 31, Prof. E. E. Rutherford, "Recent Researches on Radioactivity"; Feb. 21, Sir Oliver Lodge, "The Ether of Space"; March 27, Hon. Robert John Strutt, "Radioactive Change in the Earth"; April 3, the Right Hon. Lord Montagu of Beaulieu, "The Modern Motorcar"; April 10, Prof. J. J. Thomson, "The Carriers of Positive Electricity." The Thursday and Saturday afternoon lectures are also of interest to us. On Thursdays, March 19 and 26, Dr. R. T. Glazebrook discourses on "Standardisation in Various Aspects—*i.e.*, (1) Mechanical Engineering, (2) Electrical Engineering." Prof. Gisbert Kapp delivers two lectures on "The Electrification of Railways" on Saturdays, Jan. 18 and 25. Prof. J. J. Thomson delivers a course of six lectures on "Electric Discharges through Gases." The first of these lectures will be given on Saturday afternoon, March 7, and the others on subsequent Saturdays, the course ending on April 11.

Dynamo Cores.—In an arrangement patented by Messrs. Mavor and Coulson, Glasgow, the distance pieces for ventilated dynamo or transformer core are formed of sheet metal, bent to a hollow section and secured to one of the discs or plates of the core. Figs. 1, 2, and 3 show one



arrangement. A blank (Fig. 3) having lugs, b^3, is bent to the triangular shape shown in Fig. 2, and the lugs, b^3, are passed through slots, c c^1, in the disc, being bent back to fix the distance piece. The blanks may be so shaped that the distance piece tapers, or has a rectangular section, as shown in Fig. 4.

Commerce and Finance.—Sir Felix Schuster's presidential address delivered recently to the Institute of Bankers was a masterful review of financial events and of the commercial situation, which is especially interesting at the present time of uncertainty in regard to financial affairs. Sir Felix pointed out with convincing force the duality of our commercial position—*i.e.*, depressed markets and a falling in the value of securities parallel with prosperous trade. As to the commercial outlook, he said the indications pointed to restriction rather than expansion, not only in this country, but all over the world. The development of trade, especially of railway construction and improvement and electrical undertakings in various parts of the world, had proceeded at too rapid a pace, and the available capital had not been adequate to meet the demand made simultaneously from so many quarters. The statement made by Sir Felix Schuster deserves to be particularly emphasised. He said: "Credit, which is so essential to the carrying on of modern commerce, is a sensitive organism which must be carefully guarded from overstrain; and bankers on both sides of the Atlantic will do well to bear in mind that the too easy granting of credit to institutions and firms without sufficient working resources of their own is not rendering those institutions a good service."

Tramways and Light Railways Association.—At the annual dinner of this association held last week, Mr. Emile Garcke expressed the opinion that tramways or light railways in sparsely-populated districts ought to be treated with more sympathetic consideration by the authorities than those serving large cities, and the cost of their construction ought to be reduced. He thought the public did not sufficiently appreciate the very important services which tramway undertakings rendered. They carried on the tramways more than twice the number of third-class passengers of all the railways in the United Kingdom, and

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yet the profits on the increased capital embarked were less than they were some 10 years ago. His opinion was that they should have the necessary organisation to make their views felt before Parliament. The Duke of Argyll, who presided over the dinner, said that there were over 300 tramway and light railway undertakings in the country. The total capital invested in them amounted to about 60 millions. The total mileage open for traffic was over 2,200 miles, served by over 11,000 cars. The total passengers carried last year amounted to 2,236 millions, or over six million passengers per day. The gross receipts from these undertakings last year amounted to over 10½ millions sterling. In order properly to safeguard the interests of those responsible for the expenditure of the huge sums of money involved in this enterprise, a central organisation was of the utmost importance, and this was provided by the Tramways and Light Railways Association

Storage Battery Connections.—Those who have to deal with questions involving the use of storage batteries have found the greatest desiderata to be how to obtain the greatest possible usefulness from a battery, and also how to avoid unnecessary complications. To such, a book of "Diagrams of Connections for Storage Batteries," published by the Tudor Accumulator Company, Limited, 119, Victoria-street, London, S.W., should be very useful. The book contains a collection of diagrams showing the best methods of using storage batteries in the cases ordinarily met with in practice, while copious notes are given concerning the various diagrams which will be a help in deciding upon the best arrangement to employ in each case. At the end of the book there is given a table in which will be found a summary of the principal features of the diagrams, as well as formulæ enabling the number of cells in the battery, the number of regulating cells, and the output of boosters to be calculated. The diagrams may be divided up into three groups: (*a*) regulating switch for keeping voltage constant, increase of voltage of main generator for charging; (*b*) booster for raising volts for charging; (*c*) reversible booster for keeping voltage constant and for raising volts for charging. The distinguishing features of each of the above groups are dealt with, and the special points of each diagram are considered. The book is extremely useful, and we can strongly recommend it to all who have to deal with accumulators. It is published at 5s.

Junior Institution of Engineers.—A numerously-attended visit of this institution was recently paid to Woolwich Arsenal, appropriately arranged to follow the striking inaugural address on "Some Comparisons between French and English Artillery," which had been delivered by the newly-elected president, M. Gustave Canet, the eminent French artillerist. The chief superintendent of ordnance factories, Mr. H. F. Donaldson, received the members, and under the guidance of the chief mechanical engineer, Mr. Douglas Heap, and other officials, several hours were spent by the visitors in an inspection of the interesting processes of manufacture involved in the production of metal time fuses; bullets for the magazine rifle; siege, field, quick-firing, and machine gun carriages; mountings for heavy ordnance; woodwork for carriages; small-arm and quick-firing ammunition boxes; wheels; heavy breech-loading guns, including the hoops and tubes for them. Rifling operations were shown, and working models of breech mechanisms of heavy breech-loading guns. The process of wire winding was also seen, and, in view of M. Canet's observations on that topic in his address, attracted particular attention. The chairman of the institution, Mr. Frank R. Durham, expressed to Mr. Donaldson the members' appreciation of the special arrangements which he had kindly made for their reception, enabling so much to be seen in the limited time at disposal. At the ensuing meeting on Jan. 8 a paper on "Recent Improvements in Electric Conduit Construction" is to be read by Mr. Fitz Roy Roose, of the London County Council tramways reconstruction department.

West Ham Electric Lighting and Tramways.—From a statement as to accounts for the half-year ended September, 1907, we find that the gross revenue for the past half-year amounted to £27,645, compared with £20,496 for the similar period last year, or an increase of £7,149, equal to 35 per cent. The total gross revenue for the last financial year was only £1,900 above that of the previous year, but the total for the current year is expected to be about £16,000 higher than last. Several very large supplies come fully into operation in Silvertown during the present quarter (ending December). The increase is a rising one, the figure being 32 per cent. for the June quarter and 37 per cent. for September. Coal for the half-year was £6,197 against £4,725, an increase of £1,472, the coal in pence per unit sold is ·326d. against ·375d., and against last year's total of ·39d. The year's coal will not amount to much above ·30d. The total units sold amount to 4,528,265 against 3,028,848, 50 per cent. increase, which appears to confirm the chief engineer's estimate of 12 million for the year. The efficiency of the West Ham distributing system is improving, being 79·7 per cent. against 70 per cent. of last year. The improvement is mainly accounted for by the fact that the losses on a power load in transformers and accessories are lower than on a lighting load. The efficiency of the Silvertown system is 87 per cent., in spite of the fact that over half a million units were converted to direct current, whereas all West Ham is alternating current. The coal figures should be improved when the second turbine (now being erected) is running, and the spray coolers for circulating water are working.

Effect of Power Factor on Mining Plant.—At a recent meeting of the South African Association of Engineers some interesting observations were made as to the size of plant equipments employed at the Rand mines. It was said that motors were usually installed which were too large for the work they had to do. Thus, there were a number of large motors running at half or third loads, and, consequently, showing a bad power factor. Mr. L. Wilms said that motors should be run at 75 per cent. to 100 per cent. full loads. In connection with three-phase supplies the usual practice was to have overhead mains, but Mr. Wilms thought that if underground cables were put in there would be an improvement in the power factor, without any appreciable increase in cost. At the East Rand, he said, they had spent £135,000 for a 3,000-kw. plant. Out of that they had expended £4,000 on underground cables. There might have been a saving of £1,000 with overhead mains, but £1,000 in £135,000 was hardly worth considering. And they were free from lightning effects and the cost of maintenance was less. Mr. Wilms preferred a large motor to a number of small-size motors. It meant a better power factor, and did away with the necessity of putting in transformers. He thought it wise to try to bring the frequency down if they had a number of large motors running at low speeds. If they had a high frequency, down went power factor and efficiency. If, for instance, they were driving stamp batteries, it would pay to put in one motor and have a low frequency of, say, 25 cycles, and they would get a very good power factor. By having motors too large, said Mr. Wilms in conclusion, and by having too many small ones, it was deplorable that the power factor on these

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fields was not more than 50 per cent., or, perhaps, 70 per cent. On the East Rand, by watching these points, they had managed to get their factor up to 82 per cent. and 83 per cent.

The Practical Application of Theory.—One of the greatest difficulties which the young engineer meets with in practice is the reconciliation of the numerous theories taught in schools and colleges with actual engineering works. A student generally understands that some allowance must be made for variations in the quality and strength of the materials used. Despite this, the conditions and limitations which are often placed on pure theory, in practice so overshadow it that the original form is liable to be lost sight of. In this way, a formula founded on theory, but with certain limitations required by practical experience, is often wrongly classed as empirical. In some cases satisfactory theories do not exist, and purely empirical formulæ must be used; these are often based on assumptions which, when explained, may enable the engineer to form that mental picture of the truth which is so invaluable. Such a subject forms an extremely interesting one for the consideration of engineers, young and old, and we are pleased to note that it formed the subject of a general discussion last night (Dec. 12) at the second meeting of the session of the Newcastle-on-Tyne Students' Section of the Institution of Civil Engineers. Mr. J. Mitchell Moncrieff, M.I.C.E., was announced to open the discussion, and on a subject which is so fertile in the suggestion of ideas we should have had many interesting contributions to the debate, which forms one of the few subjects which can be discussed by engineers of all grades and ages. Older engineers can draw on their experience to furnish examples of the uses and the limitations of the practical applications of theory, whilst the younger and less experienced engineers can point out the difficulties which they have encountered.

The Electrical Exhibition, 1908, to be held in Manchester.—With reference to the meeting convened by Mr. E. H. Langdon, president of the Manchester Chamber of Commerce, held on the 6th inst., at which he took the chair, supported by Mr. W. T. Stubbs, president of the engineering section of the chamber, the following firms, in addition to a number of other gentlemen interested in the scheme, were present: the Aron Electricity Meter Company, Messrs. Berry, Skinner, and Co., British Westinghouse Company, Bruce Peebles and Co., Messrs. Drake and Gorham, D.P. Batteries, Messrs. Dugdill and Co., the Electrical and Ordnance Company, Messrs. the Electromotors, Limited, Ferranti Limited, Messrs. the General Electric Company, Lancashire Electric Engineering Company, Limited, Liverpool Electric Cable Company, Messrs. Mather and Platt, Messrs. B. and S. Massey, New Brotherton Tube Company, Limited, Messrs. Parmiter, Hope, and Sugden, Messrs. Reyrolle and Co, Limited, and Messrs. Steinthal and Boydell. The object of the meeting was fully dealt with by the chairman, and after a short discussion it was unanimously resolved to proceed with the scheme on the lines set forth in the circular in our last week's issue. It was decided, in view of the second trade meeting arranged to be held in London yesterday, the 12th inst., to elect only three representatives to serve on the General Committee, and the following gentlemen were nominated and accepted office: H. Bevis, Esq., representing the General Electric Company; D. W. Dunlop, Esq., representing the British Westinghouse Manufacturing Company; and B. Longbottom, Esq., representing Electromotors, Limited. A short discussion arose, and promise to support was mentioned by Mr. Stubbs on behalf of the engineering trades of Manchester generally. It was left for the meeting convened by Sir William Preece in London to elect a further five representatives of electrical manufacturing firms to serve on the General Committee.

The Outlook for Electrical Engineering. — The *Economist* in its recent issues has been publishing the opinions of leading experts in the different parts of the country as to the effect of dear money on home trade. The electrical industry has, of course, been inquired into along with other branches of engineering. The letter which our contemporary publishes from an eminent engineering firm shows that manufacturers are not benefiting by the fall in the price of copper: "In consequence of the policy of the large copper-producing companies in America in holding up supplies, many large electrical schemes in this country and abroad were postponed, as the promoters would not purchase cables at the enhanced prices. Now that the Americans have been compelled to reduce the price of copper, consumers are still chary of buying, recognising that the financial conditions may compel a further reduction. The stringency in the money market has also had a most detrimental effect upon the industry. The electrification of railways (to which the industry has been looking for relief from the excessive competition which has prevailed for some years) cannot be undertaken until the railway companies can raise capital upon reasonable terms. Moreover, ordinary extensions of existing municipal electric lighting and tramway stations remain in abeyance for similar reasons; in proof of which may be cited the instructions of the London County Council to the metropolitan boroughs to undertake, in the meantime, only such extensions as are indispensable." It is obvious, therefore, that manufacturers are not buying up copper as freely as was expected, and that the railway companies' difficulties, together with the shelving of electrical schemes for London, are having a detrimental effect upon the electrical industry.

Australian Tariff on Electrical Apparatus.—The original list of duties imposed upon the import of electrical apparatus under the new tariff arrangements remained in force up to and including Nov. 28, but the following tariff alterations took effect on Nov. 29. Item 178: Electrical machines, appliances, and parts thereof (*a*) dynamo-electric machines up to 500 h p., including static transformers and induction coils for all purposes, and electric fans, 20 per cent. all countries. (*a.a.*) Dynamo-electric machines over the capacity of 500 h.p., 12½ per cent. all countries. (*b*) Regulating, starting and controlling apparatus for all electrical purposes, including distributing boards and switchboards, except telephone switchboards, 20 per cent. all countries. (*c*) Electric apparatus and fittings, consisting wholly or partly of metal not elsewhere included, including switch fuses and lightning arresters, 15 per cent. general tariff, 10 per cent. United Kingdom (*d*) Electric heating and cooking appliances, 15 per cent. general tariff, 10 per cent. United Kingdom. (*e*) Electric fittings not containing metal to be dutiable according to material. (*f*) Generators for direct coupling to steam-turbines, 5 per cent. general tariff, United Kingdom free. Item 180: Electrical and gas appliances—namely (*a*) electroliers, gasoliers, chandeliers, pendants, brackets, zinc tubing, 20 per cent. all countries. (*a.a.*) Gasmeters, 5 per cent. general tariff, free United Kingdom. (*b*) N.E.I., 15 per cent. (? 5 per cent.) United Kingdom. Item 180: Electrical articles and materials—namely, accumulators or storage batteries, arc lamps, arc lamp carbons, cable and wire (covered), carbon in blocks of 12 square inches and over, electric vacuum tubes, measuring and recording instruments, prepared insulating tape, and vapour lamps—5 per cent. general tariff, free to United Kingdom.

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Daimler Engineering Scholarships. — Various authorities are at one in considering that the premium apprentice system is no longer a satisfactory medium for the training of engineers. While, however, the alternative proposals are being eagerly discussed, without any appreciable headway being made, several important engineering firms in this country have adopted their own schemes, which, in practice, promise beneficial results. We have received from the Daimler Motor Company, Limited, a circular containing particulars of a scholarship scheme, offering five scholarships, which shall be awarded in July, 1908, and be tenable at the Daimler Works, Coventry, for two years. These scholarships consist of one major Daimler engineering scholarship carrying the following advantages: (*a*) instruction in the theory of motor engineering for two years; (*b*) a systematic course of shop instruction for this period; (*c*) £100 per annum for two years, provided that the owner of this scholarship shall agree to serve the Daimler Motor Company, if the company so desire, in any capacity they may select, at a salary of not less than £150 per annum, for two years after the expiration of the scholarship. Four minor Daimler engineering scholarships are also offered, the conditions of which are similar to the foregoing, except £20 per annum for two years is offered. The scholarships will be awarded on the result of (*a*) an elimination test; (*b*) an essay on some engineering question; (*c*) a *viva voce* examination. The subjects in which the candidates may offer themselves for examination include mathematics (pure and practical), geometrical drawing, machine drawing, sound, light, and heat, magnetism and electricity, inorganic chemistry, metallurgy, theoretical and applied mechanics, heat engines, and mechanical engineering. The effort of the Daimler Company as notified in the foregoing outline of their scholarship scheme should prove an invaluable incentive to their apprentices, and attract to their service young men of the highest intelligence.

The Imperial College of Science and Technology. The Earl of Crewe, chairman of the governing body of the Imperial College of Science and Technology, has authorised the publication of the following communication: The governing body of the Imperial College of Science and Technology have appointed three standing committees—a Finance Committee (chairman, Sir Francis Mowatt), an Education Committee (chairman, Mr. Arthur Acland), and a General Purposes Committee (chairman, Lord Halsbury). In addition, they have appointed two temporary committees—a Transfer Committee (chairman, Mr. Arthur Acland), and an Organisation Committee (chairman, Mr. Gerald Balfour; vice-chairman, Sir William White). Matters relating to the transfer to the Imperial College of the constituent institutions, which it has been arranged shall take effect as from Jan. 1 next, and to the transfer of land from the Exhibition Commissioners, have been referred to the Transfer Committee. The Organisation Committee, to which have been referred matters relating to the future organisation of the Imperial College, have appointed four sub-committees to consider questions arising under this head in relation to the following sciences or groups of sciences—viz.: (1) Mining and metallurgy (chairman of the sub-committee, Sir Julius Wernher); (2) other branches of engineering (chairman, Sir John Wolfe Barry); (3) biological sciences (chairman, Sir Archibald Geikie); and (4) other pure and applied sciences (chairman, Sir Arthur Rücker). The governing body have authorised the appointment of persons, not members of the governing body, who are specially conversant with the sciences in question, or with their industrial applications, as additional members of these sub-committees, which are now engaged in considering the questions referred to them. The governing body have also approved in principle the appointment of a principal officer of the Imperial College, and have referred the question of his title and functions to the Organisation Committee.

Publications Received.—"The Internal Wiring of Buildings," by Mr. H. M. Leaf, A.M.I.C.E., M.I.M.E. (London: Archibald Constable and Co., Limited, 10, Orange-street, Leicester-square. Price, 3s. 6d. net). The third edition of this book has just come to hand. It has been thoroughly revised and enlarged with a chapter on electricity meters and the new rules for wiring recently laid down by the Institution of Electrical Engineers, the Phœnix Fire Office, and the Westminster Electric Supply Corporation. Other chapters are devoted to electric cables, the general arrangement of conductors and cut-outs in buildings, systems of wiring, accessories, testing, etc. Chapter VIII. treats the subject of costs of and estimates for wiring, giving some useful hints that may serve as a guide to those who are installing the electric light.—"The Law of Master and Servant," by Mr. T. C. Jackson, B.A., LL.B., barrister-at-law (London: Macdonald and Martin, 6, Essex-street, Strand, W.C. Price, 2s. 6d. net). Lay readers should find all they require in this useful book on employers' liability, which contains an introductory essay explanatory to the Act of 1906.—"Technical Thermodynamics," by Dr. Gustav Zeuner. Mr. J. F. Klein, D.E. (professor of mechanical engineering at Lehigh University), has now published, through Messrs. Constable, of London, the first English edition of Dr. Zeuner's comprehensive review of the historical development of technical thermodynamics ("Grundzüge Der Merchanischen Wärmetheorie"), which, in the German language, has reached its fifth edition. The English work is published in two large volumes at a price of 36s. net. Volume I deals with fundamental laws of thermodynamics and the theory of gases, while volume II. deals with the theory of vapours.—The *American Physical Review*, in its November issue (which is a double number), contains the following communications: "The Discharge of Electricity from Pointed Conductors Differing in Size," by John Zeleny; "Potentiometer Installation, especially for High Temperature and Thermoelectric Work," by Walter P. White; "The Thermoelectric Behaviour of Metals in Solutions of their Own Salts—II. Cadmium Amalgam in a Solution of Cadmium Sulphate," by William D. Henderson; "Studies in Luminescence—VIII., The Influence of the Red and Infra-Red Rays upon the Photoluminescence of Sidot Blende," by Edward L. Nichols and Ernest Merritt; "Some Electrical Properties of Silicon—I., Thermoelectric Behaviour," by Francis G. Wick; "Condensation Nuclei obtained from the Evaporation of Fog Particles," by C. Barus; "The Diurnal Variation of the Spontaneous Ionisation in Air in Closed Metallic Vessels," by T. Frederick McKeon; "The Absorption of Hydrogen by Metallic Films," by Will C. Baker; "Some Physical Properties of Current-Bearing Matter—IV., Friction," by Paul R. Heyl.

High-Speed Electrically-Driven Elevators.—A gearless 1-to-1, traction, electric elevator which is to be installed in two high buildings in New York, was described by Mr. C. R. Pratt at a recent meeting of the American Society of Mechanical Engineers. The driving mechanism is located over the hoistway, with a traction sheave and a brake pulley on the motor's armature shaft. The ropes from the car pass over this traction sheave, down under an idler sheave, and again over the traction sheave and down to the counterbalance, giving two half traction turns over the traction sheave to drive the difference in weight between the car and the counterbalance. This traction has been

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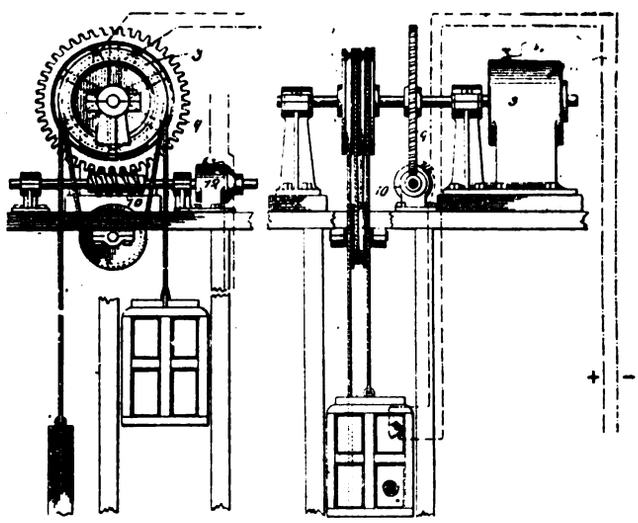
found to be sufficient in ordinary passenger elevator service, especially in high-rise elevators, on account of the weight of the ropes and variable counterbalance chains or ropes, the latter leading from the bottom of the car to the bottom of the counterbalance, thus adding to the constant load on the ropes leading to each fuse of the traction sheave, thereby reducing the variable difference in traction load caused by the variable passenger load. The car speed of 600ft. per minute requires a speed in the hoisting motor of 57 r.p.m. The loss of motor efficiency at this low speed is said to be compensated for by the saving in friction loss due to the elimination of all transmission gearing between the motor and the ropes. The action of the worm gear may be followed by reference to the accompanying illustration, which appeared in the *Electrical World*. On the shaft of the hoisting motor, 3, is a worm gear, 9, the teeth of which engage in the worm, 10, driven by motor, 12. The thread of worm, 10, has such a small pitch that no amount of pressure against the threads of the worm could cause it to revolve. The hoisting drum is thus locked, and no motion is possible until motor 12 revolves the gear, 9, through the worm, 10. Motor 12 is compound wound, and is connected in parallel with motor 3. The latter motor has a rating 10 times as large as that of motor 12, and the latter



revolves 20 times as fast as motor 3. This high speed gives it a flywheel action that ensures perfect acceleration in starting and stopping the car. In hoisting, one switch closes the circuits of both motors simultaneously, and both motors start together to hoist the load. At each change of speed one switch closes a circuit that makes the two motors synchronise with each other in speed In stopping, a small friction brake can be used on motor 12 to bring it to a full stop promptly, but no brake is required to hold the car at rest or to keep it from exceeding its normal speed. In lowering, motor 3 is driven as a generator by the weight of the car and counterweight, and motor 12 tends to drive the gear faster than the hoisting motor would allow it to be driven. This adds slightly to the load that drives the motor as a generator, but permits motor 3 to return energy to the line.

Colliery Managers and Electricity Rules.—The special rules concerning the use of electricity in coal mines which have been introduced have been instrumental in greatly reducing risks from this source. But, as is usual in the case of the issue of departmental rules, their interpretation has given rise to differences of opinion among the classes affected by them. It is, nevertheless, encouraging to witness the approach towards uniformity of understanding which is made possible by the discussion of debateable points at the various technical institutions. It is well known that on the question of electricity rules there is sometimes a considerable diversity of opinion between electrical engineers and colliery managers as to how these should be applied. But on one important point at least—*i.e.*, the management of electrical plant at collieries—there seems to be general agreement. Our contemporary, *The Iron and Coal Trades' Review*, in its last week's issue publishes an account of a discussion upon this question which took place at a meeting of the Lancashire branch of the National Association of Colliery Managers in Manchester, the general trend of which was in favour of leaving such arrangements to a man who has been properly trained as an electrical engineer, and not to one who has been simply promoted from some position on the colliery staff. Colliery managers are apt to consider it an unnecessary expense to keep an electrician down a pit to look after the motors, and who is capable of immediately repairing defects, simply because such an employé would be working only about three-quarters of his time. But if such a view is persisted in, it is likely to react upon the efficient and economic working of the mine. Experience can show numerous examples where road haulage would have been stopped and surface work brought to a standstill, if competent skill had not been brought very quickly. A question which has given rise to no little discussion among colliery managers is that relating to the earthing of cables in the mines. At the meeting referred to above there was much diversity of opinion with reference to armoured and unarmoured cables, and emphasis was laid upon the difficulty of getting good earths in some mines, and the facility in accomplishing that end in wet mines. Mr. G. H. Winstanley said it was understood that where armoured cables were used, the armouring, as well as the motors, transformers, etc., should be properly earthed. If the system was earthed at one point only, he did not see that it would be of very great use, because, having a system earthed, say, near the generator, and the current transmitted a considerable distance into the mine, it was possible to get a fairly bad shock in certain parts of the mine if there was only a single earth connection made at the generator end. The same remark applied where there were two earth connections, one near the generator and the other at the extremity of the system. There, again, it was possible for a man to get a severe shock if he made a contact with the defective arrangements somewhere between the two points. Of course, when dealing with motor-driven pumps, there should not be great difficulty in earthing the armouring of the cables. In such a case they could be connected to the pump delivery pipes where those ran in the same roadway. Mr. Holt, of the Powell Duffryn Collieries, said, with regard to earthing, that the three-phase system might be earthed at any point. This, however, did not apply to the framework or casing. The system at the Powell Duffryn pits, as our readers know, is the high-tension three-phase system, and Mr. Holt said they were working entirely with paper cables, three core, and used copper sheathing under the lead; so the whole of their system from end to end had really four conductors—three live conductors and the earth conductor. If they earthed the neutral points of transformers, and had also the neutral points of the generator earthed, they were breaking Post Office rules. They earthed the neutral points of the transformer; if for any reason the earthing was lead, it made the casing a very dangerous thing to touch, especially when working at 3,000 volts, which was as high as most collieries were using. Another speaker suggested that if the earthing were made continuous throughout, there would be no necessity for what Mr. Holt had described. It was no more difficult, he believed, to earth a three-core cable than an ordinary single wire,

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THE ELECTRICAL EQUIPMENT OF THE WORKSHOPS OF THE BUENOS AYRES WESTERN RAILWAY COMPANY AT LINIERS.

The workshops of the Buenos Ayres Western Railway are situated on the main line, about 14 km. from the centre of the city, and about 10½ km. from their terminal station in Buenos Ayres at the Plaza Once de Setiembre. These workshops comprise coach and car building and repair shops, locomotive erecting shop, boiler, smith, general machine, and wheel-turning shops, iron and brass foundries, copper, tinsmiths', painting, and varnishing departments, sawmill, and buildings for the construction and repair of steel-frame cars; besides extensive depôts for the storage of both rough and finished timber, as well as a large coach-shed, section storehouse, oil depôts, etc. The machinery throughout these works is electrically driven on the three-phase system at 440 volts. Power is furnished from a central power station, which, in addition to supplying electrical energy for power and light, supplies compressed air to operate pneumatic tools, log saws, hammers, hoists, air-lifts in artesian wells, and the pumps supplying all the water used throughout the works. The contractors for the complete electrical and gas-engine and producer plant are the British Westinghouse Electric and Manufacturing Company, Limited.

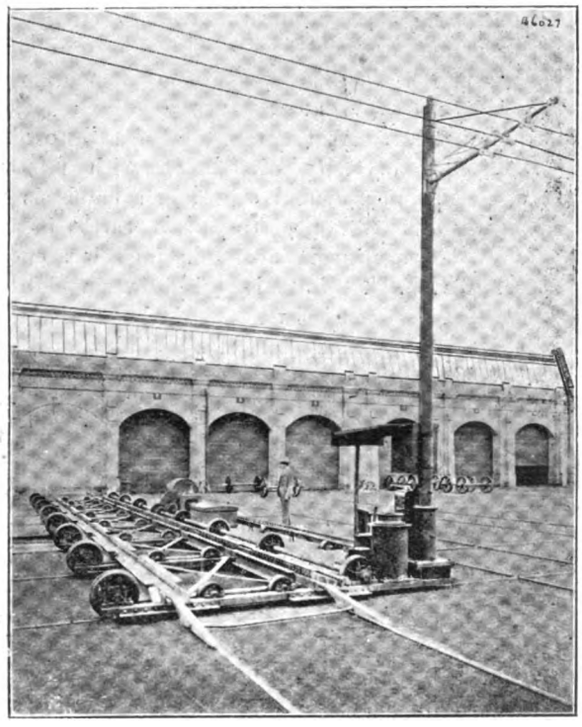

FIG. 1.—Electric Transfer Table, 70ft. long.

The Buenos Ayres Western Railway was the first railway in the Argentine Republic. It was inaugurated on Sunday, Aug. 30, 1857, the line then extending from Plaza Parque (now Plaza Lavalle) to Flores, a distance of 12,000 varas, and the rolling-stock consisting of one locomotive and four cars. The original engine, "La Portena," is now preserved as an historical relic in the Provincial Museum at La Plata. The workshops previous to the sale of the La Plata branch to the Buenos Ayres Great Southern Railway in 1900 were at Tolosa, near La Plata, the seat of the Provincial Government to which this line originally belonged. But in selling this branch line, which crossed the territory of the Great Southern, the workshops at Tolosa were included in the sale, as the new arrangement would put them outside their system, and the Western Railway started constructing new workshops which would be on their main line convenient to Buenos Ayres. Land was acquired at Liniers through which ran the Maldonado stream. Before building could be commenced this stream had to be diverted, which in itself was a costly work. The grounds cover approximately 57 acres, measuring 3,670ft. long by 760ft. wide. The company build coaches, wagons, etc., and erect rolling-stock imported from England and the United States, the shops having complete plant for this purpose. The locomotive section is equipped with machinery for the erection and maintenance of all locomotives, but not for building.

All the buildings are of native hand-made bricks, and have weaving-shed roofs. Where possible the roofs have been designed to get the south light, but in some cases this was not convenient, and the east light was substituted. To the left, on entering the main gate, is the office building, the central part of which is two storeys in height and has a mansard roof. In this building are the offices of the locomotive superintendent, the works manager, engineering and draughting department, and the timekeeping and general clerical department; while to the right of the main gate are archives, restaurant and workmen's dining-room. In the timekeeper's office is an electrically-operated recording clock which marks on a tape the time at which the watchmen make the visits on their beats. About the buildings are stations where each watchman inserts his key in a small iron box and winds up the mechanism, which then runs and sets the central clock at the number of the station, which is then printed on a tape opposite the hour at which it was visited. By this means the timekeeper can see at what hour watchmen have made their rounds. This clock is operated from the central power station.

The works are divided by a wide central avenue, which runs across the yard at the main entrance, the west side being devoted to the wood-working departments, coach and car building, storehouses, etc.; the east side containing the metal-working departments, locomotive erecting and repair shops, waterworks, and power plant. Like most railway shops, the buildings are of only one storey and necessarily scattered, owing to the lines of tracks laid all around them. The west end of the works is devoted to the wood-working departments, sawmill, carpenters' shops, coach and car building and repair departments, coach-sheds, timber yard, finished timber stores, and depôts of the stores department. These comprise timber and material sheds, a depôt for inflammables, and a general storehouse. The latter is 112ft. by 275ft., with a charging and discharging platform provided with an electric walking crane of three tons capacity operated by a 6-h.p. induction motor. The offices of the stores department are situated here. The car building and repair department is 230ft. long by 223ft. wide, and has 10 tracks passing clean through, each capable of taking six bogie wagons or a proportionate quantity of two-axle stock. These continue parallel outside for some distance to the west end, forming a large repair yard, after which they are united by curves and switches. At the east end of the building the tracks extend only a short distance to the motor-driven traverser which serves this group of buildings. As the principal work done here is carpentry, very little machinery is required, the pieces being prepared in the sawmill or other departments. There is a small shop in the centre of the building containing a drilling

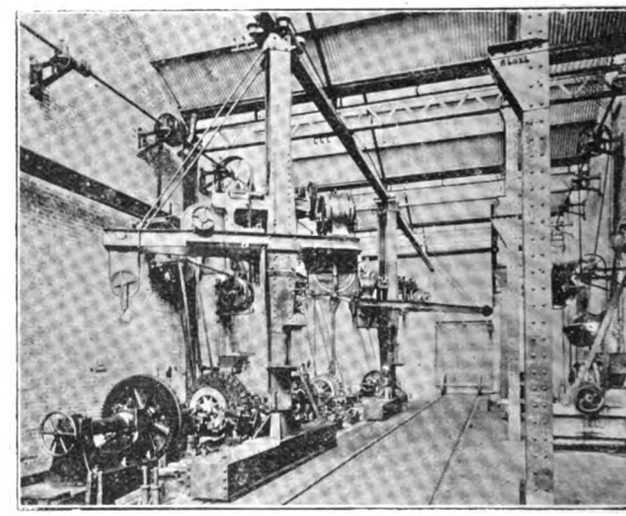

FIG. 2.—One end of Wheel-Turning Shop. Electric Walking Cranes serving all Lathes.

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machine, grindstones, and screwing machine for the vacuum brake piping, all operated by a Westinghouse 5-h.p. motor. Compressed air is extensively used for operating boring bits and drills, portable forges, etc., and there are 20 outlets for hose connection.

Between this department and the sawmill is a well-ventilated brick building, 42ft. by 186ft., having iron louvred sides for the storage of finished timber. The sawmill, carpenters' shop, coach building and repair department, upholsterers', tinsmiths', storeroom, etc., are grouped together in one building, 334ft. by 223ft., separated by interior division walls. These departments are served by an electric traverser or transport table which runs across the whole width of the yard, crossing main lines and through tracks. This gives communication between the different departments and the main lines. The traverser is 70ft. long, capable of taking one of the longest coaches or several shorter vehicles, and has a carrying capacity of 45 tons. It runs on seven lines of rails set slightly lower than the crossing tracks. There are four sets of carrying wheels, one set of which is keyed to a long shaft receiving motion through gearing from a 10-h.p. Westinghouse induction motor. A pole at one end carries the current collectors, which take current from three trolley wires.

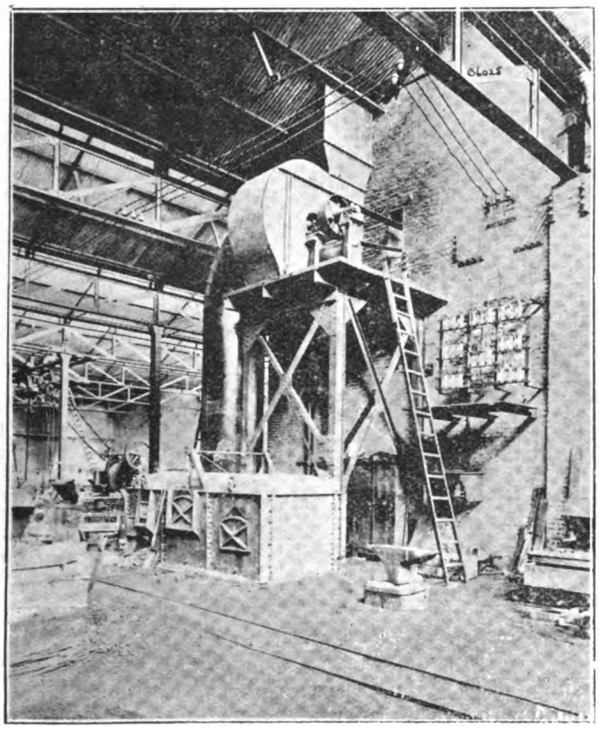

FIG. 3.—Part of Blacksmiths' Shop Sturtevant Exhaust Fan, operated by 40-h.p motor, taking smoke from down draft forges and furnaces

These rest on brackets attached to cable poles. A view of traverser is shown in Fig. 1. The sawmill is 223ft. long by 104ft. wide. Here the system of individual motor drive is to a large extent adopted because of intermittent working of the different machines. Most of the motors are placed out of the way in concrete pits below the floor, and have their auto-starters convenient for those attending the machines. The individual motor drive allowed the wood-working machinery to be set in the most convenient manner without reference to the line shafts, etc., and the sawmill presents a very clean appearance owing to the absence of the usual belting, shafting, etc. The motor equipment comprises 23 motors, aggregating 307 h.h.p, the largest being 60 h.p. and the smallest 3 h.p.

Current is delivered to wood-working departments, comprising sawmill, carpenters' shop, coach and wagon building and repair shops, by two three-phase lines, each composed of 166,000 circular mil cables. The motor circuits in the sawmill are brought to two distribution boards which are furnished with main fuses and switches for each circuit. These boards are placed high up on the wall so as not to occupy any floor space. The cables between distribution boards and motors, when they run under the floor, are in iron piping, and when they go overhead or along walls are carried on porcelain clamp insulators. Adjoining the sawmill, and opening into it, are carpenters', coachbuilding, repair, upholsterers', tinsmiths' shops, etc. In the carpenters' shop are three electric tank heaters for glue-pots, each one taking three pots. The upholstering department has a 1-h.p. motor operating a hair teaser. At the east end of the works is the locomotive section as well as all the metal-working departments, which, with the exception of the section devoted to painting and varnishing, are grouped together in one large block. This is internally subdivided into different sections or departments, an arrangement facilitating intercommunication and giving a more economical structure. The block measures approximately 550ft. long by 275ft. wide, and, like the building of the wood-working sections, has the weaving-shed type of roof.

The wheel shop occupies the west end of this block of buildings. It is 33ft wide by 189ft. long. Its machine tools are arranged along either wall, and are driven from two line shafts. On the west side of the shop are four wheel lathes for turning tyres of coach and car wheels after the wheels are on the axle; one horizontal boring mill for turning wheel centres, insides of tyres, etc.; one axle-turning lathe; and a machine for drilling rims and tyres for set screws. These machines are all coupled to one line shaft, which is driven by a 20-h.p. motor. Along the east side are three wheel lathes of the same pattern, also one of the latest model, which drives from the centre of the axle by a large worm wheel, and has large chucking

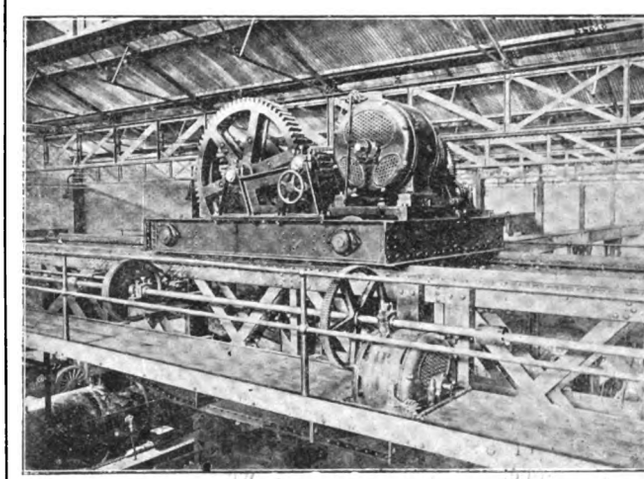

FIG. 4.—Crab Carriage of one of the 35-ton Travelling Cranes in Erecting Shop.

heads at either end gripping each wheel to prevent vibration. This lathe is capable of doing very heavy and rapid work. These four lathes are belted to the same line shaft, which is driven by two 5-h.p. motors. A little further, on the same side of the shop, is a hydraulic wheel-press. This is fitted with double pumps, one having a large plunger to bring the ram rapidly into position, the pumps being geared to an 8-h.p. motor on top of a press served by a compressed-air hoist. At the end of the shop is a lathe for locomotive driving wheels, driven separately from a 5-h.p. motor. Two electrically-operated walking cranes traverse the full length of this shop and serve all machines. One has a rapid walking hoist of two tons capacity, and is worked by a 5 h.p. motor; the other, being of four tons capacity, is operated by an 8-h.p. motor. The total connected here is 56 h.p., including the two cranes. A general view of the wheel shop, showing the two walking cranes, is given in Fig. 2.

The blacksmiths' shop is on the north side between the wheel and general machine shops. Electric power is used here to drive blast fans for forges and furnaces, exhaust fans to take smoke away from the forges and furnaces and to operate forging machines, bolt and nut machines, punches, shears, hot and cold saws, etc. All the forges are Buffalo down draught, having all smoke flues underground. These connect with the main flue going to a large exhaust fan, which draws the smoke from all forges and furnaces and discharges through a chimney passing through the roof. This fan is driven by a 40-h.p. motor (Fig. 3). The shop is equipped with 48 small forges, the majority being

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arranged in groups of four; five large forges for heavy work, situated conveniently for the hammers; a spring-tempering furnace; a furnace for working up scrap, and furnace for the bolt machine. Blast is supplied by two fans, one being driven by a 20-h.p. motor, which supplies most of the forges, and a smaller one driven by a 10-h.p. motor, which supplies the forges in the south wing. A group of machines, comprising a large punch and shear, a forging machine, and a saw, are arranged in the centre of the shop, and driven by a 16-h.p. motor. There are in this department four Westinghouse motors of from 10 h.p. to 40 h.p, aggregating 85 h.p. This shop naturally loads the air-compressing plant heavily, as it includes four pneumatic hammers—two of 6cwt., one of 4cwt., and one of one ton. Two air-receivers are placed here to equalise the pulsation caused by the intermittent working of the hammers. Next to the blacksmiths' shop is the steel-frame car and bogie shop, where are constructed and repaired steel-frame cars, bogies, locomotive tenders, tanks, etc. This department is 41ft. 6in. wide by 199ft. long, and has an electric walking crane of five tons capacity serving the whole length. This is operated by a 10-h.p. induction motor. Here is also a complete equipment of power pipes, screwing and cutting-off machines for the vacuum-brake piping. Alongside, and occupying the south side of, this block are copper and tinsmith shops, and electro-plating and polishing departments. The copper and tinsmiths' section has a complete equipment of machinery for pipe-cutting, screwing, removing scale from and cleaning boiler tubes, hydraulic tube-tester, rolls, cutters, etc., and a blower for the forges. This machinery is driven by a 5-h.p. induction motor hung from the roof truss. The electro-plating and polishing departments occupy the south-west corner of the block. The plating dynamo and polishing machines are driven by a 3-h.p. motor.

The general machine shop is on the north side between the smithy and the foundry, and opens into the erecting shop on the south by a row of arches. It measures 148ft. by 126ft., and has its machine tools belted to nine short line shafts, each of which is driven by an induction motor of from 5 h.p. to 10 h.p. These motors are carried on cast-iron brackets secured to walls 8ft. above floor level. The auto-starters are conveniently placed, so that operators can handle them from the ground level. The motors all run at the same speed, 925 r.p.m., and drive the line shafts by two reductions of belting. The motor equipment comprises two of 5 h.p. and seven of 10 h.p., besides an electrically-operated walking crane, which serves all the large lathes and planers. This is driven by a 5-h.p motor. The tool-room and department storerooms open on to the machine shop on one side and the erecting shop on the other, the foreman's offices being above the tool-room and storeroom. This department yields a fairly steady load, the current consumption being from 75 to 85 amperes per phase.

The locomotive erecting shop occupies most of the south side of the block, having on the north the foundry, and opening on to the machine shop, tool-rooms, etc. It is 126ft. wide by 300ft. long, divided by a row of columns into two bays. There are three tracks in each bay, giving a total of six tracks, all of which extend outside the building, where they are joined up. The capacity of the shop is six engines on each track, giving a total of 36. Along each side wall and down the centre are arranged the fitters' benches. The shop is served by four 35-ton electric overhead travelling cranes, two in each bay; these are of 60ft. span and run the whole length of the buildings. The crane rails are 23ft. from the floor, which enables one locomotive to be lifted and carried over another. As the tracks are laid lengthwise of the shop, two cranes are required when an engine is to be lifted or moved. The cranes are electrically equipped for all motions, and have a light hoist for loads up to five tons, which is operated by the same motor which runs the 35-ton hoist, either one being connected by a clutch on the crab carriage. The travelling motion of the crane is effected by a 10-h.p. motor, the speed being about 200ft. per minute. The carriage is moved by a 5-h.p. motor, and has a maximum speed of about 75ft. per minute. The hoists are worked by a 15-h.p. motor, the lifting speed of the 35-ton hoist being about 4½ft. per minute and the five-ton hoist about 20ft. per minute. One of these cranes is shown in Fig 4. The Westinghouse crane motors are all of the three-phase type, and are operated at various voltages from transformers having a number of taps.

Opening off the erecting shop on the west end is the boiler shop. This is situated on the south side between the locomotive erecting and blacksmiths' shops, 49ft. wide by 146ft. long. The whole shop is spanned by an electrically-operated three-motion travelling crane of 25 tons capacity, similar to those in the locomotive erecting shop. Along the west wall is a line shaft driven by a 10-h.p. Westinghouse motor, to which are belted large plate rolls, a large combined punch and shear, a grindstone, emery wheel, and a small blower to operate forges. On the north wall is another 10-h.p. motor which operates a small set of rolls and a radial drill. There are four fixed forges of different sizes to accommodate the variety of work done in this section, and also a number of small portable forges operated by compressed air.

The paint department has a building to itself, measuring 126ft. by 223ft., with seven tracks, one having a pit for locomotive work. Each track accommodates three coaches, these being brought from the coach-building department or from the main line by the transfer table, and sent in on any of the seven tracks. The floor is of cement, to meet the frequent washing down. To obviate the necessity of having the floor continuously occupied by ladders when

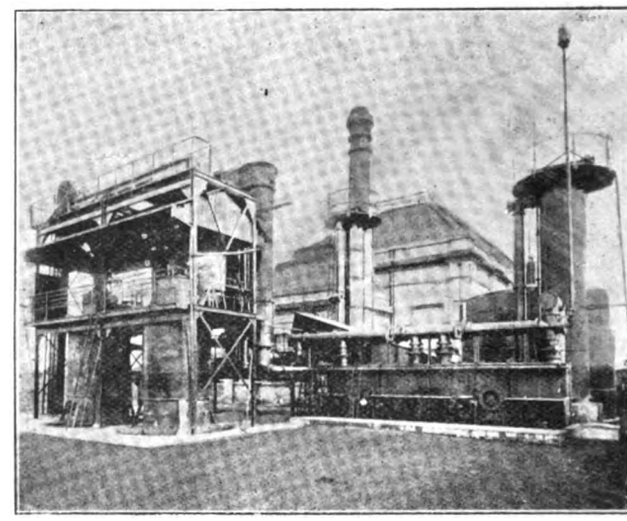

FIG. 5.—Gas Producer Plant.

working on the upper part of vehicles, the building is equipped with a very neat system of hanging scaffold supports, attached to the iron girders which carry the roof, thus leaving the floor completely free. This also enables the tracks to be placed closer together than could otherwise be done. Along the north side of the building are the wash-rooms, varnishing rooms, paint stores, etc. In painting and varnishing, an abundance of dry, fresh air is required for the proper oxidising of the linseed oil, which forms the base of all these preparations, and during the unfavourable atmospheric conditions which prevail a great part of the time, this work is greatly delayed. To overcome this inconvenience, and enable the best results to be obtained, a complete plant for the artificial ventilation of this building is installed. In the blower room, on the north side, is a large ventilating fan, which delivers air, through an extensive system of galvanised pipes, to all parts of the building, the foul air being removed near the floor level by numerous flues passing up through the roof, the fresh air entering at the top. This fan is provided with a nest of pipes, or steam coil, so that in cold weather the air can be heated to any desired temperature, either by the exhaust steam from the fan engine or live steam through a reducing valve. In the paint-mixing department is a paint mill operated by a 1-h.p. motor.

There are two distinct pumping plants situated at the east and west wells respectively. At both wells the same system is used, the water being brought up by air pressure into a cistern, from which it is pumped to elevated tanks,

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The well chambers are 12ft. in diameter and 16ft. deep, built of brickwork and lined with cement, the top being 2ft. above ground level; over this is built the pump-house. The east well is for the high-pressure service. This is fed by two 8in. bore pipes which reach down 160ft. to the water strata, pass up through the well chamber to ground level, and are provided at the top with reverse elbows. This enables the cistern to remain full after shutting off the supply of compressed air. The supply of compressed air is controlled by a float valve which keeps the cistern full. The pumps are placed right over the cistern, and are supported on iron girders. There are four pumping units, all electrically driven, the pumps being vertical triplex and driven by double-reduction gearing. Two of the units are single-acting plunger pumps, 6½in. by 6in., with 7½-h.p. three-phase motors. One is a single-acting plunger pump, 5in. by 6in., with a 5-h.p. three-phase motor, and the other is a double-acting piston pump, 3in. by 3in., with a ¾-h.p. direct-current motor, this being operated during the night and whenever it is necessary to empty the cistern. The pumping capacity is limited by the amount of water that can be obtained, which is 12,000 gallons per hour. The water is pumped up into two tanks at an elevation of 60ft., their combined capacity being 110,000 gallons. The piping is so arranged that the water can be pumped directly into the service mains. The installation at the west well has two pumps, one being a 5in. by 6in. triplex, and the other a 7½in. by 5in. by 6in. duplex pump.

The power plant is situated at the east end of the works. The gas-producer plant, like most installations of the kind, is not placed under cover (see Fig. 5). The power-house building is of brick construction with a mansard roof, is 200ft. long by 42ft. wide, and 29ft. high to top of walls, abundance of light being provided by skylights in the roof and large windows on both sides. The building is subdivided by partition walls, 14ft. high, into different rooms, there being in the main building machine room for gas-plant machinery, engine and dynamo room, air-compressor room, offices, workshop, and storeroom. The boiler-house forms an extension at the east end, this being somewhat lower than the main building, and provided with a chimney 65ft. high. The gas plant consists of two water-sealed Mond bituminous producers, 6ft. internal diameter, each capable of gasifying 10 tons of coal in 24 hours, together with the corresponding purifying and cleansing apparatus. These (shown in Fig. 5) are placed close together surrounded by columns which support the staging carrying the coal bunkers, coal elevator and conveyor, superheater towers, and charging platform. The superheater towers or regenerators are placed at the back of the producers, between them and the building, and rise to a height of 40ft. above ground level. Coal is brought in barrows and dumped into a hopper at the foot of the elevator, where it has first to pass through a feeding device which controls the rate at which it is delivered to the elevator buckets and prevents them being choked. It is then raised and carried by a conveyor and dumped into either bunker. From the bunkers of the producers until it arrives in the ashpit below it moves by gravity. The gas leaving the top of the producer passes first through the superheater towers, then through washers, gas-tower, gasometer, washing fans, sawdust scrubbers, and condensers, in each of which impurities are removed, and by the time it reaches the engine main it is a clean colourless gas. In this cleansing process a large quantity of water is used, which as it is charged with tar, ammonia, etc., cannot be thrown into the drains. It is, therefore, collected from all parts of the plant and run into a large underground sump, and is from here pumped off over some waste land, where it disappears.

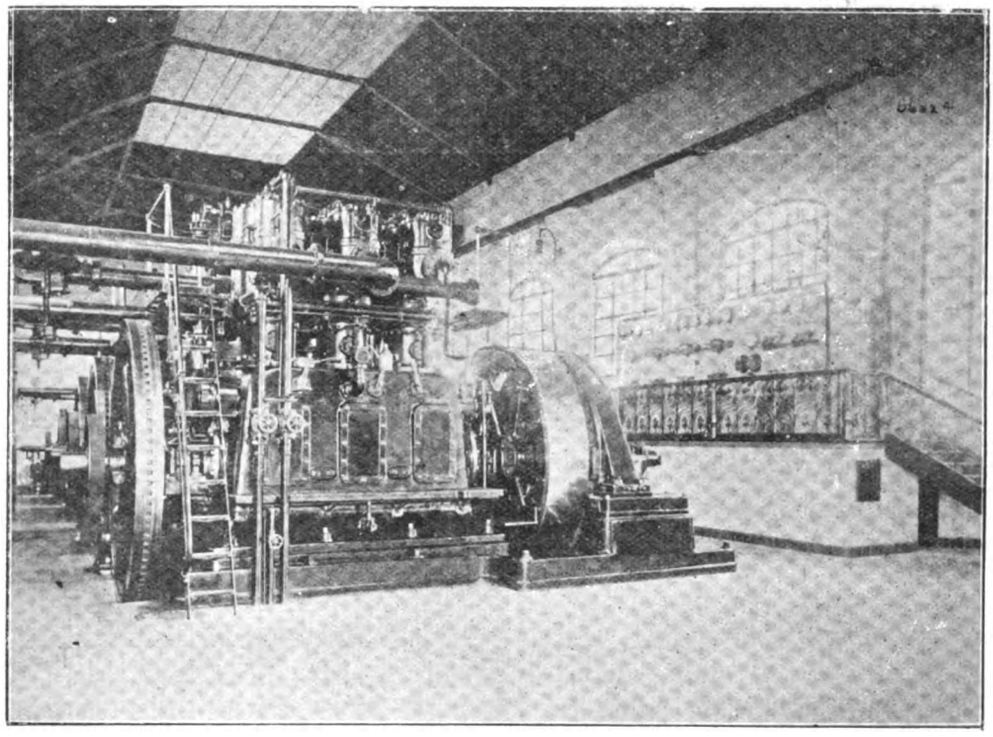

FIG. 6.—Back view of 150-kw. Units, showing Exciter and partial view of Switchboard.

None of the by-products are recovered. There is a demand for the tar, but the price offered will not repay the expenses of concentration and recovery.

In the Mond plant the heat given off from cooling the gas is used as far as possible to raise the temperature of the air blast—first in the air and gas towers by means of the circulating water, which, being heated in the gas-tower, passes through the air-tower, where its heat is given up to the air blast; then in the regenerators, the hot gas and air passing through in opposite directions, a further interchange of heat taking place; and, finally, in the producer itself this process is carried still further. For the generation of the blast two blowers are provided, a steam-driven Roots blower and a Korting blower, which latter is of the injector type. This is the one now used, its operation being controlled automatically by the gasometer. The boiler-house is at the end of the power-house, adjacent to the gas plant, and measures 16ft. by 26ft., the walls being 30ft. high and surmounted by a roof having louvre ventilators. Here are two locomotive-type boilers. These supply all the steam used. Natural draught is supplied by a chimney 65ft. high, the smoke flues from the boilers passing overhead and entering the chimney by a breeches connection. Feed water is taken from the main water service. A Worthington duplex feed pump, 3in. by 2in.

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by 3in., supplies both boilers, the feed water first passing through an exhaust steam heater.

Opening off the boiler-room is a coal store, which also serves as a passage to the machine-room in the main building. Here are the pumps for circulating the water through the gas and air towers and settling tanks, three Worthington duplex steam type, 5¼in. by 4¾in. by 5in., arranged in a row, two of which are used at a time, the third pump being a reserve, and piped so that it can be used to replace either of the others. The Roots blower, for supplying blast to the producers, is driven by a direct-connected steam-engine. The gas-washing fans (also in the machinery room) are driven from the line shaft which supplies power for gas washers and coal elevator.

There are two Marshall upright engines, one of which drives the line shaft and also a small sparking dynamo to start the main engines. After the main engines are started, this line shaft is driven by a 10-h.p. electric motor, and the steam-engine shut down. The other steam-engine is belted to a direct-current generator, which furnishes electric light for the power-house, gas plant, administration building, and locomotive superintendent's residence when the main power plant is not working, and also supplies power to an electric pump. The coal used in these producers for making gas is bituminous slack, and costs 6·50dol. (26s.) per long ton at the works. The following is an analysis:

	Of fuel, %.	Of combustible, %.
Fixed carbon	50·85	61·55
Volatile matter	32·10	38·45
Hygroscopic moisture	7·75	—
Ash	9·30	—
	100·00	100·00

Sulphur, separately determined	0·90 per cent.
Oxidised sulphur	0·045 per cent.
Calorific value	6,801 calories (gramme units).
Specific gravity, air dried	1·285

At the largest electric lighting station in this country operating gas-engines alone, the following figures have been obtained:

	d.	Per cent.
Fuel	0·3800	51·2
Oil, waste, water, and stores	0·0419	5·6
Repairs and renewals	0·1628	21·9
Wages	0·1580	21·3
Total	0·7427	100·0

The figures obtained from Buenos Ayres station, omitting superintendence, are:

	dol.	d.	Per cent.
Fuel	0·01200	0·600	43·8
Oil, waste, water, and stores	0·00416	0·208	15·0
Repairs and renewals	0·00132	0·066	4·8
Wages	0·01000	0·500	36·4
Total	0·02748	1·374	100 0

The engine-room occupies the central part of the building, being 42ft. wide by 102ft. long. The prime movers are all Westinghouse three-cylinder gas-engines direct connected to Westinghouse three-phase alternators. These engines work on the four-cycle principle, having an impulse from each cylinder every two revolutions, and are so well known that no extended description need be given. They are shown in Fig. 6. There are four units, three of which are of 250 b.h.p. each with cylinders 19in. in diameter by 22in. stroke, coupled to 150-kw. three-phase generators. These operate at 200 r.p.m. The fourth unit is a 125-h.p. engine having cylinders 15in. in diameter by 14in. stroke, coupled to a 75-kw. three-phase generator which operates at 272 r.p.m. The alternators are of the direct-coupled type, having revolving armatures, and deliver three-phase current at 440 volts 50 cycles. They are operated in parallel; and, as will have been seen, the load, owing to the intermittent working of the shops, is very fluctuating. The 150-kw. units have 30 poles. The fields are 12ft. in external diameter, split horizontally, and mounted on sliding rails, so that they can be moved over to uncover the armature. The field frame is of cast iron with laminated pole-pieces cast in. The field coils are made up of copper strip wound edgewise, there being 85 turns per coil. The armatures are 75in. in diameter, have 360 slots, are bar wound with one bar per slot, Y connected, the neutral connection being brought out. The collectors are of the skeleton ventilated type with four rings. The three terminal leads to switchboard are 400,000 circular mil cable, the neutral half that section. The weight of the field structure is 15,000lb, the armature 6,000lb. The small dynamo has 22 field poles, the outside diameter of field being 5ft, the coils being wire wound on spools. The armature is 36in. diameter, has 120 slots, a coil winding, and three collector rings. The field structure weighs 4,500lb., the armature 1,000lb. The cables to the switchboard are 150,000 circular mils. Excitation is furnished from a motor-generator set, consisting of a 60-h.p. induction motor running at 700 r.p.m. coupled to a 40-kw., type S, 125-volt dynamo. This set supplies exciting current for the whole station. To start up, the plant current is taken from the steam-driven lighting set. This motor-generator, being provided with a very heavy flywheel, runs very steadily, and is not affected by momentary fluctuation of voltage caused by changes of load. A motor-generator set, consisting of a 2-h.p. induction motor direct connected to a 1½-kw., 125-volt direct-current generator, supplies continuous current for the operation of the watchmen's clock, electric fans, etc., during the daytime, while the steam-driven unit is not running.

The switchboard is set up on a platform 5ft. above floor level, with a staircase at either end. The board is built up of four dynamo panels, two feeder panels, one load panel, and one exciter panel, all being of white marble

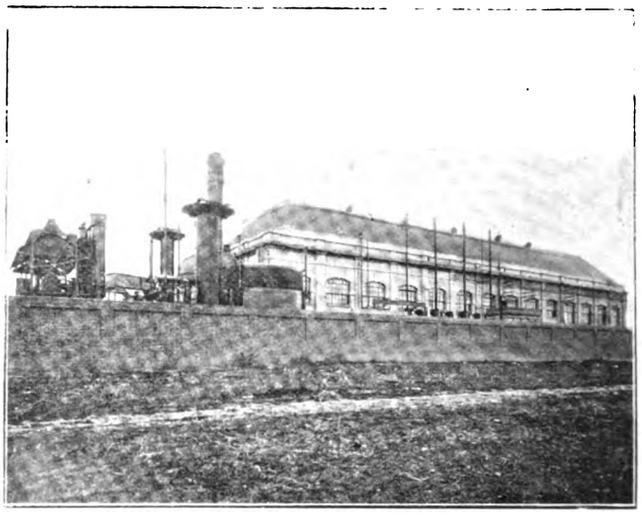

FIG. 7.—Back view of Power House and Gas Producer Plant.

with chamfered edges. The dynamo panels are 32in. wide, made up of three sections, the lower being 25in. high, containing recording wattmeter and field rheostat. The centre section is 45in. in height and has a three-pole, double-throw, quick-break main switch, ampere-meter, and switch for field circuit, voltmeter plug receptacle, and synchronising plug receptacle. The upper section, 20in. high, contains three ampere-meters, one for each phase. The feeder panels are 24in. wide. Each contains two feeder circuits, a three-pole double throw main switch, ampere-meter and recording wattmeter for each circuit. The load panel is also 24in. wide. The lower section contains a single-throw, three-pole, quick-break switch to parallel the two 'bus bars. The centre section has two recording wattmeters and dynamo voltmeter. The upper section has the two 'bus-bar voltmeters. The exciter panel is 20in. wide, is built up of three sections, like the others, and contains the auto-starter and ampere-meter for the induction motor, main switch, field switch, field rheostat, ampere and voltmeter of generator. At one end of the board, on a swinging bracket, are two total output ampere-meters and on the top of the switch-board is the synchroniser. All the instruments are black enamelled and polished copper. The switch-board has duplicate 'bus bars, and any dynamo and any feeder can be thrown on to either one. These two sets of 'bus bars can be put in parallel by closing the single-throw switch on the load panel. The cables coming from the dynamos are first connected through fuses, then series transformers for wattmeters and ampere-meters, to

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the main switch. The feeder cables are similarly arranged. The total length of the switchboard is 18ft. 4in., the platform 7ft. 8in. wide, and is surrounded by a wrought-iron grillwork finished on top by a wooden handrail. Push-buttons operate electric call and signal bells throughout the building. A wooden partition shuts in the switchboard at either end. In the enclosure below are the arc and incandescent lighting transformers and compensators, series rheostat for fields of generators, etc. Under this are the cable trenches for incoming and outgoing cables and feeders.

All the cables within the building are placed underground. Those from the dynamos are carried in clay pipes and trench. Outgoing feeders cross the building in a trench, follow up two of the columns, and pass through the wall to the outside. In the trenches the cables are carried on porcelain insulators which are attached to iron cable racks, and where they pass up the wall are held by iron clamps having porcelain bushes. These clamps are spaced so close that it is impossible for cables to touch the wall or come into contact with one another should they become slack. A wooden casing covers and conceals them completely. There are two three-phase feeders, composed of 260,000 circular mil cables, and two of 165,000 circular mil cables, besides several smaller ones. These are carried outside of the power-house on brackets formed of channel iron. There are four cables to each arm, spaced 15in. apart, the brackets being spaced 18in. apart vertically. All are anchored by strain insulators and tension screws. From the corner of the power-house the cable line continues supported on steel poles with channel iron bracket; the poles are from 120ft. to 150ft. apart. Corner poles, where turns are made, have special brackets made up of double channel iron, the turns coming on two insulators. The cables leaving the power-house can be seen in Fig. 7.

The compressor room is on the north side of the building, and measures 21ft. by 28ft. It is separated from the engine-room by a glass partition. Here is installed the air-compressing plant, which operates all the pneumatic tools throughout the works as well as three Pohle air-lifts for the water service. The installation consists of two Ingersoll-Sergeant duplex compound-piston inlet compressors. These compress in two stages, and have a collar in the receiver between the cylinders. The cylinders measure 16¼in. and 10¼in. diameter by 10in. stroke. The compressors are each driven by an 80-h.p. induction motor belted to the flywheel. The motors run at a speed when loaded of about 680 r.p.m. and the compressor at 150 r.p.m., the capacity of each being 350 cubic feet of free air per minute. They are controlled by an unloading device which permits of lifting some of the valves at both ends of the cylinders as soon as the air reaches the set pressure. The compressors are operated at 90lb. mean pressure, the low-pressure cylinder compressing to 25lb., the high-pressure cylinder receiving air at 25lb. and compressing to 90lb. The cylinder walls and heads are water-cooled. The air supply for the compressors is taken from the outside of the building, being first passed through a cooling tower, where it is washed free of dust.

The power-house is illuminated by arc and incandescent lamps, arc lamps being suspended from ornamental cast-iron brackets attached to the columns. Illumination around the engines is by means of incandescent lamps attached to the undersides of galleries and platforms. This latter, being at 110 volts, can be operated from either the alternating service or the steam-driven unit. The whole of the main section of the power-house is served by a six-ton travelling crane worked by hand power. Sparking current is furnished from a small direct-current dynamo driven off the line shaft of the gas plant machinery as well as from the sparking dynamos on each engine, a plain throw-over knife switch being used to make the change. There are two gas-engine-driven air compressors to compress the air into storage tanks for starting the large engines. Each of these consists of a Campbell 8-h.p four-cycle engine of the hit-and-miss description, the cylinder being 7in. diameter by 12in. stroke, driving a single-acting air-compressor cylinder 5in. diameter by 9in. stroke. The air is compressed into four storage tanks of approximately 40 cubic feet capacity each at a pressure of 190lb. The power distribution is all by three-phase circuits at 440 volts, 50 cycles. There are four principal feeders, whose load varies within the following limits: (1) 75 to 200 amperes; (2) 30 to 180 amperes; (3) 0 to 200 amperes; (4) 150 to 220 amperes. In Fig 8 is shown a load curve which gives an idea of the variations which occur. The total connected motor load includes at present 93 motors of an aggregate power of 1,073 h.p.

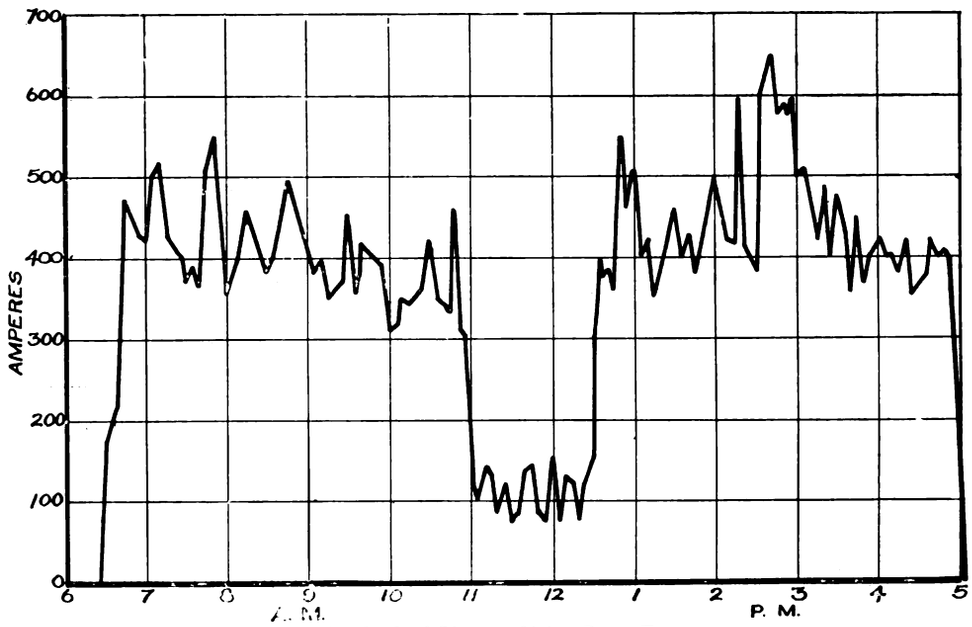

FIG. 8.—Load Diagram, Litiers Power House.

We are indebted to the British Westinghouse Company for the above description and illustrations of a most interesting installation.

THE SEPARATION OF LOSSES IN DIRECT-CURRENT MACHINES.

BY W. M. L. AND A. L.

There are several methods of separating out the losses in direct-current machines, but the majority of them are totally unsuitable for a workshop, as they are far too mathematical, take up too much time not only in the working out but in the taking of the actual tests, and, further, there is too great a source of error in them. We have found that the simplest and most reliable method is one which, we believe, was first brought forward many years ago by Prof. Kapp, and later modified by J. T. Irwin.

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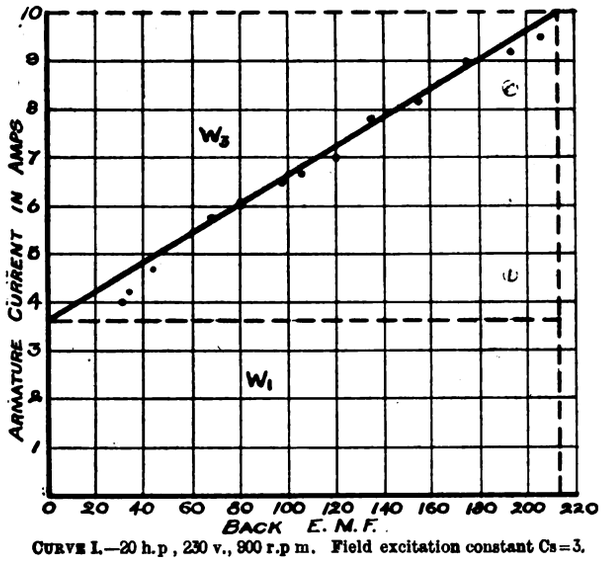
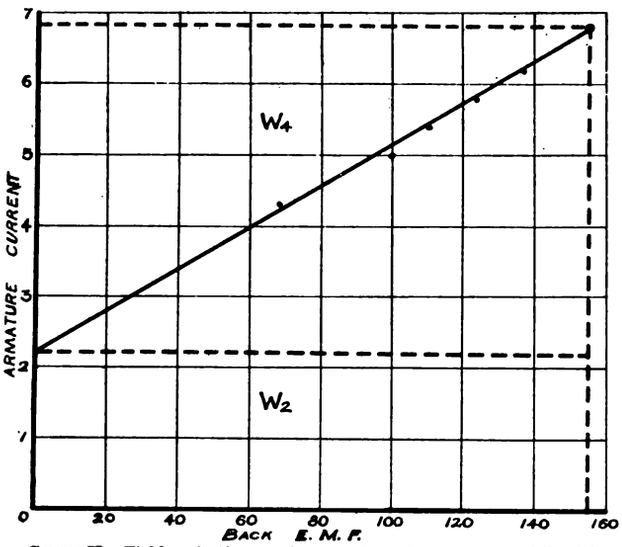
As the actual tests take about a quarter of an hour, and, perhaps, one hour to work them out, it is evident that this method is very suitable for use on the test-bed. If one puts a constant current on the field magnets, and varies the voltage across the armature, plotting back E.M.F. against current supplied to the armature, one gets a number of points lying on a straight line, as per sketch. If this line is produced, it gives at zero E.M.F. the current necessary to drive armature round against that torque which is independent of the speed—*i.e.*, friction and hysteresis torque. Now the increase of current is due to those losses which produce an increase of torque with increase of speed—namely, windage losses, eddy-current losses, and possibly an increase of mechanical friction with speed.



CURVE I.—20 h.p, 230 v., 900 r.p m. Field excitation constant Cs=3.



CURVE II.—Field excitation constant much weaker than normal Cs=1·1.

Now suppose one takes a certain speed, S (we found it most convenient to take the light speed of the motor), corresponding to an E.M.F. = V_1, the area W_1 will represent the energy spent at that speed due to the hysteresis and friction losses. The area marked W_3 will represent the energy spent in turning armature against eddy-current and windage loss. To separate W_1 into two, hysteresis and friction, one puts a different excitation, making the difference as great as possible in the two cases, getting a second curve, as shown in second part of sketch. Now, if in case 2 the field is weaker, in order to get the same speed, S, less volts are required across the armature. W_2 will now represent energy spent in hysteresis and mechanical friction, the mechanical friction at the same speed being the same in both cases. One gets

$$W_1 = \underset{\text{friction.}}{\text{Mechanical}} K_1 S + \underset{\text{Hysteresis.}}{K_2 S V_1^{1.6}}$$

$$W_2 = K_1 S + K_2 S V_2^{1.6}$$

Since the hysteresis loss varies directly as the speed and as the 1·6 power of the induction, and induction being proportional to the E.M.F. at a definite speed, by subtraction one gets rid of $K_1 S$, and can at once get K_2 and then solve for K_1 in the equations. Then the value for K_1 multiplied by speed gives mechanical friction at any speed.

Similarly, eddy-current losses may be separated out.

$$W_3 = K_3 S^2 + K_4 S^2 V_1^2$$

Windage. Eddy-current loss.

$$W_4 = K_3 S^2 + K_4 S^2 V_2^2$$

One gets rid of the windage term by subtracting, getting an equation for K_4 and then solving for K_3. Thus one obtains all the constants which determine the losses in a very simple manner. The brush friction may be separated from bearing friction by raising a number of brushes and observing decrease in driving current.

Test of a 20-h.p., 230-volt, 900 r.p.m. Motor.—In the first case the excitation current was three amperes; in the second 1·1 amperes. Two curves are drawn out from which results were calculated. The loss due to brush friction was found to be too slight to be worth including.

Hysteresis	=	794·2 watts.
Eddy current	=	1,382 ,,
Mechanical friction	=	27·3 ,,
Windage	=	18 8 ,,
		2,222·4 watts.

The armature copper loss and the field copper loss may easily be obtained by taking a volts drop test.

TABLE I.

V.	A.	R.
213	10	880
206	9·5	855
194	9·2	800
175	9	720
155	8·2	640
135	7·8	545
120	7	485
105	6·7	440
97·5	6·5	405
80	6	335
69	5·7	290
44	4·7	185
33	4·25	140
30	4	127

TABLE II.

V.	A.	R.
155	6·8	880
137	6·2	780
124	5·8	690
110	5·4	610
100	5	530
68·5	4·3	380
—	—	—
—	—	—
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FURTHER NOTES ON THE ELECTRICAL OPERATION OF TEXTILE FACTORIES.

BY H. W. WILSON, A.M.I.E.E.

The Manchester Section of the Institution of Electrical Engineers commenced the real business of the session with a largely-attended meeting at the physical laboratory of the university on Tuesday, the 26th ult., when Mr. H. W. Wilson read his paper on "Further Notes on the Electrical Operation of Textile Factories." The following is an abstract of the paper:

Three years ago the actual horse-power of motors installed for the electrical driving of textile factories in Great Britain was limited to a few hundreds, practically all in one mill, and only a very small fraction of the then total was actually in cotton mills. So far as it has been possible to estimate, this will have been increased by March, 1908, to 28,000, and this is almost entirely in cotton mills. Progress, however, was slow as compared with America, where there is about 250,000 h.p. installed in the textile factories of the United States and Canada. One firm, indeed, there has obtained orders during the last half-year for machines equal to the total horse-power used in Britain for the last three years. It will be recognised what immense room, therefore, there is for development.

The author then went on to deprecate the extravagant and exaggerated statements made in the various newspapers when discussing the question of electrical driving in textile factories. This tends to prevent fair and careful consideration of the question. He also referred to the unfortunate tendency of various electrical manufacturing firms carrying out this class of work who endeavour to impress on their customers that only their own special system will give good results. Statements of this kind are hardly justifiable,

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and only tend to mislead the possible buyer, with consequent harm to the industry. Everyone agrees that a three-phase equipment has decided advantages over a direct-current, and it is obvious to engineers there are many firms whose machines will not appreciably differ in results. Consequently, such statements as given above are most misleading. No special system will give the best results, but there is a great deal of scope in the exercising of judgment in the application of electrical driving to the conditions in textile mills. The advantages which the advocates of electrical driving urge for the operation of large textile factories are as follows: (1) The mill and engine-house can be placed each in its most convenient situation without any regard to the relative positions. (2) The internal arrangements of the mill, as regards shafting, gearing, belt and rope drives, etc., are greatly simplified and their costs reduced The flexibility as regards extensions is, of course, obvious. (3) The grouping of the machines is much less arbitrary than in a mechanically-driven mill, as the motors and the comparatively light shafting required by them can be placed where most convenient. (4) The reduction of the chance of a breakdown, which would stop the whole mill, to a minimum. (5) The ease of running one section for overtime or on special work. (6) The reduction of the maintenance and depreciation charges. (7) The greater steadiness of drive which can be obtained under suitable conditions, with a subsequent permissible higher speed and increased output. (8) The reduction in the total capital cost of the mill per spindle, or per loom, with a factory of above a given size. (9) The possibility of keeping a constant check upon the results obtained in each department of the factory. A further and important advantage now claimed is that a better cloth is obtained and sold at a better price. The author has definite information that this is correct, but is not at liberty to publish the exact figures or names. Clause 7 has also been conclusively proved and accepted as correct by certain manufacturers, who, however, will not permit any publicity of the figures.

The objections to electrical driving are as follows: (1) that the reliability of electrical driving has not been sufficiently proved; (2) that the capital expenditure involved in the adoption of the electrical system is so great in comparison with mechanical driving as to put it out of court; (3) that it is only advantageous in special cases, or where the average load factor is poor; (4) that the efficiency of a mechanical drive is considerably higher than that of an electrical one.

The author then says: "The first objection may now be regarded as finally demolished, in view of the admitted reliability of electrical machinery. The second objection, which is almost answered by the eighth clause of advantages, may now be fairly definitely withdrawn. The capital expenditure is, of course, high when a small factory is being considered, but with a large spinning mill of, say, 100,000 spindles, after making allowance for all the structual alterations which could be effected, there is absolutely no increased capital expenditure, and if the factory increases in size beyond this limit, the electrical equipment will work out more cheaply than the mechanical. The important items, of course, are the total abolition of the rope race, which under ordinary conditions is an expensive structure, and the reduced cost of gearing (see Schedule I.). The fourth objection is still brought forward, and is a very difficult thing to disprove, as it is impossible to obtain the efficiency of a mechanical system under running conditions accurately. However, where a mill has been converted to electrical drive, it is interesting to note that the indicated horse-power of the prime mover has been reduced with the same machinery running. The probability is that, granted both systems to be modern and well laid out, there is very little difference, indeed, in the actual efficiency of transmission. The motors, however, deliver the power in a rather better manner—that is, at a more constant speed."

The author then goes on to discuss the advantages and disadvantages of grouped and individual driving for the various classes of textile machines, the advantages and disadvantages of squirrel-cage and slip-ring motors, and the consideration of the best type of prime mover where the factory has its own power plant. Group driving is no doubt the best practice for most of the machinery outside mule driving, and the author's experience is that group driving is the best also for this class of machine. Recently satisfactory results have been obtained from a motor driving a single mule with a suitable arrangement of flywheel effect in the system. The keenest argument over group or individual driving has arisen in connection with ring-spinning and ring-doubling frames. These machines give a constant load individually, and it is easy to couple small motors of 5 h.p. to 10 h.p. direct and eliminate slip or transmission losses. Ring frames are not always spinning the same counts, and, in consequence, a speed variation of the spindles becomes necessary. To effect this variation in a large number of cases, slip-ring machines with wound rotors have been installed, and the variation is obtained by inserting resistance in the rotor circuit. Objections to this are: (1) initial capital outlay high; (2) low efficiency; (3) the heating effect caused by the resistance—an important point in a cotton mill where a high temperature is obtained, so special cooling arrangements in future should be adopted with this system Where individual driving is adopted and no speed variation is necessary, squirrel-cage motors with friction clutch as coupling are very satisfactory, and largely used. The capital outlay, including auto-transformer, starters, and clutches, is less than in the wound rotor system. The alternative arrangement for the driving of frames where variable speed is essential is to group the machines and drive with a single motor, changing the pulleys for speed variation. Arising from this question of driving is the possibility of direct coupling the motors to the line shafts in nearly all cases for group driving. It was very difficult to persuade manufacturers that it was safe to speed their line shafts up to an extent to permit of this, but progress has been made in this direction, and the consequence is that there is a material reduction of transmission losses and elimination of some possibilities of slip.

The author then goes on to complain of the bad placing of the motors and mechanical arrangements in some cases, and urges the necessity of engineers responsible for the lay-out of installations to go carefully into this question. Actual powers required need careful investigation, and it is not safe to assume that the horse-power is so much per 100 spindles. The class of material manufactured must also be taken into consideration.

The author then goes on to discuss the prime mover, where a mill has its own installation, and mentions that this subject causes endless discussion. From the point of angular velocity the turbine offers obvious advantages, and, in addition to this, for large sizes the capital cost per kilowatt is fairly reasonable. One or two mishaps recently have caused some millowners to have a prejudice against the turbine, and it does appear to be a fact that a steam-turbine is not altogether as reliable a machine as a reciprocating engine. Recent practice seems to be in favour of installing two turbines, either of which is of sufficient size to run the mill by utilising to the full its overload capacity. The author's preference for a mill under 1,000 h.p. is a quick-revolution reciprocating set, but the guarantees now offered by the makers of slow-speed engines—which are more familiar to the mill engineer, a point in its favour—gives thought for serious consideration. It must be remembered that the ordinary mill engine runs 55 hours per week at full load, and is usually 750 h.p. to 1,500 h.p. in size. The claims of gas-engines are also being gradually brought forward. There is endless room for discussion on all these systems. It may be mentioned that certain mill authorities who had their machinery run at various times from a central station with first reciprocating engines and then turbines preferred the latter.

The next point the author discussed was that of power supply from a generating station. The proportion of mills driven from such a source is 25 to 30 per cent., and is increasing rapidly. The author three years ago gave it as his opinion that spinning-mill proprietors would not take a public supply under ·035d. unit—that is, in large mills in Lancashire, where coal is cheap. He now alters his views, as it is common knowledge that prices much above this are

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paid. Schedule II. gives some mill power costs. The advantages of supply from a central station hold good to-day in an intensified degree: (1) independence of fluctuations of fuel price and strikes where a fixed contract is made; (2) freedom from breakdown; (3) the saving of capital expenditure on plant, which can be much more usefully employed in productive machinery—an important point, indeed, in these prosperous times. Developments along this line of supply from generating stations are bound to be fairly considerable, and millowners are more largely coming to recognise what a good thing it is from their point of view. Examples given in Schedule II. show how necessary it is to remind millowners of the necessity of depreciation, etc. The actual power cost is from 3 to 3½ times the fuel bill. The author regrets the absence of definite information, which is desirable in such a paper, but this is due to the natural reluctance of the millowner to give his business away.

In conclusion, the author strongly points out how the electrical industry must of necessity look to such an industry as the textile for their future work, and urges it, therefore, to approach the subject of textile driving in a spirit of research, and avoid the possibility of unsatisfactory work, which would inevitably do much harm and stop rapid progress.

SCHEDULE I.—Comparison of Capital Outlay for a Spinning Mill of 100,000 Mule Spindles. Driven: (*a*) by ordinary mechanical means; (*b*) by three-phase electrical transmission.

(*a*) *Mechanical.*

Engines, piping, etc., erected	£6,000	0	0
Boilers	2,000	0	0
Chimney and boiler seatings	1,000	0	0
Reservoir	1,500	0	0
Engine-house	600	0	0
Engine-bed	600	0	0
Rope race	500	0	0
Boiler-house	500	0	0
Economiser and house	750	0	0
Lighting generator and seating	1,200	0	0
	14,650	0	0
Gearing	3,000	0	0
Total	£17,650	0	0

(*b*) *Electrical.*

850-kw. turbo-generator and auxiliary comp.	£6,600	0	0
Boilers	2,000	0	0
Chimney and boiler seatings	1,000	0	0
Reservoir	1,500	0	0
Engine-house	400	0	0
Engine-bed	300	0	0
Motors, cables, and switchboard	2,982	0	0
Boiler-house	500	0	0
Economiser and house	750	0	0
	16,032	0	0
Gearing, £550; pulleys, £250	800	0	0
Total	£16,832	0	0

SCHEDULE II.—Comparison of Running Costs for a Spinning Mill of 100,000 Mule Spindles. Driven: (*a*) by ordinary mechanical means; (*b*) by three-phase electrical transmission.

(*a*) *Mechanical.*

Coal, 1,500 i.h.p.	£1,359	7	6
Wages—engineer, 55s.; assistant, 30s.; two stokers, 28s.	352	10	0
Oil, etc.	125	0	0
Insurance—E, £100; B, £22; gear, £60; buildings, £20	202	0	0
Rates, 7s. on 5 per cent. of £14,650	256	7	6
Interest and depreciation, 12 per cent. on £17,650	2,118	0	0
Total	£4,413	5	0

(*b*) *Electrical.*

Coal, 1,400 i.h.p.	£1,268	15	0
Wages (no assistant)	277	10	0
Oil, etc.	125	0	0
Insurance—E, £100; B, £22; gear, £16; buildings, £10	148	0	0
Rates, 7s. on 5 per cent. of £16,032	280	15	0
Interest and depreciation, 12 per cent. on £16,832	2,019	15	0
Total	£4,119	15	0

Cost per kilowatt-hour for 850 kw., 56 hours per week and 50 weeks per year: mechanical = 445d.; electrical = 415d. NOTE.—Coal cost, based on 2lb. per indicated horse-power, 7s. 3d. per ton, 56 hours per week, 50 weeks per year.

DISCUSSION.

Mr. M. B. FIELD (chairman), in asking the members for a full discussion on Mr. Wilson's paper, described the same as very interesting indeed, and if any apology were needed for bringing it forward, ample justification was to be found in Mr. Wilson's words at the end of his paper: "In conclusion, I would draw attention of the electrical manufacturers to the fact that for the expansion of the home trade in electrical machinery they are bound to look to developments in large industries such as the textile." He desired to strongly emphasise these words. He himself was no pessimist, and had no patience with those people who went about crying that the electrical trade in this country was dead. He believed that the average manufacturer of this country when confronted with restrictions which curtailed his particular business at the time had enterprise enough to find fresh outlets, and he considered that in the textile trade an outlet had been found for electrical work such as would continue the prosperity of the trade.

Mr. SEATON (British Westinghouse Company), as the acknowledged jester of the Manchester branch, took advantage of the privilege, conferred in the main by himself, of annually opening the debate at the first meeting of the session by giving the meeting some examples of his wisdom, wit, and—humour. Naturally, Mr. Seaton did not talk about the subject matter of the paper, but as his remarks, which wandered from the old joke of Manchester's 8s. 3d. per unit lighting charge to the "dumping" question, were punctuated by frequent bursts of laughter and applause, he sat down well pleased in the knowledge that the task he had set himself of putting the meeting in a good humour was successfully accomplished.

Mr. C. D. TAITE (Lancashire Electric Power Company) would have preferred to listen to other speakers' criticisms before getting up. One point which struck him forcibly was that Mr. Wilson's remarks were confined to spinning mills, and that no mention was made of weaving sheds. He himself considered there was large scope in weaving sheds, and, in spite of the fact that with the shafting in these sheds running at such slow speeds that direct coupling of motors was out of the question, excellent results had been obtained with electrical driving. Mr. Taite instanced a case of a personal friend of his who had two sheds—one equipped with an electrical drive and the other with a steam mechanical drive. Though his friend's interest was to depreciate the advantages of the electrical drive, his opinion, as given to Mr. Taite, was that the electrically-equipped shed was far superior. His cloth was better and sold better on 'change; he had an increased output and a reduced upkeep. The actual figures could not be given for reasons given by Mr. Wilson in his paper. Regarding spinning mills, Mr. Wilson had referred to nine advantages of electrical driving. He particularly wished to criticise No. 4: "The reduction of the chance of a breakdown, which would stop the whole mill, to a minimum." He agreed with Mr. Wilson entirely where the power was supplied from an exterior source, as in the case of a central power generating station, but not so where the electrical plant was private and *in situ*. He considered the risk was increased rather than reduced, as there were more "links" and not the same stand-bys as in the case where exterior power was used. The careful attention to turbines—acknowledged as the best prime mover for textile work — was not as possible in the private plant as with the central power supplier. Again, if a complete stand-by of turbines was put down in the private plant, two smaller machines would be used, with consequent more fuel consumption and less efficiency. Another great advantage in favour of obtaining the power supply from an exterior source was a great reduction in capital expenditure, which could be applied to putting down productive machinery, and thus getting an increased output. Mr. Taite gave the figure that a 5 per cent. increased output—which could be done—represented 1½ per cent. on the total capital of a 100,000-spindle mill. Altogether, Mr. Taite was of opinion that if electricity was to compete successfully for the driving of textile mills, the source of supply must be from a central power generating station. Turning to the question of individual or collective driving, Mr. Taite said that he had several instances of both on his mains, but no decision one way or other could be taken. Satisfaction was given in all cases. He, however, gave a preference for individual driving for powers of 15 h.p. or over, while he preferred grouping under that figure. Squirrel-cage motors to a maximum of 100 h.p. were greatly to be preferred to slip-ring motors with wound rotors, and he had found them—with auto-transformer starters—very successful. In conclusion, Mr. Taite criticised Mr. Wilson's figures on coal in Schedule II. as too low. He thought that coal based on 2½lb. per indicated horse-power at 8s. 6d. per ton was more near the truth.

Mr. W. B. WOODHOUSE (Yorkshire Electric Power Company) mentioned that the power supply put down against individual owners of textile mills amounted to 240,000 h.p. in Yorkshire. The electric supply authorities in Yorkshire, however, were waking up to the enormous possibilities for electric power contained in that statement. His own company had now got 12 mills on its mains. The Bradford Corporation were equipping themselves well for the fray, and had just concluded a very large contract for power

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with the Bradford Dyers' Association—a very large and powerful combine. The importance of this contract in favour of electric power might be judged from the fact that the Bradford Dyers used three-fifths of their present steam coal consumption for drying purposes, yet they found it policy to adopt electrical driving. Huddersfield Corporation were also launching out into textile work. There was no doubt that three-phase motor transmission was decidedly the best. Direct current was out of the question where the load varied rapidly, as it did in textile work. Mr. Woodhouse gave an instance of an experiment to prove the point. A direct-current motor was put on a very variable load. There was found to be a variation of speed of 30 per cent. With the engine alone—with three belts between it and the load—there was a variation of 18 per cent.; when a three-phase motor was put on, the variation was reduced to between 3 and 4 per cent. The reason of the unsuitability of the direct-current shunt motor was that the conditions did not act all at once; the ohmic drop caused a difference of speed in one direction, while the armature reaction caused a compensating difference in the other, but all took time to come into play, and the mules were too rapid in their variation, with consequent distress for the direct-current motor. Mr. Woodhouse considered there was a field for a special motor where yarn was being wound on conical bodies, such as cops; the speed to increase to the centre of cop and decrease to outer. He instanced the single-phase commutator motor. Regarding spinning frames, increased speed was the great thing. Increase of speed meant increased output, and there was no doubt that electrical driving could do that. In weaving sheds those electrically equipped were the best looms, and produced the best cloth. He had definite instances of this, and manufacturers had often spoken to him in that vein, but, unfortunately, he could not get permission to give actual figures, as Mr. Wilson had mentioned in the paper. In the carding department of one mill electrical driving had increased the output from a pack of wool to 1¼ packs of wool, while in a case of carding a lower quality of wool the increased output had actually paid for the cost of the electrical power. In another instance where part of a mill was equipped electrically, the other part being left with the old steam drive, the men in the latter part formed a deputation to the owners and complained that they worked longer but did less work for less money than the men in the electrically-equipped part, and they petitioned successfully for a change to electrical driving. Mr. Woodhouse agreed with Mr. Wilson that the horse-power used with electrical drive was pretty much the same as with the mechanical drive. The output, however, was larger. He found that in dealing with millowners that it was no use talking about horse-power, but that the way was to talk about number of units at — to drive certain certain machinery, putting it as units per spindle year. Mr. Woodhouse then referred to the equipment of mills, and complained that there was considerable trouble and loss due to bad millwrighting, which, however, was often the fault of the owner. Electrical driving had in some cases got a bad name due to this, and it behoved station engineers to look well into the question of millwrighting. He agreed with Mr. Taite that the coal cost given in Schedule II. was too low, and he also quarrelled with the capital charges. He considered 12 per cent. was far too low when the capital expenditure was looked upon in the light of so much money spent which could have been used for productive machinery if the power supply had been exterior. He though in such an instance that a figure of 30 per cent. was none too high.

Dr. Bowman, in a very vigorous speech, proved to be a strong opponent to many of the statements made by the power engineers. He considered that there was no doubt of electrical driving proving the superior where an exterior power supply could be got at one-third of a penny. Until that price was obtained mechanical direct driving more than held its own. He criticised Mr. Wilson's figures for the mechanical equipment given in Schedule I. He would soon make his fortune if he could get contracts at the prices given there. As a matter of fact, at the present time he had estimates from the best firms for a mill of 100,000 spindles at a figure between £3,000 and £4,000 below the figures given. Dr. Bowman ridiculed the statement that electrical driving was more reliable and free from breakdown than the modern type of mill steam-engines. He contrasted the ease with which a certain large generating station, with all its stand-bys—not 100 miles from the university—had broken down on occasions and stopped traction, with the performance of two mill engines in a mill he was connected with, which had only stopped two minutes in five years. He considered, in consequence, that not enough capital charge for stand-by was given on the electrical side in Mr. Wilson's schedule, whereas too much was given on the mechanical side. Dr. Bowman also questioned the statement that a better output was obtained with the electrical drive. Modern mill speeds were high, and he had comparative figures of a steam-driven mill with rope drive and a mill with electric drive, which showed the former better in output by 3½ per cent. Dr. Bowman gave further illustrations of a rope drive—superseding drives by means of straps put straight down from the shafting, which were often wrongfully used—proving superior to an electrical drive which had ousted the strap drive. In conclusion, Dr. Bowman reiterated his statements at the beginning, and further said that in old mills with old machinery electricity would prove their salvation, but in modern newly-equipped mills there was no gain in the electrical drive where own power was provided—only with exterior power at one-third of a penny.

Mr. E. L. Hill (Messrs. Siemens Dynamo Works, Manchester branch) said that he would like to put Mr. Wilson's statement, that a total electrical horse-power of 28,000 had been installed in textile mills, in a rather different manner. This figure amounted to 6 per cent. of the total number of spindles run, and he considered that it was a matter for congratulation amongst electrical engineers that such progress had been made in practically 2½ years. As regards a motor driving a single mule, he had seen one of the latter varying from 6 to 36 3½ times a minute, and he would like to know how Mr. Wilson's arrangement of a flywheel effect would act in such a case. He did not quite agree with the remarks regarding costs of a private electrical plant. A mill of about 100,000 spindles would require about 1,300 h.p. This would average about 900 kw. Working with turbines at 19lb. per kilowatt, which is about 2·25lb. per coal per horse-power with an output of 2½ million units per annum, works cost would be ·175d. per unit, add 13 per cent. for total depreciation, and this would be ·3d. to ·325d. per unit. This, as would be seen, came under Mr. Wilson's figure, and there was no doubt of its accomplishment. In such cases it would pay to put private plant in. He, however, thought that where power could be obtained from an exterior source at ·5d. or thereabouts, that it would pay the millowner to buy the same in preference to a private plant, mainly on account of the productive capacity of the capital he would have used for his private plant.

Mr. A. B. Mallinson (Messrs. Mather and Platt, Limited) wished to know, in Schedule I., whether it was right to saddle the mechanical side with a lighting generator at £1.200, and not the electrical side, apparently. He also thought that not enough had been allowed on the electrical side for reservoir, as the turbines would require more water in proportion. He also criticised the figures in Schedule II. as being painted in favour of the electrical side. As regards Mr. Woodhouse's suggestion of a special motor with varying speeds for cop winding, he might mention that this experiment had been tried, and dropped on account of the complication of switchgear. The idea had, however, been successfully carried out mechanically by straps being turned off and on to loose pulleys. The life of the straps, to his surprise, he found to be as much as five years.

Mr. Blackmore (Stalybridge, Hyde, Dukinfield, and Mossley Board) questioned Mr. Wilson's statement of the reliability of three-phase motors being proved by the fact that they were working satisfactorily in rolling mills and mining work. He considered that the conditions of textile work were harder than those, owing to the continuous running they had to bear under high temperatures, which reached in the motor, he said, to 185deg. He considered that the turbine drive was absolutely necessary for cotton-mill work, and that the electrical drive was only a means to attain such an end. Mr. Blackmore gave instances from his own station, where the electrical drive had proved superior to the mechanical drive. He criticised Mr. Wilson's figures on the electrical side, and stated that the allowance for cables, motors, etc., was too low. He considered that group driving was the only thing for mules, and he would use squirrel-cage motors up to 150 h.p. He gave the figures that at a modern mill in Stalybridge the coal figure was 1·98lb. per indicated horse-power at 7s. 10d. per ton. He agreed an assistant was wanted on the electrical side of the schedule, but considered that, judging from his own experience, oil and stores, etc., could almost vanish from that side. Mr. Blackmore considered that an engineer who made a fixed contract with no clause for coal fluctuation was a fool.

Mr. S. L. Pearce (Manchester Corporation) did not agree with all Mr. Blackmore had said condemning all prime movers except the steam-turbine. He had a chart showing some multiple-crank engines of his with a turning movement variation of less than ½ per cent. He did not think that electrical engineers could expect great progress in the electrical equipment of textile mills. One could not expect owners of mills with modern steam mill engines to turn them out. They were down in the books at a very low capital charge in most cases, and that explained the slow progress to a great extent. While the engines were working satisfactorily, no gain, but loss, would be made by turning them out. He agreed with Mr. Wilson that published figures were impossible, but stated as a fact that in a mill which he was equipping with the electrical drive the directors had allowed for an increased output of 5 per cent. He did not think this, however, represented the figure Mr. Taite gave. As regards efficiency, the difference at the line shaft between electrical and mechanical drives was very little—perhaps 1½ per cent. in favour of the former; but it must be remembered that where the power was taken from an electrical source the efficiency in favour of the electrical drive was much increased,

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as the losses of the steam-engine, etc., were eliminated. This over-all efficiency was the real question whether there was an advantage over the mechanical drive. He thought the cases for a private electrical plant were few and far between. As regards Schedule No. I., he agreed with Dr. Bowman *re* the high cost put down on the mechanical side. The coal figure given there would work out at about 15lb. per indicated horse-power. As a matter of fact, good modern mill engines worked at about 9lb. to 10lb. per indicated horse-power. This would reduce the figure in Schedule II. to about ·4d. as against ·415d. for electrical plant. He also considered capital put down to motors, cables, etc., on the electrical side as too low. He considered that the present rates supply authorities were offering textile mills were such as would compare favourably with mechanical power, and would yet give a profit to the authorities. It was the duty of the latter to so frame their prices, and thus give opportunities for extension of trade to the manufacturing companies of the electrical industry.

Mr. COLQUHOUN gave an instance of a mill engine—triple-expansion Corliss, with 150deg. superheat and 26in. vacuum—whose coal consumption, including the heating of the mill, worked out at 1·6lb. per indicated horse-power with coal at 8s. 6d. per ton. This was an example of a modern up-to-date engine in an Oldham mill. He emphasised the difficulty of working turbines efficiently in the Oldham district on account of the scarcity of water.

Mr. PURRETT (Lancs. Power Company) also spoke in reference to the difference in the rating of various manufacturers' motors.

Mr. WILSON, in reply, regretted that he could not possibly reply fully in the time given to the numerous points raised; indeed, so many had been raised that he had not noted them all down. He would, therefore, reply in full in the *Proceedings*. In reply to Mr. Purrett, he said that it was obviously the thing to put in the best plant, but who was to tell them which was the best? He thought that it was safe to rely on the guarantees given by firms of repute. With regard to Mr. Blackmore's assertion *re* the heavy duties of motors in textile work, he could not see why the increased temperature should worry present-day machines of repute. He criticised Mr. Blackmore's figure, but understood no harm to the insulation on a motor would happen below 200deg. F. His schedules were attacked, but he regretted time did not permit of his reply to the points raised. In answer to Mr. Mallinson, electrical wiring for lighting was not included on the mechanical side of Schedule II. A pilot lighting set was, however, included on the electrical side of the schedule. He was sorry he could not agree with Dr. Bowman as to his cost of ½d. per unit. He thought that this figure would have to be put forward by the power companies three years ago, but since then he had modified his views. He agreed with Mr. Hill in his figure of ½d. per unit. He thought Mr. Woodhouse's figures *re* 30 per cent. variation in speed on a direct-current motor were a bit steep, and considered he must have used a bad machine. He quite agreed, however, that the direct-current drive was quite out of the question, except in very special cases. He did not agree with Mr. Woodhouse as regards the quoting of electrical power to the millowner. The only way was to talk to him on the basis of cost of indicated horse-power hour based on coal consumption. The millowner had been trained to think in such terms from his boyhood.

Mr. FIELD gave the date of the next meeting as Dec. 10, but owing to the new arrangements *re* referring papers to London, it was uncertain what paper would be read.

THE PRODUCTION OF POWER FROM PEAT.*

BY T. TOMLINSON, B.A.I., M.I.E.E., M.I.C.E.I., CHAIRMAN.

(*Concluded from page 816.*)

The vital question then is: Is there enough waste heat available to deal with the moisture contained in the peat after the surplus moisture has been pressed out by power, or drained and dried out by exposure? First let us clearly know what we have to do. Turf *in situ* may contain 90 per cent. of moisture: it can be fed into the producer with 40 to 45 per cent. of moisture, the heat of the escaping gases (which must in any case be cooled before use) extracting that amount of moisture from the peat as it approaches the combustion zone. By pressure, or drainage and exposure, the 90 per cent. of moisture can be reduced to 70 per cent., so that the problem reduces itself to this: Is it possible to reduce peat from 70 per cent. of moisture to 45 per cent. of moisture by the waste heat of the gas-engines at a realisable efficiency of utilisation of the waste heat? To fix our idea, let us consider 100lb. of dry peat (chemically dry). At 90 per cent. moisture this will be associated with 900lb. of water; at 70 per cent. with 233lb.; at 50 per cent. with 100lb.; at 45 per cent. with 82lb. We have, therefore, to evaporate 233 – 82 = 151lb. of water, and, taking 1,100 B.Th.U. per pound of water, we shall require 166,100 B.Th.U. If drying by compression or exposure to 60 per cent. moisture were resorted to, we should require to evaporate 150 – 82 = 68lb., requiring 74,800 B.Th.U. Now, 100lb. of dry peat contains 864,400 B.Th.U. (from the analysis already referred to), and of this 648,000 is realisable as gas: the Mond trial gave 675,000. Assuming this gas to be used in a gas-engine with a thermal efficiency of 30 per cent., 194,400 B.Th.U. will be given as power (= 76 indicated horse power hours), and 454,900 B.Th.U. will appear as waste heat in exhaust and cooling water. The required efficiency of utilisation will then be $\frac{166,100}{454,000}$ = 36 per cent. if peat dried to 70 per cent. moisture, and $\frac{74,800}{454,000}$ = 16 per cent. if peat be dried to 60 per cent. moisture.

The question then arises, Is that a realisable efficiency in actual practice? I have but one recorded trial from which it is possible to estimate the efficiency. In a 10 hours' test of the "Dobson" dryer as recorded in the "Report of the Bureau of Mines," Toronto, 1903, the following results were obtained: "Weight of air-dried peat charged into the dryer, 29,300lb., containing 34·21 per cent. water; weight of peat discharged from dryer, 23,000lb., containing 16·61 per cent. water. The weight of water evaporated was 6,300lb. Air-dried peat containing 34 per cent. water was used as fuel at the rate of 3,145lb. per day (of 10 hours)." From this data we can estimate the efficiency so: 3,145lb. peat, 34 per cent. moisture, consists of 2,096lb. dry peat and 1,048lb. moisture; adding to this latter the 6,300lb. of water evaporated from the peat we have a total of 7,348lb. of water evaporated by the combustion of 2,096lb. of dry peat. The effieiency, therefore, was $\frac{7,348 \times 1,100}{2,096 \times 8,644}$ = 45 per cent. As we require only an efficiency of 36 per cent., we are evidently well within the limits of practical efficiency. This is the more certain because the heat available was not in this experiment used to the best advantage, as the heat carried away in the escaping gases and evaporated moisture was allowed to escape to the atmosphere without further utilisation, which certainly would not be done if it were sought to use a fixed quantity of heat to the best advantage. Note also that peat was dried from 34 per cent. of moisture down to 16 per cent. moisture, within which range it is reasonable to suppose the efficiency would be less than from 70 per cent. to 45 per cent. Of power to get pressure assistance in the drying of the peat there is ample—76 i.h.p. per 100lb. dry peat, or, say, over 1,000 brake horse-power hours per ton, 10 per cent. of which would certainly provide all the power necessary for the getting, conveying, pressing, and drying of the peat.

Two matters have not yet been dealt with: the heat necessary to raise steam for the producer and the heat necessary to evaporate the sulphate of ammonia. The first amounts to that necessary to convert about 25lb. of water at the temperature of cooling water of engine to steam (= 27,500 B.Th.U. about) per 100lb. of peat. For the second I have no data, but as the amount of sulphate of ammonia is only about 3·3lb. per 100lb. of peat it should not amount to much. It is, of course, a waste of heat to use the gas before being used in the engine to generate this heat, as apparently was done in the trial referred to in *Engineering*. My belief is that the difference between the 36 per cent. shown to be necessary with the compression of the peat to 70 per cent. moisture and the 45 per cent. shown to be attained in practice, is ample to cover contingencies; but if it were not, then drying by compression or exposure to 60 per cent. moisture, increased efficiency of heat utilisation, air drying under cover after pressing, and, finally, storage of air-dried peat harvested in good summers, put it, I submit, beyond the

* Opening address delivered before the Dublin Local Section of the Institution of Electrical Engineers, Nov. 21.

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possibility of doubt that there is obtainable from one ton of dried peat, or 10 tons of peat, *in situ*, about 1,000 brake horse-power hours as power, and that the fuel for this power will cost nothing, the cost of getting the peat and extracting the moisture being covered by the value of the sulphate of ammonia recovered.

We in Ireland are so familiar with the fact that the wetness of the peat and our climate have wrecked so many schemes of peat utilisation, that it is rather difficult to get a patient hearing for the demonstration of the fact that a scheme of utilisation which provides over 60 per cent. of the fuel value of the peat (for the heat of the gases is over 10 per cent.) for this purpose is an entirely different thing for schemes in which it is attempted to carry the whole fuel value off the bog, as in pressed-peat schemes and the like, which, so far as I can see, must always fail. One does, however, generally succeed in this, but then one is often met by the objection, What market is there for cheap power generated on the bogs of Ireland? I need not tell you that, with one-seventh of its limited area under bogs, very little of Ireland is beyond the reach of economical electrical transmission of cheap power from these bogs; that Ireland is not such a howling industrial wilderness that there is no demand for cheap power and light in her towns and cities; nor that, even if it were so, is Ireland so far from the industrial and distributing centres of Europe that cheap power, cheap sites, cheap labour, and cheap carriage (for her bogs are traversed by canals and navigable rivers) should not attract industries to which these are essential?

A further objection may be raised. If this can be done with peat, it can be done as cheap or cheaper with coal, and Ireland for cheap power production will be in no better position as compared with England. This is not so for the following reasons: (1) peat is very much more easily got than coal, and is not dependent on specialised and highly-organised labour for its mining; (2) peat has no exportable calorific value as compared to coal, and its value is, therefore, not regulated by an enormous demand for purposes other than power production; (3) peat has a very much higher percentage of fixable nitrogen per thermal unit than coal, so that the return in sulphate of ammonia for a given horse-power is greater. Peat has about 98lb. and coal 60lb. to 70lb. per 10,000 B.Th.U.

You can readily satisfy yourselves that producer plants of 10,000 h.p. and upwards and gas-engine plants driving three-phase generators up to 4,000 b.h.p. are in operation, while capital costs and costs of production will be much more satisfactory when given later in connection with the discussion of an able and interesting paper on this subject by Mr. Snell, presented to the London centre early in the coming year, and which we shall probably discuss here later on in the session. I have, therefore, confined myself simply to the demonstration of the possibility of a power scheme from peat in which the fuel cost shall be at least covered by the by-product value. Better than this is certainly probable in the future through advances in scientific chemistry, and inexperience in peat getting and drying on a large scale; but if even this be possible, I need not point out to you the economic value to Ireland of her peat nor the industrial possibilities for Ireland involved in its exploitation.

SOCIETY OF ENGINEERS.

The fifty-third annual general meeting of the Society of Engineers was held on Monday, Dec. 9, 1907, at the offices of the society, 17, Victoria-street, Westminster. The chair was occupied by Mr. J. W. Wilson, vice-president. The following gentlemen were duly elected by ballot as the council and officers for 1908—viz.: as president, Mr. J. W. Wilson; as vice-presidents, Messrs. G. A. Goodwin, E. J. Silcock, and D. A. Symons; as ordinary members of council, Messrs. John Aird, F. G. Bloyd, S. Cutler, jun., A. G. Drury, G. Green, J. Kennedy, H. C. H. Shenton, and W. A. Valon; as honorary secretary and treasurer, Mr. D. B. Butler; as honorary auditor, Mr. S. Wood, F.C.A. The chairman announced that the following premiums had been awarded by the council for papers read during the past session—viz.: the president's gold medal to Mr. R. W. A. Brewer for his paper on "Liquid Fuels for Internal-Combustion Engines," the Bessemer premium of books to Mr. E. J. Stead for his paper on "The Connaught Bridge, Natal," a society's premium of books to Mr. C. A. St. George Moore for his paper on "Working Experiences with Large Gas-Engines," and a society's premium of books to Mr. H. Blake Thomas for his paper on "Subaqueous Operations." A vote of thanks was accorded to the scrutineers, and the proceedings terminated by a vote of thanks to the president, council, and officers for 1907, which was duly acknowledged.

The annual dinner was held on Wednesday evening at the Hotel Cecil, the president-elect, Mr. J. W. Wilson, presiding in the absence of the president, Mr. St. George Moore (who is at present in China). The guests of the evening included Sir William Matthews, president of the Institution of Civil Engineers, Sir Alexander Binnie, Colonel Sir Ed. Raban, Captain Riall Sankey, and others.

FORTHCOMING EVENTS.

FRIDAY, DEC. 13.

Electro-Harmonic Society.—At 8 p.m., at King's Hall, Holborn Restaurant, smoking concert.

Physical Society.—At 7 p.m., exhibition at South Kensington.

SATURDAY, DEC. 14.

Junior Institution of Engineers.—At 3 p.m., visit the Franco-British Exhibition Buildings, etc., the exhibition extension works of the Central London Railway, and Central London Railway power house at Shepherd's Bush.

MONDAY, DEC. 16.

Society of Arts.—At 8 p.m., "The Theory of the Microscope," by Mr. Conrad Beck.

TUESDAY, DEC. 17.

Institution of Civil Engineers.—At 8 p.m., "Keyham Dockyard Extension," by Sir W. Eliot; "Keyham Dockyard Extension: Temporary Works and Plant and Appliances used in Construction," by Mr. G. H. Scott.

Liverpool and District Electrical Association.—At 8 p.m., at the Common Hall, Hackins Hey, Dale-street, "Electrical Appliances," by Mr. J. J. Richardson.

Institution of Electrical Engineers (Manchester Students' Section).—At 7.30 p.m., at the Municipal School of Technology, "Electricity and Matter," by Mr. L. H. A. Carr.

Faraday Society.—At 8 p.m., at 92, Victoria-street, "A Physico-Chemical Study of the Complex Copper-Glycocoll Sulphates," by Mr. J. T. Barber; "The Centenary of the Discovery of the Alkali Metals," by Mr. H. Davy; "The Industrial Developments," by Dr. F. M. Perkin.

WEDNESDAY, DEC. 18.

Institution of Electrical Engineers (Students' Section).—At 7.30 p.m., at 92, Victoria-street, "Wattmeters and their Connections," by Mr. J. C. Connan.

Royal Meteorological Society.—At 7.30 p.m., at the Institution of Civil Engineers, Great George-street, S.W., "The Possibility of a Topography of the Air based on Balloon Observations with Special Theodolites," by Captain C. H. Ley; "Indications of Approaching Frost," by Mr. R. Strachan.

THURSDAY, DEC. 19.

Institution of Electrical Engineers.—At 8 p.m., Great George-street, London, S.W., "Electrical Power in Railway Goods Warehouses," by Mr. H. Henderson, Newcastle-on-Tyne.

Institution of Electrical Engineers (Leeds Local Section).—At 7.15 p.m., at the University, Leeds, "The Commercial Aspects and Electric Power Supply," by Mr. W. B. Woodhouse.

The Optical Society.—At 8 p.m., at 20, Hanover-square, London, W., "Demonstration of Autochrome Colour Photographs," by Mr. J. McIntosh; a note on "The Effect of Distance on High-Power Sphero-Cylindrical Lenses," by Mr. H. L. Taylor; "Exhibition of Vacuum Tubes," by Mr. F. A. Darton.

FRIDAY, DEC. 20.

Institution of Civil Engineers (Students' Meeting).—At 8 p.m., "The Mechanical and Thermal Efficiency of a Petrol Engine," by Mr. L. G. E. Morse.

PERSONAL.

The Eccles Corporation have appointed Mr. A. Mulliner as assistant electrical engineer.

We share in the regret of all classes to learn of the illness of Lord Kelvin, and wish him a speedy recovery.

Mr. R. Seymour has been appointed chief assistant, and Mr. F. Evans general assistant, at the Grantham electricity works.

We understand that Messrs. J. Milne and Son, of Edinburgh, have appointed Mr. J. Hardisty as their new manager.

The Bo'ness Town Council have appointed Mr. H. G. Young, of the Musselburgh and District Electric Light and Traction Co., as engineer and manager of the electricity works.

We are informed that Messrs Putz, Curphey, and Co., 19 and 20, Strand-street, Liverpool, have opened an electrical supplies department, and will be pleased to receive catalogues from manufacturers of all classes of electrical goods.

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TO CORRESPONDENTS.

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TRAMWAY MANAGER v. ELECTRICAL ENGINEER.

The action of the Tramway Committee at Leeds, by which they tried without success to get control of the electricity works and to appoint the tramway manager supreme head over both departments, has not been successful. The outcome of the lobbying of the party in power on the Leeds Council is likely to be very different from what those who started the agitation had in view. The reason for this is that the Tramway Committee have used the profits from the tramways to relieve rates, which is against the first principles of municipal trading. This mistake is intensified by the fact that last year they plundered the tramway reserve fund and appropriated eighty-five thousand pounds which had been put by to meet renewal in the future. It is curious that the same question of the joint control of the tramway and electricity departments should have been under discussion at Halifax at the same time as at Leeds. Elsewhere in this issue will be found a report of the meeting of the Halifax Town Council at which it was decided that the electrical engineer (Mr. W. M. Rogerson) should in future have charge of both the undertakings. This proposal was strongly combated by Alderman Hey, and we honour this gentleman for his plain speaking. His belief is that this electrical engineer is not capable of taking charge of the tramway system. Holding these views strongly, he hit straight from the shoulder at the proposal before the Council and used certain arguments which we think were ill-judged. For example, he has been chairman of the Electricity Committee for some years, and hence responsible for the commercial management of the undertaking under Mr. Rogerson's charge. If he thought then that the works were mismanaged and the tramways overcharged for the current supplied, he had ample opportunity of rectifying these matters. The real object of this leader is to raise the question of the long-standing fight between corporation electrical engineers and tramway managers as to who should be the superior official. Of course, a corporation of business men will prevent this question interfering with the success of either department, but, unfortunately, some of our corporations allow their policy to be dictated by their officials. Taking the tramway manager on his own estimate, we find, as explained in our leader of Sept. 27, that they are so superior to any other corporation officials that their meetings have to be held with closed doors. Even if a city engineer constructs the whole of the tramways and is still responsible for the working of the same, he is not allowed into the meetings of the association. His subordinate officer, the traffic manager is, however, admitted. One is, therefore, led to conclude that tramway managers, like lawyers, must be specially trained men, and that there is something in tramway management which is quite beyond the ordinary engineer, however good an organiser he may be. Going back, say, ten years, the then tramway managers were chosen for their knowledge of horseflesh, and noted for their capability of getting the maximum amount of work out of a horse for the minimum amount of food We can say, we believe without dispute, that not one of the old horse tramway managers was directly responsible for the engineering work of the conversion of these old lines into electric tramways. Where they held the supreme control of their lines they employed consulting engineers to do the conversion work, or well-trained electrical engineers as subordinates. When once the lines had been changed over, the superiority of the tramway manager again became evident. His training in the management of horses and of the unskilled staff employed on horse tramways, aided him in his endeavour to keep his engineering assistants well beneath him. As explained at

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the Manchester meeting of the Municipal Tramway Association in the discussion on Mr. Dalrymple's paper, the tramway manager will trust neither the borough accountant to manage his accounts, the borough engineer to keep the street surface in repair, nor the electrical engineer to supply him with electricity at a reasonable price. We, of course, are rather biassed in favour of having an engineer as manager, and we know of a number of instances where tramway managers have made many costly mistakes by undertaking the three obligations referred to above, for which they have had absolutely no qualification. The tramway manager owes his success to his organising abilities, and on a large system has ample scope in the management of his staff and the arrangement of the services on the many routes in and around his city so that the public convenience can be best served. With the modern electric tramway there is a great deal which requires an engineer to keep in order, and being electric, the well-trained electrical engineer is, perhaps, the best man to look after the details in question. In smaller towns the neglect of engineering details in the equipment leads to endless and costly repairs. On such small systems a large staff is impossible, and the question arises as to whether the electrical engineer of the town is then not the most fitted person to undertake the supreme charge of the tramways. If he is a good organiser, we have no doubt that this will be found the case, and there are numerous instances throughout the country to prove our contention. Halifax itself is the latest example, but Birkenhead recently made the tramway manager chief over both departments. This might seem to be a reversal of our contention, and would be but for the fact that Mr. Wyld is a trained electrical engineer and held several positions in corporation and other generating stations before he became a tramway manager. We feel sure that in other towns where they now make a loss on both their tramways and electric supply undertakings, one engineer in charge of both will go far towards retrieving the situation. In those cases where the tramways are large, as in Leeds, the most economical arrangement is to keep their management in the hands of an expert and to place the production of all the electricity under the city electrical engineer, each being directly responsible to the corporation for his own department.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

RE THE RAILWAY CRISIS.

SIR,—I am sorry I cannot agree with the "firm foundation" which your "Writer on the Railway Crisis" provides in the issue of your valued paper of Nov. 29.

Prof. Jones says the original sources of wealth are the raw materials found in Nature. With this I agree. He then goes on to say that without labour none of these "productions of Nature" could be made useful to man, and with this I can also agree. It must, however, be borne in mind that natural resources are not, *in themselves*, wealth. They are merely potential wealth. They only become *real wealth* (which we are dealing with) when labour has been exerted on them and made these raw materials into *useful* things. Therefore it follows than labour is the *sine quâ non* without which wealth could not be produced, and is the source of all wealth, because it *must* be exerted on natural resources to make them serviceable. It seems to me to be merely splitting hairs to say otherwise, for, because Nature has provided the storehouse fully stored, it does not follow that she has provided wealth; she has provided the *means* of obtaining wealth—a rather different thing.

Nature may provide wild blackberries, but before they can be any service to me I must perform sufficient labour to gather them, otherwise they may as well be off the earth for all the benefit they are to me.

You say: *Efficiency* of labour depends (1) on the continuity with which it is applied (you cannot have continuity without capital); on (2) the skill with which it is directed (you cannot have skill without capital); and (3) the power by which it is aided (you cannot have machinery without capital).

In the first place, you cannot have capital unless labour has first been exerted—labour comes first—land, labour, capital. That is the order, and labour is the more important, because without it capital could not have existed, and could not continue to exist. I showed in my last letter that capital is worth nothing unless labour is continually exerted upon it—*i.e.*, using it to keep it in being.

Another point is that you *can* have continuity and skill without capital in certain cases. Before capital existed in early British times, and where it does not now exist (in countries yet peopled by so-called uncivilised tribes, children of Nature), you may have continuity of labour. These people make their weapons, tools, boats, and continuously apply their labour in hunting, fishing, etc., to keep themselves alive, and their skill also is not missing, though capital does not give it them. Their food is the wages of their labour, and for these wages they do not require capital. The reason they can do this is because the land they live in is open to them, and they can apply their labour directly to it without let or hindrance If all capital was sunk in the Atlantic to-morrow, and men still had the use of their brains and muscles, and their native land, they would manage to live without capital, and would very soon be producing more capital to replace that lost

Labour made capital, and keeps it in being, and labour should, therefore, get *all* the result of increased efficiency which capital provides—if the moral law holds good, that the producer is entitled to what he has brought into being. The reason capital can exact a toll, in the form of dividends, is because this labour store, in the form of buildings, machinery, etc., is in the hands of a comparatively small class, and the land containing the raw materials is in the hands of another small class. Labour has only its labour to offer to keep itself alive, and the instruments of livelihood being held from it, the classes who own these can get labour to work on *their* conditions, otherwise labour would starve.

You, again, assert that wages are paid out of capital, while ignoring the arguments in my last letter. Let me see if I can put the case again in a different way.

Wages are paid for the rendering of labour—almost universally after the performance of the work. Of all the vast number of unemployed, there is probably not one willing to work who could not be employed without an advance in wages.

What does the rendering of labour in production imply? Evidently the production of wealth. This wealth, if it is to be exchanged or used in production, is capital. Therefore the payment of capital in wages presupposes a production of capital by the labour for which the wages are paid. And this payment of wages is but the return to the labourer of a portion—or all, if no profit is made by the employer—of the capital he has received from the labour. So far as the labourer is concerned, his wages are the receipt of a portion of the capital his labour has previously produced. As the value paid in wages is exchanged for a value brought into being by the labour, how can it be said that wages are drawn from capital or advanced by capital? As in the exchange of labour for wages the employer gets the capital created by labour *before* he pays out capital in the wages, at what point is his capital lessened even temporarily?

Bring the question to a test of facts.

A company is floated with a certain capital to build a dock. It pays out of its banking account at the end of each week's work so much in wages till the dock is finished. Is its capital any less? No, for although its banking account may be gone in wages, the value of these wages has been continuously created in the growing dock week by week till the dock is complete. And these wages

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have always been paid at the week-end *after* the company has received the value created by labour in the week.

Then how are these wages paid *out of* capital? The capital subscribed in money is now a dock value—the money subscribed.

Adam Smith begins his chapter on "Wages" like this: "The produce of labour constitutes the natural recompense or wages of labour."

You say my £10 worth of castings are obtained out of capital. Let us see. The iron ore is in the earth; it is, humanly speaking, valueless while there. A man mines it for me and I pay him 20s. in wages for doing so. The mined ore is now worth 20s., and could be sold for that. Another man crushes and smelts it for 20s. wages. It is then worth 40s. to me; and so on through other processes till its castings value to me is £10. The £10 I have paid in wages, and this value has *all* been created before the wages were paid. Have these wages been paid out of capital or are they not paid out of the value labour has created and after it has been created?

The capital is *not* advanced till value has been created, and this has *all* to do with the point, because it shows that labour is the primary requirement in wealth production, that capital does *not* act as the provider of wages—it is not one of capital's functions, and no credit or reward is due to it for something it doesn't perform. What capital's real functions are cannot be discussed here.

I cannot agree that capital has any "right" to participate in results—meaning profits. If it is kept in existence by labour, then it has all the "rights" it can morally demand it seems to me, for without labour it is valueless; it is in itself dead.

Take the railways. The shareholders receive more in dividends without working for them than is paid in wages to *all* the railway workers. Since 1870 the shareholders have had their capital back, and the railways are still theirs. The average wage of the employés is about 25s. a week. Where does the "right" come in here? The shareholder risks his wealth—the worker risks his life and gives his labour. What is a just division of the produce? The division which takes place is possible because the shareholder holds a gun to the head of the worker, and it is loaded with unemployment.

The question is whether the shareholder is entitled to any dividends at all. He doesn't work, but he has "risks." If I save £100, I invest it because it is useless to me if I keep it and bury it in my garden; because it is risky to keep it in the house; because it would bring no dividends if I did; because if I spend it in enjoyment, it would soon be gone; because if I build a house, the house will continually depreciate unless I am continually spending more on it. So I invest it because I can get other men to work for me to take the risk, to supply labour to preserve it in being, and at the same time to make dividends for me without my working myself.

Without these workers my capital would rot, would be useless, would decay if put into buildings or machinery or anything else unless labour was applied to preserve it for me. And as labour is so kind as to do this, I, in return for its kindness, and for allowing it to keep my capital in real existence, make a profit out of it; or, in other words, I appropriate as dividends part of labour's work, which labour has a moral right to while I have none. I ought to be thankful if these workers keep my savings in existence, instead of which I prefer to talk about my "right" to dividends. Why I should be entitled to more than the money I have saved I don't know. I *can* get more, because there are poor people who must work to live, and who are at my mercy because they have neither land open to them nor tools of their own. I can force labour legally to take care of my savings for me, and also take a portion of its earnings in addition. But where does the "right" come in? Is it moral?

I do not consider that pecuniary profits are necessary for the carrying on of industry—they are not necessary in any transaction for the *serviceableness* of the transaction. Work should be done to supply human needs—that is the sole object. At present, work is done for personal gain, and while the unemployed are competing among themselves for work, and with the employed worker, and while the employed compete among themselves, and master competes with man, and master with master, there can never be any permanent compromise between the various sections of the industrial world, and strikes, lock-outs, and trades disputes will always be occurring.

The conclusion is that the only sane and permanent basis for industrial agreement and efficiency is that all industry shall be carried out for *use*—for mutual service—and not for profit and private gain. My private gain is of necessity at someone else's expense under the present industrial system.

In conclusion, I would point out that Bastiat's "proof" has been disproved, notably in Henry George's "Progress and Poverty," Book III., Chapter III.—Yours, etc.,

LANCASTRIAN.

SIR,—At length we have arrived at a common starting point in this discussion. The "Writer on the Crisis" has not seen his way to accept my definitions, but I can accept those of the authorities he quotes, for I do not see that they differ essentially from my own. I also accept his statement that capital is necessary for efficient production, but here our agreement ends, for "Writer" goes on to say that "capital ought to participate in the increased efficiency of labour." This statement indicates a confusion between two entirely distinct ideas, for capital is not the same as the capitalist. Capital, to repeat John Stuart Mill's definition, is the stock previously accumulated of the products of former labour—for example, roads, ships, factories. The capitalist is the private owner of part of this stock of products of (usually somebody else's) labour, who claims the right to use these products to his own private advantage

Capital is obviously necessary if labour is to be employed efficiently, but the private capitalist, although, perhaps, expedient at a certain stage of industrial development, is not in the least necessary. The whole community might own the capital necessary to make its labour efficient, as in England—they do already own roads, battleships, equipment for their postal and telegraph services, waterworks, tramways, etc.—and on the Continent, among other things, railways, coal mines, and land. Assuming, for the sake of argument, that the capitalist has some just right to the capital he holds, having produced it by his own labour, perhaps, and that he does allow it to be used to make the labour of others more efficient, can the "Writer" say to what extent each should participate in the products of this increased efficiency?

Then, is this theoretically perfect degree of participation ever attained in practice?

Further, is it a fact that in many industries—for example, textile and metal work—the advent of labour-saving machinery has increased the efficiency of labour to such an extent that a man can now produce 20 times and often very many more times as much of a commodity as his predecessor could make by hand? If so, is it more usual for the capitalist to pay his worker in some proportion to this increased output, or to pay the least rate for which a capable man will work?

Finally, can it be maintained that a system which permits a capitalist to have the chance of choosing the second alternative is the best possible?—Yours, etc.,

STAFFORDIAN.

METALLIC-FILAMENT LAMPS.

SIR,—I must strongly dissent from the views expressed in the very pessimistic article by "A Lampmaker" in your last week's issue. I much regret that he should have such a poor opinion of we "central-station engineers" as a class, and that he considers it his duty to administer such a grave warning.

There are a few statements, however, I should like to refer to. In the first place, he states that an 8-c.p., 8-watt high-voltage lamp will shortly be on the market. Well, I, for one, will believe it when I see it, but I shall be much surprised if such a lamp is obtainable at a low price for many years to come. I also do not consider that it would pay any firm to produce such a lamp, as, notwithstanding "Lampmaker's" statements, there is no doubt that the

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light unit *has* materially increased during the last few years. I know many cases where some time since a 16 c.p. lamp was considered sufficient, but now, at least, 32 c.p. is required. I believe the standard for metallic-filament lamps will in the future be nearer 25 c.p or 32 c.p. than 8 c.p., and what is now required is a 25 c.p. high-voltage lamp supplied at a low price. I am of opinion it was always a mistake to fix the light unit as low as 8 c.p, although in the early days, when current and lamps were both dear, there may have been some excuse for it. I am not at all alarmed by "Lampmaker's" forecast, and look to the future with every confidence.

In this district the majority of our consumers are private houses of the class referred to, nearly all the houses having been wired by the builders. A considerable number of these have now adopted metallic-filament lamps in their chief sitting-rooms, but owing to our supply being at 230 volts it is at present necessary for them to use two lamps in series. We find, however, that, although they obtain considerably more light than they did previously with possibly three 8-c.p. lamps, they do not object, as they prefer the extra light, and their total consumption is only very slightly reduced. Even should metallic-filament lamps be adopted throughout at a later date, when the hypothetical 8-c.p. lamp comes in, I am of opinion that the consumption would not be reduced by anything like the amount "Lampmaker" anticipates, and unless such a lamp could be supplied at a price very slightly in excess of an 8 c.p. carbon lamp, these lamps will still continue to be used in bedrooms, etc., where a light is only required for a short time each night.

We have also a considerable number of small houses supplied through slot meters, the cost of services being reduced to a minimum, from which we get very fair results. I am not surprised to hear that the company near Manchester found it impossible to supply small houses at a fixed rate of 5d. per week per house, and I do not agree that such a system was "a great advance towards the commonsense distribution of electricity." I had some experience of such a system abroad some 12 years since, and consider it is not applicable in this country, where coal enters so largely into the costs of generation, unless the rate charged is so high as to be prohibitive.

In conclusion, as "Lampmaker" has been so kind as to point out the precipices towards which we are blindly running, may I in return give him one word of advice, which is that I think he would find it more profitable to look to his end of the business rather than to ours. The ordinary carbon lamp has certainly deteriorated during the last few years, and I believe the lamps supplied at the present time are not equal to those supplied, say, five years since. If "Lampmaker" and his brethren would bestir themselves and produce a really good inexpensive 8 c p and 16 c p. lamp taking between two and three watts per candle-power, it would be to the benefit of the whole of the electric lighting industry.—Yours, etc.,

Ilford, Dec. 9, 1907. ARTHUR H. SHAW.

RE QUESTION 1,017.

SIR,—Would you kindly allow me to draw the attention of your readers to two errors which appear in the printed answer to the above question in last week's issue. On page 828A, column 1, line 39 should read "to send the flux through the 1½in. length of air-gap," not "12in. length of air-gap." In column 2, lines 33 and 37, to obtain the area the diameter should be multiplied by 3·14, not 3·14in. as printed.—Yours, etc. MAGNET.

EXHAUST STEAM HEATING.

SIR,—I shall be obliged if your readers can advise me as to the following: I require an economical heating arrangement for five shops, whereby the intermittent exhaust steam from two large hammers is to be employed; also, when hammers are not working, live steam is to be used from same boiler (boiler pressure 100lb.), Valves must be so interlocked as to avoid any possibility of accident.—Yours, etc.,

A. H. B.

THE RAILWAY CRISIS.

Unfortunately, the letters of "Staffordian" and "Lancastrian" came too late into the hands of the editor for me to consider them in time for comment in the last issue.

"Staffordian" practically agrees with the definitions of Jones and Mill, p 778, but would differentiate between the terms "capital" and "capitalist." I do not object to that, though one often uses the words as synonyms. The controversy is on the point "that the interests of capital and labour are identical." It has in the letters widened somewhat, but I do not intend to be drawn into a long discussion upon other topics. In this article I shall casually refer to these other questions because they are referred to in the letters, but my remarks on them will be rather dogmatic than argumentative.

"Staffordian," p. 777, Nov. 29.	Remarks.
Capital is wealth withheld from consumption to aid in the production of further wealth. *Labour* is the human element in the production and distribution of wealth.	Mills's rendering, p. 778, emphasises the fact of *previous* accumulation of *former* labour, but better the definition of "Staffordian" and Jones in that they recognise capital as that part of accumulation used to aid further production. "Staffordian," too, accepts the view *that labour is only one of the factors*—an important factor, if you like, but only one.

"Lancastrian" differs in that to him labour is not a factor. It is the whole, and nothing else counts in the production of wealth. A follower of Henry George.

"Wild blackberries." Jones would say poor Nature is here one of the factors. But I would rather convert "Lancastrian" from his own words than appeal to authorities. My part in this controversy is to hold that capital as a right participates in the results of production in which it and *visible labour* (this is all the labour "Lancastrian" sees, so I denote by this what I think he is writing about) are employed.

I presume "Lancastrian" believes what he writes and means what he says. If that is correct, he has not a leg to stand upon. Here are his own words:

> "Labour made capital, and keeps it in being, and labour should, therefore, get *all* the result of increased efficiency which capital provides, if the moral law holds good that the producer is entitled to what he has brought into being."

"Labour made capital." Good! Then a certain amount of labour is equivalent to a certain amount of capital, and a certain amount of capital is equivalent to a certain amount of labour.

Labour in the shape of capital is labour which has not yet benefited in *any result*—it is stored up and can only be rewarded when used.

"Lancastrian" says the stored-up labour which has never participated in anything is not to participate, but only the visible labour. The latter is only a part of the total labour expended, and should participate only in its proportion.

Capital being stored-up labour, labour which is seen, from the very definition of Mill, and accepted by "Staffordian" never to have participated in the results "Lancastrian" claims for labour, is entitled as a right to its share in the results, same as "Lancastrian" claims. My late friend, Thorold Rogers, said: "All capital has been saved."

That is my case, m'lud.

So far as my particular object is concerned I might stop, but both "Staffordian" and "Lancastrian" have opened up other points that were I not to refer to them it might be taken that I agree, which emphatically I do not. "Lancastrian" evidently believes in Henry George. I do not, and, though I regret to say it, George is to my mind a most inconsistent, incompetent, and ignorant writer. "Lancastrian" is the disciple, and accepts the master's dicta, to which I cannot object. "Lancastrian" suggests that George, Chapter III., Book III., disproves Bastiat. I cannot accept that view, but to argue the matter now would take too much time and space. Here, however, is something for "Lancastrian" to think over. George says, Chapter I., Book III.: "Capital is a result of labour, and is

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used by labour to assist it in further production." This says plainly that labour does not benefit by capital till *after* it has been used in further production. But that is not the sentence I want to direct your attention to so much as this: "Labour exerted upon land can produce wealth without the aid of capital, and *in the necessary genesis of things* must so produce wealth before capital can exist." That statement is unmitigated nonsense. Labour is only one factor in the production of wealth; the other factors existed, and only by their existence was labour possible. In the genesis of things you can only imagine the labour to exist by means of roots, fruits, etc., provided by Nature. Labour has expended nothing upon these in the genesis of things, and they formed the first store to be utilised by labour in reproduction. Unfortunately, "Lancastrian" cannot see that one factor is just as important as the other. Labour is no more the *sine quâ non* than the other factors which combine to produce wealth. The able writer of the article "Political Economy" in the "Encyclopædia Metropolitana" discusses this question as put by M'Culloch, Malthus, Torrens, and others. M'Culloch says:

"Labour is the only source of wealth. Nature spontaneously furnishes the matter of which all commodities are made, but until labour has been expended in appropriating matter, or in adapting it to our use, it is wholly destitute of value, and is not, nor ever has been, considered as forming wealth. Place us on the banks of a river, or in an orchard, and we shall inevitably perish of thirst and hunger if we do not, *by an effort of industry*, raise the water to our lips or pluck the fruit from the parent tree. An object which it does not require any portion of labour to appropriate or to adopt to our own use may be of the very highest utility, but as it is a free gift of Nature it is utterly impossible it can possess the smallest value." That seems to express "Lancastrian's" opinion as well as M'Culloch's and George's. Of course this is—I don't mean to use the word offensively—nonsense. "If," says the comment on the above, "it be an act of industry to gather an apple, it is equally an act of industry to raise it from one's plate, and every guest at a festival earns his food by the labour which he exerts in appropriating his own portion." Ricardo admitted there might be a few unimportant things outside M'Culloch's definition, and on this the "Encyclopædia Metropolitana" says: "The articles of wealth which do not owe the principal part of their value to the labour which has been bestowed on their respective actual production *form, in fact, the bulk of wealth*, instead of a small and unimportant portion of it."

Both "Staffordian" and "Lancastrian" are followers of the St. Simonians, who preach that "capital, in the form of instruments and means of future labour, does not belong to and should not be regarded as the property of the individual in such a sense that he could deal with it as he pleased. It belongs to the community, which would have to keep it up in the capitalist's absence under peril of future penury" (*vide* Graham, "Socialism, New and Old," p. 80). I am not going to be tempted into a discussion on Socialism generally, though it is evident my opponents are imbued with the fallacious views preached under this flag. Writers of repute have dealt lightly with the promulgators of Socialistic doctrines, but there is no difficulty in showing that a general acceptance of the doctrine would lead to a state of slavery ten times more terrible than at any slave period in the world's history. Graham goes on to say, p. 84, that the St. Simonians "agree with the founder of the sect, that a new religion and morality will be necessary before men can be brought to see the justice of their proposals." I have as yet had no chance of studying the tenets of this new religion or this new morality. This is also the wail of Henry George. Yet George admits that "as to what is the just distribution of wealth there can be no doubt. It is that which *gives* wealth to him who makes it, and *secures* wealth to him who saves it."

"Staffordian" asks me several questions: (1) To what extent, etc. Given exact conditions, it can be calculated with mathematical accuracy to what extent each should participate in the products. But (2) practically this mathematical accuracy is impossible, because many of the conditions are continuously changing; but, again, within fairly narrow limits the proportions can be adjusted. Most of the text-books discuss this matter. From the abstract economic point of view, why should the man's labour which is rendered more efficient by some other man's labour be remunerated at a higher rate than if it was not rendered so efficient? It seems clear that the labour which renders it more efficient should get its proportion of the result. The last three questions seem to me to be based upon an entire misconception.

He, like "Lancastrian," fails to realise the increased efficiency brought about by (1) previous labour + (2) immediate visible labour. They see nothing but the visible labour, and so claim everything for that

Lastly, "Lancastrian" has not fully grasped the idea of "continuity" as the word is used economically. What he talks about is really discontinuous labour of a miserably ineffective character. A little less of Henry George and a little more of some of the other writers named would expand his economic vision. Surely "Lancastrian" cannot want me to argue the point that wages are advanced out of capital. I have never heard it seriously questioned by anyone who has thought for five minutes on the point. This, again, is Henry George, Chapter III., Book I. But there is hope for him. He introduces the word "save" and asks questions about what is saved. He will find that, in addition to "natural agents" and "labour," a third factor in producing wealth is "abstinence" or "saving" But all this is desultory. My one point is that

> Production as seen every day needs, so far as labour is concerned,
> Previously accumulated labour + immediate visible labour.
> Previously accumulated labour = capital.

And each of these should participate in the result proportionally and as a right.

THE WRITER ON THE CRISIS.

METALLIC-FILAMENT LAMPS: HOW WILL THEY AFFECT ELECTRICITY UNDERTAKINGS?

AN ANSWER BY A SUPPLY MAN.

It is, perhaps, hardly correct to call this an answer to the communication by "Lampmaker" in the last issue of the *Electrical Engineer*, for, after careful perusal and reperusal of the article, there seems to be no conclusion to answer. True, the following excerpt appears at the end of the article, as if to sum up the position: "This is the point! The metallic-filament lamp has come to stay, and radical alterations in systems of connection and charging are necessary unless disastrous results are invited. And when the coupling up of small consumers without such alterations is suggested as a sound method of meeting the new conditions of affairs, may we be reminded, always and ever, of the fact that those whom the gods would destroy they first make mad!"

But if this is meant to be the gist of the whole case, the writer would point out that the whole article fails to establish its title, in that it does not in the very least point out the effect of metallic-filament lamps on the future of electrical undertakings; but it is an exposé of certain fallacious remedies for a disease which does not exist, and points out only what might happen if some lunatic central-station engineer were to adopt the methods of meeting the new conditions, which are condemned, and rightly so, by the writer of the article. Further, "Lampmaker" makes several false premises, which errors, common though they be, are still errors, and the chief of them is probably that of supposing that all the lighting there is left to get is that of "small" consumers—meaning chiefly cottage property and workmen's dwellings.

A simple periphrasis of this is to say that the gas companies have no lighting consumers left, as "Lampmaker" points out that the illuminant used by the "small" user is oil; but such a statement is so obviously absurd that one naturally immediately sees that the original assumption is wrong, and that there is an enormous amount of extra (to the electric light undertaking) lighting still to be picked up at remunerative rates if the *apparent* cost to the consumer can be reduced, and *that* is what the metallic-

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filament lamp is doing for us, and will do in the future. It will enable us to sell "light" cheaper without reducing our rates per unit, though the effect on the consumer will be a reduction in rates.

Granted that our output will be temporarily checked, or even reduced. But even so, what of it? Is it to be so disastrous that our peak is going to come somewhere nearer our average load line? Except in the cases of those stations with a negligible day load, the result will be positively beneficial in that it will raise the load factor of the station, as it is only peak load that will be reduced, metal lamps having obviously no effect on the power load. Again, the change will be very gradual, giving us time to gather in that large class of customer (possibly also reducing costs of service, etc., as well) who uses gas solely and only because it is *apparently* cheaper, being cheaper in first cost and running cost per candle-power at present, everything else being ignored. A glance at the numbers of gas consumers will show the vast field open here.

As to the size of the lighting unit, the writer traverses the statement made by "Lampmaker," that this will not be raised. The chief complaint made by electricity consumers is the high cost of using the present high candle-power lamps, and when these high candle-power, high-efficiency, *high voltage* are available they *will* be used very largely. Were it otherwise, why have Nernst's made any headway at all in spite of their previous many defects?

Let lampmakers in general give up putting off inquiries for high-voltage metal lamps, with the usual twaddle about it being "perfectly simple to run our lamps two in series on your circuits," when most of us realise that the real reason is that at present they can sell *two* low-voltage lamps where they would only sell *one* high-voltage one; and give us the lamps, there will be no doubt about their being used. It is simple nonsense to say that the high candle-power gas mantle failed to raise the light unit. That is exactly what it *did* do, and gave us a nasty jar at the same time, for although our 16-c.p. and 8-c.p. carbon lamps put the poor old flat flame 5-c.p. Bray into oblivion, it could not, *ceteris paribus*, meet the incandescent mantle on the same terms of cost per candle-power. A very cursory acquaintance with modern gas literature would show "Lampmaker" that *that* (the high candle-power per point) is their chief argument, and one must grant *some* commonsense even to gas engineers, and allow them to know a little about the wants of the public.

It is to the consumer of moderate means who now uses gas for lighting that we can now go and say, "Look here, we can now give you all the light you are now getting from gas at the same or even less cost, less 100 per cent. of stink, dirt, headache, and redecoration." Far from the metallic lamp proving the undoing of the station, it will act for us exactly as the mantle has done for gas companies, and will prove a valuable means of gathering in non-consumers. No district known to the writer has approached anything like "saturation point" from a lighting point of view, and we need not, as yet, fight for the cottage to make up our lost units, though with improved methods the cottages may be worth the getting also.

As mentioned above, the chief mistake made by "Lampmaker" is that of supposing that we are more universal than we are. There are plenty of gas-pipes to turn out yet before we fight the oil lamp and tallow dip. With most of "Lampmaker's" statements *re* faulty financial schemes for getting business few can have any quarrel, but they prove nothing beyond the fact that the methods *are* faulty, and it is a large assumption to make that all those in control of electrical undertakings are going to adopt the scare methods so lugubriously condemned by "Lampmaker's" requiem of the supply authorities. It would almost seem as if "Lampmaker" wished to be "undertaker" both to his own trade and that of the other undertakers, as assuredly if the supply authorities "go bust" there will be no circuits to use lamps on!

May one suggest that the true conclusion of "Lampmaker's" article is that "if outlying districts and small consumers do not pay under present conditions, still less will they pay with the smaller consumption due to metal lamps," which is a fairly obvious fact, and has very little to do with the future of electrical undertakings in general.

CARBURETTORS AND VAPORISERS.*

BY A. G. ELLIOTT.

The study of carburettor and vaporiser action in connection with the explosion engine is very important, inasmuch that in great measure, not only the economy, but the efficiency is largely dependent on the proper design and manipulation of the carburettor. The carburettor should be able to supply the varying qualities and quantities of explosive mixture to the engine, to suit the varying conditions of torque and speed under which the engine may be run, and so many conditions have to be satisfied, and economy combined with ability to give maximum power, that carburation presents the greatest problem to the motor designer of any part of his engine.

A motor is designed to work at normal conditions of running, and as higher compression is obtained by an increase of speed within limits, an alteration in the quality of the mixture is necessary to prevent preignition. Again, if the compression pressure be such that the engine will run with a rich mixture above normal speed, in the course of time overheating will take place, with the result of preignition; because the cylinder jackets, etc., were designed for normal running, and therefore for higher speeds, a weaker mixture is necessary. On the other hand, at speeds below the normal a richer mixture is required to keep the engine going, and the general practice is to control by throttling the gas, the variation of the quality of the mixture with the speed of the engine taking place more or less automatically.

The essential requirements of a carburettor are: (1) automatic fuel feed; (2) a mixing chamber; (3) an extra air supply; (4) a throttle valve. The extra air supply does not necessitate a second air-port, for one type of carburettor is so devised that the extra volume of air drawn in by an increase in engine speed does not increase the quantity of petrol being sprayed through the jet. However, the usual practice is to employ another air-port, the supply being controlled automatically.

HALIFAX ELECTRICITY AND TRAMWAYS MANAGEMENT.

The reorganisation of the management of the electricity and tramway departments at Halifax has been under discussion for a few weeks, and has been decided promptly. At the meeting of the Corporation last week the subject was thrashed out, leaving Alderman Hey in a hopeless minority. From the *Halifax Guardian* we take the following extracts from the speeches then made:

Councillor SPENCER moved the adoption of the report containing the proposed changes in the tramway service. The report, he said, dealt with the question on a business footing, and upon the basis that any man who was conducting the tramways and electric lighting as his own business would choose. The first thing they asked the Council to do was to acknowledge the principle that the person who was in control of the electricity station should also be in control of the tramways. The machinery they had at the electricity works was of a very technical character—much more technical than that in the tramways department. He felt certain that any gentleman who was competent to manage the electrical and mechanical branch of electricity works was capable of managing the tramways. If they admitted the principle that one man should be in charge of both departments they would have gone a great step in dealing with this question, because on that one question hung the whole issue. The person they suggested should be in charge was Mr. Rogerson, the electrical engineer, in whom he had implicit confidence. He had held his present position in the employ of the Corporation for a good many years. Prior to that he was five years apprenticed as a mechanic; he was afterwards a ship's engineer, and following upon that he took a position in an electrical works before coming to Halifax. Those were qualifications which went to prove that he was not only a competent electrical engineer, but a competent mechanical engineer. Every member of the Council knew that it was time they employed in their tramways department someone who had a thorough knowledge of mechanics. If they took what was recommended in the report, he felt that they would have taken one step towards safeguarding the interests of the travelling public. After they had got the confidence of

* Abstract of paper read at the Northampton Institute Engineering Society on Dec. 6.

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the public they would have to endeavour to put the tramways on the soundest business principles, even if it meant taking 6d. in the £ from the rates. Next, it was their duty to devise the best possible means of earning the largest amount of revenue. They proposed to appoint a traffic superintendent. Nobody could say that up to the present they had ever had a skilled traffic manager. The traffic manager whom they proposed to appoint, and upon whom they would depend for the whole of the revenue, must have had experience for some years in other towns, and must be an adept. They wanted to get the best man possible, but he must come from another town. If £250 a year was not sufficient to attract such a man, they must offer £350. Councillor Spencer went on to explain that they also proposed to appoint a rolling-stock superintendent. He explained the proposal to transfer the accountancy department of the tramways to the borough accountant's office, expressing an objection to the manager having control of the clerks who drew up the final balance sheets. In drawing up this report, he said, in conclusion, the committee had not been actuated by any feeling as to savings. What they wanted was efficient management and efficient control, and the saving would follow. The report showed a saving of £173, but they looked to this new scheme for increased revenue, and he hoped the Council would endorse the almost unanimous opinion of a committee that was trying to do its best under very trying circumstances.

Councillor HANSON seconded the motion, and assured the Council that this scheme had had most serious consideration.

Alderman HEY (who until recently was the chairman of the Electricity Committee) said that if he sat still on that proposal he should consider himself very much to blame. If he had gained any experience, or had any opinion upon tramways affairs, it ought to have some weight. He was bound to say that except for the principle of the scheme initiated he could not agree with it. He never knew a scheme of that magnitude, dealing with such vast undertakings, born in such a hurry. It was at the first meeting of the committee that the manager tendered his resignation. He made up his mind at Midsummer to do that, and intended to hand it in on Jan. 1. He advised him to hand it in at the first meeting in order to give the committee not three months, but four or five months, to make arrangements for his successor. As soon as the resignation was read and accepted the chairman had this scheme to put before the meeting, and the Council could judge for themselves whether the committee had been in a hurry or not. With the principle of a chief officer for the whole undertaking he heartily agreed. But he said the chief officer must be at the top and every other official under his control. They would see whether that principle upon which the committee have started had not been violated in the scheme. It was proposed that Mr. Rogerson should be the chief officer. He was there to dispute the qualification of Mr. Rogerson for such a position, and to dispute it *in toto*. It was of the greatest importance that the man over the whole undertaking should be supremely well educated, and have had ample experience and practice in tramway management. That Mr. Rogerson had never had, and he had not had five years' mechanical training, but 18 months' only. The rest of his apprenticeship was taken up with electrical matters. Proceeding, Alderman Hey said he regretted that he was bound to criticise Mr. Rogerson, but he did not do so with any personal feeling. He was helpless in that matter if he did not agree with his fitness for the position. It was said that Mr. Rogerson had ample time to take over the duties of the tramways management. If he had, it was a very strong reflection either on Mr. Rogerson or on the committee that was employing him. In recommending Mr. Rogerson for the appointment it was not because of the mechanical training he had had or the experience in tramway management, because he had had none. Was it because of any success he had obtained at the generating station? In asking that question they had to consider the position of affairs at that station. He was bound to be very plain and candid in his statements, but he challenged any refutation of any statements he made. The first four years that the electricity station was running there was a deficit which had to be made up out of the rates. After the tramways were started they were able to make a profit on account of the price that was charged for tramway traction. Not only that, but they were able to reduce the price charged for lighting and for power. He wished to state plainly and emphatically that the tramways had kept the generating station out of the Bankruptcy Court ever since they were established. Last year £19,000 was paid by the tramways for current received from the generating station, at a charge of 1½d. per unit. Out of that £19,000 there was a surplus above the total costs—which Mr. Rogerson said was ·99d.—of £6,500, a sum sufficient above the total cost of generation to pay all the interest and sinking fund of the whole of the electricity undertaking, and leave £1,000 to subsidise customers for light and power. Was the Council satisfied with a state of things like that? If they had had two electricity stations, one for generating traction current alone and the other for generating light and power, the traction station would have served the tramways at almost half the figure that had been charged, and the other would never have paid at all at the price current was being sold to the public. Was the Council satisfied with that state of things? Was it a sufficient recommendation that the man responsible for it should be taken and put over the tramway management in addition to all that work? Alderman Hey proceeded to quote the prices charged for current to tramways in other towns. He said that on the scheme before them they proposed to take a man whose time would be fully occupied—and his skill and capacity too—to do what they must have done before they could have the trams paying. The trams had always been handicapped because of the excessive charge for current. If they were charged the same price as other towns—a long list of which he had—they would save £6,000 to £8,000 a year. There was ample scope for the electrical engineer to use his skill and ability in order to reduce those excessive and extortionate charges to the trams. The reason why that had not been accomplished before was that for the last four or five years they had had to pay off for plant put out of use; they had had to pay the cost of changing over from alternating to direct current; they had had to pay a lump sum for depreciation of £3,000 to £4,000 a year. Now they had got to the end of the bill, and Mr. Rogerson had finished his work on that account. So long as they had to pay extravagant prices for current no manager in the world could make the trams as successful as they should be. His only objection to Mr. Rogerson being taken from his present position was that he had had no experience in tramways management, and a proposal of that kind was doomed to failure. Under that arrangement the traffic superintendent would virtually be the manager, and at £250 a year they would not get a man that was good enough for the job. If they got a man equal to the position for that money, they would be sweating in a way that they denounced in other people. A man of the capacity they required would not come to have the brains of a first man and draw the salary of a second man. A rolling-stock superintendent was inadequately paid at £130 per annum. A minimum of £150 and a maximum of £200 would have been the least temptation to attract a suitable man. He had a strong objection to the accountancy proposals in the scheme. The manager ought to be able to put his hand on the pulse of the department at once, and to take away the responsibility of the accounts and the cash violated the principle laid down in the scheme. The scheme left a great deal for interpretation, and he was so persuaded that the scheme would be disastrous in the interests of the Corporation that he was bound to move its reference back for further consideration. He did not think it had had the consideration worthy the name. It was full of intricate details, and it was so full of possibilities of huge mistakes that it ought to be dealt with very carefully. He approved with great heartiness the principle of one chief over the whole, and if both heads of the undertakings were leaving, the ground would be perfectly clear. In spite of that the Corporation ought to insist upon a man being advertised for who should have qualifications sufficient to take the position of a chief officer, and the salary offered should be adequate for the position.

Alderman SMITH seconded the amendment. He said he went to that meeting with a perfectly free and open mind to listen to both sides of that important question. He thought that Alderman Hey had given them plenty of reason to believe that there were certain matters connected with this important change worthy of further consideration.

After a long discussion, in which many speakers alluded to Alderman Hey as denouncing his own work as chairman for several years of the Electricity Committee, the amendment was defeated by a large majority.

We congratulate Mr. Rogerson on his enlarged sphere of influence.

TRADE NOTES AND NOVELTIES.

MARRYAT AND PLACE, 28, Hatton-garden, London, E.C.—From this firm we have received an illustrated card calling our attention to their gears and facilities for gear cutting. Messrs. Marryat and Place design complete gears suitable for any description of machinery.

THE ELECTRICAL COMPANY, LIMITED, 121-5, Charing Cross-road, London, W.C.—This company have recently placed on the market a very highly efficient metallic-filament lamp which, they claim, consumes only one watt per candle-power. The lamp is becoming very popular, we understand, owing to the satisfactory results obtained. The life is about 800 to 1,000 hours, and practically no depreciation in candle-power takes place during the whole of this time. They are equally suitable for alternating and direct current, and can be burnt in any position. The sizes made are 25 c.p. and 50 c.p. for voltages between 100 and 130. Miniature lamps for accumulators are also supplied.

SIEMENS BROS. AND CO., LIMITED, Queen Anne's-chambers, Westminster, S.W.—There has just been issued from the

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electric appliances department catalogue No. 506, in which are listed the well-known Siemens electro-medical apparatus. The chief features of interest and novelty in the catalogue are: the Siemens patent tantalum X-ray tubes, which can be worked with the anti-cathode at red heat; Siemens induction coils with variable primary windings; electrolytic interrupters; Siemens portable X-ray outfits; Dr. Albers-Schönberg's compressor apparatus; Siemens protective tube stand; Siemens electrolytic valve apparatus; Siemens orthodiagraph, and a carefully standardised line of electro-medical switchboards.

"Victor" Arc Lamps.—The Electric and Ordnance Accessories Company, Limited, Stellite Works, Cheston-road, Aston, Birmingham, have sent us a copy of their recently-published catalogue dealing with the "Victor" arc lamps, which have been standardised under three distinct types—the "Standard," "Miniature," and flame lamps. Among the special features of the "Victor" arc lamp we may mention that it has no clockwork or mechanism of any kind to be affected by gases or deposits, and no shunt coils are used. In all the types the chief feature of construction is simplicity, and the lamps are remarkably free from complicated and delicate mechanism. There is practically only one moving part in the lamp, which is contained inside a sealed tube. Special mention needs be made of the "Miniature" lamps, which are standardised in two sizes, 1½ amperes and 2½ amperes, and are made for working in parallel on 100 to 125 volts in series on 200 to 250 volts; also for high-voltage working singly on 200 to 250 volts with external resistances. These lamps are intended to replace existing incandescent lamps, as, so far as working costs are concerned, the power consumed is only one to two watts per candle, instead of three to four watts in the ordinary carbon incandescent lamps.

General Electric Company, Limited, 71, Queen Victoria-street, London, E.C.—There has come to hand a number of sections of catalogues recently issued by this well-known company dealing with a variety of specialities. Catalogue Section O is devoted to electro-medical apparatus, among which are described induction coils, constant-current batteries, apparatus for cautery and electrolysis, Röntgen X-rays, batteries, etc. The illustrations depict noteworthy improvements in the various types of apparatus now produced, and disclose several important additions to electro-medical apparatus. Among induction coils we notice some of the portable type. Outfits of the latter type are fitted with G.E.C. dry batteries, and are sent out in working order and ready for use. The cells when exhausted are simply renewed, there being only a pair of flexible wires to detach and place in a similar position on the new cells. A new form of pocket galvanometer—in size no larger a watch—should be found most useful for electric bell and medical work. The apparatus for producing Röntgen rays now embodies a somewhat unusual design in the form of the coil. Instead of the latter being fixed to the condenser base in the usual manner, it is held in position by four brass corner pieces, and can be detached in a few moments without removing any screws or nuts. List C gives prices of the various sizes of Sheradized Geekoduct conduit fittings and accessories. A large showcard, intended for display in the shops of dealers in electrical accessories, installation contractors, and ironmongers, forms a conspicuous advertisement for "Osram" lamps. The style of the card is of itself sufficient to attract attention, and the arguments in favour of the adoption of "Osram" lamps stated on the card are convincing. Thus, the assurance of a saving of 70 per cent. of the current bill, with a life of 1,000 hours without loss of candle-power, should make it patent to lighting consumers that the economy in current consumption is a sufficient set-off against the higher cost of the lamps. We have also received a booklet illustrating "Witton Carbons," which we would point out are the only arc lamp carbons manufactured in England.

APPOINTMENTS VACANT.

Electrical Engineer, Carlisle Corporation. Commencing salary, £300, advancing to £400 per annum. Applications to Mr. A. Collingwood, town clerk, by Dec. 23.

Mains Foreman, Birmingham Corporation. Salary, £2. 5s., rising to £3. 5s. per week. Applications to Mr. R. Chattock, city electrical engineer and manager, by Dec. 30.

Chief Clerk, Mansfield Corporation Electricity Department. Applications to Mr. J. Harrop White, town clerk, by Dec. 18.

Switchboard Attendant, Stockton-on-Tees Electricity Works. Wages, £1. 7s. 6d. rising to £1. 15s. Applications to Mr. J. J. Smith, borough electrical engineer. See advertisement.

Junior Demonstrator in electrical engineering department of the City and Guilds of London Institute, Central Technical College. Salary, £100. Applications to Prof. W. E. Ayrton. See advertisement.

Assistant to working and consulting electrician over large factory. Applications to "Electrician," care of Street's, 30, Cornhill, E.C. See advertisement.

LEGAL INTELLIGENCE.

NORWICH CORPORATION v. TRAMWAYS COMPANY.

The hearing of the action of the Mayor and Corporation of Norwich *v.* the Norwich Electric Tramways Co. commenced on the 5th inst. before Mr. Justice Bray in the King's Bench Division of the High Court.

Mr. Macmorran, K.C., in opening for the Corporation, said this was a special case which raised a question of construction of Sub-Section 5 of Section 57 of a special Act called the Norwich Electric Tramways Act of 1897. The Corporation were seeking to recover a sum of money which they had spent in repairing what was called the "junction" in the surface of the roads along which the tramways passed. The question was whether the Corporation were entitled to recover under the Act. Sub-Section 5 of the Section 57 said that if the tramway company failed to maintain and keep in good condition, to the satisfaction of the Corporation, the junction of the paving laid and maintained by the tramway company with the surface laid and maintained by the Corporation, the Corporation might, after giving due notice to the tramway company, do the work necessary to repair the roads, and all expenses reasonably incurred should be repaid by the tramway company. That special Act incorporated the Tramways Act of 1870, which said that in any difference between the promoters of a tramway undertaking and a corporation the matter should be settled by an arbitrator nominated by the Board of Trade. A dispute arose between the Corporation and the tramway company as to what was the duty of the company under this section in regard to repairing the roads, and the Corporation gave the company the notice required by the section, and did the work necessary to repair the roads. In the first instance they brought an action which was tried before Mr. Justice Phillimore at Norwich. He gave judgment for the Corporation, but the tramway company went to the Court of Appeal, and took the objection that the matter should have been referred to arbitration. The Court of Appeal upheld the objection, and quashed the judgment. The Corporation then applied to the Board of Trade, and they appointed Mr. Lyttelton, K.C., M.P., arbitrator, who had stated the special case. The point involved was exactly the same as that tried by Mr. Justice Phillimore, and the question now was whether the construction placed by Mr. Lyttelton on the section in question was the right one or not. The arbitrator in his award found as a fact that on certain roads, by reason of the presence of the company's tramways, the traffic had caused the surface of the road adjacent to the paving of the company to become worn down below the level of the tramway paving, so as to form a ridge or channel inconvenient for the use of the roads by the public. He held as a matter of law that on the true construction of Section 57 the expense in question had been incurred in maintaining and keeping in good condition the junction of the paving laid by the company with the surface laid by the Corporation, and he awarded and declared that the Corporation were entitled to recover £320, with interest at 5 per cent., and costs of the arbitration. If his inferences of law were incorrect, then the Corporation could recover nothing. The arbitrator had really decided that where they got in the ordinary way a difference in the level between the Corporation part of the road and tramways by reason of the presence of the tramways in the streets that was the junction which had to be repaired by the tramways company as part of their duty under the Act, and that was the matter in respect of which the expenses had been incurred which the Corporation were now seeking to recover.

Mr. Danckwerts, K.C., for the tramway company, submitted that the arbitrator was wrong in finding that it was the junctions mentioned in Section 57 which had been repaired by the Corporation. The junction was nothing more than the line where the macadam of the Corporation joined the paving of the tramways.

The case was adjourned.

ATTORNEY-GENERAL v. GREAT NORTHERN, PICCADILLY, AND BROMPTON RAILWAY.

The case of the Attorney-General *v.* the Great Northern, Piccadilly, and Brompton Railway Co. was heard last week in the Court of Appeal, before the Master of the Rolls and Lords Justices Fletcher Moulton and Farwell, on the appeal of the Attorney-General from a judgment of Mr. Justice Walton.

The action was brought to recover a sum of £13,200, under Section 113 of the Stamp Act, for failure to state an increase of the nominal capital of the company. It appeared that an Act was passed in 1899 incorporating the Great Northern and Strand Railway Co. with a capital of £2,400,000, and upon that capital duty was paid, though the capital was not issued. Another company had been incorporated two years before, called the Brompton and Piccadilly-circus Railway. In 1902 the Great Northern got a Bill by which it was provided that if the Brompton Bill was passed the Brompton Co. was to take over all the rights, powers, and liabilities of the Great Northern Co., including the right to issue the unissued capital upon which duty had been paid. The two companies became united as the Great Northern, Piccadilly, and Brompton Railway Co., now the defendants. The case for the Crown was that the unissued capital now became the capital of the new company, and was liable to duty as such, and that the mere fact that the duty had been paid and the capital authorised to be issued by somebody else did not relieve the new company of the liability to pay duty on the increase of its capital. On behalf of the defendant company it was argued that the taking over of the Strand Co.'s capital was not an increase of the capital of the latter, because the Brompton Co., by the Act of 1902, became clothed with the same entity as the Strand Co., and had been substituted for the Strand Co. It took over

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all its liabilities and was endowed with all its immunities. It was alleged that to decide that the duty was again payable would certainly be to deprive it of one of the immunities, and that the aim of the Crown was to get two duties in respect of the same capital. Mr. Justice Walton came to the conclusion that the view of the Crown was not the true one. He thought the capital of £2 400,000 which the Brompton Co. were authorised to raise would be raised, if at all, under the Act of 1899, and not under any power given by the new Act of 1902; so that there was no new Act or grant to make the duty payable. He, therefore, gave judgment for the defendants, with costs. Hence the present appeal of the Crown.

After hearing the arguments of counsel, their Lordships allowed the appeal, holding that Mr. Justice Walton had taken a wrong view of the effect of the private Acts of the year 1902. Judgment was accordingly entered for the Crown for £13,200 and costs; but the Solicitor-General stated that all the Crown would ask for was the exact amount of the duty and 3 per cent. interest, and not ask for the penalties which were included in the £13,200 claimed in the action.

RHONDDA COUNCIL v. TAFF VALE RAILWAY.

Overhead Lines.

The action of the Rhondda Urban District Council *v.* the Taff Vale Railway Co. was heard before Mr. Justice Bray in the King's Bench Division last week.

Mr. ELDON BANKES, K.C., for the defendants, said this was a special case stated by Mr. Abel Thomas, K.C., in an arbitration under these circumstances. The Rhondda Council obtained powers to construct a tramway along certain roads, and in some portion of its course the roads crossed the Taff Vale Railway lines on bridges which were the property of the Taff Vale Railway. Across these bridges transversely, at various heights from the ground, there were a great number of telegraph wires. The Act under which the Council obtained their powers left it entirely open to them to decide what form of traction they should adopt. Apparently they adopted the overhead trolley system, and there were Board of Trade regulations which, unless modified, required that the live wire should be 21ft. from the line under protest. They now said that the arbitrator exceeded his powers in making his award. Their case was that the special Act incorporated the Lands Clauses Act, and if the tramway company interfered with anybody's property they were bound to proceed under that Act, and to give notice to treat to clear away the obstruction. The arbitrator had held that the contention of the tramway company was correct, that they were entitled to call upon the railway company to alter the position of their telegraph wires so as not to obstruct the working of the tramway system; and he ordered the railway company to carry out all necessary alterations, with reasonable speed, at the expense of the tramway company. He submitted that was a thoroughly bad award. Even if the tramway company got out of this difficulty with the railway wires, there were the Post Office wires and the wires of private owners which would have to be dealt with. He contended that under the Tramways Act respondents must make out a case where the alteration of the wires was required in order to prevent frequent interruptions of the traffic of an existing tramway by repairs or works in connection with the same.

After argument, his Lordship held that counsel's contention on behalf of the Council was correct, that they were entitled to have these telegraph wires altered at their own expense, and also that this was a proper dispute for arbitration. He gave judgment for the District Council with costs, and refused a stay of execution.

COMPANIES' MEETINGS AND REPORTS.

ARON ELECTRICITY METER.

The tenth ordinary general meeting of Aron Electricity Meter was held on Tuesday, Mr. H. Hirst presiding.

The CHAIRMAN, in moving the adoption of the report and balance-sheet, said the figures had again justified the policy of the Board. The gross profits were over £2,000 more than last year; on the debit side the figures were very similar to those of last year. The increased gross profits and the economies exclusively effected accounted for an increase in the net profit by about £3,000. As regards the balance-sheet, on the debit side there were three items which seriously differed from those of last year. The first was the amount of debenture debt, which stood at £41,600, and showed, therefore, a reduction of £7,360. Sundry creditors and outstandings were about £3,000 more than last year. That was due to the increased purchases required for the larger turnover, and also to the higher price of raw material. The third item was the profit and loss account, which showed £4,000 more. Although the fall in price of raw materials took place after Oct. 1, which fact would have justified them in presenting the accounts with their raw material at the increased cost price, they had decided to depreciate their stock sufficiently in accordance with the lower prices ruling at the end of October. He believed that with continual care the Company had a right to anticipate a number of good years to come. In addition to the patents originally purchased from Dr. Aron which were strong enough to prevent anyone attempting to tamper with them, and which, in consequence, secured to the Company a monopoly of a certain type of meter, they had had to develop cheaper meters at prices to suit small consumers' installations. They spent nearly every year £600 or £700 for patent fees, and several thousands of pounds for experiments, designs, and production of proprietary articles. He was of opinion that the Company's patents were worth as much to-day as at any other time in the history of the Company. As regarded goodwill, the item of £180,000 on the balance-sheet not only included goodwill or patents, but also land, buildings, machinery, plant, and other very tangible assets. They did last year a larger turnover than ever since the formation of the Company; more meters were sold in nearly every civilised country, and the goodwill of the Company, though standing at less on the books, was certainly greater than at the time of the issue of the prospectus and first balance-sheet. Since the formation of the Company they had put out of revenue the sum of nearly £70,000 in cash into the business. That did not include the sum of £1,000 paid to acquire what was thought might prove a useful patent, nor the shares received from the American company, but it did include the cash received from America, about £10,000. It included about £16,800 spent in additional machinery and instruments, about £11,000 spent for lands and buildings, about £10,500 for office and workshop installation, £4,000 for office and workshop furniture, and about £13,600 for tools. In spite of the expenditure of that £70,000, the item on the top of the credit side of the balance-sheet, which included goodwill, patents, land, buildings, machinery, tools, etc., stood at £10,000 less than it stood in 1899. In the minds of the directors the process of strengthening the Company had to be continued, because, both from a trading and financial standpoint, the competition grew daily keener, the profit on each meter in consequence grew less, and it was necessary to do an ever-increasing business if they wished to make the same or increased profits, and for that purpose more and more capital would be required every year. The directors had also to face the repayment of the debenture loan at the rate of about £5,000 a year. For that reason they had this year put a substantial amount for a reserve towards goodwill. It would be their endeavour to pay out at least something of the arrears each year in addition to the standing 6 per cent., and if their anticipations of continued good business were realised, they might one day feel strong enough to make short work of that liability. He counselled those who held ordinary shares to be patient a little longer. He was pleased to say that all the branches had contributed to the profits of the Company, and the London branch, which several years showed a loss, had reached the turning point. They had had in London last year 50 per cent. more orders and sales than in the previous year, and had between Oct. 1 and that day booked orders equal to 50 per cent. of last year, whilst the orders and sales all through the Company were also considerably ahead of last year. For the better conduct of the business in Austria they had formed a company there, similar to those in Germany and France, under the title of Elektra Apparatenbaugesellschaft, the whole of the capital of which was in the hands of this Company. They had given considerable attention to the taximeter question, and had produced an instrument which the Commissioner of Police had approved, and which was now under test at the National Physical Laboratory. They were making a keen bid for that business in this country, and experimenting in connection with the production of the instrument. They had also developed in Germany a business in small motors, which were manufactured at their Schweidnitz works. That business, though showing a loss for the first year, promised progress very favourably.

Sir JAMES PENDER, Bart., seconded the motion, which was carried unanimously.

A further dividend of 6 per cent. on the preference shares (3 per cent. having been already paid on the arrears) was agreed to.

INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS.

The report of the India Rubber, Gutta Percha, and Telegraph Works Co. for the year ended Sept. 30 last shows, after provision for doubtful debts, a net profit of £56,809. Adding £42,224 brought forward, and deducting £12,500 interim dividend paid in June, there remains a disposable balance of £86,533. The directors recommend a dividend of 15s. a share, free of income tax, making a total payment of 10 per cent. for the year, and leaving £49,034 to be carried forward. The general business of the Company shows an increase compared with the results of last year. The prices of raw material remained at a high standard until the end of the summer quarter, but since then prices have declined. The Palmer and Persan motor and bicycle tyres, which are manufactured by the Company, continue to grow in favour, their merits being more generally recognised. The electrical installation in Dumfries has been completed, and in the future a revenue from this source may be expected. The laying of a cable between New York and Havana, manufactured to the order of the Commercial Cable Co., has been completed since the closing of the financial year. The cable steamers "Silvertown," "Dacia," and "Buccaneer" have had employment during the year, and are in an efficient condition. The Hon. Henry Marsham, on his return from abroad, was appointed a director, a vacancy on the Board having been created by Mr. Henderson's death.

ADELAIDE ELECTRIC SUPPLY.

The report of the Adelaide Electric Supply Co. for the year ended Aug. 31 last, to be submitted to the meeting on the 19th inst., states that the profit and loss account shows a profit for the year of £9,319. After payment of the dividend on the preference shares for the half-year ended Feb. 28, 1907, writing £525 off suspense account, the latter consisting of the cost of the last two issues of preference shares, and placing £1,000 to depreciation account, there remains, including the amount brought forward, an available balance of £6,335. The directors recommend a dividend of 2½ per cent. on 26,005 ordinary shares for the year ended Aug. 31, 1907, and that £829 be carried forward. During the year £22,266 has been expended in Australia on capital account in the provision of additional buildings, plant, and mains. The directors are continuing their policy of including the residential districts surrounding the city of Adelaide in the Company's

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field of operations, and for this purpose the supply mains are being gradually extended into such districts as are expected to yield additional revenue. Owing to delay on the part of the manufacturers in delivering the necessary additional generating plant, the arrangements for closing down the small station at Port Adelaide and supplying that district from the Company's principal station at Adelaide could not be completed during the past year. The change over, however, took place on Oct. 12 last, and Port Adelaide is now being supplied from Adelaide, with consequent substantial reduction in the working expenses.

COSTA RICA ELECTRIC LIGHT AND TRACTION.

The accounts for the year ended June 30 show a surplus, after payment of debenture interest and administrative expenses, of £3 960, and, after deducting the debit balance of £1,374 brought forward, there remains a credit to profit and loss of £2,586, of which the directors propose to reserve £1,771 for the redemption of the outstanding debentures and to place the remainder to credit of discount on debenture issue account. It is stated that a further provision of capital for development and improvement of the service will be necessary in the near future.

BLACKPOOL, ST. ANNES, AND LYTHAM TRAMWAYS.

The ninth annual report of the Blackpool, St. Annes, and Lytham Tramways Co. states that the invariably wet weather experienced during most of the year seriously affected receipts. Still, the net profit is only £244 less than in the previous year. The receipts are £27 490 and the balance from revenue £6,500. Debenture interest absorbs £7,500, and £1,500 is put to sinking fund. The debit balance from the previous year has been increased to £13,053.

NEW COMPANIES REGISTERED.

Denton Electrical Construction Co.—Registered Nov. 30 by Jordan and Sons, 120, Chancery-lane, W.C. Capital, £1,000 in £1 shares. Objects as title. Registered offices: 11, Ashton-road, Denton, near Manchester.

Liens Registered.

Electric Vehicles Development Co., Limited, London, E.C.—Lien Dec. 2, £1,390 4 per cent. debentures, part of £3,000. Amount previously issued, £1,610. No trustees (entire business and assets).

Appliances and General Engineering Co., Limited, London, E.C.—Lien Nov. 30, £200 7½ per cent. debentures, part of £2,000. Amount previously issued, £500. No trustees (property and assets).

Maxim Electrical Co., Limited, Westminster, S.W.—Lien Dec. 3, £800 5 per cent. debentures, part of £15,000. Amount previously issued, £14,200. No trustees (entire undertaking and effects).

Coatbridge and Airdrie Electric Supply Co., Limited, London, E.C.—Mortgage Nov. 29, £6,650, the mortgagees being the County of London Electric Supply Co., Moorgate-street, E.C. (entire undertaking, assets, rights, properties, and uncalled capital).

Vulcan Motor and Engineering Co. (1906), Limited, Southport.—Lien Nov. 28. £10,000 5 per cent. debentures of £100 each, part of a total series authorised not to exceed £20,000. No trustees (undertaking and all the property, present and future, including the uncalled portion of the nominal capital of £75,000).

North Wales Power and Traction Co., Limited.—Memoranda of satisfaction (*a*) to the extent of £70,000 of a security, dated Aug. 15, 1905, covering £110,000 and other moneys; (*b*) to the extent of £70,000 of debenture stock covered by a trust deed of same date, securing £150,000; and (*c*) in full of a charge, dated Oct. 16, 1905, securing £30,000, have been filed.

OPENINGS FOR CONTRACTORS.

ABERDEEN—Goods shed and offices, G.N. of Scotland Railway.

ACCRINGTON—Additions to relief pay station, Board of Guardians.

ACTON—Additions to school, Acton Education Committee.

ALNMOUTH—Golf house. Mr. W. Hindmarsh, Alnwick, architect.

APPLEDORE—Elementary school (£3,000), Devon County Council.

AUCKLAND—Alterations at workhouse (£600), Board of Guardians.

BANBURY—Rebuilding a house in North Bar, Mr. F. T. Kilby; conversion of workshops, etc., into three dwelling-houses, Foundry-square, Mr. W. W. Trolley.

BARGOED—Town hall. Mr. P. V. Jones, Hengoed, architect.

BARKING—Extensions to electricity undertaking (£2,000), Urban District Council.

BARNSTAPLE—Secondary school (£4,100), Devon County Council.

BARRY—Public abattoir (£800), Urban District Council.

BATTERSEA, S.W.—Extension of St. Mary-le-Park parish hall. Messrs. J. S. Quilter and Son.

BELFAST—Electric tramway and equipment. Mr. W. R. Kelly, engineer.

BELFORD—Two houses, South-lane, Mr. G. Paull, Gosforth.

BIRMINGHAM—Additional plant, electricity undertaking (£231,228).

BIRR—Workmen's dwellings (£9,095), Rural District Council.

BLACKBURN — Elementary school, Cedar-street (£5,225), Town Council.

BOSTON—Two houses, Hartley-street, Mr. Crick.

BRIGHOUSE—Extensions to electricity undertaking (£3,624), Town Council.

BRIXTON, S.W.—Garage, Cranmer-road, Kennington, General Motor Cab Co.

BROMLEY—Municipal buildings (£17,000), Urban District Council.

BROOMHILL — Presbyterian church, Mr. G. Reavell, Alnwick, architect.

BRYNCOCH—Elementary school, Glamorganshire County Council.

BRYNNA—Schoolroom, Welsh Congregational church, Rev. D. Davies, Llanharan.

BUNGAY—Institute, Messrs. Clay and Sons.

BURGHEAD—House, Dunbar-street. Mr. J. Wittet, Elgin, architect.

BURNLEY—Extension to Victoria Mill, Messrs. J. Stuttard and Sons.

BURY—Rebuilding 14 and 16, Fleet-street, Lancashire and Yorkshire Bank; new club and bowling green, Cliff-road and Mill-street, Blackford Bridge Conservative Club; amended plan of magazine, drill hall, 1st Volunteer Battalion Lancashire Fusiliers; packing-room, sawmills, etc., Hacking-street, Hacking and Co.; social club, Tottington-road, Woolfold Wesleyan School.

BUSHEY—New offices (£3,350), Urban District Council.

BUXTON—Extension electricity works (£1,800), Town Council.

CAMBERWELL—Baths and wash-houses (£9,000), Borough Council.

CANNOCK—Higher standard school (£4,000), Education Committee.

CANNOCK—Nurses' home, Guardians. Mr. Veall, architect, Guardians' Offices, Cannock.

CARDIFF—Goods shed, G.W.R.

CARLISLE—Dwelling houses, Dalston-road. Mr. Johnstone, architect.

CELBRIDGE—Workmen's dwellings, Rural District Council.

CHATTERIS—Workshop and showroom, South Park-street, Mr. W. Dyson.

CHESTER—Alterations to Queen's School (£3,000).

CLAREMONT—Congregational church school, Warley-road (£300).

CLOGHER—Workmen's dwellings (£10,540), Rural District Council.

COEDPENMAEN—Church of St. Matthew's (£3,500).

COLCHESTER—Mortuary, St. Peter's-street, Town Council; pavilion, Castle Park, Town Council.

CROYDON—Enlargement of central baths (£8,000), Town Council.

CWMGWILI—Elementary school. Architect, Mr. W. V. Morgan, Carmarthen.

CWMSIFIOG—Houses, Sunny Bank, Mr. J. S. George, Bryn Gelli.

DARLINGTON—Five houses, Uplands-road, Messrs. J. P. Pritchett and Son; house, Lodge-street, Messrs. G. Dickinson and Son; four houses, Greenbank-road North, Mr. J. Culley; ice manufactory, Valley-street North, Messrs. G. Dickinson and Son; house, Brinkburn-road, Messrs. G. Dickinson and Son; new shop front and alterations to house, 76, Bondgate, Mr. C. Peacock; new billiard-room, "Rosebank," Trinity-road, Mr. J. Taylor; alterations of London Tavern into offices, Priestgate, Messrs. Kitching and Lee; six houses, Lewes-road, Mr. J. Wallis; carriage works, Valley-street North, Messrs. G. Dickinson and Son; 10 houses, Hawthorn-street, Messrs. J. W. and M. McKenzie; clubroom, Elmtree Mission, Whessoe-lane, Messrs. Clark and Moscrop.

DARLINGTON—Elementary schools, Harrogate Hill and Bank Top, Education Committee.

DARWEN—Pattern store at Atlas Foundry, Messrs. Pickup and Kelly; 19 houses, Marsh House-lane and Naples-street, Mr. J. Pilkington; extensions to school, Hollins-grove, trustees of Hollins-grove Chapel; alterations at Robert-street Foundry, Messrs. A. J. and A. Coulthurst; extension to golf pavilion, Darwin Golf Club; warehouse, Campbell-street, Messrs. Harwood Bros.; two houses, Earnsdale-avenue, Messrs. Marsden and Yates.

DEPTFORD, S.E.—Reconstruction cattle markets (£2,375), Estates Committee, City Corporation.

DERBY—Nurses' home (£2,600), Board of Guardians.

DEWSBURY—Four houses, Leeds-road. Messrs. Kirk and Son, architects.

DOWNPATRICK—Free library, Town Council.

DUDLEY—Secondary school (£18,000); enlargement of post office (£300), Town Council.

DUMFRIES—St. Joseph's College (£11,500). Mr. C. Hay, architect, Dumfries.

DUNDEE—Alterations on property, Messrs. Esplin and Clark, Cowgate; house, Seymour-street, Mr. James Lowe; alteration on premise, Ward-road, Ancient Order of Foresters.

DUNFERMLINE — Technical school (£11,000). Messrs. H. and D. Barclay, Glasgow, architects.

DURHAM—College, Durham County Council.

EAST HAM—Mission church, Hertford-road (£1,700). Mr. B. Martin, architect.

EASTWOOD—Elementary school (£8,000); alterations to British and National schools (£800), County Education Committee.

EDINBURGH—House, Arboretum-road, and stationer's store, Dalgety-road, Mr. William Thyne.

EDZELL—Convalescent home, Infirmary House Committee.

EPPING—Parish church (£7,000).

FAKENHAM—Church. Mr. A. F. Scott, 24, Castle-meadow, Norwich, architect.

FARTOWN—Liberal club. Messrs. Stokes and Sykes, Huddersfield, architects.

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FARNHAM—House at grammar school, Surrey Education Committee.
FELIXSTOWE—Public conveniences, Undercliff-road, Urban District Council.
FLINT—Elementary school, Flintshire Education Committee.
FOVERAN—Additions to church, erection of vestry, Church Secretary.
GLOSSOP—Elementary school, Hadfield-road, Mr. J. Walkden.
GORTON—Extension of tramways (£11,349), Town Council.
GOSFORTH—Parochial hall (£1,900). Messrs. Hicks and Charlewood, Newcastle, architects.
GOSPORT—Elementary school, Education Committee.
GRANGE MOOR—Houses. Mr. J. H. Hall, Market-street, Huddersfield, architect.
GREAT BOWDEN—Motor garage, Mr. Straker.
GREYSTONES—Electric lighting of district. Clerk of Council, Loughlinstown, Dublin.
GWAENYSGR—Elementary school, Flintshire Education Committee.
HALIFAX—Extension of electricity works (£16,281), Town Council.
HASTINGS — Additions to operating theatre at the Hastings, St. Leonards, and East Sussex Hospital, Messrs. Pigott and Oxley, architects; covered way, Hastings Union Workhouse, Messrs. A. W. Jeffery and Son, architects; alterations to the Stag Inn, All Saints-street, Messrs. Cooper and Coussens, architects; additions to cooling tower at the Hastings tramway power station, Parker-road, Hastings Tramways Co.
HEREFORD—Extension of electric lighting (£1,500), Town Council.
HERNE HILL—Church, parish hall, and vicarage, Red Post-hill. Messrs. Greenaway and Newberry, Westminster, architects.
HESSLE—Ten houses on the east side of Barrow-lane, Mr. Parkinson; two semi-detached villas, Ferriby-road, Mr. G. Eckles.
HIGHWEEK—Enlargement of Council school (£2,500), Devon County Council.
HONLEY—Houses, Far Bank. Mr. H. S. Drake, 17, Westgate, architect.
HOUGHTON-LE-SPRING—Two houses, Station-avenue, Fence Houses, Mr. Marshall; house, Herrington Burn, Mr. H. Ritchie; additions to Free Church, Colliery-row; flour store, Messrs. Braham, Limited; additions to Houghton Roman Catholic Schools.
HULL—Pavilion, Hedon-road, Education Secretary, Albion-street.
INGATESTONE—Rebuilding Anchor Inn, Baddow Brewery Co.
ISLINGTON, N.—Elementary school, Cloudesley-road, London County Council.
KELTY—Additions to elementary school, Beath School Board.
KELVINSIDE—Baptist church (£2,000).
KENSINGTON, W.—Fifteen houses, Wallingford-avenue, Messrs. Trant, Brown, and Humphreys.
KIDDERMINSTER—Swedenborgian church, Cumberton-hill.
KING'S NORTON—Secondary school, Worcestershire County Council.
KINGUSSIE—Church. Mr. A. Cattanech, The Laurels, architect.
KINVER—Pumping station and turbine house. Architect, Mr. S. R. Lowcock, Birmingham.
LAMBERHEAD—Elementary school, Lancashire Education Committee.
LANCASTER—Church, Borrodale-road, Independent Methodists.
LEICESTER—Central fire station (£1,784), Town Council.
LEIGH (LANCS.)—New theatre, Leigh-road. Messrs. Prescott and Bold, architects, Wigan.
LICHFIELD—Children's homes, Wissage, Board of Guardians.
LIVERPOOL—Additions to railway offices, G.W.R.
LIVERPOOL—New chief office, Royal Liver Friendly Society.
LLANFROTHEN—Additions to schools, Merionethshire Education Committee.
LOCHGELLY — Municipal buildings (£2,048). Mr. J. T. Scobie, Dunfermline, architect.
LOCKWOOD—Four houses, Mount Pleasant. Messrs. J. B. Abbey and Son, architects, Huddersfield.
LONGTON—Conversion of premises in Earl-street into two houses, Mr. E. Sutcliffe; alterations and additions to shop in Stafford-street, Mr. J. Harrison; workshop and stores, Globe Works, Cooke-street. Messrs. Edwards and Jones; alterations and additions to 100, Trentham-road, Mr. J. E. Bourne; alterations to bakehouse, 68, Caroline-street, Mr. G. H. Crooks; stable off Bold-street, Mr. Rushton.
LOUTH—Workmen's dwellings (£9,190), Rural District Council.
LOWESTOFT—Secondary school, Education Committee.
LYDD—Three houses, Messrs. Balcombe Bros.
MAIDENHEAD—Elementary school, Berkshire Education Committee.
MAIDSTONE—Elementary school, Union-street, Town Council.
MARKET HARBOROUGH—Four houses, Nithsdale-avenue, Mr. Hickman.
MARSDEN—Stables, Warehouse-hill, Equitable Industrial Society, Limited.
MARYPORT—160 houses, Flimby Firebrick and Colliery Co.
METHIL—Dock and offices, N.B.R.
MEXBOROUGH—Secondary school (£14,000), County Education Committee.
MIDDLETON—Extensions to baths (£750), Town Council.
MILFORD HAVEN—Home of rest and Bethel. Messrs. Wood and Gasgell, architects.
NEWTON HEATH—Secondary schools for Wesleyan Methodists.
MORLEY—Motor garage in High-street, alterations to shops, Queen-street, Mr. G. L. Hainsworth; engine-room, Prospect Mills, Messrs. T. and S. Rhodes; additions to Springfield House, Messrs. Hudson, Sykes, and Bousfield; offices to warehouse, Middleton-road, Messrs. G. Stockwells.
NELSON—Extension to dyeworks, Brunswick-street, Messrs. Penny Bros. and Winder; 13 houses in Bentley-street, Mr. A. Edmondson; alterations to 41, Whitehall-street, Mr. J. Blackburn; alterations at baths in North-street, Mr. Jos. Brown; alterations to house in Railway-street, Mr. W. Hartley; sanitary conveniences in Cooper-street, Trustees of Wesleyan School; weaving shed off Waid's House-road, Messrs. Townsley Bros.; workshop in Hey-street, Mr. T. Downham; alterations at 40 and 42, Leeds-road, Mr. C. Horsfall; warehouse extension in Southfield-street, Mr. J. Nelson; lock-up shop off Bankhouse-road, Mr. T. Rushton.
NEWARK—Secondary school. Messrs. Shepherd and Lockton, architects.
NEWCASTLE (IRELAND)—Electric lighting (£4,000), Urban District Council.
NEWCASTLE-EMLYN—Electric lighting of district, Urban District Council.
NEWCASTLE ON-TYNE—Alterations to Old Theatre Royal, Mr. C. H. Baines.
NEWCASTLE (STAFFS)—Alterations and additions to Middle Boys' School. Architects, Messrs. A. R. Wood and Son, Bursley.
NORTHALLERTON—Isolation hospital, Rural District Council.
OLDBURY—Elementary school, Education Committee.
OLD DEER - Higher-grade school, School Board.
PANT—Alterations to schools, Merthyr Tydfil Education Committee.
PEMBERTON—Enfield Mill and weaving shed. Mr. R. Pennington, architect, Wigan.
PENYDARREN—Alterations to schools, Merthyr Tydfil Education Committee.
POOLE—Two houses, Douglas-road, Mr. G. W. Jackson; additions to house, Alexandra-road, Messrs. Smart and Wyeth; additions to three houses, Globe-lane, Mr. J. Puddy; three houses, Spencer-road, Mr. W. B. Rabbetts; house, Langdon-road, Mr. A. E. Hoare; house, Carter's-avenue, Hamworthy, Mr. J. Jones; additions to house, Churchill-road, Mr. T. Heath; house and shop, Bournemouth-road, Messrs. Smart and Wyeth; two houses and shops, Bournemouth-road, Messrs. Smart and Wyeth; house, De Redvers-road, Messrs. Smart and Wyeth.
PONTYPRIDD—Extensions to Electricity Department (£3,650), Urban District Council.
PORTHCAWL—Shops and dwellings. Mr. G. Lambert, architect.
PORTUMNA—Workmen's dwellings (£28,102), Rural District Council.
RADCLIFFE—Council offices, Urban District Council.
RAWMARSH—Elementary school, Education Authority.
RIPON—Secondary school, Education Authority.
ROTHERHAM—Secondary school, Middle-lane, Education Committee.
ST. ALBANS—Church, parish of St. Paul's.
ST. ANNES—Town hall, Corporation.
SALFORD—Gymnasia, Chapter-square, Mr. A. Wilsher, Peel Park.
SALTBURN—Cemetery lodge (£450), Urban District Council.
SCHOLES—Elementary school, West Riding Education Committee.
SHEVINGTON—Weaving-shed for Shevington and district.
SHILDON—Power house, wagon works, N.E.R.
SILSDEN—Fire station (£1,000), Urban District Council.
SOUTHPORT—Secondary school (£13,000), Education Committee.
STEPNEY, E.—Elementary school, Redman's-road, London County Council.
STIRLING—High school (£3,993), School Board.
STOCKPORT—Extensions to electricity department and plant, Town Council.
STROUD—Conversion of synagogue into dwelling-houses, Mr. W. E. Beard.
SUNNINGDALE—Improvements, National school (£350).
SUNNIFIELD—Dwelling-houses, Guisborough Co-operative Society.
SURBITON—Electric lighting (£20,000), Urban District Council.
SWANSEA—Forty-four houses, Town Council.
SWINDON—Thirteen houses, Montague-street, Mr. E. Hill; house, Shelley-street, Mr. A. J. Colborne; six houses, Exmouth-street, Mr. H. W. Pope; two shops and alterations to public-house, Victoria-road, Messrs. J. Groves and Sons; five houses, The Mall, Mr. E. H. Bradley; additions to Baptist church, Rodbourne-road, Mr. A. A. Pilcher; conversion of clubhouse into boarding-house, Prospect-place, Mr. H. J. Stevens.
TALSARNAU—Additions to schools, Merionethshire Education Committee.
TEIGNMOUTH—Houses on land between Halden-avenue and Brimley-road, Mr. W. Turpin.
TEMPLE—Parish manse, Trustees of Church.
TEUCHAR—Houses, Meadow Bank, Mr. G. Morrison.
THIRSK—Elementary school, Parish Council.
TINTERN—Elementary school, Monmouthshire Education Committee.
TODDINGTON—Renovation of Wesleyan schools.
TONBRIDGE—Alterations at Lion Chapel, Pembury-road, Trustees; alterations to 1, Ventnor-place, Pembury-road, Messrs. Israd.
TOTNES—Infirmary, rooms for nurses, porter's rooms, receiving wards (£8,554), Board of Guardians.

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TUNBRIDGE WELLS—Rebuilding warehouses, 25, High-street, Mr. T. G. Edwards; offices, etc., Mr. G. Langridge, Vale-road; alterations and additions to 21, Frant-road, Mr. J. Martin.

USK—Elementary school, Monmouthshire Education Committee.

VERNON PARK—New mill, Broadstone Spinning Co.

WALTHAMSTOW—Electricity generating station (£17,349), Urban District Council.

WANTAGE—Houses in a meadow opposite engineering works, Messrs. Wheeler and Co.

WARE—Extensions at Messrs. Allen and Hanbury's factory.

WARLEY — Elementary school, Abbey-road, Oldbury, Education Committee.

WEST EALING—Wesleyan church, Northlands-lane.

WEST HARTLEPOOL—Public conveniences (£2,000), Town Council.

WESTMINSTER, W.—Premises, Grosvenor-road, London, Hydraulic Power Co.

WEYMOUTH—Bakery, District Co-operative Society.

WHITBY—Additions and alterations to Conservative club. Mr. J. S. French, architect.

WHITEBROOK—Elementary school, Monmouthshire Education Committee.

WIGAN—Church in connection with St. George's parish, Ecclesiastical Commissioners.

WIMBLEDON—Additional plant, electricity station (£14,000), Town Council.

WOODHOUSE—Secondary school. Mr. J. E. Knight, Rotherham, architect.

WORKSOP—Extensions to electricity undertaking (£1,700), Urban District Council.

WREXHAM—Electric lighting (£575), Town Council.

YARMOUTH—Electric lighting, Dunham School, Education Committee.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Montreal.—Tenders are invited for a bulk supply of gas and electricity to the Municipality. Tenders by Dec. 16.

Perth (Australia).—The Postmaster-General invites tenders for accumulators for telegraph purposes. Tenders by Dec. 16.

Melbourne. — The Postmaster-General invites tenders for 30 metallic iron telephone switchboards. Tenders by Dec. 31.

Manila.—The Municipality invite tenders for pumps, together with electric motors, for sewage works. Tenders by Jan. 15, 1908.

Dartford.—The Urban District Council invite tenders for two pumps together with electric motors. Tenders to the Clerk by Dec. 18.

Swansea.—The Graigola Merthyr Co., Swansea, invites tenders for the annual supply of stores, including electrical goods. Tenders by Dec. 24.

Buenos Ayres.—The Municipality invite tenders for the installation of electric light and electric lifts for a new asylum to be constructed.

Brussels.—The Post and Telegraph Department invite tenders for the supply of telegraph and telephone material and appliances. Tenders by Dec. 18.

New South Wales. — The Postmaster-General, Sydney, invites tenders for one branching metallic multiple magneto switchboard. Tenders by Jan. 8, 1908.

Madrid.—Tenders are invited for the construction and working of the North-West interurban service. Deposit, 181,675 pesetas (about £6,375). Tenders by Dec. 18.

Keighley.—The Electricity Committee invite tenders for the supply of one motor-generator. Tenders to the Chairman of the Electricity Committee, Coney-lane, by Dec. 16.

Bootle.—The Corporation invite tenders for the supply of coal for use at the electric light station for six months ending July 1. Tenders to the Town Clerk by Dec. 14.

Napier (New Zealand).—The Town Council invite tenders for lighting and power plant and an electric tramway equipment. Particulars from Mr. F. Bowen, town clerk. Tenders by Dec. 31.

Madrid.—The Post and Telegraph Department invites tenders for the construction and working of the South-East interurban service. Deposit, 144,695 pesetas (about £5,077). Tenders by Dec. 26.

Melbourne.—The Postmaster-General's Department invite tenders for 11 sets and a common-battery switchboard, and 3,000 subscribers' telephones, etc., for the Windsor exchange. Tenders by Jan. 7.

Calcutta.—Tenders are invited for the lighting of the town by gas or electricity. Particulars from Mr. P. N. Mookerjee, secretary to the Corporation. Tenders to the Vice-Chairman by Jan. 2, 1908.

Warrington.—Tenders are invited by the Corporation Electricity Department for the annual supply of motors. Particulars from the Borough Electrical and Tramways Engineer. Tenders by Dec. 17.

Madrid.—The Public Works Department invite tenders for the construction of electric tramways in Bilbao. Particulars from the Dirección de obras publicas, Ministerio de Fomento. Tenders by Dec. 26.

Punjab (India).—Tenders are invited for electric and pumping plant for water supply. Particulars from the Executive Engineer, Special Work Division, Patiala, Punjab. Deposit £133. 6s. 8d. Tenders by Jan. 6, 1908.

Buenos Ayres.—Tenders are invited for the construction of underground electric tramways. Particulars from the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London. Tenders by June 1, 1908.

Wigan.—The Corporation invite tenders for the supply of 6,000 tons of best quality quick-firing slack, to be delivered free at the electricity station, Tunstall-lane, Pemberton. Tenders to Mr. Harold Jevons, town clerk, by Dec. 16.

Lyons.—The Corporation invite tenders for the erection of a refuse destructor, the heat to be utilised in generating steam for electric motors. Particulars from the Commercial Intelligence Branch of the Board of Trade. Tenders by Dec. 15.

Aberdeen.—The Town Council invite tenders for the annual supply of various materials. Particulars from Mr. J. A. Bell, city electrical and tramways manager. Tenders by Dec. 14.

Buenos Ayres.—Tenders are invited for (1) the construction of and (2) the concession to work the two principal sections of the underground electric railway. Particulars from the Argentine Legation, 12, Rue van Moer, Brussels. Tenders by May 1, 1908.

Leipzig.—Tenders are invited for a three-strand high-tension cable without armature after the trough system, for the second electric works which are to be constructed. Tenders to Hochspannungs Rabellieferung fuer das Elektrizitaetswerk by Dec. 19.

Adelaide.—The Deputy Postmaster-General for Queensland invites tenders for a common battery switchboard and 3,000 subscribers' telephones. Specification No. 166. Particulars may be obtained from the Commonwealth Offices, 72, Victoria-street, London, S.W. Tenders by Jan. 8, 1908.

Belfast.—The Harbour Commissioners invite tenders for the construction of a double line of electric tramway, permanent way, electric masts, cables, wiring, lamps, etc., on the co. Down side of the harbour. Tenders to Mr. W. A. Currie, secretary, Harbour Offices, Belfast, by Dec. 28.

Wigan.—The Electric Light Committee invites tenders for the supply of cables, carbons, engine-room stores, electric accessories, meters, ironmongery, and motors. Specifications, etc., from Mr J. Slevin, electrical engineer, Bradford-place, Wigan. Tenders to the Town Clerk, King-street West, by Dec. 16.

Madrid.—Tenders are invited for the construction of an international telephone system with France, and for the working of the interurban service of the North-East. Deposit, 120,000 pesetas (about £4,211). Tenders will be received at the Registro de la dirección general de correos y telegrafos, Madrid, by Jan. 3.

Victoria.—The Deputy Postmaster-General at Melbourne invites tenders for the supply and delivery at Melbourne of 11 sections of a common-battery switchboard and 3,000 subscribers' telephones and other apparatus for telephone exchange, Windsor, in accordance with Victorian specification No. 148. Tenders by Jan. 7.

Gillingham.—The Corporation invite tenders for the erection of plant capable of effectually burning a minimum of 30 tons of refuse per day of 16 hours, the heat to be utilised in a water-tube boiler for raising steam in connection with the electricity works, Windsor-road, Gillingham. Tenders to the Town Clerk by Dec. 12.

Adelaide.—Tenders are invited for the supply and delivery, c.i.f. Port Adelaide, of special work, points, and crossings for tramways. Specfication, etc., from the Agent-General for South Australia, Threadneedle House, 28, Bishopsgate-street Within, London, E.C. Tenders to the Chairman, Municipal Tramways Trust, Adelaide, by Feb. 11, 1908.

Nanking (China).—Tenders are invited from actual manufacturers only for the supply and delivery f.o.b. of the following materials required for the Nanking tramway—viz: wheels and axles, springs, chain, steel bars, plates and angles, steel channels, rivets, bolts and nuts, plate glass. Specifications, etc., from Messrs. Sir John Wolfe Barry and A. J. Barry, engineers, 7, The Sanctuary, Westminster, S.W., on payment of a fee of 5s. each. Tenders to Messrs. Matheson and Co., 22, Abchurch-lane, E.C., by Dec. 16.

RESULTS OF TENDERS.

Yarmouth.—The Town Council have accepted the tender of Geipel and Lange for carbons at £3. 1s. 7½d. per thousand pairs.

Wigan.—The Electric Light Committee have accepted the tender of F. E. Moss for the supply of 200 tons of best washed slack at the electric light station.

Southampton.—The Electricity Committee recommend the acceptance of a tender from Babcock and Wilcox, London, at £1,680, for the supply of a boiler for their works.

Tunbridge Wells.—The Corporation have accepted the tender of the British Westinghouse Manufacturing Co., at £2,575. 10s., for a 500-kw. turbo-alternator, and that of J. P. Hall and Sons, at £865, for condensing plant.

London County Council.—The tender of the India Rubber, Gutta Percha, and Telegraph Works Co. has been accepted for the supply of 600 rubber plough bases and 1,200 plough leads required for use in the Council's Tramways Department.

Metropolitan Asylums Board.—The following tenders have been received for alterations and extensions to the fire alarms and telephones at Gore Farm Hospital:

T. Potter and Sons (accepted)	£225	0	0
W. Cannon and Sons	226	8	0
Electrical Engineering and Maintenance Co.	239	0	0
Private Wire and Telephone Installation Co.	278	0	0
J. Bryden and Sons	287	0	0
Bell Telephone and Electric Co.	335	0	0
H. Hooper	373	0	0
Revy, Phillips, and Co.	396	15	0

Walsall.—The Corporation have accepted the following tenders, amongst others, for the annual supply of stores to the tramways

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department: British Thomson-Houston Co., Rugby, lamps and forged steel G.E. pinions; Magnolia Metal Co., London, bearing metal; Lambert Bros., Walsall, trolley wheels; C. Richards and Sons, Darlaston, brake blocks.

BUSINESS NOTES.

TRACTION.

Bristol.—The tramways company have decided to erect a shelter at Black Boy-hill.

Hammersmith.—The Borough Council have consented to the construction of the proposed junction line providing access to the London County Council car-sheds, but not for public traffic.

Yarmouth.—The tram receipts from April 1 on the Yarmouth and Gorleston sections total £16,447, a decrease of £910 compared with last year. The takings on the Caister section since May 17 have been £2,852.

Tucuman (South America).—The electric light and power station and electric tramway concession granted by the Municipality to Mr. B. S. Garcia will be taken over on completion by the Campania Alemana Transatlantica de Electricidad.

Bedford.—The Town Council have granted permission to the Ortona Motor Co. to ply for hire in the borough for a period of three months, provided the borough surveyor is satisfied that the vehicles in question are in every way suitable for the purpose intended.

Buenos Ayres and Belgrano Electric Tramways Co.—Receipts for the week ending Dec. 9, 1907, converted to gold were £4,178; corresponding week last year, £4.129—increase, £49. Aggregate from Jan. 1, 1907, £189,749; aggregate from Jan. 1, 1906, £179,537—increase, £10,212.

Taunton.—The Council have received complaints as to the excessive noise made by the running of the tramcars, and have decided to instruct the town clerk to inform the tramway company that unless the noise is at once abated the Town Council will take steps for enforcing the existing by-laws.

Torquay.—The tramway company are applying to the Town Council for permission to lay lines from Torre along the sea-road to the railway station. It was originally stipulated by the Corporation that before trams could be allowed along the promenade they must run successfully in other parts of the town.

Hertfordshire.—The formal opening of a stretch of tramway from Tramway-avenue, on the Edmonton and Enfield boundary, to Waltham Cross, Hertfordshire, took place on the 12th inst. On the first car were Sir Cory Wright, chairman of the Middlesex County Council, and several other members of that body.

Hove.—Having considered an extensively signed petition from ratepayers of Hove on the subject of the "unnecessary amount of noise, dust, vibration, and smell" caused by the motor 'buses, the Watch Committee of the Town Council have requested the 'bus company to send representatives to interview the committee.

Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board.—At the last meeting of the Board the commercial manager reported that the traffic receipts for the four weeks ended Nov. 16 amounted to £2,923. 7s. 5½d., and that the total receipts to that date from March 31 last were £26,243. 19s. 6½d.

Clayton-le-Moors.—The District Council have assented to a notice from the Blackburn, Whalley, and Padiham Light Railway Co., who announced their intention to make application to the Light Railway Commissioners for an order to revive and continue their powers, and to extend the time limited by the Blackburn, Whalley, and Padiham Light Railways Order, 1901.

Coventry.—The Tramways Committee of the Council have instructed the secretary to write to the manager of the tramways company calling his attention to the unpunctuality of the service between Stoke and Earlsdon, and to suggest that a new route to Earlsdon *via* Warwick-row and the Butts would be a great benefit, and would also put an end to the unpunctuality of the service.

Thornton Heath.—On Friday evening last, while negotiating the points at Friends-road, a tramcar came into collision with an L.B. and S.C. railway parcels van. One of the windows of the tramcar was smashed, and the broken glass strewn over the roadway and the seat and floor of the car, but by a fortunate chance only two passengers were riding inside, and these being seated on the other side of the car escaped uninjured.

Brighton.—At the meeting of the Town Council Alderman Blaker, on behalf of the Tramway Committee, wished to withdraw the resolution with reference to the proposed extension of tramways through Weston-road, concerning which the frontagers offered strong opposition. The majority of the Council declined to allow the matter to be dealt with in that manner, and a division being insisted upon, the Tramway Committee's scheme was rejected by 41 votes.

Birmingham.—The Digbeth and Moor-street tramway, which connects the East Birmingham and Small Heath routes, and provides a through service between Victoria Park and Nechells, has been opened for traffic. With the exception of the line from Ward End to the Fox and Goose, which it is not proposed to construct at present, the whole of the tramway scheme which the Corporation received parliamentary power to carry into effect has now been completed.

Dundee.—So rapid has been the progress in the construction of the new tramway line from Fairmuir to Downfield that it is expected early next week cars will be able to run out to the terminus at Baldovan-road. Work began on Sept. 5, and when it is considered that there has been a good deal of broken time, and that in addition to laying the rails workmen had to be employed paving the roadway from side to side, it will be conceded that the work has been pushed through with expedition.

Morecambe.—The Town Council at a special meeting advanced another step towards the acquisition of the tramways, for they approved the minutes of the committee which recommended proceeding with the Bill in Parliament. The town clerk reported that the Board of Trade had given the Corporation permission to give the necessary notice to the tramway company for the acquirement of that part of the tramways within the borough. The question is arousing keen interest in the town.

Walsall.—At the Town Council meeting the Chairman of the Tramways Committee in presenting a report, justified the committee's action in declining to accede to a petition from their employés for an abandonment of the Christmas Day tram service. He said the inconvenience to the general public would have outweighed that which was occasioned to the tramway servants. By granting double pay the committee had shown that they wished to avoid any hardship. Permission was given for seven additional tramcars to be fitted with covered tops at an approximate cost of £455.

Richmond (Surrey).—The Town Council have passed a resolution to request the London United Tramways Co. to promote a Bill for the construction of a tramway across Kew Bridge. The resolution is the outcome of several years' negotiations, and the company have agreed to waive the further consideration of the overhead trolley wire for the Kew-road line and to install a system of surface traction instead. The proposed line will bring Richmond into communication with the company's main system from Shepherd's Bush and Hammersmith to Hampton Court and Hounslow.

Lexden.—At a meeting of the Rural District Council the clerk reported the receipt of a notice from the Light Railway Commissioners in respect of the Southend and Colchester light railways, informing the Council that application was intended to be made for certain orders and powers, etc., with respect to the railway, and the clerk said the tenor of the notice was that certain roads in their district would be gone over—at West Mersea, Peldon, and Abberton—and assent had to be given. It was agreed that the assent of the Council to the requirements contained in the notice should be given.

Wandsworth.—At the last meeting of the Borough Council the General Purposes Committee stated that they had adjourned the consideration of a letter from Mr. H. B. Renwick, stating that a Bill would be introduced in the next session of Parliament by the promoters of the West London, Barnes, and Richmond tramways; that the route of the proposed tramways would be from Bridge-road, Hammersmith, over Hammersmith Bridge, through Barnes and Mortlake along Lower Mortlake-road to Kew-road, Richmond, and from Castelnau, Barnes, through Rocks-lane, over Barnes Common, along Upper Richmond-road and Sheen-road to a point near the fire station at Richmond.

Fulham.—A further discussion on the Fulham Palace-road tramway scheme took place at Tuesday evening's meeting of the Works and Highways Committee of the Borough Council. The committee at its previous meeting passed a recommendation urging the Borough Council to inform the County Council that unless they accepted the terms laid down in a communication to the London County Council last July, the Fulham Council would not favourably consider the County Council's scheme. This recommendation, when submitted to the Borough Council, was withdrawn, and on Tuesday evening warm criticisms were passed by members on the subject. The committee ultimately agreed to re-present its recommendation.

Hampton Wick.—With reference to the state of the tram track in Hampton Court-road, it was reported to the Council at their last meeting that the company had executed none of the promised repairs, and it was decided to make a complaint to the Board of Trade, asking the Board to have an inspection of the track. It was further resolved that the attention of the Commissioner of Metropolitan Police be drawn to the undue noise made by the passage through the district of the cars of the London United Tramways Co., and that the Council ask the commissioner to make inquiry into the state of the cars and to refuse his licence in respect of such cars as may be found to be defective or worn, or to be creative of the undue noise complained of.

Ipswich.—The breaking of an overhead electric wire in St. Matthew's-street on Saturday evening, caused the stopping of the trams within the area between Barrack-corner and King-street, and Major's-corner. It seems that the strain put upon the wire by the trolley of tramcar No. 84, which was passing under it at the time, snapped the wire at one of the standards, causing a report and a brilliant flash. One end of the wire fell into the gutter, but fortunately no one seems to have been struck by it, although there were many people in the thoroughfare at the time. The conductor of the car at once made a connection with one of the tramlines. Mr. F. Ayton, manager of the tramways, had the wire removed between the two standards and after nearly three-quarters of an hour's delay the cars were able to proceed.

Newport.—The Electricity and Tramways Committee have received a letter from the Car and General Assurance Corporation stating that the motorcar belonging to Mr. J. W. Reynon, shipowner and coal exporter, Cardiff, met with an accident on Caerleon-road owing to the defective condition of the tramway. The car collided with a coal cart, and they claimed for damages to the car and injuries to the driver. The Newport borough engineer denies that the road was in a defective condition, and the committee has decided to repudiate liability in the matter. Claims against the Tramways Committee have also been sent in by Mr. Isaac Evans, who says that a tramcar moved from a stopping place when he was mounting, and caused him injuries; from Mr. E. Griffiths, whose horse and cart collided with a

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car; and from Mrs. Catherine Price, who met with an accident as she was alighting from a car at the Westgate.

Dulwich.—At a crowded meeting of the inhabitants attention was drawn to the great meeting held previously at Forest Hill to urge the London County Council to proceed to link up the existing system of tramways to Forest Hill. It was stated that the extension was greatly needed by Dulwich residents. Easier access would be given to Dulwich Park by the entrance in Lordship-lane, greater access to the Crystal Palace by train from Lordship-lane Station, and better means afforded of reaching Horniman's Museum and the beautiful grounds, which were not visited as they should be because of the difficulty in reaching them. A resolution was carried calling upon Messrs. H. C. Gooch L.C.C., and F. Hall, L.C.C., to support the efforts being made by the residents of Forest Hill and Sydenham to press upon the Council the necessity of proceeding with the authorised tramways between Lordship-lane and Forest Hill.

Glasgow.—The ninth annual social gathering of employés of the Glasgow Corporation tramways department took place on the 4th inst. in the City Hall. Lord Provost Sir William Bilsland presided, and in an address made an interesting review of the history and present position of the department. At the present time, he said, there were 180 miles of single track, and a staff of over 5,000 persons in the department, serving with the facilities of the department no less a population than one million people. Referring to the financial aspect of the department, he said there had been from first to last about three millions of capital expended on making the system what it was to-day, and of that so much of the debt had been already paid off that there was now only one and a half million owing to the lenders to the Corporation, and before very long there would be no debt at all if they continued, as now, without having additional capital expenditure, and leaving the fares as they were.

Manchester.—At the Queen's-road tramcar shed on the 6th inst. Alderman Bowes, the chairman of the Tramways Committee, presented a number of ambulance certificates, badges, medallions, and labels to the tram drivers and guards. Mr. Bowes congratulated the members on the fact that all who had entered the examination had been successful. The Tramways Employés' Social and Athletic Society, which had formed football, cricket, billiard, ambulance, swimming, and fishing clubs amongst the members, was evidently in a flourishing condition, and he wished it every success. The Tramways Committee were at all times willing to meet the men on any grievances they might have in a friendly spirit. They should be reasonable in their demands. Alderman M'Cabe and Councillor Bowie also spoke, and Alderman Bowes proposed a vote of thanks to Mr. M'Elroy, the general manager, for presiding. No tramway undertaking in the country, he said, had a better general manager, or one who studied the interests of the employés more, than Mr. M'Elroy.

Ayr.—At a meeting of Ayr Town Council, it appeared from the minutes of a meeting of the Tramway Committee on Nov. 29 that the clerk had read a letter from Mr. R. A. Oswald's factor stating his objections to the proposed extension of the tramways to the new racecourse, and that he was not prepared to give the land required for road widening except under compulsion. The clerk had further reported that no reply had been received from Mr. Campbell, of Craigie, nor from the Western meeting. A statement had been submitted showing that, inclusive of £2,313 for street widening, the extension would cost £18,250, and it had been agreed to recommend that the Council, in their provisional order, apply for borrowing powers for £25,000. The clerk reported that he had that morning received a letter from Mr. Kennedy, of Underwood, the parliamentary agent, recommending the Council to apply for powers to borrow £28,000. Mr. C. H. Millyard said they might as well make it £40,000 when they were at it. The extension was at first estimated to cost £14,000, and now it was apparently going to cost double that amount. It was agreed not to adopt the suggestion to borrow £28,000, and the minute was approved.

Wigan.—At a meeting of the Wigan Tramways Committee it was decided to adopt the following bonus scheme: To each driver and conductor who during the previous quarter has been (1) free from suspension; (2) free from collision or damage to car for which he is held to be blameworthy; (3) free from passenger or public complaint for which he is held to be blameworthy; (4) not more than twice late on duty; (5) free from report for neglect in the matter of collecting fares, a bonus to be paid as follows: after one year's service at the rate of 6d. per week with one merit stripe; after two years' service at the rate of 9d. per week with two merit stripes; after three years' service at the rate of 1s. per week with three merit stripes, which stripes will be liable to subsequent forfeiture at the hands of the committee for any offence which would, if committed prior to the earning of the stripes, have prevented the holder thereof from gaining the same. Also a bonus to be paid at the end of each financial year in which a reduction in the current consumed per car mile has been effected in comparison with the previous year. Five per cent. of the sum represented by any saving of current to be divided equally amongst all motormen in the service at the end of each year who have been so employed for not less than six months in such year.

LIGHTING AND GENERAL

Bournemouth.—The Corporation have decided to erect an electric lift on the West Cliff.

Eastern Telegraph Co.—A quarterly interim dividend of 1¼ per cent. is announced, payable on Jan. 15.

Burnley.—An extension to the plant at the Corporation electricity works is in contemplation by the committee.

Bermondsey.—The London County Council have agreed to lend the Borough Council £2,000 for electric lighting purposes.

Wimborne.—Telephones are to be installed at the workhouse by the Guardians, and a connection made to the telephone exchange.

Claresholm (Alberta).—The Town Council are making arrangements to take over the electric light plant from the existing company.

Erith.—The Council, having received an application for two 20-h.p. motors under the Council's hire system, have instructed the electrical engineer to place the order for them.

Dewsbury.—The borough electrical engineer has been instructed to lay down electric mains to Messrs. E. Fox and Son's premises in Watergate, at an estimated cost of £132.

Fort Qu'appelle (Saskatchewan).—Arrangements are being made for the construction of a long distance telephone line from this town to Balcarres, a distance of 32 miles.

Carnarvon.—Estimates for extending the electricity mains along Market-street and Church-street have been approved by the Council for sums of £21. 10s. and £43. 15s. respectively.

West Bridgford.—The District Council have decided to support a petition, containing 415 signatures, in favour of the establishment of telegraph facilities at the Loughborough-road Post Office.

Walthamstow.—The Local Government Board will hold an inquiry on Dec. 19 into the application of the Council for sanction to borrow £17,349 for the purposes of an electricity generating station.

Broughty Ferry.—The amount of electric current generated from Nov. 1 to 30 at the Corporation works was 17,455 units, being an increase of 1,889 units over the corresponding month of last year.

Stafford.—The output of electricity from the Corporation works has during the past three weeks increased by 24 per cent., against an increase of only 3½ per cent. in the consumption of gas for the same period.

Buenos Ayres.—Messrs. P. Chambers and Co. have advised the Municipality that they have acquired the concession granted on Feb. 16, 1907, to Messrs. Newbury and Kempt for an automatic telephone installation.

Vancouver (British Columbia).—The Canadian Pacific Railway Co. will electrify its South Kootenay branch of the Columbia and Western. The motive power will be supplied by the West Kootenay Light and Power Co.

Notice of Dividend.—The *London Gazette* announces that the first dividend of 2s. 6d. in the £ has been declared in the estate of R. S. Blackburn, electrical engineer and contractor, Ribstone Works, Hebden Bridge, Yorkshire.

Stepney.—Complaints were made at the last meeting of the Borough Council concerning the lighting of Old Gravel-lane by inferior gas, and the matter was referred to the Electricity Committee with a view to an installation of electric lamps.

Hamilton (Ontario).—The Board of Works have decided to submit a by-law next January for 225,000dol. for a municipal street lighting. For this amount the city will be able to install an underground system in the centre of the city and bury all wires.

Beckenham.—The Council have decided to make application to the Local Government Board for sanction to the borrowing of £4,642 for the provision of six mechanical stokers, accumulators, and boosters, and the necessary extensions to the buildings.

Eastern Extension, Australasia, and China Telegraph Co.—The directors of the Eastern Extension, Australasia, and China Telegraph Co. have declared an interim dividend for the quarter ended Sept. 30 last of 2s. 6d. per share, free of income tax.

Victoria (British Columbia).—The British Columbia Electric Co. has commenced the equipping of an additional steam plant, which will, it is expected, give an additional 2,000 h.p., which will be utilised for supplying electricity for lighting and power purposes.

Bognor.—At the last Council meeting it was reported that 14,235 electric lamps had been connected up to the end of October, and during November 274 were added. An increase of 1,352 units had been sold during the last month of the present year than for the same period last year.

Torbrook (Ontario).—The Londonderry Iron Mining Co., which recently acquired the iron deposits, is preparing to install an electric system for operating its mines. The power will be drawn from the Nictaux Falls, about a mile from the property. The estimated cost of the plant is 50,000dol.

Flintshire.—Considerable telephone extensions are taking place in Flintshire. A connection with Caerwys (in the Chester area) has just been completed, and connections between Flint and Halkin and Halkin and Rhosesmoir (taking in the Flintshire lead-bearing district) are to be immediately carried out.

Hampstead.—The Council have approved of the action of the Lighting Committee in authorising the electrical engineer to fix and light flame arc light burners in place of five of the existing arc light burners in the Finchley-road. This is an experiment, and, if it is successful, the new method will be extended.

Bury.—During the last month extensions were made on the premises of 17 consumers, equal to 152 8-c.p. lamps, and applications for current for four radiators, equal to 90 8-c.p. lamps, received by the Corporation engineer. During November there were 41,912 units generated, 8,064 more than in the corresponding period of 1906.

Yarmouth.—The Corporation have erected several new lamps in Southtown, each of which is fitted with two electric incandescent lights, and their illumination is very effective compared with the old flat-flame gas-burners that have hitherto lighted the Lichfield estate, where the Corporation have made a start with electricity for public lighting.

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Electricity in Mines.—Last Tuesday at Houghton-le-Spring Henry Bowman, a miner, was ordered to pay costs for having broken a special rule of the Lambton D pit in connection with the use of electricity. It appeared that the man failed to cut off the current between a coal-cutting machine and the trailing cable. This was the first case taken under the new rules.

Hereford.—The Electric Lighting Committee have reported to the Council that owing to the great increase in demand for current they were laying an additional feeder cable to Offa-street. The committee recommended the borrowing of £1,500 for cables and services, the amount to be expended from time to time as required. The Council have agreed to the proposal.

Longton.—In response to a request from the Improvement Committee of the Town Council, the Gas and Electricity Committee have offered to light St. John's clock with electricity for the sum of £17 per annum, and a charge for installation of £4. The offer has been accepted. The output of electricity during the month has been 20.371 units, being an increase as compared with last year of 14 per cent.

Sowerby Bridge.—A sub-committee of the Council has met representatives from the Electrical Distribution of Yorkshire Co., who are proposing to take over the provisional order. The deputation has reported that the company are prepared to proceed conditionally with the transfer and to pay the costs and Board of Trade fees in connection with the obtaining of the order. This procedure has been agreed to by the Council.

Ipswich.—On Thursday evening of last week the new electric light installation at Tacket-street Congregational Church was informally inaugurated in the presence of several prominent members of the congregation. The work has been effectively and creditably carried out by the Ipswich Corporation electric light department, under the supervision of Mr. F. Ayton, the manager, who designed special brackets and coronas for supporting the lamps.

Arbroath.—At a meeting of the Council Electric Lighting Committee, an offer was made by Mr. George Balfour, London, the promoter of the electric lighting scheme for Arbroath, to erect lamps and provide electric light for certain streets in the burgh. The committee resolved to recommend to the Town Council that the electric company be asked to place lamps up to the number of 20 on the thoroughfares leading from Invernook to the end of Keptie-street.

Sandringham.—Edward Thornton, 41, an engineer, employed at Sandringham House electric light works, has met his death under painful circumstances. He was assisting other men to remove an inlet valve from a gas-engine when he was overcome by the fumes, and, despite the efforts of the King's doctors, quickly succumbed. At the inquest a verdict of accidental asphyxiation by the inhalation of noxious gas was returned, sympathy being expressed with the family.

Aston.—The sub-stations at Erdington have been completed, and are now in a position to supply current. Already there have been 23 consumers connected, and the Armourduct Co. and the Wolseley Sheep Shearing Co. are both taking current for power and lighting purposes. The committee have reported to the Council that the department is making good progress in the supply of current, as will be seen from the following figures: October, 1906, 189,106; October, 1907, 268.819.

Pontypridd.—A Local Government Board inquiry has been held into the application of the Urban District Council for sanction to borrow £3,600 in respect of the electrical undertaking. The Council was represented by Mr. L. R. Williams, the accountant, and Mr. J. E. Teasdel, the electrical engineer and manager, and Mr. P. R. A. Willoughby, the surveyor, gave evidence. Mr. Teasdel stated that an additional feeder was required for the town, owing to the increased demand for electricity, and also for the lighting of the Rhondda-road with electricity in lieu of gas.

Simplex Co.—The expansion of the Simplex Co.'s business in the metropolitan district has necessitated the removal of the London branch office to more commodious premises, where larger stocks and other facilities to meet the increasing business demands will be available. The company have acquired large and central premises in Charing Cross-road, London, W.C., and these will be formally taken over on Tuesday next, Dec. 17. To celebrate the official opening of the premises the directors have invited a number of friends to inspect the premises on that day. The inspection will be held on Tuesday afternoon at 5 p.m., and at 8 p.m. a dinner, to be followed by a concert, will be held in the Holborn Restaurant.

Hastings.—The Electricity Committee have reported to the Town Council that they had recently had before them a report from the borough electrical engineer stating that in connection with a cable which is being laid to Castle Hill-road to supply current to a 10-h.p. motor it would be necessary, with a view of ensuring a constant supply of current to the premises, to erect two pillar disconnecting boxes, one at the bottom of the steps on the east side of Wellington-square, and the other near the tramway pole at York-buildings, at a cost of £40, and recommended that the work be carried out, and that the cost be charged to the loan of £4.000 for new mains, etc., sanctioned on April 19 last. The Council have adopted the recommendation.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to "Argyll Motors" further issue of 10,000 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 20,001 to 30,000; and Canadian General Electric Co.'s interim certificates (fully and partly paid) for 2.000,000dol. 7 per cent. cumulative preference stock in shares of 100dol. each. The committee have further been asked to allow the following securities to be quoted in the official list: "Argyll Motors" further issue of 14,458 ordinary shares of £1 each, fully paid, Nos. 335,543 to 350,000; and Shanghai Electric Construction Co.'s 32,000 shares of £10 each, fully paid, Nos. 1 to 32,000.

Glasgow.—On the invitation of Prof. Archibald Barr and Prof. Andrew Grey, the members of the Glasgow Local Section of the Institution of Electrical Engineers visited Glasgow University on the 10th inst., and had the opportunity of inspecting the James Watt and the physical laboratories. There was a numerous attendance. Much interest was manifested in the equipment of both laboratories, the members of the institution being shown round and having the working of the machinery and apparatus explained to them by lecturers at the university. At the close a hearty vote of thanks was accorded to Prof. Barr, Prof. Grey, and the lecturers.

Hanley.—At the last meeting of the Town Council, the report of the Electric Lighting Committee stated that during September 106,586 units were sold, against 84.863 in September, 1906. The coal consumption per unit was 8·83lb., against 9·95lb. a year ago, and the works cost ·767d. compared with 1·026d. per unit sold. The committee had received a letter from the Local Government Board referring to the Council's application for sanction to borrow £18,000 for purposes of electric lighting. The letter stated that, before deciding upon this application, the Board would direct a local inquiry to be held on the subject by one of their inspectors. The inquiry would take place as soon as the other engagements of the inspectors would permit, and due notice of it would be given.

Clydebank.—The Clyde Valley Electrical Power Co. have made a proposal to the Clydebank Town Council to transfer the burgh electric lighting order to the Strathclyde Electric Lighting Co., the Clyde Valley Co. still remaining liable for the obligations contained in the agreement of 1903. They asked the consent of the Town Council to the transfer, but that body resolved at their monthly meeting to delay the matter till the Finance Committee had had an opportunity of perusing the provisions of the Strathclyde order and an agreement had been come to regarding the manner in which streets and pavement are to be opened up and restored; further, that the company should undertake to relieve the Town Council of any expense incurred by them in protecting their interests in the matter.

Electrobus Headlight.—Thirty electrobuses, of a new type and brilliantly illuminated, are to be put on the London streets in a few days. The outside passengers of omnibuses at nightfall have hitherto been in darkness. This is to be remedied by the new vehicles. The London Electrobus Co. have invented a new light, the glow from which is sufficiently powerful to suit a dozen or more requirements. It is a searchlight, a reading lamp, and, on a foggy night, will act as a beacon, stronger than the electric standards on the roadways. This lamp consists of an adjustable standard surmounted by a patent reflector, in which are encased three 16-c.p. lights of 80 volts capacity. The current is taken direct from the accumulators which supply the motive power for the propulsion of the vehicle.

Tonbridge.—The Electricity Committee report that since the last report applications for connections have been received equal to 63 8-c.p. lamps. The total connections to date are as follows: lighting, 6,629; power and heat, 1,729; public lighting, 542—total, 8,900. The committee have gone into the question of extending the Council's business with regard to outside lighting, and have recommended that the price of current supplied for the purpose of lighting the outside of shops after Jan. 1 next be 3d. per unit, and that tradesmen in the town be canvassed in this connection at once. They have also recommended that the engineer be instructed to prepare plans, specification, and estimates, with a view to an application for the sanction of the necessary loan for the extension to the plant, and this has been agreed to by the Council.

Colchester.—At the last meeting of the Electricity Supply Committee it was resolved that permission be given to Mr. W. Frisby, the assistant engineer, to conduct the evening class in electric lighting and power at the Albert School of Science and Art. It was further resolved that the Tramways Committee have their attention called to the engineer's report relating to the quantity of current supplied for tramway purposes, and informed that, as this department's meters are regularly examined, cleaned, and calibrated, the committee is of opinion that their readings of such meters are correctly registered. The engineer's report contained the following particulars: Output of electricity in units during October, 1907—lighting, 95,502, against 78,943 in 1906 and 75,248 in 1905; traction, 42,288, against 41,887 in 1906 and 32,719 in 1905.

St. Annes.—At the Electricity and Lighting Committee's meeting the electrical engineer reported that 69,527 units were sold during October, and the total number of consumers were 616. He had in hand applications from nine consumers for the equivalent of 235 8-c.p. lamps. The work of the department has been progressing satisfactorily. He recommended the committee to connect the mains foreman's house to the National Telephone exchange in order that he may be more easily communicated with in the evening should his services be required. The committee resolved to purchase two miles of main cable from W. T. Glover and Co. at the same rate and under the terms of their present contract, also that the mains foreman's house be put into telephonic communication on the National Telephone Co.'s system, as recommended by the electrical engineer.

Wednesbury.—A letter has been received by the Council from the Local Government Board stating that they will defer dealing with the application of the Town Council for sanction to borrow a further sum of money for the purpose of their electricity undertaking, including the construction and equipment of a generating station, until the Town Council have considered a letter from the Board of Trade to the Local Government Board. In this letter the Board of Trade incline to the view that, before proceeding with their application, it would be desirable for the Corporation to make representations to the Board of Trade for the revocation of the order obtained by the Midland Electric Corporation for Power Distribution, so far as it relates to Wednesbury. The General Purposes Committee will submit a recommendation that representations be made accordingly to the Board of Trade.

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Hazel Grove-cum-Bramall.—At the Council meeting a letter was submitted from the secretary of the General Post Office applying for the consent of the Council for the placing of an overhead telegraph line along Jackson's-lane in accordance with the plan submitted, and it was resolved that the necessary consent be given subject to the posts being placed in the fence or as near thereto as possible. The clerk reported that as previously requested he had been in communication with the National Telephone Co. with regard to the establishment of a call office at Bramall, and that the company's representative had stated that a public call office would be established at an early date. He also reported the conditions upon which the company would be willing to put down a private line between Bramall and the Stockport fire station, and also particulars of the subscription if the Council become subscribers to the exchange and had a telephone instrument at Bramall.

Penybont.—The Penybont District Council, representing the rural parishes in the neighbourhood of Bridgend, considered on Saturday the draft provisional order to be applied for by the Bridgend Urban Council, which will enable them to take over the local undertaking of the South Wales Power Co., and to supply electricity in three parishes in the Penybont Council's area. The Rev. H. Eynon Lewis said the Bridgend Council wanted to have powers to supply the remunerative portion of the parishes—the county asylums—while there was nothing in the order to compel them to carry out a scheme for lighting the entire parishes. Mr. Davies (Llangynwyd Middle) said the parish which he represented desired that the Bridgend Council should supply energy to their parish. The chairman, Mr. D. H. Price, doubted whether any other parishes could be added now. After further discussion the matter was referred to a committee, which was empowered to meet the Bridgend Council for the discussion of terms.

Clacton.—At the last meeting of the Urban District Council, the Electricity Committee reported having had under consideration the question of putting down additional plant at the works in order to cope with the increased load which it is expected the station will have to bear next summer. They recommended that the committee be empowered to make inquiries as to engaging an engineer for advising them as to the plant to be put in, etc. In connection with the new generating station, the committee reported having had a statement of the expenditure on the works prepared, so that a comparison of the cost of the scheme as carried out might be made with the engineer's original estimate of the cost of a steam generating station, this information being required by the Local Government Board. The totals were: estimated expenditure, £15,225 ; actual expenditure, £13,598. 13s. 9d. ; balance, £1,626. 6s. 3d. During the discussion it was suggested that their own electrical engineer was quite capable of putting down a suction plant and doing what was necessary without calling in an expert. The clause relating to the calling in of an expert was, therefore, struck out and the report adopted.

Morley.—The Lighting Committee's last report contained a statement by the borough electrical engineer that the output from the electricity works for the month of October was 22,223 units, as compared with 18,626 units the same period of last year, being an increase of 3,597. There were sold to consumers by meter 16,805 units, against 13,420 units the same month last year, being an increase of 3 385 units. There were now 31 motors connected, with an aggregate of 103 h.p. It was resolved that the contract with Messrs. Bedford and Co. for the supply of coal be renewed to the end of March, 1908 ; that a joint meeting of the Electric Lighting Committee and General Purposes Committee be held to decide the payment to be made for steam supplied to the baths ; that the wages of the engineer and officials at the electric lighting station be advanced as follows as from Jan. 1 next: W. L. Browne, assistant, from £1. 17s. 6d. to £2 per week ; Thos. Bates, engineer in charge, from £1. 10s. to £1. 12s. 6d.; H. C. Crisp, engineer in charge, from £1 to £1. 2s. 6d. ; Alfred Richmond, engineer in charge, from 10s. to 15s. ; Charles Sadler, jointer, from £1. 2s. to £1. 4s.; A. E. Binks, clerk, from 8s. to 10s.; that the sample arc lamp submitted by the Oliver Arc Lamp Co. be purchased at a cost of £11, and fixed at the junction of Queen-street and Albion-street ; and that a stock of cable be purchased at a cost not exceeding £30. The report has been adopted by the Council.

PROVISIONAL PATENTS, 1907.

DEC. 2.

26546. Improvements in telemeters. Otto Eppenstein, Jena, Germany.

26551. Full-way swing joint for electric light fittings, also for conduit or any other electrical wiring purposes. Edward Phillips, 109, Westminster-road, Handsworth, Birmingham.

26607. Improvements in and connected with direct-current electrical machinery. Felten und Guilleaume-Lahmeyerwerke Act.-Ges., 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Dec. 6, 1906, being date of application in Germany.) (Complete specification.)

26612. Improvements in methods of and devices for protecting electrical systems and apparatus. Elmer Ellsworth Farmer Creighton, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Feb. 23, 1907, being date of application in United States.) (Complete specification.)

26643. Improvements in and relating to electric systems of railway signalling. Henry Leitner, 4, South-street, Finsbury, London.

26647. Improvements in electric alarm clocks. Frederick Herbert Palmer, 4, South-street, Finsbury, London. (Complete specification.)

DEC. 3.

26656. Improvements in or relating to sight-feed lubricators and other articles in which screw-regulated valves are employed. The Electric and Ordnance Accessories Company, Limited, and Robert Frederick Hall, 24, Temple-row, Birmingham.

26661. Portable electric egg-testing lamp. Henry Langham, Guernsey Cottage, Rye Park, Hoddesdon, Herts.

26673. Improved system of telegraphing or telephoning to or from a railway vehicle. John Hodge, Vine Cottage, Tywardreath, near Par Station, Cornwall.

26721. Improvements in coils for telephony and other electrical purposes. John Alexander Romer, 1A, Waveney-villas, Lausanne-road, Peckham, London.

26730. Improvements in and relating to the manufacture of composition suitable for electric insulating and other purposes. Frederick Walton, 7, Southampton-buildings, London.

26762. Transforming machine for operating arc lamps and incandescent lamps circuits of low voltage. Walter Schäffer, 18, Lindenstrasse, Berlin, Germany. (Date applied for under Patents Act, 1901, Dec. 3, 1906, being date of application in Germany.) (Complete specification.)

DEC. 4.

26779. Improvements in measuring and consuming devices for gas, electricity, and the like. Chamberlain and Hookham, Limited, and Sydney Holmwood Holden, 4, New Bartholomew-street, Birmingham.

26787. Improvements connected with the covering of wires, strips, ribbons, plates, and the like with metal. British Insulated and Helsby Cables, Limited, and George Hinde Nisbett, 15, Water-street, Liverpool.

26797. Improvements in or relating to starting switch sets or arrangements for polyphase motors. Siemens Bros. Dynamo Works, Limited, and Robert Alexander Raveau Bolton, 139, Queen Victoria-street, London. (Complete specification.)

26801. Combined electric and magnetic curative device. Joseph Willig, 60, Doughty-street, London.

26829. Process for the electrolytical refining of copper. Josef Awalow, 7, Southampton-buildings, London.

26834. Improvements in apparatus for producing high-frequency electric discharges. Herbert John Haddan, 31, Bedford-street, Strand, London. (Synchronous Static Company, United States.) (Complete specification.)

26838. Improvements in the manufacture of electric glow-lamp filaments from metals and metallic oxides having high fusing points. Heinrich Paul Rudolf Ludwig Pörscke, known as Rudolf Pörscke, 31, Bedford-street, Strand, London. (Complete specification.)

24839. Improved process of manufacturing filaments for electric glow lamps from metals and metallic oxides having high fusing points. Heinrich Paul Rudolf Ludwig Pörscke, known as Rudolf Pörscke, 31, Bedford-street, Strand, London. (Complete specification.)

26840. Improvements in the manufacture of glow-lamp filaments and in the method of cementing the same to leading-in wires. Heinrich Paul Rudolf Ludwig Pörscke, known as Rudolf Pörscke, 31, Bedford-street, Strand, London. (Complete specification.)

26841. Improved process of manufacturing filaments of non-fusible metals. Heinrich Paul Rudolf Ludwig Pörscke, known as Rudolf Pörscke, 31, Bedford-street, Strand, London. (Complete specification.)

26844. Improvements in or relating to electric sparking devices and the like. Georg Bartels and Land-und Seekabelwerke Akt.-Ges., 18, Southampton-buildings, London. (Complete specification.)

26846. Improvements in and relating to arc lamps. Allgemeine Elektricitäts-Gesellschaft, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Dec. 5, 1906, being date of application in Germany.) (Complete specification.)

26848. Improvements in and relating to electric heating devices. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

DEC. 5.

26888. Improvements in electric clocks. Frank Hope-Jones, 32, Clerkenwell-road, London.

26911. Improvements in or connected with commutating dynamo-electric machines. Valere Alfred Fynn, 70, Chancery-lane, London.

26920. Improvement in electrical locking apparatus for railway signals. Siemens Bros. and Co., Limited, Queen Anne's-chambers, Broadway, Westminster. (Siemens und Halske Act.-Ges., Germany.) (Complete specification.)

26923. Improvements in and relating to trolley heads for overhead tramway systems. William Frederick Barnard Brown, 322, High Holborn, London. (Garnet Bowden Holmes and William Dunscombe Allen, New Zealand.)

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26925. Method of ensuring insulation of the current-conducting parts of high-tension magneto-electric sparking apparatus. Gustav Adolf Unterberg and Fredrich Helmle, trading as Unterberg and Helmle, 322, High Holborn, London. (Complete specification.)

26931. Improvements in the production of records of sound waves and apparatus therefor. Sherard Osborn Cowper Coles, 4, South-street, Finsbury.

26934. Improvements in electric accumulators or storage batteries. Sidney Arthur Ingrey and Robert Davy Bowman, 22, Southampton-buildings, London.

26937. Improvements in coin-operated apparatus for controlling the supply of electricity. Evan Evans, 31, Bedford-street, Strand, London. (Complete specification.)

26938. Improvements in electrical signalling systems for railways. Harry Lemuel Rider, 31, Bedford-street, Strand, London. (Complete specificatiou.)

26940. Improvements in alloys useful as electric resistance conductors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Dec. 27.)

1906.

19737. Signalling systems for railways and the like, and apparatus therefor. British Thomson-Houston Company. (Kintner.)

21873. Alternating-current dynamo-electric machines. British Thomson-Houston Company. (General Electric Company.)

24179. Electric incandescent lamps. Le Tall. (Lederer.)

24448A. Control of electric motors. British Thomson-Houston Company. (General Electric Company.) (Date applied for under Rule 5, Patent Rules, 1905, Nov. 1, 1906.)

26212A. Anodes for electro-deposition. Cowper-Coles. (Post-dated, June 19, 1907.)

26212B. Anodes for electro-deposition. Cowper-Coles. (Post-dated, June 19, 1907.)

26212C. Anodes for electro-deposition. Cowper-Coles. Post-dated, June 19, 1907.)

27204. Electromagnetically operated device for circuit closing, indicating, transmitting power, and other purposes. Anders and Thomson.

27211. Systems of electric train lighting. Leitner.

27318A. Apparatus for electrically firing mines or the like. Schaffler and Weiss. (Date applied for under Rule 5, Patents Rules, 1905, Nov. 30, 1906.)

27318B. Apparatus for electrically firing mines or the like. Schaffler and Weiss. (Date applied for under Rule 5, Patents Rules, 1905, Nov. 30, 1906.)

27593. Electrical communication between guard and driver, warning them of the opening of doors whilst in transit. Crepin.

27725. Double-carbon electric arc lamp having inclined carbon-holders. Brockie.

27740. Electrolytic refining of copper. Cowper-Coles.

28112. Switch-controlling mechanism for electrical installations. British Thomson-Houston Company and Woodbridge.

28187. Electric junction boxes for telephone systems. Schörg and Löhner. (Date applied for under International Convention, Dec. 11, 1905.)

28189. Apparatus for cooling dynamo-electric machines. Bidwell.

1907.

156. Protective devices for electric transmission systems. British Thomson-Houston Company. (Allgemeine Elektricitäts-Ges.)

880. Dynamo-electric machines. Lincoln. (Date applied for under International Convention, Jan. 12, 1906.)

1854. Protective devices of the type known as lightning arresters. British Thomson-Houston Company. (General Electric Company.)

2759. Means for transmitting power to dynamo-electric machines carried by vehicles. Page. (United States Light and Heating Company.)

6118. Cooling and ventilation of rotary or other electrical apparatus. Westinghouse.

9177. Primary batteries. Lake. (Hite.)

13674. Electrolytic ship-bottom protector. Schoneberger and Frazier.

14753. Means for preventing inductive disturbances and for phase adjusting in telephone, telegraph, and other electric circuits. Scott. (Date applied for under International Convention, July 9, 1906.)

17973. Manufacture of electric incandescent-lamp filaments, consisting of difficulty fusible metals. Bloxam. (Siemens und Halske Akt.-Ges.)

18923. Electric incandescent lamps. Westinghouse Metal-Filament Lamp Company. (Date applied for under International Convention, Nov. 23, 1906.)

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £		Last price. £
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	½-⅝
—— Ord., 1,125 000	1	..	⅛-¼
Aron Electricity Meter, 6 p.c Cum. Pref. Shares, 1-125,000	1	..	⅛-¼
—— Ordinary, Nos. 1 125,000	1	..	5/32 9/32
British Aluminium Co., Ordinary, 2,001-40 000	5	..	3½-4½
—— 7 per cent. Cum. Pref., 1-40 000	5	..	4½-5
—— "A" 6 per cent. Cum. Pref., 1-20 000	5	..	4½ 4⅝
—— 4 per cent. Funding Certificates, 1-20 000	5	..	3⅝ 4½
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	100-102
—— 5½ per cent Loch Leven Deb. (Reg.). Red., 1-3,000	100	..	94-97
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6½-7
—— 6 per cent. Cum. Pref., 1-100 000	5	..	5⅝-6½
—— 4½ per cent. Mortgage Debentures	100	..	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	85 89
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375 000	3	..	¾-1⅛
—— 4 per cent. Mortgage Debenture Stock	100	..	55 65
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	0-½
—— Non. Cum., 6 per cent., Pref.	2	..	⅜-⅝
—— 4½ per cent 1st Debenture Stock	100	..	83-86
—— 4½ per cent. 2nd Debenture Stock	100	..	65-68
Callender's Cable, Debentures	100	..	105½-107½
—— Ordinary	5	..	9½ 10½
—— 5 per cent. Pref.	5	..	5⅜ 5⅝
Consolidated Electrical Co., Ordinary, 1-110,000	1	..	7/16-9/16
Crompton and Co.	3	..	1-1⅛
—— 5 per cent Debentures	100	..	96-99
Dick, Kerr and Co., Ordinary, 1 260 000	1	..	1⅛-1⅜
—— 6 per cent. Cum. Pref., 1-305 000	1	..	1-1⅛
—— 4½ per cent. Debenture Stock Red.	100	..	101 104
Edison and Swan United, "A" Shares, 1-49 261	3	..	⅝-1⅛
—— "A" Shares 01-017,139	5	..	1½-2½
—— 5 per cent. Debentures	100	..	87-90
—— 4 per cent. Deb. Stock, Red.	100	..	79-82
Electric Construction, Nos. 1 to 112 100	2	..	3/16-7/16
—— 7 per cent. Cumulative Pref.	2	..	⅝-1¼
—— 4 per cent. Perp. 1st Mort. Deb	100	..	59-64
Electrolytic Alkali Co., Ordinary, 1-202,218	1	..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock Red	100	..	—
General Electric Company (1900) 5 per cent. Cum. Pref.	10	..	8-8½
—— 4 per cent. 1st Mort. Deb. Stock	100	..	89-92
W. T. Henley's Telegraph Works, Ordinary	5	..	10½-11½
—— 4½ per cent. Preference	5	..	5- ½
—— 4½ per cent. Debentures	100	..	104-106 xd
India Rubber, Gutta Percha, and Telegraph Works	10	..	14½-15½
—— 4 per cent. Debentures	100	..	6-8
National Electric Construction Co., 1-170,000	1	..	13/16-15/16
Parker, Thos., Limited, Ordinary	10	..	10-10½
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5	..	—
Telegraph Construction and Maintenance	12	..	28½-30½
—— 5 per cent Bonds	100	..	100-105
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	..	8¼-9¼

Electric Lighting and Supply.—

Name.	Amount p-id. £		Last price. £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10.000	5	..	4½-5
Bournemouth and Poole, Ordinary	10	..	9½-10½
—— 4½ per cent. Cum Pref., 7 501-15 000	10	..	9¾-10
—— 6 per cent. Cum second Pref., 15 001-22,500	10	..	9⅞-10⅛
—— 4½ per cent. Debenture Stock, Red.	100	..	100-103
Bromley (Kent) Electric Light and Power Co	5	..	4⅝-5⅛
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	95-98
Brompton and Kensington, Ordinary	5	..	7-8
—— 7 per cent. Preference	5	..	7-8
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	..	6-6½
—— Nos. 80,000-100 000	5	..	5½-6½ xd
Cambridge Electric Supply Company £10 Ord.	8	..	12½-13½
Canadian General Electric Co., Common Shares	$100	..	101-105
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	..	96-99 xd
Charing Cross, West End, and City Electric Supply. Ord., 1-80,000	5	..	3¾-4⅛
—— 4½ per cent. Cum Pref., 1-80 000	5	..	3⅜-4⅛
—— 4 per cent. Debenture Stock, Red.	100	..	97-100
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	3¾-4¼
—— ditto (.905) 40,001-80.000	5	..	3¼-4¼
Chelsea Electricity Supply	5	..	3¼-4¼
—— 4½ per cent. Debentures	100	..	102-105
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000	..	—
City of London, Ordinary	10	..	9½-10½
—— 6 per cent. Cumulative Pref.	10	..	11-12
—— 5 per cent. Debenture Stock	100	..	122-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs (all pd.)	100	..	95-98
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1 630	£0	..	50-53
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100	..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5	..	3½-4½
—— 5 per cent. Preference, 1-50,000	5	..	4⅜-4⅞
County of London Elec. Supply, Ordinary	10	..	6½-7½
—— 6 per cent. Cum. Pref.	10	..	10-10⅝
—— 4½ per cent. Debentures Prov. Certs. All pd., Red.	100	..	105-108
—— 4½ per cent. 2nd Debentures Prov. Certs	100	..	94-97
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5	..	⅜-⅝
—— 6 per cent. Cum. Pref.	5	..	1-1½
—— 4½ per cent. First Mort. Deb.	100	..	75-80
Electrical Development Co. of Ontario. 5 per cent. 1st Mort. 30-year Gold Bonds, 10 751-15 750	—	..	74-77 p.c.
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5	..	2½-2¾
—— 5 per cent Debenture Stock, Red	100	..	85½-89½
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red	100	..	94-96
Folkestone Electric Supply, Ord., Nos. 1-10 000	5	..	4½-5
—— 5 per cent. Cum. Pref., Nos. 1-10 000	5	..	4⅞-5⅛
—— 4½ per cent. First Deb. Stock, Red.	100	..	96-99
Hove Electric Lighting, Ord., 1-13 000	5	..	6⅜-6¾
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red	100	..	101-104
Isle of Wight Elec. Lt. and Pr., 4½ p.c. Db. Stk., Red	100	..	92-95
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref. 1-150,000	1	..	1/16 3/16
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000	5	..	8-9
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100	..	98-102
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9⅞-10½

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Name.	Amount paid. £	Last price. £
London Electric, Ordinary	5 ..	1¼-1⅜
—— 6 per cent. Pref.	5 ..	4-4½
—— 4 per cent 1st Mortgage Debenture Stock, Red.	100 ..	89-93
Madras Electric Supply Corporation 5 per cent. Construction Deb. stock, Red (Prov. certs), all paid	100 ..	92-95
Metropolitan Ordinary, 100,001-00,000	5 ..	5½-5¾
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	102 06
—— 4½ per cent. Cum. Pref.	5 ..	4½ 5
—— 5½ per cent. Mortgage Debenture, Red.	100 ..	97 98
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds 1935, C 1-1,000 ($100), D 1-3,000 ($500), M 1-4,400 ($1,000)	— ..	76-78 p.c.
Mexican Light and Power Co., Capital stock	$100 ..	41 43
—— 5 per cent 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14 000 ($1,000)	— ..	83-85
Midland Electric Power Dis., 4½ p.c 1st Mort. Deb.	— ..	96½ 9⅛
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009	5 ..	6½-6⅝
—— do., 57,010-75,000	5 ..	6½-6⅝
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid)	5 ..	6½-6⅝
—— 5 per cent., Pref., 1-57,009	5 ..	5-5⅛
—— do., 75,001-87,500 (issued at 10s. prem., 4s paid)	5 ..	5-5⅛
Notting Hill Electric Lighting	10 ..	10½ 11½
—— 4 per cent. First Mort. Debs. Nos. 1 500 (Reg.)	100 ..	95-97
Oxford Electric, Ordinary, 1-96 and 40-14,310	5 ..	5⅛ 6
—— 4 per cent. Debenture Stock	100 ..	96-97
River Plate Electricity Co, Ord., 1-119 687 & 120,501-120 507	1 ..	9/16-11 16
—— 6 per cent. Non-Cum. Pref., 1-100,000	1 ..	⅞-1
—— 5 per cent. Debenture Stock, Red	100 ..	95 98
Rosario Electric Co., 6 per cent Cum Pref., 1-20 000	5 ..	4⅜ 5⅛
—— 6 per cent. Cum 2nd Pref., 1-15 000	5 ..	4⅞ 5⅛
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	96 98
Shawinigan Water and Power Co, 5 p.c. Cons 1st Mt. Bds.	— ..	98-100 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5 ..	⅛ 1½
—— 4 per cent. Debenture Stock	100 ..	71-75
South London Ordinary	5 ..	2⅜-2⅝
South Metropolitan Electric Light and Power, Ord.	1 ..	⅛-⅜
—— 7 per cent Cum Pref.	1 ..	15/16-1 1/16
—— 4½ per cent. 1st Mort. Deb.	100 ..	99 102
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	7½ 8¼
—— 7 per cent. Pref.	5 ..	6-7
—— 3½ per cent. Deb.	100 ..	87-92
Urban Electric Supply Co., Ordinary, 8-30,007	5 ..	1⅜ 2⅛
—— 5 per cent. Cumulative Preference, 50 001-80,000	5 ..	1⅝-2⅝
Westminster, Ordinary	5 ..	7½-8½
—— 4½ per cent. Cum. Pref., 110,101-135,251	5 ..	4⅜-4⅝

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine, 6 per cent. Cum Pref., 1-260 007	5	..5 13 16-6 1/16
—— 10 per cent. Non-Cum 2nd Pref., 2-0,008-280,037	5 ..	7½-8
—— Permanent 6 per cent Debenture stock, 1888	100 ..	123-131
Auckland Elec Trams., 5 p.c. 1s Mor. Deb. Stk, Red.	100 ..	102 105
Barcelona Tramways, Ord., 1-20 000	10 ..	—
—— 5 per cent. Cum. Pref shares, 1 10 000	10 ..	—
—— 5 per cent Deb., Red., 1-600	100 ..	—
—— 4½ per cent. Red. Deb Stock	100 ..	—
Bath Elec Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1 ..	11/16 13/16
—— 5 per cent. Cum. Pref. Shares, 1-75 000	1 ..	1316/-15/16
Birmingham and Midland Trams., 4½ p. c 1st Db. Stk, Red.	100 ..	9--95
Blackpool and Fleetwood Tramroad	10 ..	13⅜ 1 ⅜
Bombay Elec. Supply and Trams Co, 6 per cent. Cum. Pref.	8 ..	7⅛-7⅜
—— 4½ per cent. Deb. Stock, Red.	100 ..	93-96
Brisbane Tramway Invest., Ord., 1-75,000	5 ..	3 1/16 3 5/16
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4⅜ 4⅝
—— 4½ per cent. Deb. Stk, Red., Prov. Certs. all pd.	100 ..	96-100
British Columbia Electric Railway Co., Ord Def.	100 ..	123-128 xd
—— Ord. Pref.	100 ..	104 109 xd
—— 5 per cent. Cum. Perpetual Pref. Stock	100 ..	99 103
—— 4½ per cent. 1st Mt. Debs., Nos. 1 6,250, of £40 each	40 ..	98-101
—— 4½ per cent. Vancouver Power Deb.	100 ..	100 103
British Electric Traction, Ord. 1-300 000 & 60 001-90 000	10 ..	1⅜ 2⅛
—— 6 per cent. Cm Pf., 30,0001-60 000	10 ..	4⅜ 5⅛
—— 5 per cent. Perpetual Debenture Stock	100 ..	91-94
—— 4½ per cent 2nd Deb. Stock	100 ..	70-75
Bueno Ayres and Belgrano Trams	5 ..	4⅜-4⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	4⅜-5⅛
—— "B" 6 per cent Cm. Pf., 1-27 500	5 ..	4⅜ 5⅛
—— 5 per cent. Deb. Stock, Red.	100 ..	105 115
—— Prov. Cert., all paid	100 ..	104 105
Buenos Ayres Electric Trams, 5 p.c Deb. Stk., Red.	100 ..	91-96
Buenos Ayres Gd Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100 ..	99-103
—— 6 per cent. Deb. Bonds, Red., 1-2,875	100 ..	98-103
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	91 94
Calcutta Tramways, Ord., Nos 1-137,610	5 ..	6⅜-6¾
—— 5 per cent. Cum. Pref., Nos. 1 30,000	5 ..	5 5⅛
—— 4½ per cent. 1st Deb. Stock. Red.	100 ..	101 105
Cape Electric Tramways, Nos. 1-480,000	1 ..	⅛-⅜
City of Birmingham Tramways, 5 per cent. Cum Pref.	5 ..	4¼-4¾
—— 4 per cent 1st Mortgage Deb., 1-3 000 (1917)	100 ..	96-99
City of Buenos Ayres Trams. Co. (1 04), 1-248,000	5	..4 15/16-5 1/16
—— 4 per cent. Deb. Stock, Red. 1985	100 ..	98-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	93-97
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	13-14
—— 6 per cent. Cum Pref.	10 ..	12⅞-13⅜
—— 4 per cent. Debentures	100 ..	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	12⅛-13⅛
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	12⅜-13⅜
—— 3½ per cent. Mort. Debs., 1-3,000 Red.	100 ..	90-95
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk, Red.	100 ..	97-100
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1,000 ..	82-87
Imperial Tramways, Ordinary	all ..	18-19
—— 6 per cent. Cum. Pref.	all ..	14-14½
—— 4½ per cent. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30 001-50,000	5 ..	⅛-1⅜
—— 4 per cent. 1st. Mt. Db Stock. Red.	100 ..	66-71
Kalgoorlie Electric Tramways, 1-250,000	1 ..	1/16-⅛
—— 5 per cent. "A" Deb. Stock	100 ..	89-93
—— 6 per cent "B" Deb. Stock	100 ..	74-78
Kidderminster and District Lighting and Traction, Pref.	5 ..	10-10½
Lancashire United Tramways, Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	94-97
—— £296 500 2nd Mort. Deb. Stock	— ..	—
—— £83,-30 Deferred Deb. Stock (all fully paid)	— ..	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1 ..	⅛-1⅛
—— 6 per cent. Cum. Pref., Nos 1-425,553	1 ..	⅛-1⅛
—— 5 per cent. Mort Deb., 1-5,000 Red.	100 ..	92-97
London United Trys. (1901), 5 per cent. Cum. Pref.	10 ..	7½-8¼
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100 ..	82-86
Madras Elec Trams. (1904) 5 per cent. Deb. Stk., Red.	100	96-99
Manila Elec. R.R. and Lightg. Corp., 5 p.c. 1st Lien and Coll Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-16,635	$1,000 ..	88-92
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-23,635 and 23,436 25 000	— ..	4½ 5
—— 4½ per cent 1st Mort. Deb Stock, Red.	100 ..	96-99
Metropolitan Elec Trams., Defd., 1 000 001-1 314 016	1 ..	1/16 3/16
—— 5 per cent. Cum Pref., 500,001 1,000 000	1 ..	13/16-15/16
—— 4½ per cent. Deb. Stock, Red.	100 ..	93-96
Mexico Trams. Co, Gen. Cons 1st Mort 50-year 5 per cent. Gold Bonds	— ..	80-82 p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con. Mort Bonds, 1926 1-5,500 and 7,001-8,000	$1,000 ..	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., £01-2,000 1922	100 ..	101-103
New General Traction, 6 per cent. Cum Pref., 1-10,000 and 34 001-74 000	5 ..	⅜-1⅛
Oldham, Ashton, and Hyde Tramway, Ordinary	10 ..	2
—— 5 per cent. Cum. Pref.	10 ..	8⅜-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100 ..	99-103
Potteries Electric Traction, Ordinary, 1-245.000	1 ..	5/16-9/16
—— 5 per cent Cum Pref., 300,001-545 000	1 ..	⅛-⅜
—— 4½ per cent Debenture Stock	100 ..	93-96
Provincial Tramways Co., Ordinary, 1-24 912	10 ..	4⅜-5⅛
—— 6 per cent. Cum. Pref., 1-10,000	10 ..	10¼-11¼
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum Pref., 1-20,000	5 ..	5-5⅛
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100 ..	97-99
Sao Paulo Tramway, Light, and Power Co.	$100 ..	110-115
—— 5 per cent. 1st Mort Deb., Red. 1929. 1-11,000	$500 ..	91-93 p.c. xd
South Metropolitan Electric Tramways and Lighting Co., 6 per cent Cum Pref., 19,571-169.570, Prov. Certs.	1 ..	⅞-1⅛
—— 4 per cent. Deb Stock, Red. 1 40	100 ..	80-84
Sunderland District Electric Tramways, 5 p.c 1st Mort. Debs, Red., 1-1 600	100 ..	84-88
Yorkshire (West Riding) Elec Tram Co. Ord., 70 001-110,000	5 ..	1-1⅛
—— 6 per cent Cum Pref., 1-46,261	5 ..	3⅛ 3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	86-89

Electric Railways.—

Name.	Amount paid £	Last price. £
Central London, Ordinary	100 ..	62-65
—— 4 per cent. Pref.	100 ..	83-86
—— " " deferred	100 ..	41-44
—— 4 p c Deb. Stock (Prov. Script Certs, fully paid)	100 ..	101-104
City and South London, Consolidated Ordinary	100 ..	43-45
—— 4 per cent Debenture Stock	100 ..	100-103
—— 5 per cent. Pref. Stock '91	100 ..	116-119
—— " " " '96	100 ..	113-116
—— " " " '01	100 ..	113 116
—— " " " '05	100 ..	108-111
Liverpool Overhead, 5 per cent. Pref	10 ..	10-10½
—— Ordinary, 1-50 000	10 ..	3⅜-4⅛
—— 4 per cent. Mortgage Debentures, Red., 1-1 700	— ..	94-96
Underground Electric Railways of London, 5 per cent. Profit-sharing Secured Notes	— ..	35-39 xd

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price. £
Amazon Telegraph Co., 1-25,000	10 ..	2½-3½
—— 5 per cent Debs., Red., within 1-1,069	100 ..	85-88
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28 000 and 53,001-78 000	$1 000 ..	88-90
Anglo-American Telegraph Co., Ordinary	100 ..	55-58
—— 6 per cent. Preferred Ordinary	100 ..	99-101
—— Deferred Ordinary	100 ..	14⅜-15⅛
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	99-102
Chili Telephone Co., 1-44 000	5 ..	6⅜-7⅛
Commercial Cable Co., Ster., 500-year 4 p.c. Deb. Stk., Red.	100 ..	82-86
Cuba Submarine Telegraph Co., Ordinary, 1-16 000	10 ..	6-7
—— 10 per cent Preference, 1-6 000	10 ..	15-16
Direct Spanish Telegraph Co., Ordinary	5 ..	3⅛-3⅜
—— 10 per cent Cum. Preference	5 ..	8⅛-8⅜
—— 4½ per cent. Debs., 1-600	50 ..	98-101
Direct United States Cable Co.	20 ..	13⅛-13⅜
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100 ..	100-102
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100 ..	98-101
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8 000, 1913	25 ..	98½-100½
Eastern Extension, Australasia and China, 1-300 000	10 ..	12⅜-12⅝
—— 4 per cent. Mort. Deb Stock. Perp.	100 ..	99-102
Eastern Telegraph Co., Ordinary Stock	100 ..	128-130
—— 3½ per cent. Preference Stock	100 ..	83-86
—— 4 per cent. Mortgage Debenture Stock	100 ..	98½-101
Great Northern Telegraph Co. (of Copenhagen)	10 ..	30½-32½
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs, within 1-1,200, Red.	100 ..	99-10[illegible]
Indo-European Telegraph Co.	25 ..	52-55
Marconi's Wireless Telegraph Co., Nos. 255,128-284,190	1 ..	11/16-13/16
Monte Video Telephone Co., Ordinary, 1-72,680	1 ..	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492	— ..	⅛-1
National Telephone, Preferred	100 ..	107½-109½
—— Deferred Stock	100 ..	106-108
—— 6 per cent. Cum. First Pref.	10 ..	10½-12½
—— 6 per cent Cum. Second Pref.	10 ..	10-12
—— 5 per cent. Non. Cum. Third Pref.	5 ..	5 3/16-5 7/16
—— 3½ per cent. Deb. Stock, Red.	100 ..	97-99
—— 4 per cent. Deb. Stock, Red.	100 ..	100-102
Oriental Telephone and Electric Company	1 ..	1 1/16-1 3/16
—— 6 per cent. Cum. Pref.	1 ..	1 1/16-1 3/16
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100 ..	97-100
United River Plate Tele. Co., Ordinary, 1-100,000	5 ..	6⅜-7⅛
—— 5 per cent. Cum. Pref., 1-40,000	5 ..	4⅜-5⅛
—— 5 per cent. Debenture Stock, Red.	100 ..	—
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100 ..	98-101
West African Telegraph Co.	10 ..	10-10½ xd
West Coast of America, 1-30,000 and 53 001-53,008	2½ ..	1⅛-1⅜
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100 ..	97 100
West India and Panama Telegraph Co., Ordinary	10 ..	13/32-17/32
—— 6 per cent. Cum. 1st Preference	10 ..	7-7½
—— 6 per cent. Cum 2nd Preference	10 ..	7-7½
—— 5 per cent. Debs., Red., 1-800	100 ..	98-102
Western Telegraph Co., 1-207,930	10 ..	12⅜-13½
—— 4 per cent. Debenture Stock, Red.	100 ..	98½-101

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week. Ending	1907.	1906.	Increase or decrease. Week.	Current year.	Miles of single track open. 1907.	1906.	Accounts for past year. Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	Cost per car mile.
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Dec. 4	1,249	—	- 17	— h	25½	25	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	Nov. 17	1,019	966	+ 53	- 176	8	8	,, 15	14,528	3,316,380	353,945	1	9·71	1,830	5·16
Baker Street and Waterloo Ry.	Dec. 7	2,875	2,075	+ 800	+ 19,355	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 8	984	977	+ 7	- 30	23·53	23·53	March 31	55,025	11,145,531	1,309,903	1 18	10·08	2,338b	6·03
Birmingham Corporation	,, 7	6,489	—	—	—	56½	—	,, 31	17,133	4,709,798	266,526	·86	14·5	8,866	—
Blackburn Corporation	,, 4	987	883	+ 103	+ 2,716	24	24	,, 25	48,875	8,661,720	986,953	1·35	11·89	2,036	7·44
Blackpool Corporation	,, 5	308	311	- 3	- 1,322	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	Oct. 26	311	279	+ 32	- 1,139	16½	16½	Dec. 31	31,846	2,325,677	579,264	3·28	13 19	—	7·27
Bolton Corporation	Dec. 8	2,116	1,977	+ 139	+ 4,988	42	40	March 31	95 766	20,205,196	2,161,130	1·13	10·63	2,39	6·14
Bournemouth Corporation	,, 4	1,320	1,226	+ 94	+ 1,179	17·41	16·82	,, 31	55,276	10,058,288	1,121,623	1·32	11·83	3,22	7·19
Bradford Corporation	,, 7	4,220	4,088	+ 132	+ 3,262	95	95	,, 31	230,085	47,108,000	5,053,382	1·172	10 927	2,396	—
Brighton Corporation	,, 8	685	718	- 33	- 3,050	9½	9½	,, 31	50,339	11,321,160	1,152,82	1·06	10·48	,914·8	8·014
Bristol Tramway Company	,, 6	4,617	4,541	+ 103	—	51½	51½	Dec. 31	259,799	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	,, 7	1,253	1,090	+ 163	—	40	40	March 31	57,992	11,092,704	1,197,772	1·31	11·61	5,388	8·17
Burton Corporation	,, 8	246	—	- 23	- 525	8½	8½	,, 31	17,950	3,878,269	454,082	1·07	9·21	2,06	6·76
Cardiff Corporation	—	—	—	—	—	32 62	†32·26	,, 31	112,209	24,134,363	2,770,049	1·12	9·72	3,782	9·44
Carlisle Tramways Company	,, 7	161	162	- 1	- 541	8·5	8·5	Dec. 31	10,713	2,935 002	359,756	—	7·14	—	5.18
Central London Railway	,, 7	6,005	6,749	- 743	- 18,355	6	6	,, 31	347,588	4,875,547	1,281,214	1·86	65·10	57,931	35·80
Charing X, Euston, & Hamp. Ry	,, 7	2,9 0	—	—	—	8	—	—	—	—	—	—	—	—	
City and South London Railway	,, 8	3,222	2 943	+ 279	+:0.017	6¼	6¼	,, 31	—	—	—	—	—	—	
Colchester Corporation	Nov. 6	193	194	- 1	-	8	8	March 31	10,588	2.457,653	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	Dec. 5	392	417	- 35	- 879	15½	15½	Dec 31	24,895	5,814,376	882,256	1 01	6·64	—	4·69
Croydon Corporation	,, 6	1,283	—	—	—	12 c	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 6	236	235	+ 1	- 33	7 23	7·23	March 3	—	—	—	—	—	—	
Dover Corporation	,, 7	170	178	- 8	- 1,122	4½	4½	,, 31	11,250	2,853,200	284,343	·94	9·49	2,500	
Dublin and Lucan Electric Ry.	,, 6	89	93	- 4	+ 222h	6¾	6¾	Dec 31	6,358	402,611	113,738	3 79	13·78	942	7·33
Dublin U.T.	,, 6	4,717	4,663	+ 55	+ 30 914	48½	48½	,, 31	267,489	50,050,949	7,077,372	1·18	9 07	691	5·56
Dundee City Tramways	,, 4	1,098	1,069	+ 29	+ 970	22	22	May 15	52,154	13 086 396	1,005 911	·906	11·96	2,180	7·42
East Ham Corporation	,, 7	839	771	+ 68	+ 24	14	14	March 31	56,652	3,689,658	863,816	·64	10·18	2,994	6 79
Glasgow Corporation	,, 7	16,858	16,298	+ 560	+13,3.8h	79½	79½	May 31	756,480	195,767,519	17,945,595	—	10·12		—
Gloucester Corporation	,, 4	223	226	- 3	—	15	15	March 31	15,465	3,902,077	563,595	·20	6·58	999	5·32
G.N., Piccadilly and Brompton	,, 7	5 000	—	—	—	9	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	37	37	,, 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 7	1,530	1,395	+ 135	+ 2,676	35	35	,, 31	69,938	12,838,150	1,665,262	1·24	9·71	1,923	—
Hull Corporation	,, 7	2 496	2,326	+ 169	+ 4,854	26	26	,, 31	112,651	27,10,,921	2,910,698	1	9·29		—
Ilford Corporation	—	—	—	—	—	10½	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 4	122	119	+ 3	+ 297	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	11,586	3,626,656	419,800	·737	6 62	1,480	5·22
Lancashire United Tramways	,, 4	1,047	1,027	+ 20	+ 13,906	39	38	—	—	—	—	—	—	—	—
Leeds Corporation	,, 7	6,213	5,957	+ 256	+ 9,633	89½	89½	March 25	298,233	64,223 666	7,121,038	1 10	10·02	351	—
Leicester Corporation	,, 7	2,044	2 041	+ 2	—	42	42	Dec. 31	26,011	12 039,252	1,229,507	1	9·79	—	4·82
Liverpool Corporation	Nov. 30	10,133	10,540	- 407	+ 7 664	104	104	,, 31	547.625	116,642 663	12,166 419	—	—	—	—
Liverpool Overhead Railway	Dec. 8	1,341	1,318	+ 23	+ 1,740h	6·65	6·65	June 30	81,302	11.171,865	1,024,275	—	—	—	—
London County Council	Nov. 30	29,644	25,956	+3,688	+182.645	98	98	—	—	—	—	—	—	—	—
Lowestoft Corporation	Dec. 7	160	149	+ 11	- 11	6	6	Sept. 30	14,511	3,128 867	359,435	1·08	9·68	630	6·48
Maidstone Corporation	—	—	—	—	—	2	2	Mareh 31	4,740	850 121	112,227	1·33	10 13	2,370	
Manchester Corporation	,, 7	14,192	13,122	+1,070	+ 36,674	149	149	,, 31	631,956	126,900,875	14,123,124	1·19	10 73	4,298	6·89
Metropolitan District Railway	,, 7	8,580	8,221	+ 359	+ 330	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 8	15,863	15,725	+ 138	+ 6,266	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 7	127	126	+ 1	- 23	2¾	2¾	,, 31	6,159	1,992,647	206,358	82	7·14	2,239	—
Newcastle-on-Tyne Corporation	,, 7	3,990	3,973	+ 17	+ 537	50	50	,, 31	197,849	43,063,934	4,326,152	1·07	10·98	3,957	7·0
Newport (Mon.) Corporation	,, 7	622	566	+ 55	+ 1,880	15½	15½	,, 31	30,356	7,252,535	783 435	—	9 29	—	6·4
Oldham Corporation	—	—	—	—	—	34	34	,, 25	65,553	13,466,245	1,504,740	1·16	10·45	1,886	—
Portsmouth Corporation	May 25	2,330	1 578	+ 752	+ 632	28½	28½	,, 31	95,702	19,625,329	197,499	1·17	11·63	—	—
Reading Corporation	Dec. 5	567	553	+ 9	- 788	33½	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	11·29	21·29	,, 31	14,881	2,837,110	386,547	1·24	9·24	1,102	7·92
Rotherham Corporation	—	—	—	—	—	9½	9½	,, 31	23,569	5,251,472	593,054	1·07	9·53	2,612	7·49
Salford Corporation	,, 9	4,397	4,183	+ 209	+ 4,491	70¾	70¾	,, 31	214,111	39,213,560	4,894,590	1·28	10·29	—	—
Scarborough Tramways Co.	—	—	—	—	—	4½	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 8	5,425	5,340	+ 85	+ 9,405	35¾	35¾	,, 25	240,565	63 952,283	,049,899	·903	9 543	3,653	5·94
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,365	9 294,771	1,108,369	1·27	11·02	—	7·83
Southend-on-Sea Corporation	,, 4	261	244	+ 17	- 36	9	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	,, 31	39,550	6,766,031	1,027,730	—	9 23	—	4·75
Sunderland Corporation	,, 8	1,112	1,266	- 144	- 1,134	20	20	,, 31	64,858	15,364.463	1,495,685	1·004	10·36	—	6 37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	4,937	1,315,757	102,751	0·87	11 53	1,37	—
Torquay Tramways	Dec. 6	177	—	—	—	5 16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 7	749	763	- 21	+ 685	12 68	12·43	,, 31	43,607	7,995,451	862,12	9·27	12·14	3,1	7·6
Warrington Corporation	—	—	—	—	—	9	9	,, 31	17,057	4,418 225	403 363	—	9·85	—	6·33
West Ham Corporation	,, 5	2,175	2, 25	+ 49	+ 1,513	14·7	14 7	,, 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	,, 4	807	769	+ 38	+ 193	20	20	,, 31	41,905	8,847,066	950,338	—	10·583	2,0	6·1o

† And 96 miles of interlacing track. a Train mile. b Per mile of single track. c Miles of route. h Half-year's figure k Double track

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NOTES.

Another Simplon Tunnel.—It is reported that the Council of States at a meeting at Berne last week agreed to the scheme, put forward by the management of the Federal Railways and endorsed by the Federal Council, for the construction of a second tunnel through the Simplon, and voted the sum asked for in connection with the scheme in the Federal railway estimates. The question, however, still has to come before the National Council.

Birmingham and District Electric Club.—The third annual meeting of this club was held at the Colonnade Hotel on Thursday evening, the 12th inst., when the following officers were elected for the forthcoming session: committee, Messrs. J. J. Inniss, J. A. Jeckell, R. G. Mercer, E. R. Phillips, G. A. Pope, R. Thompson, and V. E. Walters; president, Mr. E. C. R. Marks, A.M.I.C.E., M.I.Mech.E.; vice-presidents, Mr. R. Coles and Mr. H. Roberts; treasurer, Mr. E. A. Morgan; secretary, Mr. W. G. L. Riddle; assistant secretary, Mr. R. Thompson. The members decided at this meeting to again hold their monthly meetings on Saturday evening, time of meetings to be 7 p.m.

Electrical Industry in Germany.—The Berlin correspondent of the *Economist* reports that the stockholders' meeting of the Allgemeine Electricitäts-Gesellschaft last week brought out some interesting remarks upon the business situation in the electrical industry by Dr. Rathenau, the leading director of the company. Although this company has many contracts extending more than a year ahead, it was admitted that new orders are hardly coming in at all now, while other orders were fixed for shorter periods. The company's total turnover for the business year ended June 30 was given at £11,000,000, and during the first four months of the current year it was above £4,500,000. Orders were on hand at the beginning of November to the amount of £8,800,000, as against £6,950,000 at that date last year.

The Franco-British Exhibition.—At a meeting of the London Chamber of Commerce held last week Mr. Charles Carleton, chairman of the council (and a member of the executive committee of the exhibition), delivered an address on the Franco-British Exhibition of 1908. Mr. Carleton said one-half of the entire space would be occupied by French exhibits, which would be more extensive than that country had ever displayed in any exhibition outside Paris. The colonies of both countries would be largely represented, and our own Colonies were entering very heartily into the work. The amount to be spent by the Colonies would reach a total of £150,000, while the Indian Government had voted £15,000 and the city of Paris £12,000. After indicating the scope of the exhibition, Mr. Carleton made an appeal to the leaders of British industry to support it to the full, in order to bring up the British exhibits to the French level.

Street-Lighting.—The question of the public lighting in Oxford-street, one of the most important thoroughfares in London, has engaged the attention of the Works Committee of the St. Marylebone Borough Council, who have prepared an interesting tabulation showing the comparative costs of the St. Marylebone Borough Council lamps and the St. James's and Pall Mall Electric Light Company's lamps in the city of Westminster. The Borough Council have 35 double and 12 single arc lamps in Oxford-street. The total original cost of these lamps was £3,387, or £72. 1s. 3d. per lamp. The annual cost of maintenance is £1,675, or £20. 13s. 5d. per lamp. In the following tabulation the figures given in the first column are those for the St. Marylebone Borough Council, and in the second for the St. James's and Pall Mall Electric Light Company:

	£. s. d.	£. s. d.
Capital cost per standard	72 1 3	45 0 0
Capital cost per lamp...	41 6 1	—
Cost of illuminant per arc per ann.	20 13 5	17 0 0
Average c.p. of single arc lamps ...	1,600	1,018
Cost per c.p. per annum	3s. 1d.	4s.

The candle-power of the double arc lamps is more, but the exact figure cannot be ascertained. The Works Committee state that the readings from the double lamp observations are not satisfactory by reason of interference of the light rays from each of the two lamps.

Junior Institution of Engineers.—At a recent meeting of this institution, held at the Society of Arts, the chairman (Mr. Frank R. Durham) presiding, a paper entitled "Some Notes on Arc Lighting," by Mr. William Krause, was read and discussed. The author first compared the position of arc lighting of to-day with that of 10 years ago, the special features of the open and enclosed types being pointed out. The development of the former was apparent from the increase in the number of lamps for public lighting. By the year 1907, out of 428 stations giving returns, 280 reported public arc lighting with a total of 23,134 lamps. The open type was, however, now on the wane, and there were indications that it would eventually become quite obsolete. With reference to the enclosed type, the author touched upon the various systems of control, and considered that for internal lighting that lamp would maintain its position for some time to come. The inverted arc system of reflection gave excellent illuminating results, but its cost, which was about 40 per cent. greater than that of direct lighting, limited its application. Dealing with the composition of carbons, the different effects produced in the colour of the light by the introduction of various salts and metals were described, and consideration given to questions relating to the arrangement of the carbons. Comparisons of mean hemispherical candle-power of different types of lamps followed, after which some notes on flame arc lighting were given, and the paper concluded with a plea for the introduction of a two-colour light standard. In the discussion which ensued Messrs. A. W. Marshall, C. H. Smith, C. G. Evans, H. H. Hankin, H. E. Angold, B. Brooks, F. D. Napier, W. T. Hogg, A. H. Stanley, R. H. Parsons, and the chairman took part, and the proceedings closed with the usual vote of thanks.

New Electrical Issue.—Announcements appeared in the daily papers during the earlier part of the week relating to an electricity issue of debenture stock of considerable importance, which closed on Wednesday last. The County of Durham Electrical Power Distribution Company, Limited, offered to the public £250,000 5 per cent. first mortgage debenture stock at par of their undertaking, interest on which was guaranteed by the Newcastle-on-Tyne Electric Supply Company, Limited. The County of Durham Distribution Company was formed in 1899, and has a paid-up share capital of £500,000. It controls all the capital of the County of Durham Electric Power Supply Company, which was incorporated in 1900, and has a paid-up share capital of £144,800. The two concerns, of course, work together, and take all the electrical energy they want from the Newcastle-upon-Tyne Company. The area they are entitled to serve is 250 miles in extent, and includes important coalfields and manufacturing districts. The joint capital expenditure of the two companies to June 30 last was £493,300, and is represented by 161 miles of transmission and distributing cables and 30 transforming, converting, and distributing stations. The quantity of electrical horse-power supplied in 1905 was 7,600; this

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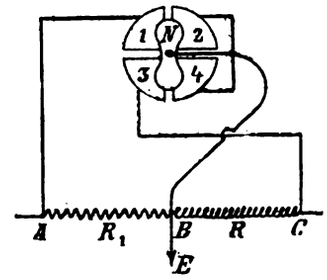
year it is put at 22,000. The profits earned by the Distribution Company in 1906, including the dividends received on its holding in the Power Company, were £19,700; they are calculated this year to amount to £25,000, and next year to £38,000. The Newcastle Company has, as it will be seen, a deep interest in the welfare and development of the two other Tyne electrical companies. The stock is secured practically on the resources of all the three companies, and as the Newcastle Company has paid 8 per cent. on its ordinary shares for nine years, and as the Distribution Company has paid 4 per cent. on its ordinary capital in 1902, 1903, 1905, and 1906, the debenture stock just offered would seem to be a good investment.

Languages by Correspondence.—Many of our readers have attempted to learn French and German, both of these languages being specially useful to electrical engineers. Some have succeeded, others have failed. It has depended on their teachers, the methods, and their own opportunities. Many who have never yet learnt at all would like to do so, but often have no time to go to classes, yet they feel the need of foreign languages, especially French, for without French no man nowadays is fully educated. How convenient for them it would be if some careful teacher were to analyse the various idioms of the language and the best method of teaching, scene by scene, giving the exact pronunciation, and then set it down in print, exactly as a good lesson would be given by a skilful and sympathetic teacher! In any spare time—in the train or 'bus, and more carefully at night—these lessons would be studied and read aloud and worked over, using the imagination to fill in the scenes as if in Paris—travelling, French home life, scenes in the country which give rise to idiom, or in town, engineering or commerce. This has been very fully done by our old collaborator, Mr. Howard Swan, in conjunction with his friend, Prof. Bétis, and is now being published in a series of booklets sent out weekly for the small fee of half-a-crown a month (or 27s. in advance). Prof. Swan has recently returned from an extended visit to Japan and China, where he has been engaged in organising the language teaching for the Japanese and Chinese Governments as adviser and professor in the Imperial colleges. He is, with M. Bétis, author of several well-known books on the "psychological method," in which the principles of psychology, visualising and memory of sounds are used to organise language teaching scientifically. His little "Colloquial French for Travellers" (Nutt) must have been used by many of our readers when going abroad. A copy of two interesting articles on "The Self-Study of Languages" can be obtained by sending an addressed envelope to the Swan-Bétis Self-Study Courses, at 1, Albemarle-street, Piccadilly, W.

Borough Polytechnic Institute. — Sir Edward Carson, K.C., M.P., who was supported by Sir Philip Magnus, M.P., presented on the 12th inst. to the students of the Borough Polytechnic Institute in the Borough-road the prizes and certificates gained by them during the past year, and in so doing paid a high tribute to the value of the educational work — commercial, industrial, and scientific—done by the institution presided over by Mr. Leonard Spicer, with Mr. C. T. Millis as principal and Miss Helen M. Smith as lady superintendent. During the year there have been nearly 3,000 individual students, of whom 330 were day students and the remainder evening students. In connection with the day work regard was had to the fact that one of the pressing educational problems was that of providing for the adequate preparation and training of young people for their future occupations, and much had been accomplished in this direction by the facilities offered in the institute. The evening class department continued to maintain its character of providing in well-equipped workshops and laboratories instruction for a large number of young workmen engaged in various trades. The total number of class entries for evening work amounted to nearly 4,000, while the number of student hours worked during the session was nearly 100,000. The evening work was partly tested by voluntary examinations, and with 911 papers worked at examinations held by the Board of Education, the City and Guilds of London Institute, the Society of Arts, and other examining bodies 581 successes were obtained—91 with honours, 321 in advanced subjects, and 169 in elementary work. An interesting feature of the instruction had been that in connection with fogs. The first course of lectures to stokers held under the auspices of the Coal Smoke Abatement Society was attended by 90 stokers, who had opportunities of visiting electric lighting stations and large factories to see improved methods of stoking, having for their object the economical burning of fuel and the consequent abatement of the smoke nuisance.

The Determination of Self-Induction Coefficients by Means of an Electrometer.—The method of determining inductances by connecting them in series with non-inductive resistances, and noting the voltage drop across each when a sinusoidal alternating current is passing, may be simplified into a single reading by employing an electrometer connected differentially, as shown in the diagram which appeared in *Elektrotechnik und Maschinenbau*. Quadrants 2 and 4 are connected together and to the needle, as well as to the junction point, B, of the inductive and non-inductive resistances, and to earth at E. The end of the resistance, A, is connected to quadrant 1, and that of the inductance, C, to



quadrant 3. When the potential difference between A and B is equal to that between B and C, two equal and opposite torques act on the needle, N, and it therefore rests in the zero position. This result is attained by adjusting R_1. Then R_1 and R (the ohmic resistance of the inductance) being known, as well as the frequency, n, the coefficient of self-induction, L, can be found from the expression, $L = \frac{1}{2\pi n}(R_1^2 - R^2)$. The sensitiveness of the instrument increases with the voltage between A and C, so that the method does not permit of great accuracy when dealing with low resistances. For determining the inductance of telegraphic coils, induction coils, etc., it is, however, very suitable. The current supply may be advantageously taken for a small 20 or 30 volt alternator.

Local Objections to Tramway Proposals.—Those who have given their attention to municipal affairs in the Metropolis must have noticed that the borough councils of the London County Council are frequently at loggerheads. The following are instances of these disagreements, which interest us because they refer to questions of electric tramway construction. The County Council propose to widen a certain bridge which is in the boroughs of Fulham and Chelsea, and have asked the local authorities

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to contribute a third of their cost, and to assent to the construction of a tramway. The Works Committee of the Fulham Council are unwilling, however, to accept the principle of a tramway as part of the bargain. In St. Pancras a similar proposal is being opposed by the Borough Council. Here the County Council propose to construct a new bridge across the Metropolitan Railway, King's Cross, 60ft. wide, for traffic between Gray's-inn-road and Caledonian-road, and a double line of tramway across such bridge; also a single line of tramway from the existing tramways in King's Cross-road along Swinton-street to connect with the tramways in Gray's-inn-road, and also to widen Southampton-road to provide for double lines of tramway along that thoroughfare in the place of the existing single and loop lines. The Borough Council have been asked to contribute towards the cost of these works, but, while they are prepared to give their statutory consent to the construction of the lines of tramways, they do not see their way to make any special contribution towards the cost of them. Their ground of objection is that the proposed works would benefit the whole of the Metropolis, and the Parliamentary Committee have recommended the Borough Council to formally dissent from the London County Council's proposals. No doubt the objections of the borough councils to necessary and important works of tramway construction will in due course be over-ridden or adjusted, but it would be a pity if this could only be done by incurring additional expense, or by delaying the passing of the proposals through Parliament. Some arrangement should surely be come to whereby the financial differences between the borough councils and the County Council could be automatically arranged, and the work permitted to progress without such local objections.

Physical Society.—There was a good display of electrical apparatus at the third annual exhibition held last week by the Physical Society. The exhibits covered a wide range, and were representative of some of the principal manufacturers of electrical instruments and apparatus. Messrs. Everett, Edgcumbe, and Co., Limited, showed a combined flicker and inclined screen photometer, suitable for all classes of work, independently of the colour of the lights measured. Amongst the advantages claimed for this instrument are: (1) the exceptionally long range, whereby both arc lamps and incandescent lamps can be measured with a comparatively small photometer room; (2) ease of adjustment, owing to the fact that neither of the lamps need be moved; (3) absence of angularity errors; (4) the fact that the instrument can be used either as a flicker photometer or as an inclined screen photometer, so that the maximum possible sensitiveness is obtained at all times. Among the other exhibits of the same firm was a frequency indicator, of the resonance pattern. A special feature of this instrument is the long range provided, and the fineness of its sub-division. The difference of frequency between one reed and the next can be made $\frac{1}{2}$ per cent. or less. Messrs. Evershed and Vignoles showed an interesting variety of their well-known "Megger" type instruments, as well as a portable combined ammeter and voltmeter for direct currents, provided with a series of shunts such that its readings cover all values from milliamperes to 1,000 amperes; and the voltmeter scale similarly extends by means of a switch from millivolts to 1,000 volts. Messrs. Nalder Bros. and Thompson, Limited, showed a number of portable testing sets, an automatic accumulator switch, and an indicating wattmeter. Mr. B. S. Cohen's barretter, designed for the measurement of alternating currents of small amplitude and high frequency (this instrument has already been described in these columns), was shown in use at the stall of Mr. Robert W. Paul. Messrs. Crompton and Co. showed a number of portable instruments, including a thermo-electric pyrometer for boiler testing. A "Century" mains testing set, shown by Messrs. Elliott Bros., was designed with a view to providing the mains superintendent with an instrument that will cover the whole range of testing that is likely to be met with in the laying and maintenance of underground cables. The exhibition was, on the whole, a most interesting one judged from the electrical, optical, and other physical apparatus which it brought together, and many of which were to be seen in use.

Tramways and Light Railways Association.—The December issue of the *Official Circular* of this association is of unusual interest, dealing as it does with the proceedings at the ordinary general meeting, and giving a copy of the Board of Trade revised memorandum concerning the construction and equipment of tramways and light railways on public roads (particulars of which appear elsewhere in this issue). The Hon. Arthur Stanley, chairman of the association, in moving the adoption of the report at the annual meeting, referred to several matters which have excited no little attention of late. One of these matters is the proposal to have one association to cover the whole of the tramway world, or a combination of associations where the interests of each are identical. Our readers will remember that this proposal had been before the various associations, but that it fell through earlier in the year. All hope of carrying such an idea into effect is not yet abandoned, however, for the Tramways and Light Railways Association propose to continue their endeavours to bring about some sort of combination. Mr. Stanley also referred to the brakes inquiry which is now being conducted. As was pointed out by Mr. Stephen Sellon in his speech at the annual dinner of the association, the committee now inquiring into the matter is one of the most important committees which have sat in connection with this business. The committee, he said, had been sitting for the past 11 months at the suggestion of the Board of Trade, to whom they were hoping within the next few weeks to present a report which, he believed, would be one of the most important treatises on the question of braking that had ever been issued. That committee had been industrious in its work, and it had received the assistance not only of a large number of companies, but also of a large number of municipalities. Mr. Stanley intimated that they had concluded negotiations with the Postmaster-General as to a standard clause which it has proposed should be included in all Tramway Bills. They had now got an arbitration on with the Post Office on the question of "fuses and heat coils" put up for the protection of the Government's wires. An arbitrator was shortly to be appointed by the Board of Trade. The association are to be congratulated on the work of their Income Tax Committee. They have impressed upon Somerset House that some recognition ought to be given to tramway companies of the wasting character of their assets, and that there ought to be some definite rule when income tax assessments are made in regard to allowance—a fixed allowance in respect to the decay or wastage that is going on.

Foreign Trade Returns.—In our issue of the previous week we drew attention to the evidence amassed by a contemporary on the condition of trade in Great Britain, and to the reports that business was beginning to be less brisk than for the last two years. If the circumstances mentioned by our contemporary be true in fact (and of this we can have little doubt in so far, at least, as the electrical industry is concerned), the signs are not discernible in the most recently issued figures of our foreign commerce. According

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to the Board of Trade returns for the month of November, the imports during that month reached a total of £57,145,000, an increase of 2·4 per cent. compared with November, 1906, while the exports totalled £35,862,176, an increase of 8·7 per cent. on those of the corresponding month of the previous year. On tracing the movements of electrical commodities, we find that during the month of November last the imports of electrical goods and apparatus aggregated £102,190, which, compared with November, 1906, showed a decrease of £11,974, or 1·4 per cent. For the 11 months of the present year the value of the imports of this class of goods is returned as £1,145,878, an increase of £53,182, or 4·8 per cent. The imports of wire (including telegraph and telephone wire) amounted to 4,394 tons, valued at £47,962, during the month ended Nov. 30, compared with 4,025 tons, valued at £42,061, during the corresponding month of 1906. The imports of wire during the first 11 months of 1907 and 1906 amounted respectively to 53,416 tons, valued at £576,486, and 53,012 tons, valued at £545,218. Electrical machinery was imported last month to the extent of 789 tons, valued at £56,704, compared with 431 tons, valued at £40,905, in November, 1906. The value of the 7,086 tons of electrical machinery imported during the 11 months of the year is returned as £558,876, compared with £529,228, the value of the 6,671 tons imported during the first 11 months of 1906. Turning now to exports, we find that under the heading of electrical and telegraph goods and apparatus there was a decrease during the past month (compared with last year) of £46,986, or 26·7 per cent., the total value of the exports of this class of goods during that period being £128,688; for the first 11 months of the year the value of the exports amounted to £2,360,251, an increase of £121,075, or 5 4 per cent. Both in quantity and value do the exports of wire (including telegraph and telephone wire) show favourable increases for last month, the quantity exported during November amounting to 4,872 tons, valued at £84,299, against 3,652 tons, valued at £64,799. The export of this commodity for the 11 months of the year has thus been brought to an aggregate of 50,619 tons, which bears a value of £911,944, compared with 40,189 tons, valued at £698,142 last year. Under the heading of electrical machinery we notice a decrease in the exports for last month as compared with those for November, 1906, the weight of such machinery exported last month being 1,052 tons, valued at £88,385, compared with 1,404 tons, valued at £89,055. The returns for the 11 months of the year are as follows: 1907, 12,193 tons, valued at £917,173; 1906, 10,737, valued at £759,225. The export of electrical goods (not including machinery, telegraph and telephone wire, returns for which are included in other items) of foreign and Colonial origin last month reached a value of £12,872 compared with £16,631 for November, 1906, thus bringing the total figures for 11 months up to £155,409 compared with £113,605 last year.

Electrical Manufacturers and the 1908 Exhibitions.—The second trade meeting in connection with the electrical exhibition to be held next year in Manchester was held on the 12th inst. at the Hotel Cecil, London. Sir William Preece presided over the gathering, which was well attended by representatives of the electrical trade and industry in the metropolitan district. At the outset Sir William Preece welcomed a deputation from Manchester, on whose behalf Councillor Kaye (deputy-chairman of the Manchester Corporation Electricity Committee) intimated that the exhibition would be strongly supported by the electrical industry in the large and important Manchester district. Councillor Kaye said the Manchester Corporation were supporting the exhibition because they appreciated the business advantages of such enterprises, and he pointed to the satisfactory results that had accrued from the holding of a gas exhibition in the same town some few weeks previous as justifying the holding of an electrical exhibition there. Sir Wm. Preece said that the name of Manchester was a sufficient guarantee for the success of the exhibition. The 1905 Olympia Exhibition had helped to improve the industry, and had been instrumental in contributing to the funds of the benevolent association connected with the industry. That exhibition had also helped to restore mutual relations between the members of the trade, and was a step towards co-operation, in which respect British electrical manufacturers were woefully behind other nations. The meeting thereupon elected Mr. G. J. Grainger (Sunbeam Lamp Company) and Mr. O. H. Bishop (Messrs. Edison and Swan) to the General Committee. At a meeting of the Electrical Manufacturers' Association held earlier in the day, Mr. H. Berry (Messrs. Berry, Skinner, and Co.), Mr. H. Nalder (Messrs. Nalder Bros. and Thompson), and Mr. H. Oppenheimer (International Electric Company) were elected to represent that body on the General Committee. At the end of the meeting Dr. Glazebrook and Mr. Cunliffe-Owen addressed some remarks on the Franco-British Exhibition. It was pointed out that the committee of the electrical section of this exhibition are desirous of obtaining support from electrical manufacturers interested in special or proprietary articles daily required by the public in connection with electrical installations. The possibilities of making a striking advertisement in conjunction with electric supply undertakings of London in a collective exhibition or demonstration of electricity is one which must appeal to many, and, although an exhibition of this description cannot be looked upon as an ordinary exhibition, yet it certainly affords a direct means of bring the makers' or suppliers' names of special apparatus before the public. Mr. Cunliffe-Owen mentioned at the meeting that he had been assured unofficially by several of the supply companies' officials that if he could make an application to them for support from a representative number of electrical manufacturing firms, the same would be forthcoming. It would seem to us that if electrical manufacturers expect any recompense for the heavy expense of supporting a six months' exhibition, it can only come about by their acting in co-operation with the supply companies. Such a combination should be able to make a really effective show, and to do much to counteract the the effect of a combined show which, we understand, the gas companies are having. It should be added that Mr. C. S. Northcote is organising manager to the committee of the electrical section of the Franco-British Exhibition as well as to the Manchester Exhibition Committee.

Publications Received. — "Superheat, Superheating, and their Control," by Mr. William H. Booth (London: Archibald Constable and Co., Limited, 10, Orange-street, Leicester-square, W.C. 6s. net.) In this book Mr. Booth indicates the principles of superheating, and shows several examples of types of superheaters on the market. The reader who searches the pages of this book for illustrations of the many superheaters on the market will meet with disappointment, since the author has avoided compiling a book of the catalogue type. On the other hand, he shows the application of the various types of apparatus. He explains that his personal prejudices are in favour of the fully water type, but he also recognises that this type must necessarily be more costly. The book is divided into 19 chapters, the chief of which deal with the generation and physical properties of steam, superheat and steam-turbines, the

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behaviour of engines with superheated steam, controllable superheaters, feed-water heating, etc. Some useful hints, definitions, and tables form the conclusion of an interesting work upon a most important subject.—"The 'Mechanical World' Electrical Pocket-Book for 1908" (Emmott and Co., Limited, 65, King-street, Manchester. 6d. net.) This little book is a companion of the "Pocket Diary" which we noted recently. It is specially intended for those in charge of electrical plant and machinery, and for power users and others interested in the industrial application of electric power. More particularly attention has been given to the mechanical side of electrical engineering, hence, while such matters as belt and rope driving, worm gear, raw-hide pinions, electric cranes, electric pumping, etc, are fully discussed, no attempt has been made to deal with telegraphy, telephony, or electric traction, nor with the refinements of dynamo design.—The November issue of the *Proceedings* of the American Institute of Electrical Engineers contains the following paper, "An Analysis of the Distribution Losses in a Large Central Station System," by W. L. Elden, together with reports of discussions on the following subjects: "High-Tension Transmission," "Power Factor, Alternating-Current Inductive Capacity, Chemical and other Tests of Rubber-Covered Wires," "Interaction of Synchronous Machines," "Fractional Pitch Windings for Induction Motors" and "Zigzag Leakage of Induction Motors," "Track-Circuit Signalling on Electrified Roads," "Regeneration of Power with Single-Phase Railway Motors," "Some Power Transmission Economics," "Single-Phase High-Tension Power Transmission," "Lightning Arresters." — The *Bulletin* of the Imperial Institute (vol. v., No. 3. Price 1s.) contains an interesting account of the use, occurrence, and production of manganese ores, and some reports of recent investigations concerning the product of rubber in various centres, among other useful contributions. "Lord Wantage, V.C., K.C.B.: a Memoir," by his wife (Smith, Elder, and Co., 15, Waterloo-place, S.W. Price, 10s. 6d. net). This sketch of the life of Lord Wantage was originally intended for private circulation, but, yielding to the opinion expressed by friends that it will appeal to a wider public, it is published by Lady Wantage in the hope that it may stimulate those of a younger generation to follow in the footsteps of one who looked upon life as a field of opportunities for the service of his country and his fellow-men.—"Practical Advertising" (Mather and Crowther, Limited). This is a handy guide prepared by practical men, and contains some useful articles of interest to advertisers, with a variety of types of illustrations for advertisements.—From the office of the *Street Railway Journal*, New York, we have received a "Dictionary of Electric Railway Material," in which is given brief descriptions of a very large percentage of the principal types of electric railway apparatus and supplies manufactured in the United States.

Volunteer Electrical Engineers.—The military authorities have not been slow to recognise the advantage to the country in its having among its auxiliary forces a highly and scientifically trained body of men, prepared to render service in the time of the country's need. Such a part as that which may be fulfilled in warfare—and, as the recent South African War proved, can be satisfactorily fulfilled—by the Electrical Engineers (R.E.) Volunteers renders them unique among all other volunteer regiments, and shows that they deserve the special attention which they had received from the War Office. Special interest has centred upon the question as to how the future of this corps would be affected by the new territorial army scheme. It was generally assumed from a speech made by Mr. R. B. Haldane, the War Minister, at the regimental dinner in 1906 that an important place in the new scheme would be assigned to the Electrical Engineers, and later events have proved the assumption to have been a correct one At the annual dinner of the London division which was held in the Café Monico on Saturday evening, and over which Lieut.-Colonel R. E. B. Crompton presided, reference was made in the after-dinner speeches to this matter. Lieut.-General W. H. Mackinnon, proposing "The Corps of Electrical Engineers," observed that there had been great difficulty in arranging for a special and technical corps like this in the new scheme, but the authorities hoped that a satisfactory result had been attained. They were going to have a far more important and useful part to play in the territorial army than ever they had had to play in the volunteer force. The principal factor in their case had hitherto been non-territorialisation. They had been more or less scattered, consequently had not quite fulfilled the requirements of a territorial army. In the future they would be grouped in different parts of the country—in their own counties, so far as administration was concerned. They would be trained, so far as could be seen at present, very much under the present system; there would have to be a certain amount of give and take. The committee of Electrical Engineers, the Army Council, the county associations, and the regiment would all have to lend a hand in pulling together and smoothing over any difficulties that might arise. One thing the authorities were anxious about was that, so far as possible, the recruits should be local—namely, enlisted on the spot where their services would be required. There could hardly be a higher development in the art of war than that which had relation to communications in the field, and that was where their duties would largely lie in the future. Lieut.-Colonel Crompton, responding, said last year the corps were fearful of their future. They had spent much time in perfecting a system of military education which they believed to be unique. He did not think the War Office appreciated the extent to which they had gone in training their ranks, from the commanding officer to the last recruit, so as to raise the average intelligence of every unit of the corps to the highest point. They hoped now to see their reward. They did not consider their duties ended with questions involving electrical engineering. It was possible they would be localised. They knew how to use local knowledge to the fullest advantage, but it was not desirable that the electrical engineer should stay at home all his life. He must be encouraged to go to the Colonies and work in other countries. How were they to satisfy the local conditions? By never losing sight of men they had once trained, and passing them into a reserve to be called upon, if necessary, for the defence of the country. There was a great future for electrical developments in respect of communications. We were only on the verge of signalling through the air. It was practically certain that in the wars of the future there would be no secrecy as to the whereabouts of the enemy or of their own units. In conclusion, Lieut.-Colonel Crompton referred sympathetically to the illness of the colonel-in-chief of the corps, Lord Kelvin. During the evening a presentation of a silver cigar-box was made to Captain W. Dumble, R.E., who has recently been appointed general manager of the London General Omnibus Company, and to Sergeant-Major Bufton, who was the recipient of a gramaphone on the occasion of his appointment as curator of the Birmingham Law Courts. There was a large company present at the dinner, included among which were Dr. Glazebrook, Sir Wm. Matthews, Prof. J. Perry, Mr. W. M. Mordey, and a distinguished gathering of military gentlemen. Needless to say, a most enjoyable evening was spent.

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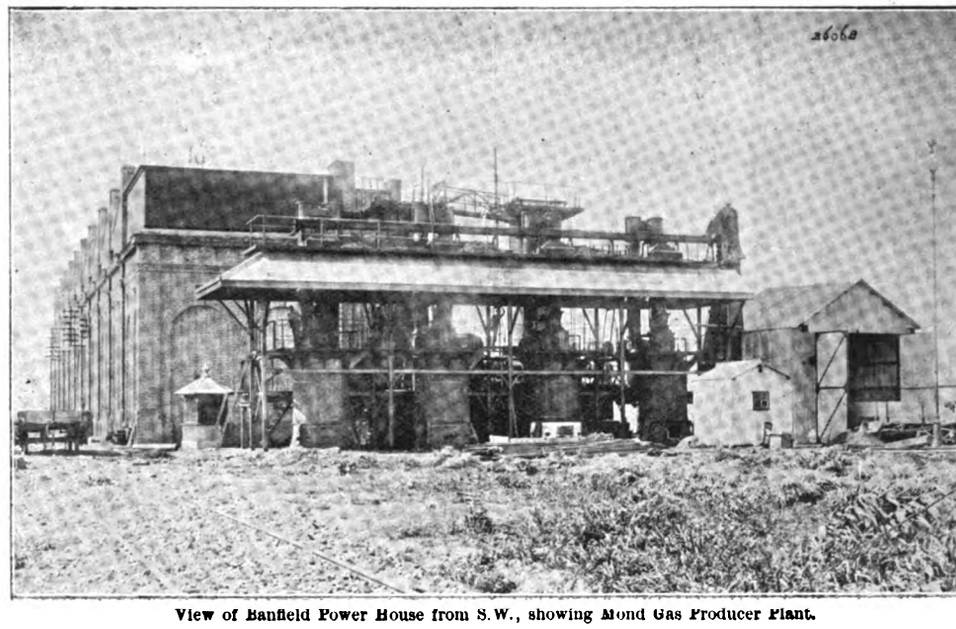
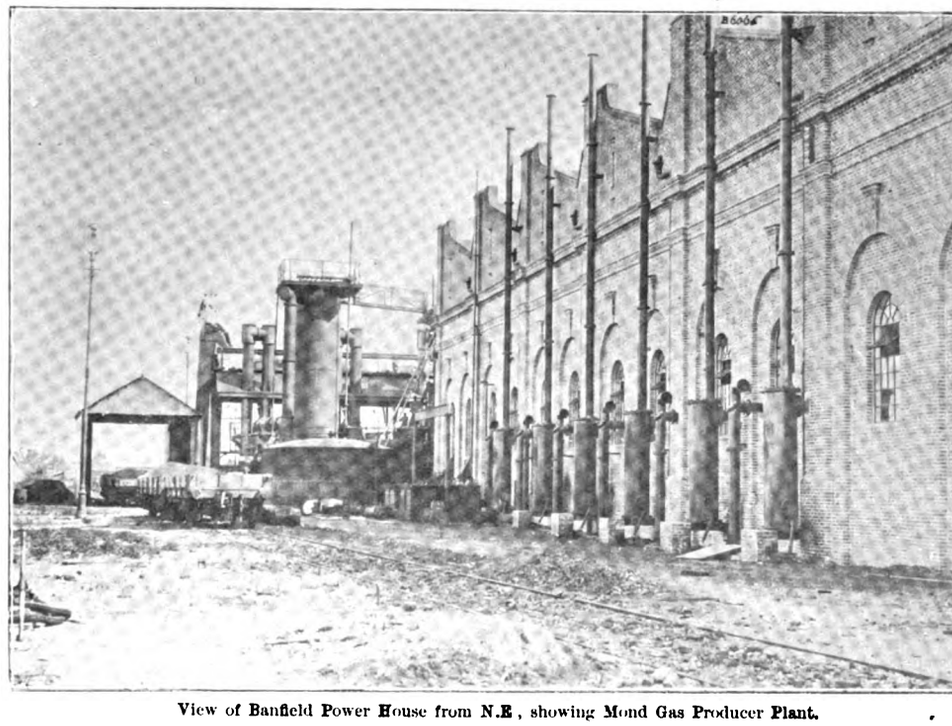
THE ELECTRICAL PLANT AT THE BANFIELD SHOPS OF THE BUENOS AYRES GREAT SOUTHERN RAILWAY COMPANY.

The Banfield workshops—for the equipment of which the British Westinghouse Company were the contractors—are situated on the main line of the Buenos Ayres and Great Southern Railway Company, Limited, 12 km. from Plaza Constitution terminal station in Buenos Ayres, and about 14 km. from the company's dock on the River Plate, known as "Dock Sud." The workshops are distributed over a considerable area, as is generally the case with large railways, and for this reason the engineers in charge of the construction recommended to the management of the company a central power station from which electrical energy could be distributed to the various shops and stores departments, with light and power for Dock Sud, and all the freight and passenger stations along the line, from Plaza Constitution to Burzaco, a distance of about 22 km. After thoroughly investigating the local conditions, and considering the high price of fuel in this country, it was decided by the engineers of the company to install Mond gas-producer plant, and Westinghouse vertical three-cylinder gas-engines direct coupled to Westinghouse three-phase 50-cycle generators.

The gas-producer plant, which is designed to supply gas continuously to 2,000-i.h.p. gas-engines by gasifying bituminous slack, is one of the most complete and compact of its kind. Coal is conveyed by rail to the plant, and is then dumped into the elevator boot. The elevator, which is of the bucket type, delivers it into a worm conveyor passing over and delivering into the 25cwt. coal bunkers, one of which is situated over each producer, and forms a storage of about six hours. From the bunker the coal passes through a chute down into the producer. The producers, of which there are four, are 5ft. internal diameter, each resting on a water lute, from which the ashes are drawn as found necessary without stopping the make of gas. Inside each producer is fixed a bell through which the coal passes, partly filling it, and automatically keeping the level of the fuel in the producer at the same point. The process of forming gas is briefly as follows. A steam-driven Roots air blower supplies air, and forces it through an air-heating tower, through which a stream of hot water is passing, and takes up a certain amount of heat and moisture. The air and steam are then conveyed along mains to the superheaters. The superheater consists of



View of Banfield Power House from S.W., showing Mond Gas Producer Plant.



View of Banfield Power House from N.E, showing Mond Gas Producer Plant.

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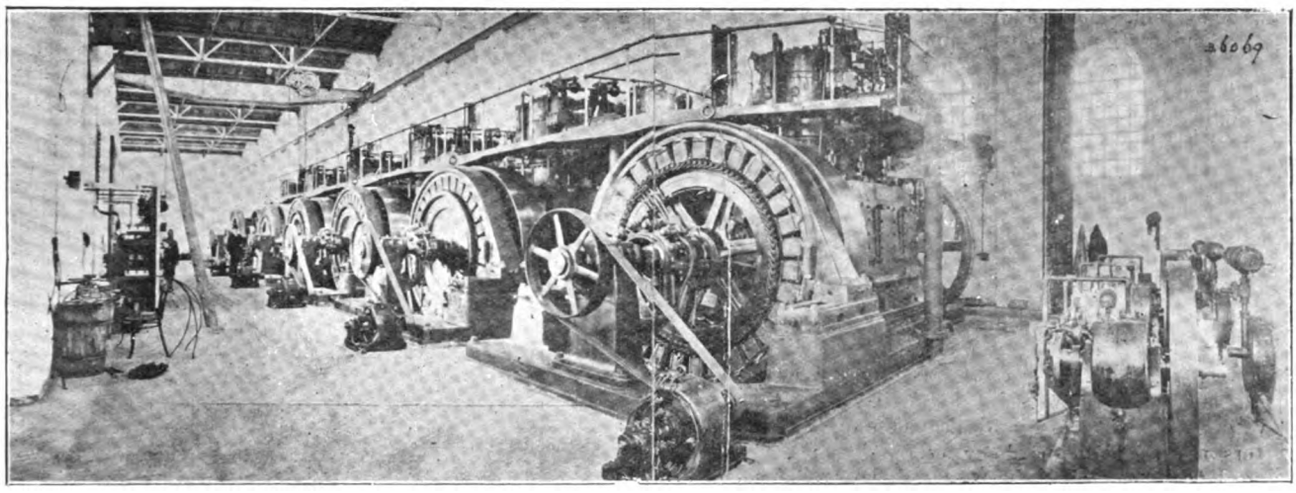
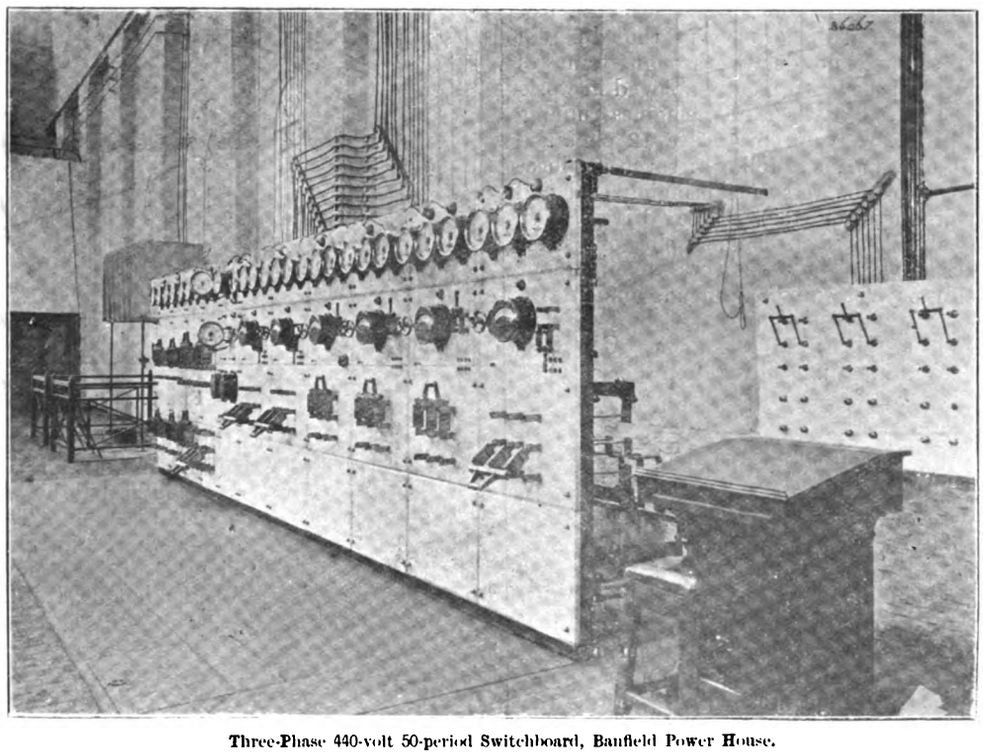
two tubes, forming an annular space through which the air and steam pass. The hot gases from the producer pass through the inner tube in the opposite direction to the air and steam, and a large amount of heat is transferred from the hot gases to the air and steam. From the superheater the hot air and steam pass to a similar annular space round the producer, and downwards through the firebars to the fuel bed. The gas made in the producer comes away from the top of the fuel bed, and is carried to the superheater passing through the inner tube before mentioned. After leaving the superheater the gas is taken to a mechanical washer fitted with two dashers. The latter, which revolve at a good speed, throw the water contained in the washer into a fine spray, through which the gas passes, thereby being cleaned and at the same time giving up a large amount of heat. The washer is divided into two parts, either of which can be cut out, if necessary, without stopping the plant. The gas is then taken to the gas-cooling tower, which consists of a cylindrical vessel packed with small earthenware tubes. The water leaving the air-tower (which is of a similar construction to the gas-cooling tower) is pumped through the gas-cooling tower in the opposite direction to the gas, cooling it, and carrying the heat away. The hot water is then pumped through the air-heating tower before mentioned, which in its turn cools the water in readiness for being pumped to the gas-cooling tower.

From the foregoing it will be seen that the water acts as a vehicle for transferring heat from the gas to the air, and the air also takes up a certain amount of water in the form of vapour or steam. On leaving the gas-cooling tower the gas is taken to a 20ft. diameter gasholder, and thence to two 25in. diameter fans. The fans, by their centrifugal force, throw out any particles of tar and dust, etc., being aided by the injection of a stream of cold water into the interior of the fans. To ensure absolutely clean gas, it is finally passed through two 8ft. square sawdust scrubbers, after which it is ready for use in the gas-engines. Worthington pumps are provided for circulating the water round the towers; tanks are provided for each tower, and are periodically skimmed of the tar and dust which collect on the surface of the water.

In the generating station itself are six Westinghouse vertical, three-cylinder, single-acting gas-engines, each having a normal output of 250 h.p., directly connected to Westinghouse three-phase, 50-cycle, 440-volt alternators of 150 kw. each. The switchboard is of the well-known Westinghouse standard type. From this plant power is distributed by overhead transmission lines to the various workshops and stores departments, offices, etc, at 440 volts for power and 110 volts for lighting. Westinghouse three-phase, type C induction motors are used throughout the works. In the locomotive erecting, carriage, and wagon shops groups of lathes, shaping tools, etc., are driven from



Six 150-kw. Three-Phase 440-volt Generators direct connected to Westinghouse Three-Crank 19in. by 22in. 250-b.h.p. Gas-Engines, Banfield Power House



Three-Phase 440-volt 50-period Switchboard, Banfield Power House.

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countershafts belted to motors ranging from 10 h.p. to 20 h.p. Individual drive is practised for driving sawmill machinery, air compressors, fans, pumps, etc. The shops work eight hours per day, and consume about 4,500 kw. during the daily run.

In the power station a large part of the current generated is stepped up from 440 to 6,600 volts, and transmitted over the high-tension system by underground, lead-covered, paper-insulated cables, laid in earthenware troughs and pitched in, the cables being laid in duplicate throughout the system. The main cables are run direct to kilometre 5 sub-station, a point about half-way between Plaza Constitution and the power-house From this sub-station two branches are taken off, one to Plaza Constitution terminal station and the other to Dock Sud, both of which are protected by high-tension fused switches. In this sub-station step-down transformers are also installed for the lighting of kilometre 5 clearing yard. These work day and night, and consume a considerable amount of current. From this point, along the main line of the railway to Plaza Constitution, branches are taken off for the various freight and passenger stations along the line, each of which are protected by high-tension fused switches.

In the Dock Sud sub-station there are installed two 50-cycle 400-kw. Westinghouse rotary converters which supply direct current at 550 volts for cranes, capstans, grain elevators, etc., all along the dock. One of the rotary converters is sufficient for the present demand, the other being held in reserve. Two step-down transformers are installed for the lighting of the dock, grain elevators, stores, offices, etc. The low-tension cables, both for light and power, are lead covered, paper insulated, and laid in the same system as the high-tension cables, but carried in wooden troughs suspended from the wooden piles of the wharf. There is now under construction an overhead high-tension line from the power station to Burzaco, a distance of about 10 km. This line will also supply light and power to the intermediate stations along the line.

The plant was put into service on March 14, 1904, and during the first six months there were three stoppages, the whole amounting to nine minutes, the delays being principally caused by accumulation of water in the gas-mains, but during a period of two years the different departments have suffered no delays through want of energy. The number of men at present employed in working the plant for 24 hours a day, with five engines running from 6.40 a.m. to 4.15 p.m., two from 4.15 to 12 p.m., and one from 12 p.m. to 6.40 a.m., is as follows: seven producer men, three stokers, two labourers (for bringing coal and dealing with by-products or tar), three drivers, two greasers, and three switchboard attendants, plus one fitter and two boys for cleaning. The men work in eight-hour shifts. The monthly pay-roll for the 23 hands amounts to 1,113·00 gold (£2,223).

We are indebted to the British Westinghouse Company for the above description and illustration of a most interesting plant.

COIL-WINDING MACHINE.

We have pleasure in calling the attention of our readers to a coil-winding machine which undoubtedly marks a vast improvement upon the tedious methods of winding armature coils hitherto in vogue. The inventor of this machine is Mr. W. Cramp, A.M.I.E.E., who, it will be remembered, has contributed many valuable articles to our columns. But while full credit must be given to Mr. Cramp as the patentee of the device, scarcely less praise is due to the Saxon Engineering Company, Limited, of Fenton, Stoke-on-Trent, for their enterprise in placing the machine, with improvements in detail, upon the market, and in acquiring patents in Germany, France, and the United States. Primarily, the apparatus is designed to dispense with the large number of clumsy formers now necessary for winding small coils. Being adjustable in all its dimensions, independently of one another, it enables almost any size or shape of hexagonal coil to be wound for a range of machines from ¼ kw. upwards to 15 kw. Moreover, the forming of the coils is done on the same machine by means of an ingenious motion preparatory to removing the coils. The accompanying illustrations will enable the simplicity of the device to be appreciated. Fig. 1 shows a side elevation,

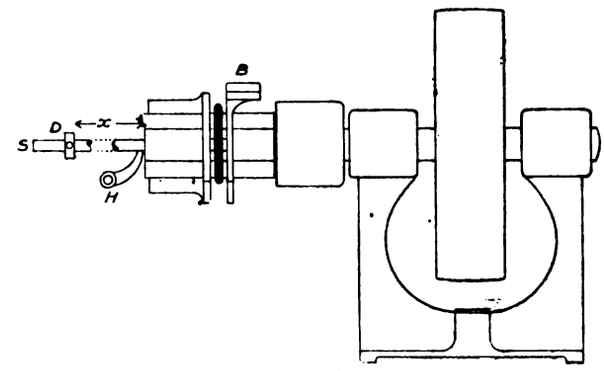

FIG. 1.

while Fig. 2 is reproduced from a photograph of the machine in use. The initial step in winding a coil is to fasten one end of the wire with a single twist to the screw provided on the machine for that purpose. Then,

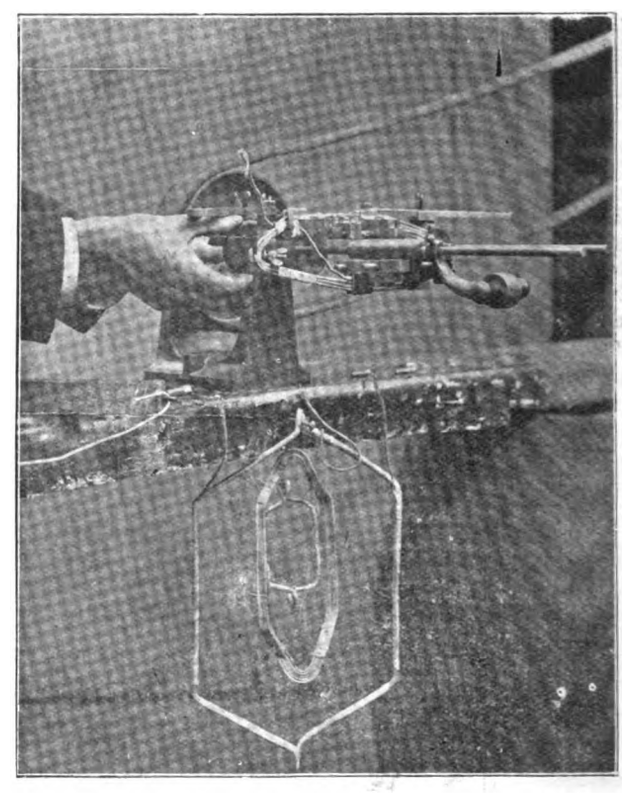

FIG. 2.

while guiding the wire through all the slots, the machine is rotated until the required number of turns has been made. A coil of the shape indicated by the thick lines in Fig. 3 is then on the machine. The subsequent steps are to remove the pins, K K and L L (thus leaving the arm, C, and the slide, B, free to move about their centres), and by means of the handle, H, draw the whole

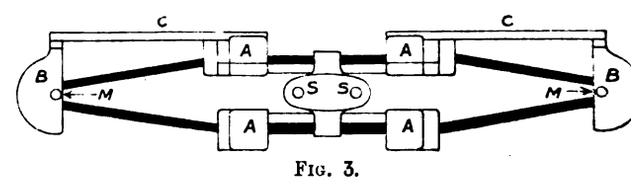

FIG. 3.

of the movable block forward until the collar, D, stops further movement (see Figs. 4 and 5). A coil of typical shape, as shown in Fig. 5, is now on the machine, and can be removed by a simple process after fastening with tape, thus liberating the apparatus for another coil. The driving, by power or hand, is always arranged to suit the particular requirements of the user, and does not form part of the

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machine, which, by the way, can be readily mastered and worked by youths or girls. In Figs. 3, 4, and 5 the driving gear has been omitted for the sake of clearness. It follows from the foregoing that the machine is essentially a labour and space saving device. Due to this fact it has already been widely adopted, although of quite recent introduction on the market. Among its users are Messrs. Mather and Platt, the Lancashire Dynamo and Motor Company, the Sunderland Forge and Engineering Company, Messrs. Campbell and Isherwood, the Electrotechnische Industrie of Holland, De Beers Consolidated Mines of South Africa, and the Electric Ordnance and Accessories Company, Limited.

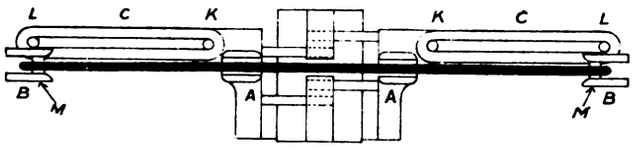

FIG. 4.

The Saxon Engineering Co., Limited, have, we understand, also acquired a patent, which they are now exploiting, for winding coils for induction motors and alternators of the semi-enclosed type. They have not, however, entered the field of electrical manufacturing, their chief specialities remaining tool steels and grinding and crushing machinery. In this connection it is interesting to note that they claim to be the first company outside Sheffield to take up the manufacture of high-speed steels. Their

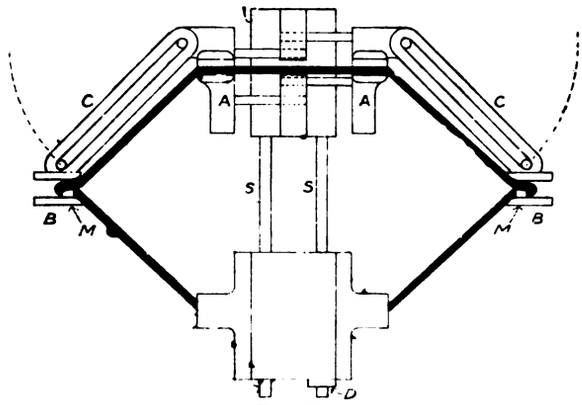

FIG. 5.

"Opal" brand of this class of steel tested against 30 other brands in several of the largest works in England, including the shops of one of our biggest railway companies, has shown, it is claimed, from 200 to 400 per cent. better results than anything pitted against it. In conclusion, we may add that this steel is manufactured by a carefully-guarded secret process, on entirely different lines from that employed in Sheffield. No apparent reason exists why the coil-winding machine described above should not prove an equally successful line of the firm's manufactures.

CONNOLLY'S PATENT ENAMEL INSULATION.

That there is a demand for a good enamel insulation is evinced by the persistent efforts which have been made to meet it. Therefore, it is gratifying to report that Messrs. Connolly Bros., Limited, of Blackley, Manchester, have hit upon the right thing, judging from some most satisfactory samples of enamelled wire we have received from them to test. The process by which these wires are enamel covered is based upon a recent discovery, whereby results of hitherto unequalled reliability and durability are, it is claimed, obtained, thus opening a wide field of usefulness for such wires. Nor have the important claims enumerated below been advanced without ample substantiation through a careful and prolonged series of tests. Here are the chief advantages:

1. The covering is flexible, tough, and elastic.
2. It does not peel or shale off even with the sharpest bending.
3. Used as an insulation for electrical wires it can, if necessary, be made finer than the finest covering of silk; it is specially intended to take the place of silk and cotton coverings.
4. It is waterproof.
5. It is a good insulator; its specific resistance is high, as also its dielectric strength.
6. It is not affected in any way by ordinary acids, alkalis, salts, alcohol, and by scarcely any of the ordinary solvents; a special covering can be supplied that is not affected by mineral oils, naphtha, etc.
7. The covering will stand a very high temperature without melting or being otherwise damaged. For example, it will stand a temporary heat of 600deg. F. or a heat of 400deg. F. for several hours without being affected at all.
8. It is almost impossible to burn the covering.
9. The covering is not affected by exposure to air or to light, and cannot be injured or altered by oxidisation.

As regards the uses for these enamel-insulated wires, the advantage that will appeal most to the instrument maker is the great saving in the space factor as compared with silk or cotton covered wires. Three coatings of enamel are used on Messrs. Connolly Bros.' regular stock wires, which altogether add rather less than one-thousandth of an inch (0·025mm.) to the diameter of the bare wire, and finer coatings, if required for special purposes, can be applied with the utmost ease and at a very slight increase in the cost. The covering will stand all the handling necessary for winding without fear of damage. Coils of the smallest diameter required in practice may be wound without fear of cracking the enamel. The waterproof qualities of the enamel and its power of resisting a higher degree of heat than any fibrous covering will also be an advantage in many cases where instruments are concerned.

The wires may with equal advantage be used for arc lamp coils, while electric bells, indicators, and telephone receivers offer a promising field for their further use, as likewise do induction coils. In cases where it is necessary to embed the coil in hot paraffin wax or it is to be immersed in mineral oil, Messrs. Connolly Bros. recommend their "oil-proof" enamel to be used. This enamel is made on the same principle, but is not quite so flexible—that is to say, it cannot be wound with safety around quite so small a diameter. Even with the oil-proof enamel, however, a 20's L.S.G. wire may, for instance, be wound around a diameter of 0·2in., which is quite sufficient for nearly all conceivable purposes, and in other respects it will stand rough handling even better than the ordinary enamel, and has all the other good qualities described.

For dynamos, motors, and transformer whose windings are to be of fine wire the enamel-insulated conductors may be used either plain or with cotton coverings, the space factor, power of resisting heat, toughness, flexibility, and unchangeable nature of the enamel being advantages of no small importance for this class of work. Messrs. Connolly Bros. recommend the "oil-proof" enamel for transformers that are to be immersed in oil. They do not at present manufacture larger sizes of their enamel-insulated wire than 12's L.S.G. in continuous lengths, but anticipate that eventually they will be able to supply the largest sizes that may be called for. They can also supply wires of square or rectangular shape. As regards electric bell and telephone wires, they are introducing a line suitable for all classes of interior wiring to take the place of the pure indiarubber, cotton-covered, and paraffined bell wires now in common use. These wires are coated with the firm's oil-proof enamel, and have besides the usual textile coverings and finishes. The textile coverings are used solely as a mechanical protection or padding, the enamel coating being relied upon entirely for the necessary insulation. It is claimed that these bell wires will be immensely superior in insulation, efficiency, and durability to those at present in vogue; that they may be used in the most trying situations without fear of breakdown; are suitable for use in damp situations, such as cellars, works, collieries, ships, and in many places where the much more expensive guttapercha-covered, or vulcanised indiarubber-covered, wires are now considered necessary; and will compare favourably in price with the ordinary pure indiarubber-covered bell wires now in general

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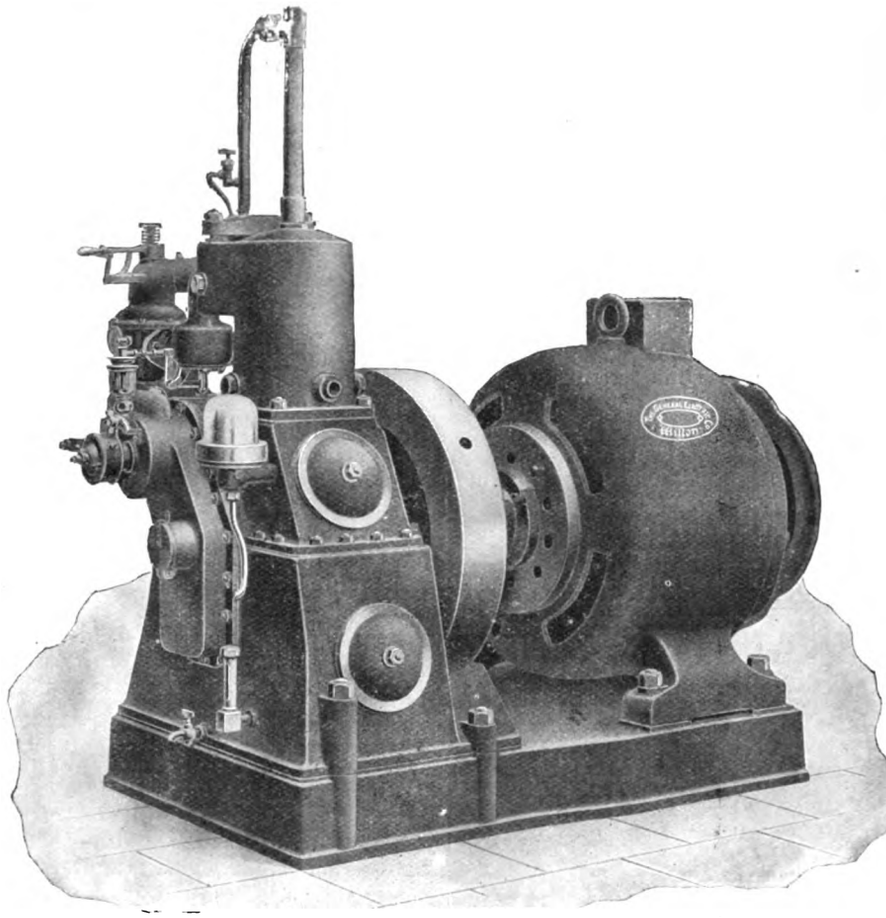
use. For the purpose of making joints or connections the enamel can be removed by scraping with a sharp knife or with fine emery paper.

Other uses for these wires besides those touched upon in the foregoing will doubtless suggest themselves to the reader.

PARAFFIN ENGINES.

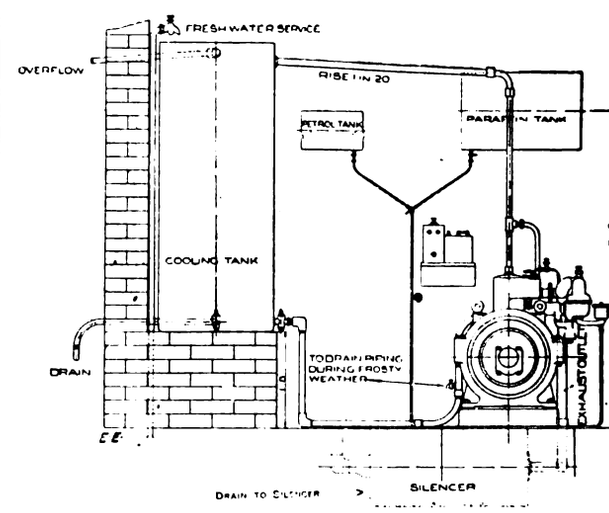
Despite the expansion of the areas over which electricity supply undertakings have powers for distributing electrical energy and the tendency among power users to obtain their supplies from central generating stations, there are yet innumerable places where the demand for electrical energy can only be satisfied by a supply from isolated plant. This accounts for the growing demand which there has been for a simple and efficient electric lighting plant for country houses, ships, mines, etc., and for the various types of such plant now on the market.

Messrs. Belliss and Morcom, Limited, of Birmingham, have introduced a direct-coupled patent self-lubricating, quick-revolution paraffin engine, designed mainly for electric lighting, but which may be used for other purposes too. We had an opportunity last week of inspecting one of these engines at the showrooms of Messrs. A. P. Wright and Co. in London (Messrs. Belliss and Morcom's representatives for the sale of these engines in the London district), where it has been running intermittently during the past two years, and were much impressed with the ease of starting and controlling the engine and its steady running. The engines are of the enclosed type, with forced lubrication to all bearings, run at high speeds, and work on the Otto cycle. Every working part is lubricated under pressure, even to the gudgeon pin, and the noise usually noticeable with this type of engine was reduced to a minimum in that one which we inspected. There is a constant film of oil in the bearings, which prevents knocking. The moving parts of the engine are evenly balanced, and there was noticeable a remarkable freedom from vibration. An oil-depth gauge is fitted to the crank case, and a patent sight-feed arrangement shows whether the bearings are receiving their proper supply of oil, which is forced under pressure through all bearings by a pump. Cleanliness and brightness of an engine-room appeals to owners of large country houses, and as so many oil-engines of open type and cheaper make are dirty and present a bad appearance after being worked some little time, it is important to point out that in the Belliss oil-engine all the working parts are completely enclosed. There is thus overcome an intolerable nuisance caused by the splashing of oil in the engine-room. Moreover, the absence of a lamp added to the aforenamed feature removes a source of work for the attendant, and tends to make a bright and clean engine-room possible.



B. and M. Paraffin-Engine coupled to Multipolar Dynamo.

The engine is started on petrol, and after running on that fuel for about seven minutes the petrol supply is shut off, and paraffin turned on by means of a three-way cock. Before paraffin can be used to run the engine the vaporiser must be heated, and to do this it is most convenient to



Typical Arrangement of Paraffin-Engine.

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start from cold with petrol. As soon as the vaporiser has been warmed sufficiently by the exhaust, the change over is effected in the manner already described. The oil used is Russian Rock light, and the cost of that fuel is said to average ·8d. per brake horse-power. Absence of smell and freedom from sooty deposit were noticeable features of the tests carried out in our presence, and the exhaust was quite clean. Ignition may be by means of a high-tension coil or by magneto, the latter being recommended except for cases where it is desired to start up on paraffin. The patent carburettor is automatic in action, and adjusts itself to give a constant mixture under varying loads, keeping the engine running steadily without attention and without fouling any cylinders, valves, or passages. A supplementary hand adjustment varies the setting to suit changes in atmospheric conditions, and also in order that any of the usual brands of paraffin may be used to the best advantage. The governor embodies the principles and well-known advantages of the Belliss and Morcom steam-engine governor, and we noticed that the speed regulation of the paraffin engine under varying loads was quite satisfactory. The high speed of revolution makes the engines very small for their output. Thus, a 4-b.h.p. and a 6-b.h.p. set, each running at 900 r.p.m., have an output of 2·5 kw. and 3·5 kw. respectively; the output of an 8-b.h p., 10-b.h.p., and a 12-b.h.p. set, each running at a speed of 800 r.p.m., is 5·0 kw., 6·0 kw., and 7·5 kw. respectively An extremely compact engine has been produced, but this compactness has been secured without any sacrifice in the wearing surfaces or that will add to convenience in handling.

Messrs. A. P. Wright and Co., of 60, Queen Victoria-street, E.C., are the London representatives for Messrs. Belliss and Morcom for this engine, and at their showrooms in Union-street, Borough, S.E., they have two or three types which they are prepared to show in operation.

AUTOMATIC CAB-SIGNALLING ON LOCOMOTIVES.*

BY J. PIGG, MEMBER.

Introduction.—Of late years the subject of the signalling of railways—that part by which instructions are given to the drivers of trains—has received a good deal of attention, and the difficulties under which drivers labour under exceptional conditions of weather have been officially recognised by references and recommendations from the inspecting officers of the Board of Trade after inquiry into the causes of certain accidents. A number of systems has been devised and put forward during the last 10 or 12 years for supplementing the ordinary outdoor mechanical signals, but practically no progress has been made in their application. Many of the suggestions have obviously, from internal evidence, been made by persons having little or no knowledge of the conditions to be satisfied in railway working, and are impracticable by season of the arrangements proposed; others are impossible because of the expenditure involved; and some, again, could not be adopted because they involve departures from the regulations under which traffic has to be worked. Some projects have been of a most ambitious character; in others the designers have been content with the simplest possible indications. In some cases the apparatus has been purely mechanical, in others purely electrical, and in others, again, a combination of the two has been made use of. In certain cases the indications are to be given directly upon the engine, in others they are to be produced on the line, but to be of such a character that they could not fail to be noted by the driver in the opinion of their designers. In some cases visual indicators are provided, in others audible signals are given, and also a combination of the two is suggested. In certain proposals indications are to be obtained by direct impact between apparatus carried upon the engine and other apparatus fixed on the line; in other proposals impact is lessened by the use of brushes sliding over prepared surfaces, and some contactless systems, depending for their action upon magnetic influence, have been proposed. Whatever the merits of the various proposals, not one has made any headway towards adoption, and railways still continue to use the system of visual signalling—during clear weather—supplemented by the audible, explosive signal during fog, etc., with which all are familiar, notwithstanding its admitted deficiencies, and the lessons taught from time to time by accidents of a grave character. This delay cannot, however, be laid to the charge of the railway companies who have on many occasions furnished opportunities for the trial of apparatus, but whose officers have, necessarily, to gauge carefully the merits of proposals from every standpoint.

Of other causes which have led to the admitted want of progress in this class of signalling it is not intended to speak here, although in most cases they are evident. The problem to be faced is not a simple one. There are many factors to be taken into account which render the designing of a system a matter of some difficulty. The engineering difficulties are evident when consideration is given to the speeds at which trains travel at the present day. At high speed the time allowable for the collection of a signal, by any reasonable design of apparatus, is very short, and the apparatus must be exceedingly prompt in operation. Where mechanical impact is relied upon for the operations, the stresses to which the parts brought into contact are subjected are tremendous, and in such forms as have been used, sooner or later, according to the frequency of use imposed by the design of the signalling apparatus as a whole, flaws develop in the stoutest material, and consequent failure. In all forms of actuation involving mechanical contact between parts on the engine and parts on the line, the greatest possible care must be taken to minimise the blow experienced.

The financial difficulties connected with such proposals are no less evident than the engineering difficulties. The requirements in connection with signalling have extended so marvellously of late years that its maintenance is likely to become a severe tax on railway companies. Any system of supplementing the present signalling which does not take into account the cost factor will fail in a most important point. If the proposals hold out any prospect of relief in this respect, so much the better. It is comparatively easy to devise means to almost any end if cost is immaterial. The engineer's object, however, should be the keeping of the cost within the value of the service given. Certain things must be provided for railway operations—as in other industrial concerns—regardless of cost, and signalling is one of those, but the expenses incurred fall in the end upon the customer. Railways, however, are in a position in which it would be difficult to maintain increased charges to cover increased expenses of operation. The public would, without doubt, oppose any increase of charges, even if they were incurred for the further guarantee of their safety when travelling. Of course, it may be argued that there would be no need to increase charges to the public for such additional service as is here being considered, as railway companies would save considerably on the cost of accidents. The argument is a legitimate one, considering railways in the aggregate, but it must be remembered that it is much more difficult to prove that an accident has been averted by some means, than to point out, after the accident has taken place and the circumstances become known, how it might have been avoided by the means referred to.

If we carefully consider the operations involved in that mass of conventions known as the "block system" (in which term is included all apparatus used for signalling), we find that the sole aim of that complex system of signalling is the exhibition of appropriate signals to the drivers of trains for their guidance, and that it implies implicit observance on their part of the signals exhibited. We further find that whilst the signalmen, by whom the driver is guided, are provided with reminders to a certain extent, and hedged about more or less completely with restrictions on their actions, the driver must rely upon his physical powers—sometimes under most difficult conditions—to enable him to observe and obey the signals by which he is to be guided. We find, also, that whenever accidents have taken place due to errors of signalling, they have had their origin in variations of one main cause—the human element of control and operation which is the basis of the system. Man has many

* Paper read before the Institution of Electrical Engineers.

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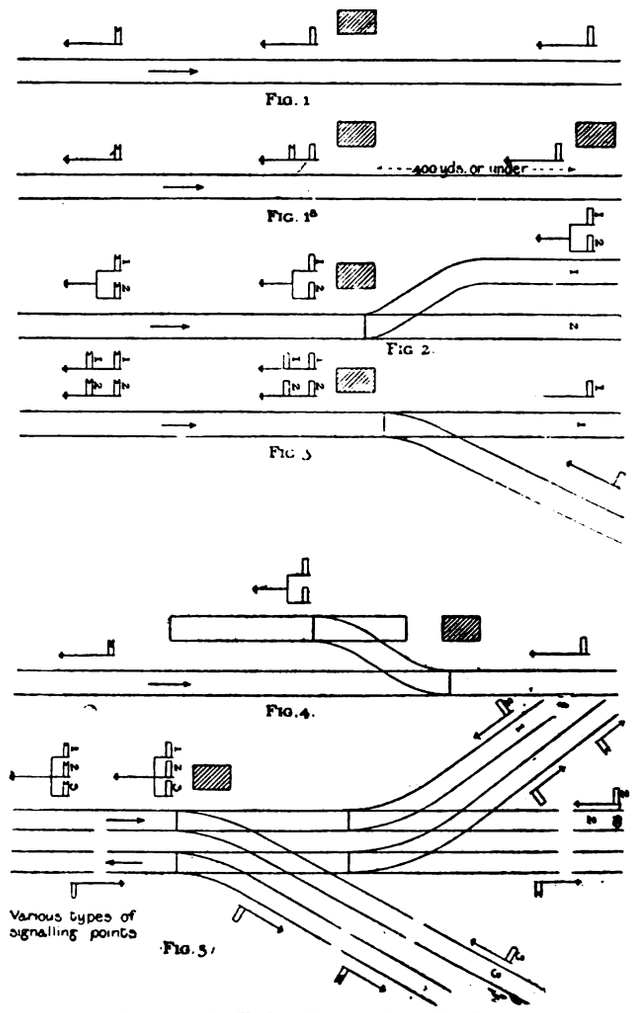
more interests than those appertaining to any one task he may undertake, and to carry out any work requires, more or less, exclusive concentration of the mind upon its details. Probably nothing is more difficult for the average man to accomplish than to concentrate his attention exclusively upon one subject for any length of time; his other interests will rise in his mind, and engage his attention unbidden, and especially is this the case if his other duties are of a routine character and monotonous Only in so far as a man is able to concentrate his attention on his immediate duties is he efficient for the performance of those duties. This want of the ability to concentrate the mind has been described variously as "absence of mind," "forgetfulness," "momentary aberration," and "neglect of duty." The name applied depends greatly upon the results following display of this human characteristic: in one case it may furnish the theme for a jest, in another it may result in a railway disaster. The results depend upon the surroundings. The characteristic, however, is the same in all cases.

There are three men concerned in the passage of a train past any signalling point—the signalman at that point, who controls it by the mechanical signals, the signalman at the next signalling point ahead, from whom the former takes instructions before allowing the train to pass forward, and the driver, who must obey the signals exhibited. A study of the causes of railway accidents will show that each of these men has failed in his duty, and collisions have been caused by: (*a*) the signalman at the receiving end of a section giving permission for a train to enter the section before it is clear of the preceding train; (*b*) the signalman at the sending end of a section allowing a train to enter the section before he has obtained permission to do so; (*c*) the driver of a train ignoring the signals exhibited for his guidance at that point.

If we carefully consider these causes, it will be seen that they show the driver to be by far the most important of the three men engaged. Errors on the part of the signalmen *may* be neutralised and disastrous consequences obviated by the vigilance and promptitude of the driver; but if the latter acts under misapprehension, and ignores the guidance provided for him, there is no power capable of averting the consequences that may follow from the conditions obtaining at the point at which the error is committed, or subsequently, before he again comes under control. The driver, then, is the pivot of railway signalling, and it is of the utmost importance that every means should be taken to ensure his duly receiving the guiding instructions provided for him. During the last two years the author has been associated, in a minor part, in experiments having in view the best means of supplementing the ordinary signals given to drivers. The apparatus has been designed by Mr. Vincent Raven, the chief assistant mechanical engineer of the North-Eastern Railway, by whose permission the author is enabled to give the details which follow, and to show one of the instruments fitted to a model representing the locomotive and a section of line as used in practice. The system is essentially an electrical one, which aims at reproducing, in the cab of the locomotive, all the information that the driver now obtains from the present mechanical signals, but is not intended as a substitute for those signals. Before proceeding to describe the apparatus, however, it may be advisable to look a little more closely than is usually done into the characteristics of the outdoor mechanical signals in order to ascertain what is required from an efficient form of cab-signalling, and to compare the results obtained with the apparatus put forward for the purpose.

Characteristics of Semaphore Signals.—Consider the signals provided for main-line work, with which alone this paper deals. The principal signals are the "distant," the "home," and the "advance," the relative positions of which are shown by Figs. 1-5. The "distant," as its name implies, is fixed at a considerable distance from the box from which it is operated. It is the first signal belonging to the signalling point from which it is operated reached by a train approaching that point. The "home" signal is placed in the immediate neighbourhood of the signal box, and so as to protect any points which may be situated there, and the "advance" is placed at some distance ahead of the signal box in the direction in which trains pass towards the next signalling point. Signals may be divided into "stop" and "non-stop" signals. The "home" and "advance" signals are "stop" signals in that drivers must not pass them when at "danger"; the "distant" signal is a "non-stop" signal inasmuch as the driver is not required to stop at it when at "danger." The principal indications given by semaphore signals are "on" and "off," indicating "danger" and "line clear" respectively, and the positions are the same for both "stop" and "non-stop" signals. In this respect the indications represent "condition of line" signals. A distinction, however, must be drawn between "stop" and "non-stop" indications of this character. The cautionary character of the "non-stop" distant when "on" has already been alluded to. When "off" the information given to the driver is fuller than that given by a "stop" signal in the same position—inasmuch as the interlocking between the points and signals, at any signalling point, is



Figs 1 to 5.—Various Types of Signalling Points.

such that the "distant" cannot be lowered to "off" unless the succeeding "stop" signals have also been lowered Hence a driver, when passing a "distant" signal which is "off," is assured that the "stop" signals are also "off," and the road is clear into the next section. If the signal is "on" he knows that the road is not clear, and he must be prepared to stop at the "home" signal. Hence the "distant" signal may be considered as *an indication at a distance* of the "condition" of the "stop" signal. In addition to this characteristic of the "distant" signal, it is a "position" signal, in that it marks to the driver his position relatively to the signalling point he is approaching, and is to that extent a warning of his position. "Stop" signals are also "position" signals, but of a different character, in that they represent positions which must not be passed when they are at "danger." A further characteristic of semaphore signals, common to "distants" and "homes," is also shown by Figs. 2, 3, and 5. As will be seen, there are as many "distants" and "home" signals as there are diverging lines at the junctions, and

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that the signals are erected in the same order, relatively to each other, as the diverging lines are to each other. Thus: "distant" "1" and "home" "1" refer to line "1" and so on. Hence the "distant" and "home" signals for a diverging junction are "route" indicators in addition to their other characteristics. The duplication of signals shown on Fig. 3—one high up on the post and the other lower down—is intended to allow the driver to see the high signals at as great a distance as possible in clear weather, and the lower signal is to facilitate his observing the indications exhibited when weather conditions do not admit of his seeing the higher signals.

Need for Supplementary Indications.—The time when the driver most urgently requires supplementary indications is undoubtedly during fogs and snowstorms, but it by no means follows that it is only during such exceptional conditions of weather that supplementary indications are of value. The history of railway accidents is not without cases where absence of mind of the driver has resulted in serious disaster in clear weather, and there have been other cases in which it has been strongly suspected that absence of mind has been the principal cause. Apart from this, however, the need for additional means of signalling during fogs, etc., is sufficient. No more strenuous duty can be imposed on a man than the driving of a 100-ton engine, with from 250 to 350 tons behind him, at a speed of 60 or 70 miles per hour, through a grey wall which never seems to end, where sight is useless, and on the rack with the endeavour to keep track of his position by the "feel" of the road, and for the explosive signal which means for him the "danger" signal—the only practicable signal given to him. Special arrangements have to be made for giving the present supplementary explosive signals, but instances are not unknown where they have broken down with lamentable results.

Point at which Supplementary Indications are Required.—Many suggestions for providing supplementary indications have been made during the last 12 or 14 years, most of which have had as their object the giving of the indications directly on the engine, in the cab where they are most easily observed. Others, however, have aimed at producing a signal, ordinarily an audible signal, on the line. The latter are merely variations of the present supplementary explosive signal, with the added disadvantage that they are not so readily heard. Much of the efficiency of the explosive signal is due to transmission through the body of the engine. The difficulty of conveying sounds from the line to the cab of an engine, running at a high speed, under ordinary circumstances is so great as to render such systems totally useless. Cab-signalling is undoubtedly the only method worth consideration.

Character of Supplementary Indications to be Provided.—The choice of means by which the indications shall be given is limited, and to all intents and purposes lies between the adoption of visual or audible signals, or a combination of the two. Purely audible signals leave no record; and purely visual signals need considerably more attention than the driver can easily give. With the first he may forget *which* indication he obtained after it has ceased, either automatically or by his own action; with the second he may forget to observe it. From these considerations alone it seems imperative that both classes of signal should be employed, the audible signal being of the nature of an alarm, or "call attention" signal, and the visual signals giving the "condition of line" signals, and "route" indications.

Choice of Design of Apparatus.—The design of the apparatus divides naturally into two parts—that of the indicating apparatus, and that by which the indications are to be produced. The conditions to be satisfied in either class are not easily overcome. The indicating apparatus will be subject to violent vibration whatever arrangements are made, and must be capable of withstanding it. The means by which the indications are produced, if a contact system is used, will necessarily be subject to severe shocks, and must be strong. Purely mechanical apparatus for producing the indications, depending as it does upon impact, involving movement of some part against a resistance, has small chance of adoption on account of liability to failure under the stresses sustained, and the difficulty of operating such devices at the distances rendered necessary by the high speeds of trains. Where "off" signals are to be given, the cumulative effects of the multiplied blows would render such apparatus liable to constant failure. Moreover, mechanical systems at their best can never hope to reproduce in the cab, under the driver's immediate notice, all the information he obtains from the line signal. The use of electricity offers much greater advantages, and enables the effects to be produced at any required distance from the operator without effort. The combinations that may be made with a given apparatus are more numerous, and the methods in which electricity can be utilised preclude the necessity for the violent shocks which are almost inseparable from purely mechanical operation. Nevertheless, mechanical means may, if designed with a knowledge of the conditions to be met, be made to form a valuable auxiliary to electrical systems. The collection of signals on the engine is a matter of the highest importance in any system of cab-signalling. In purely mechanical systems, as has already been stated, this is done by contact of apparatus carried on the engine and apparatus fixed on the line, which partakes more or less of an impact or blow. This blow may be minimised to some extent by the adoption of yielding devices on the engine or track, or by applying the contact more or less gradually by sloping devices, but the effects are but slightly reduced owing to the extremely short time during which the contacts are made, with any reasonable length of slope, etc., when trains are travelling at high speeds, and the effects are enhanced when heavy bodies are brought into contact by their inertia, and by strong control. Electrical systems have generally to provide some form of mechanical contact between the circuits on the engine and those on the track, but as they do not necessarily involve the movement of the apparatus, their design need not follow the same lines. If efficient contact is established, that is sufficient The collection of currents from the track has other points, however, which need to be considered. Metallic contact is necessary, and it has been thought that under the conditions of use snow and ice, or dirt, might form an objection by causing failure to make efficient contact. In any system whatever, the design is the most important point. If the apparatus brought into contact is not such as will tend to clean, but rather to press and consolidate whatever the bar may be covered with, failure is sure to result. Considerations like these have given rise to suggestions for contactless systems of collecting indications, of which Mr. W. S. Boult's system is, perhaps, the best known. These systems depend upon magnetic influence for the operation of the signalling apparatus on the engine, and are, therefore independent of such conditions as have to be provided for in contact systems.

Requirements to be Satisfied by Supplementary Apparatus.—Having reviewed the conditions under which signalling is carried out and the characteristics of the various signals, it will be gathered that the "distant signal" is one of the greatest importance, since at that signal the driver gains information by which he is guided in his immediate subsequent actions. At that point he is informed of his position relatively to the stopping place of that signalling point, and he there obtains the "condition of line" and "route" indications if the line has been prepared for his further passage. What is required, therefore, in any supplementary apparatus is that it shall advise the driver, when he is passing a position corresponding to that fixed upon as the distant signalling point, of the condition of the "stop" signals in advance. If that is done, the driver is informed on all the points which it is necessary for him to know. From what has been said it will be seen that the following points should be provided for: (1) The first useful operation is to inform the driver, by way of warning, of his position relatively to the signalling point he is approaching at such a distance as will enable him to carry out any steps as may be necessary. (2) To advise him immediately afterwards of the condition of the "stop" signals he is approaching—*i.e.*, whether they are "on" or "off." (3) If the "off" signal is obtained it should be accompanied by a "route" indication, which will enable him to judge whether the right road has been prepared at a diverging junction. It should be possible to reverse this indication

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at some point or points before the train passes the "home" signal, in case of emergency, just as it is possible to reverse an indication with the mechanical signals by throwing them to "danger" before they have been passed. (4) If the "on" signal is obtained, the indications on the engine should be maintained until the "off" signal is received. It should be possible to receive the "off" signal at some point or points between the "distant" signalling point and the "home" signal to prevent unnecessary delay, just as the driver is able to note the lowering of the signal before he arrives at it by the projection of his vision in clear weather. It should be possible for the apparatus to indicate to the driver at some point or points how far he has travelled between the distant signalling point and the stop signal when the indication continues at "on." It should be possible for the driver to obtain the "off" indication when standing at the "home" signal. It should also be possible to give a signal to a train standing at the "home" signal which would be of a cautionary character and distinguishable from the ordinary authority to proceed.

As corollaries, the following conditions should also be provided for: (*a*) The indication required under (1)—*i.e.*, the "warning" signal—should be given by the natural operations of the apparatus, and should require no action on the part of the driver or signalman to bring it into operation. (*b*) The "condition of line" and "route" signals required under (2) should be under the sole control of the signalman, should be subject to the control imposed by the interlocking, and must be such that failure shall not be liable to give a dangerous false indication. (*c*) The signalman shall be provided with indicators which will show him that the apparatus on the line for giving the signals on the engine is in order, and that the apparatus prepared is in accordance with the positions of the signal levers. (*d*) The apparatus on the engine should be of a reliable character, easily seen and heard, and such that the indications shall, as far as possible, correspond with the apparatus it is intended to supplement. It should be self-testing and be continually in use, so that failure may be instantly indicated, and it should be so arranged that attention can be readily given and defective apparatus easily removed and replaced. (*e*) The apparatus should be capable of easy adaptation to single or double line working.

(To be continued.)

RECENT DEVELOPMENTS IN SINGLE-PHASE WORK FOR POWER AND TRACTION.*

BY V. E. WALTERS.

The single-phase motor, which in the early days of power work was probably more extensively used than any other type, after passing through a period of considerable discredit, has recently come very much to the front both for power and traction, and I propose to briefly describe some of the recent developments in this form of motor, and its modern applications. The chief defects hitherto have been, of course, the inability to start against load, and failure in the matter of satisfactory speed regulation, which latter characteristic has been shared by all forms of alternating-current motors. I propose to show, however, that the single-phase motor is quite capable of starting against heavy loads with a moderate starting current consumption, and that its speed can be varied over a wide range by very simple methods. It is, perhaps, too much to say that the single-phase system of electrical distribution will supersede all other forms, but I am of the opinion that we are within reasonable distance of seeing it adopted very extensively for all purposes where electric power is applicable, and almost universally for electric traction. The majority of early electric supply systems were single phase at high frequencies, alternate current being chosen owing to the ease of transmission over considerable distances at high tension, with stationary transformers for low-tension distribution, and a high frequency being adopted as being more satisfactory for arc and incandescent lighting, and involving cheaper generators and transformers. At that time there was no idea of the immense demand for electric power, which now in some cases exceeds the lighting load, and the supply systems were laid out solely with a view to lighting.

It is well known that the single-phase induction motor operates far better on a low frequency than a high one, and on the then existing systems it held a very poor reputation. In fact, it was not until the more modern form of series, repulsion-series, and repulsion-induction motors were put on the market that the single-phase motor was generally and satisfactorily adopted for any work that required a machine which would start against load and be easily reversed. The series and repulsion-series types have found their application rather in traction than general power work, and as I propose to describe these types when dealing with the former subject, I will defer a general description of them till then. The repulsion-induction motor, originally introduced from the U.S.A., where it was made by the Wagner Company, of Philadelphia, under Arnold's patents, and further improved in the Schuler type, has in the past year or two been still further developed by the Rhodes Company, of Doncaster, and others, and applied to practically every purpose to which motor driving is applicable. The simple induction motor, as we all know, consists of two parts, one stationary and one rotating, the stator being connected to the mains, and inducing a current in the windings of the rotor, which, together with the flux of the motor, produces the torque. Such motors, while being simple in construction and low in first cost, have the serious disadvantage of poor starting performance and small overload capacity, while their capability of speed regulation is for all practical purposes negligible. The repulsion motor has the advantage of good starting performance, having large torque with moderate current consumption, but its running performance is poor owing to its low power factor and efficiency. By combining these two with suitable means for changing over from the repulsion to induction when nearly at synchronous speed, we obtain a motor having a large starting torque with moderate current consumption and also a satisfactory running performance.

The repulsion-induction motor as now described consists, therefore, of an ordinary alternating-current stator wound with a suitable primary winding, and a rotor with drum type or ring winding, as in an ordinary continuous-current machine, and fitted with a commutator. By placing a pair of short-circuited brushes on the commutator, and displaced from the axis of the primary coil by a suitable angle, which is somewhere between 15deg. to 30deg., we obtain a repulsion motor which will start with a powerful torque. By adding a second pair of brushes, and short-circuiting one or other of the two pairs, we have a reversible motor. In the Rhodes motor the armature shaft is fitted with an automatic device, which consists of a centrifugal governor arranged to operate a sleeve which short-circuits the commutator brushes on attaining full speed, after which the motor runs as a simple induction machine.

Having briefly described the general construction of these motors, I now proceed to discuss some of their more important applications.

Lifts and Cranes.—The use of lifts in all large towns and in many of moderate size has grown at a very rapid rate, and while it is admitted by all who thoroughly understand the subject that the electric lift is generally superior to any other type, the poor performance of single-phase motors on such work in the past has done much to discredit electricity for this purpose. Now, for lift and crane work repulsion-induction motors are made which, even on a 100-cycle circuit, will start with twice full-load torque, taking not more than twice full-load current, being easily reversible by means of a simple change-over switch. This type of motor, being fitted with an automatic governor, and requiring no controlier, would seem to be an ideal one for the purpose, and is only open to the following objection—namely, that in the hands of an incompetent operator it is possible to pull the hand rope right over at full speed, which action, seeing that the governor has not time to come to rest and open the commutator circuit, fails to reverse the motor, which continues to run in the same direction with possibly disastrous results. To remedy this, a patented device is now fitted which, in conjunction with the controller, ensures that if the hand rope be inadvertently pulled right over the motor will automatically stop and reverse.

Bakers' Machinery.—Certain forms of dough mixers require most exacting work on the part of the motors that drive them. For instance, a Werner machine driven by a 5-b.h.p. motor direct coupled through worm gear has the following cycle of operations. The mixer starts up light and runs for five minutes in the forward direction, the load gradually increasing to a maximum as the mixture thickens: it then stops, reverses against full load, and runs for 30 seconds in the reverse direction, in order to clear the blades, after which it stops and reverses against full load and runs in the forward direction for another five minutes; this cycle of operations being repeated several times. The work is efficiently performed by a repulsion-induction motor controlled by a change-over chopper switch only, and it is obvious that such a simple form of controlling gear is not possible with any other type of motor, whether direct current or alternating.

Organ Blowing.—It is not the easiest matter in the world to blow an organ by electricity, as many electrical engineers have found to their cost, and with alternating current it is almost a necessity to have the motor outside the building, and at some distance from the organ, to avoid the motor being audible inside. This with the ordinary form of induction motor means com-

* Paper read before the Birmingham and District Electric Club.

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plicated and unreliable controlling gear. As an example of the simple arrangement possible with this type of motor, the following plant, recently installed in a large church, will be of interest: a 7½-b.h.p., 100-volt, 50-cycle, repulsion-induction motor is fixed in a chamber outside the church and 50 yards from the organ. The motor drives a fan by belt, and is controlled simply by a double-pole switch at the keyboard of the organ. No other switch is necessary, and the organist starts and stops the motor from a distance as required, the motor and fan being inaudible within the church.

Automatically-Controlled Motors for Pumps and Air Compressors.—It is frequently required to operate pumps and compressors in conjunction with a tank or storage receiver in such a way as to keep a constant water-level or air pressure without the continual presence of an attendant to start and stop the motor. It is obvious that a motor which can be operated by a simple switch lends itself admirably to this purpose. A solenoid-controlled switch is easily arranged, worked in the case of a pump by a float and in the case of a compressor by air pressure, without complication and with reliabilty.

Variable-Speed Motors.—Motors of the repulsion type are made whose action and performance is similar to that of an ordinary direct-current series motor. They are fitted with a resistance in series with the rotor, and operated by a drum-type controller. As an example, a 50-cycle single-phase motor, normally rated at 5 b.h.p. at 1,000 r.p.m., was easily regulated to run at any speed from 1,100 r.p.m. to 190 r.p.m., the outputs varying from 5·5 at the maximum speed to ·2 at the minimum. These motors are specially suitable for fan driving and other similar work.

General Remarks.—It will be admitted, I think, from the foregoing examples that the single-phase motor is capable of doing any kind of work requiring large starting torque with moderate current consumption, is capable of a wide range of economical speed variation, and is exceedingly simple to operate,

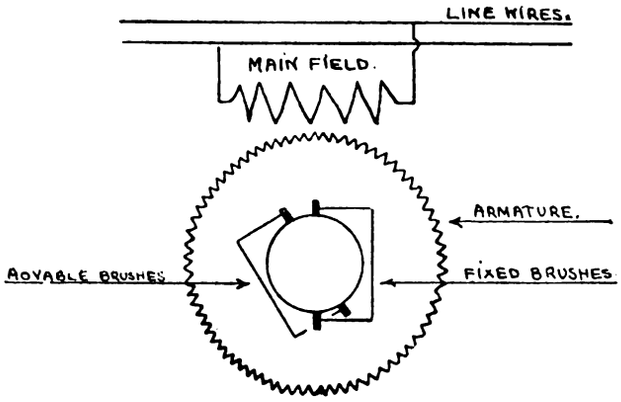

Diagram of Connections, Deri Variable-Speed Motor.

and that its qualities only require to be better known to give a considerable impetus to power work on existing single-phase circuits. There are, of course, other methods employed by various makers for changing over from repulsion to induction, such as varying the number of stator poles, as in the Deri motor, and by short-circuiting the rotor windings, by means of slip-rings, and a rotor resistance, as in the Schuler motor, but none of these methods appear to be as simple and reliable as the automatic device already described; and, in the writer's opinion, simplicity and certainty of action, provided efficiency is not sacrificed, are of the first importance. As regards voltage and frequency, the power factor is necessarily lower on a higher frequency, and it is advisable to run motors at as high a speed as is practicable to minimise this as far as possible. It has also been found from experience that on a 100-volt circuit, for instance, where voltages of 100, 200, and 400 were obtainable, on 400 volts motors were uniformly successful, on 200 volts only moderately so, and on 100 volts their performance was more or less indifferent, which suggests that for power work on high frequencies both high speed and high voltage are very desirable, in order to obtain the most satisfactory results; on frequencies of 50 cycles and under motors of this type have proved quite successful on all usual voltages.

Traction.—Electric motors for suburban railway service have been successfully adopted for some time past, the severe competition from electric trams, motor 'buses, and tube railways having been the chief factor in bringing about this method of operation, and several installations over considerable distances have been at work for some years, notably on the Continent; and there is little doubt that electric traction will be in general use in the future for all classes of railway and tramway work, its only possible rival, as far as appears at present, being the petrol motor. The systems now in use are the continuous-current, with one or two live rails, and the alternate-current, single or polyphase, with overhead conductors, the former method being, as yet, the only one in actual use in this country, although the single-phase overhead system is now being installed by the Midland Railway between Heysham and Morecambe, and by the Brighton line from London Bridge to Victoria. The continuous-current system has been successful on lines of comparatively short length with heavy traffic, which are free from complicated junctions, and where speeds are generally moderate, but there are serious objections to its use for main-line and long-distance traffic, where speeds are considerably higher and the service is less frequent and more varied. Chief amongst these are the difficulty of arranging complicated junctions, which with three or four rails to each track would in some cases be a practical impossibility; the necessity for extra high-tension current for long-distance transmission, the use of which with live rails is out of the question; and the employment of rotating machinery in sub-stations, which is indispensable in the case of continuous-current distribution for any but short-distance lines, entailing the constant presence of attendants, with additional wear and tear and risk of breakdown. With alternate-current distribution these objections disappear, as there is no difficulty in generating and transmitting high-tension alternating current over long distances with stationary transformers in the sub-stations and overhead equipment for the track.

Several successful polyphase systems are in operation at the present time, amongst the most notable of which is the Valtellina line in Italy, equipped on the three-phase system by Ganz and Co., the speed regulation of the motors being controlled on the tandem-parallel or cascade method. Over this line of some 50 miles in length both passenger and goods trains have been working for some years with great success. Another well-known line on this system is the Marienfeld-Zossen Railway near Berlin, where experimental trains have reached a

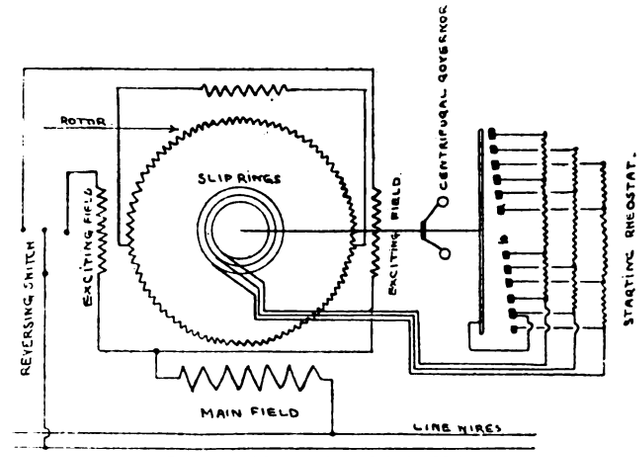

Diagram of Connections, Schuler Motor.

speed of over 120 miles per hour. It is quite obvious, however, that, providing a satisfactory motor can be obtained, the single-phase system will be superior to either the continuous-current or polyphase, because, while possessing all the advantages of alternate current for distribution, it is simpler than the polyphase and cheaper to install. The special characteristics demanded from a traction motor are: (1) rapid acceleration; (2) economical speed variation; (3) capacity for regenerative control.

It now remains to examine the types of single-phase motor we have at our disposal, and to see how far they can meet the above-mentioned requirements. The induction motor pure and simple is for all practical purposes useless for traction work, owing, as previously explained, to its inability to start against heavy load, its excessive current consumption when starting against light loads, and the practical impossibility of regulating its speed with economy over any considerable range. Before leaving the subject of this type of motor, however, mention may be made of Arnold's ingenious electro-pneumatic system, where ordinary induction motors are employed in conjunction with air compressors and a storage reservoir, by means of which a powerful starting torque is obtained by utilising the air compressed during running. Variable speed is effected by rotation of both stator and rotor at various relative speeds to one another, such variation being controlled by throttling the compressor outlet pipe. This system, while enabling a cheap form of motor to be employed, and admitting of simple speed control over a wide range, has the disadvantage of requiring the motor to be run continuously even when the train is at rest, and prohibiting energy being returned to the line when braking or coasting. The locomotive being partly self-contained has, of course, the advantage of having a temporary reserve of energy in case of failure of the electric supply. It has also been proposed to use high-tension single-phase currents worked from an overhead conductor, and utilised to drive a motor-generator operating continuous-current motors with separate excitation on

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the car axles. This, however, is a needless complication, and was only proposed at a time when satisfactory single-phase motors had not come into existence. The series motor for alternating-current working is identical in construction with the ordinary continuous-current series machine, except that the field system is laminated. On high frequencies it is a failure, but has met with some success on frequencies as low as 15 or 20 cycles, especially in the case of the Lamme and Finzi systems. Its chief defects are excessive sparking, low efficiency and power factor, the necessity of using step-down transformers on the locomotives, as such motors can only be worked on comparatively low voltages. Speed control is obtained very economically, however, by varying the ratio of the transformers.

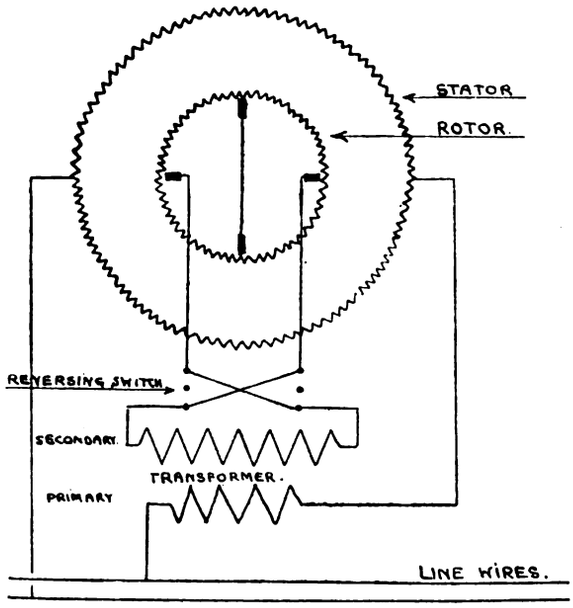
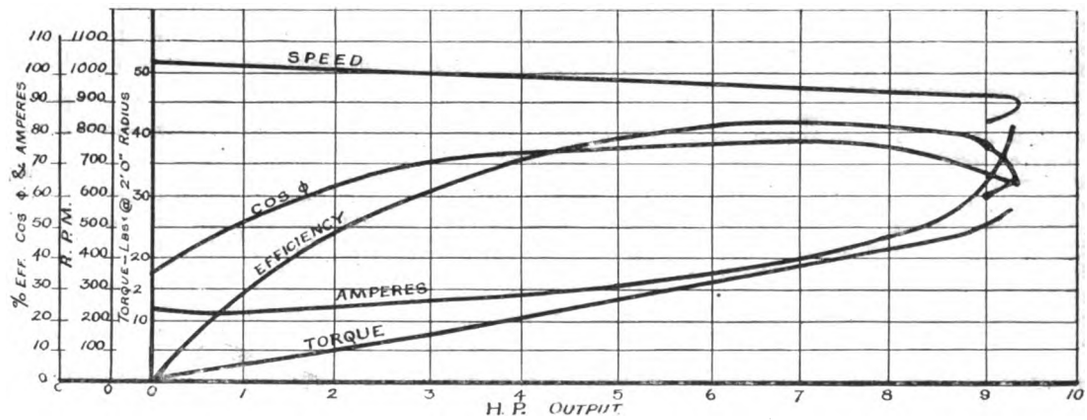


Diagram of Connections, Winter-Eichberg Motor.

The repulsion-induction motor has been previously described when dealing with power work, and has the additional advantage for traction work that step-down transformers on the locomotive are not required, as it is possible to use high-voltage currents direct on the motor stators. The repulsion-series motor is one of the most successful types for traction work, as, like the repulsion-induction motor, high-voltage currents may be use without transformers, the power factor is high, being nearly unity, and it possesses a powerful starting torque and capability of economical speed regulation over a wide range. One of the best known motors of this type is the Winter-Eichberg as made by the Union E.G. of Berlin, the principle of which is as follows: The motor is constructed with the usual induction-type stator, and an armature wound with an ordinary continuous-current winding having a commutator with a large number of segments. On this commutator are fixed two pairs of brushes, one pair short-circuited and fixed at 90deg. from the other pair, which latter are so connected as to put both armature and stator windings in series. For purposes of speed regulation, the armature receives current from the secondary of a transformer whose primary is in series with the stator winding. By means of this transformer the pressure applied to the armature can be varied through wide limits without resistances. The transformer also enables low-voltage current to be supplied to the armature, thereby doing away with the chief difficulty with commutation. The application of variable voltage by means of a transformer as described has a similar effect to that of variable voltage applied through resistances to a continuous-current motor, without the waste of energy entailed in the latter case. Reversal of direction is obtained in a similar manner to the continuous-current series motor by reversing the direction of the current in the armature or field windings. Seeing that all reversing and speed regulation is effected on the low-tension side or secondary of the transformer, and the motors being always in parallel, it is a simple matter to arrange multiple-unit trains with this system.

The question of regenerative control is an important one in traction work, especially on lines where frequent stoppages and considerable speed variation are required. The amount of power absorbed when braking is very large, amounting on some lines to nearly 50 per cent. of the total energy supplied to the line. Then, again, with variable-speed control effected by resistances as much as 25 per cent. of the total energy supplied may be wasted in heating the rheostats. It is quite obvious, therefore, that these items involve a very serious loss of efficiency and waste of energy, and any method of reducing them is deserving of the utmost consideration. With continuous current it is quite feasible to arrange the motors to work as generators when braking or coasting, returning energy to the line, and saving wear and tear of brake blocks. Such systems as those of Raworth and Johnson-Lundell have been applied to tramway work in this country, especially on hilly routes, with success. In the matter of speed regulation, however, the continuous-current traction motor is still responsible for a considerable loss due to heating of resistances. The speed regulation of polyphase motors by inserting resistances in the rotor circuit is exceedingly uneconomical, being similar in effect to varying the speed of a continuous-current motor by resistance in series with the armature. Moreover, these resistances are bulky and expensive, and require very ample ventilating arrangements. The best method so far devised is the tandem-parallel or cascade system employed by Messrs. Ganz and Co., and proposed by them for the Inner Circle. Generally, the rotor of the secondary motor is in series with the rotor of the primary, the stator of the former being shorted at half speed, the stator of the primary being direct on the line. By this means two speeds are obtained without the use of resistance, and the system is similar to the tandem-parallel control of continuous-current motors. Moreover, current can be returned to the line during braking to the amount of about 10 per cent., but even with these advantages the polyphase traction motor suffers from low efficiency and power factor when running under these conditions. Of the different types of single-phase motors the series machine is capable of economical variable-speed control by altering the transformer ratio, against which must be put its general disadvantages, especially on high frequencies, which have been already described. In the repulsion-induction motor speed regulation is obtained by resistance in the rotor circuit with smaller losses than in the case of the polyphase motor; it is not, however, so well suited for traction as for power work. The series-repulsion motor, such as the Winter-Eichberg previously described, is highly economical in its method of speed variation there being no rheostat losses, the regulation being effected by means of variable transformation ratio. This motor appears to be the most promising of all types for traction work.



Repulsion-Induction Type Motor, Single-Phase, 200 volts, 7½ b.h.p., 50~, 940 r.p.m.

We have now seen that the single-phase motor is capable of successfully meeting all the conditions required from a traction motor. It is superior to the polyphase motor in requiring a less complicated system of distribution, while it has been shown that for long-distance lines continuous current is out of the question for primary distribution, and for secondary requires converting machinery which is expensive both to install and maintain. On some lines it is possible to install polyphase generating plant with single-phase secondary distribution, whereby the benefits of both the best type of generating plant and the simplest form of distribution would be obtained. At the present time, in addition to the two lines in this country already mentioned which are being equipped on

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the single-phase system, a large number of lines in the States are already at work or in progress, amongst which I may mention the Erie Railroad, which has equipped a section of line 34 miles long. Three-phase current from Niagara is supplied at 60,000 volts and transformed down to 11,000 volts, at which pressure single-phase current is supplied through the trolley wire on to transformer on the car, which further reduce the pressure to from 300 to 100 volts at the motors.

In conclusion, I have been able in the foregoing remarks to give only a very brief description of modern single-phase motors and their application both to power and traction, and there are many other forms and methods which I have been unable to touch upon in the time at my disposal. I hope, however, that I have succeeded in showing that the single-phase motor is not by any means dead, in spite of rumours to the contrary, but rather is very much alive, and likely to outlive the majority of its rivals.

LAYING-OFF BOILERS AND BOILER CLEANING.

BY CENTRAL-STATION MAN.

In view of the accidents which are reported from time to time due to the bad methods adopted in preparing to clean boilers, and in the actual work of carrying out such operations, it may be worth while to give a few general hints as to the way in which to treat a boiler when it is proposed to lay it off for any time. The general conception as to how to treat a boiler when it is to be laid off for any length of time is to empty all or part of the water, and to leave the boiler standing with the fire-doors in any position in which they may happen to be placed at the time. It does not matter to the intelligences of those in charge of such installations as to whether the doors are open or shut, or whether there is any water or none in the boiler. No trouble is even taken to ascertain whether the boiler is under heavy pressure or not.

The correct procedure should be as follows: Do not attempt to blow the boiler down at all, but let it cool down until the pressure gauge stands at zero. When this is the case, in order to make sure that the gauge is not deceiving the operator, open the gauge-glass cock, or any other convenient opening, to make sure that there is no pressure in the boiler. Then, when this is certain, but not before, take off the top manhole cover and pump water into the boiler until it is full right up flush with the manhole flange rim. It should be carefully seen that all the flue doors are shut in order to prevent air circulating through the tubes, etc., of the boilers. Shut as far as ever possible all openings in the front of the boiler. The advisability of this is apparent when it is remembered that the variations of temperature, especially in a boiler-house which shuts down all night, or in an open-fronted boiler-house, are enough to cause a considerable amount of condensation on the exterior of the tubes and drums of a standing boiler. Cases have come within the experience of the writer where, with boilers standing exposed to all sorts of temperature variations, it has been possible after two months to take flakes of rust of considerable size off the outside of the tubes.

The folly of attempting to remove the manhole cover when there is any pressure at all in the boiler is illustrated by the two cases of fatality arising through foolishness of this sort which were reported in the technical Press quite a short time ago. One case was at Cambridge, where two men started to take off the cover of a boiler for cleaning purposes with the idea that there was no steam in the boiler because the pressure gauge stood at zero. They took out all the bolts and then proceeded to force off the cover, with the result that a rush of steam occurred, which scalded one of the men to death. Another case, an American one, was that of two men who started to take off the cover of a large vessel no less than 5ft. in diameter and 40ft. in length, under the impression that no steam was in, whereas the pressure had not been relieved. After a number of the bolts had been removed the head was suddenly blown off, with the result that the two men were killed. The vessel shot backwards, smashing a water-tower, a windmill, and alighting 500ft. from its original position, where it killed a third man. Details of these incidents can be found in "The Vulcan" for August of this year, and they illustrate very forcibly the foolishness of considering the indications of a pressure gauge at low readings as Gospel truth. If the boiler is to stand idle for any length of time, it is not advisable to leave it empty. However carefully it may be dried and sealed up, there is always a risk of dampness, either from the atmosphere or due to water being left in some part of the boiler, whereas if the boiler is pumped full there is no risk of any part of the surface being exposed to the air.

In boiler cleaning, a very useful method, if there is much scale in a boiler, particularly in one of the Babcock type, where there are a large number of small tubes, is to put about one hundredweight of soda ash into the boiler, and fill it right up with water. Then keep a very small fire in the grate for about 48 hours in order to keep the water just boiling; the top manhole cover should be left off in order to prevent steam pressure being generated, and immediately after this boiling process is finished the water should be run off. This makes the scale far easier to remove. If the operation of scaling takes more than a day, in order to prevent the scale from getting hard again, it is advisable to pump the water full up when the men knock off at night, provided that all the tube caps have not been removed. For this reason, if no other, it is advisable to take off the tube caps row by row as required, because if the boiler is once allowed to get thoroughly dry the scale hardens and the good effects of the soda boiling are lost.

While the boiler is down it is advisable to look out for signs of grease pitting—that is to say, corrosion of the boiler due to decomposition of the fatty compounds which make their way into the boiler with the feed water, if this is derived in any way from engine exhausts. If there is any likelihood of grease getting into the feed in this way, a useful thing is to paint the inside of the steam-drum along the sides and ends to a depth of about 4in. below the normal water-level with Portland cement. Only a very thin coat is necessary, and it will be found that this will entirely prevent grease pitting.

Some experts are believers in the idea that boilers, when laid off, should be kept dry. In the case of large-diameter drum boilers of the Lancashire type, coke fires have been kept alight in the interior of the boiler in order to drive off any moisture, but in the writer's opinion by far the best way in every case, provided the feed water is pure and free from acid, is to pump up as full as ever possible and carefully seal all outlets of escape for the water. Corrosion only occurs where iron and steel surfaces are subjected alternatively to the action of air and water.

THE ASSOCIATION OF ENGINEERS-IN-CHARGE.

A large party of members of the Association of Engineers-in-Charge recently paid a visit to the works of the General Electric Company, Witton, near Birmingham. The party travelled from London under the charge of Mr. Alf. Penn, chairman of the Education Committee, and Mr. W. Capsey, hon. secretary, and were accompanied by Mr. Chris. Wilson, Mr. Barfield, and other members of the General Electric Company's staff in London. At Birmingham Station they were met by Mr. Ernest Wilson, and, after luncheon was partaken of, were conducted round the engineering works, and later round the new carbon works, which proved of special interest, inasmuch as it is the only factory of its kind in this country. Mr. H. Hirst, managing director of the company, met the visiters at tea, and extended to them a hearty welcome. A most instructive and enjoyable day was spent, and the committee, Association of Engineers in-Charge, and especially Mr. Penn and Mr. Capsey, are to be congratulated upon their ability in carrying out the arrangements for this and similar outings, and so making them features of much value to the members.

FORTHCOMING EVENTS.

FRIDAY, DEC. 20.

Institution of Civil Engineers (Students' Meeting).—At 8 p.m., "The Mechanical and Thermal Efficiency of a Petrol Engine," by Mr. L. G. E. Morse.

SATURDAY, DEC. 21.

Robertson's Social and Athletic Club.—At 7 p.m., ball at Brook Green Works, Hammersmith.

SATURDAY, DEC. 28.

Royal Institution of Great Britain.—At 3 p.m., at Albemarle-street, Piccadilly, W., "Astronomy—New and Old," by Sir David Gill (Lecture I.).

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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KELVIN.

Last night the Institution of Electrical Engineers, by postponing its usual ordinary meeting to emphasise the loss sustained in the death of Lord Kelvin, its president, recorded its greatest possible tribute to the general feeling of its members, that they, the Institution, and the whole world had lost the highest scientific genius this world ever held. Kelvin stood on a plane apart, for not only was he intensely scientific, but he was also as intensely practical. No other man, so far as we know history, past or present, ever approached him in this respect. Few theorists really understand the limitations imposed by matter in its practical applications, but it always seemed to us that Kelvin grasped to the full these limitations, hence his successful applications where others failed. We have often repeated the tale told of the late I. Todhunter, who lost his temper by the constant iteration of the hangers-on of science that Britain had lost her supremacy as the nation of leaders of science. He is said to have challenged the pessimists to name names of scientific men throughout the whole world outside, and he would give name for name a name of a British scientific man who should be his acknowledged equal, if not superior. Of course, Kelvin—then Sir W. Thomson—easily took first place. It is not necessary to readers of this paper to enumerate the claims of Kelvin to the foremost niche in the realms of science. By him, undoubtedly, submarine telegraphy became commercially successful. But it is recognised that his wonderful mirror instrument, the Thomson galvanometer, the siphon recorder, and the quadrant electrometer first made possible exact electrical measurements. It is not too much to say that the development of electrical engineering is based upon these instruments, and entirely owes its exact character to them. The problem of giving visible motion to something with the expenditure of an exceedingly small amount of energy was solved by practically giving motion to a something which did not consume energy. Ponder over the instrument so familiar that by familiarity it has lost its strangeness, and try to imagine the faculties of the mind that invented so simple a solution, and then only will you admire its greatness. Before the dawn of the modern electrical engineering era Lord Kelvin—then Sir W. Thomson—had reached the highest pinnacle of scientific fame, but he did not rest satisfied with what he had done; he proceeded to make his mark in the interests of the new development. Go where you will you meet with Kelvin instruments in electrical engineering work as well as in cable work. The practical part of the great physicist's work, however, was comparatively small when we come to consider his theoretical work. The immensity and exactitude of this will be better understood by asking how often and remarking how seldom were his stated conclusions combated. His following number the whole tribe of physical students in the universe, and although most of what he wrote or said wanted interpretation, when duly interpreted it was found to be almost perfect. A great scientific man must be imaginative, he must be able to see what he conceives to be the workings of Nature, and so to follow these workings through all their courses to the ultimate conclusion. Kelvin was, if possible, too imaginative, and this ideal gift often led him in the midst of a simple discourse to diverge into realms wherein only those in the know could follow, but to these the divergence was entrancingly magnificent. The regrets expressed at the loss we have sustained can but feebly express the feelings of all who ever came into contact with our late President, whose life history in all its phases was one of the most beautiful ever recorded. We sincerely hope that the Dean

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and Chapter of Westminster will acknowledge the universal desire to pay homage to the late master in science, to the friend of humanity, to the genius who had led the world of physics, by giving him a resting place within the walls where the great, the glorious, and the noblest of the land have been laid till the great trump of doom severs the bonds of mortality everlastingly. Kelvin was a believer—no truly great mind can be otherwise.

CAB-SIGNALLING ON LOCOMOTIVES.

Mr. J. Pigg's valuable paper on "Automatic Cab-Signalling on Locomotives" produced a good discussion at the Institution last week. The question is one which is of vital importance to the general public, although the introduction of cab-signalling rests rather with the railway engineers, who have to consider its cost and influence on the working of their systems. We have pointed out on several occasions that the devices for preventing errors on the part of signalmen have been carried to a fine art by expert electrical engineers like Mr. Pigg who are connected with our large railway systems. What with the mechanical locking gear between the levers controlling the points and signals and the numerous electrical systems for indicating the positions of these signals, there remains little to be done to nullify the effect of an absent-minded or overworked signalman. The devices are usually most complete where the lines enter large stations and at the termini of the various railways. It is remarkable how free from accidents due to signalmen these parts of our railways are. In spite of the great advances made in this direction since the earlier days of railways when electricity was first resorted to as a means of securing safety in working, the link connecting the driver and the signal remains as weak as ever. A driver, through the interference of the elements, may have extreme difficulty in reading the signals, or may in a few instances, as have proved to be the case, neglect to obey the warning given by the signals. In such cases he has had until now no second line of defence like the signalman. Instead of that, he runs into danger, as has been proved again and again, sticks to his post, and gives his life in the vain attempt to minimise the effect of his mistake. The system of cab-signalling which Mr. Pigg describes is not a new and untried system. It has been in use on the North-Eastern Railway under the author's supervision for nearly two years on the fastest trains on the system. The author gives eleven different conditions of successful working which are fulfilled by the system, but his twelfth statement will appeal most strongly to those who have no experience in electrical signalling work. The statement is that "the directors of the North-Eastern Railway Company have arranged for the equipment of twenty more of their express engines, and of about fourteen miles of their main line between Newcastle and Durham." One other system which has much the same effect of preventing the engine driver from overrunning the signals is that employed on the Underground Railways of London. It consists of a valve in the air-brake pipes, the handle of which projects downwards to a point slightly above the track. When the signal is at "danger," this handle strikes against a block which is raised above the permanent way by the signalling gear. In consequence the brakes are put on, and the train pulls up. This gives a safety which is very necessary on these lines, where the headway between trains is so short. We feel sure that the passengers on the North-Eastern Railway will appreciate the device described by Mr. Pigg, and we shall be pleased to hear any time of instances in which this automatic cab-signalling has prevented an accident.

THE LATE LORD KELVIN.

Probably every science student in the world knows by this time that the world is poorer by the death on Tuesday night last, Dec. 17, of William Thomson, Lord Kelvin. Time as yet is too young to realise adequately the loss we have sustained. Without distinction, all physicists have for years looked upon Lord Kelvin as the supreme head of physical science workers, and awaited and accepted his decisions as those of *the* master mind. To review the work of the late Lord Kelvin would be to review the scientific work of the past 60 years, but the crown was put upon his fame by his work in connection with the early Atlantic submarine cables. Since then his genius carried him to the foremost position amongst men of science in every subject in which he took interest. His colleagues in cable work have long since passed away. Each—Varley, Jenkin, Smith, Bright—left his mark, but the greatest of them all was Thomson.

William Thomson, son of James Thomson, LL.D., professor of mathematics, was born in Belfast on June 24, 1824. Early in life he gave signs, not of precocity, but of great genius. Precociousness is usually temporary; genius,

THE LATE LORD KELVIN.

on the other hand, is permanent, and consists not only in brain ability but in an unlimited capacity for taking pains. Kelvin possessed both ability and capacity, hence the unprecedented value of his scientific investigations and applications.

Prof. J. Thomson left Belfast to become professor of mathematics at Glasgow, and, of course, his son William went also, becoming a student at Glasgow at the early age of 11 years. From Glasgow he went to Peterhouse, Cambridge, and in the year of his majority was second wrangler and Smith's prizeman. It has always been understood that that year the better man was not wrangler, only second, and this is attributed to Parkinson having trained for pace in answering questions as well as accuracy, and pace, and pace alone, put him in front He was elected to the Royal Society in 1851, and became president in 1890. In 1864 he was knighted for his marvellous work in connection with the Atlantic cables, and in 1892 received a peerage—the greatest honour the country can bestow to show its admiration for one of its noblest sons. Both as Sir William and as Lord Kelvin, Thomson was a devoted member of the British Association, and the volumes of the association teem with valuable papers from his pen. The Institution of Electrical Engineers was another

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society to which he became attached, so much so that he permitted himself to be nominated and elected president for the third time during the present year. Owing to the illness of Lady Kelvin, and subsequently his own, he was unable to occupy the chair, and for ever the members will mourn

"The sound of the voice that is still."

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

RE RAILWAY CRISIS.

SIR,—I read "Writer's" pleasant remarks last week, and, not feeling so crushed by his song of triumph as I should do, venture to have another say if I may be allowed.

I do not say that labour is the whole. I say land, labour, and capital are necessary to modern production, but that land being provided without man's labour, and capital only being provided by labour, then labour is the most important factor in production because it is the *active* one. Labour should, therefore, have the say as to how much labour is to be set aside for future production, in whose hands it should be placed, and what lines production should take.

I am not a follower of George any more than of Mill, Fawcett, or Marx, except in so far (and this is "Writer's" position, for he quotes quite legitimately certain economists in support of his case) as they seem to argue correctly. I long ago took your writer's advice to read other economists than George, and if he knew anything of George, as he professes, he would know that George preached the right of the community to possess the value of the land, and that that once achieved capital and labour would prosper together. I believe that capital and labour are intrinsically opposed, so that his kind advice is entirely beside the mark.

I did not mean that visible labour is only to participate, but that the stored-up labour (capital) made by labour should belong to labour and be used in labour's interest. As "Writer" is fond of Mill, let me quote what he says about the holders of land and capital: "They live mainly upon the portions of the national product which are called rent and interest by the legal guarantee to them of the fruits of the labour and abstinence of others transmitted to them without any merit or exertion of their own" ("Political Economy," p. 129, Popular Edition). And this is the "right" of participation for which "Writer" pleads.

The capitalist claims are chiefly claims resting on claims. This class of people is comparatively small, and the capital it holds has mostly been claimed (or withheld by it) from value previously created by labour. It means that the hands that have laboured, brains that have devised, were not the capitalists, but he or his forebears claimed a share of the value created.

The holders of capital (results of past labour) as shareholders, hold something which is only kept in being and in service by labour. They themselves are functionless, they do no productive work (as capitalistic shareholders), and if they were all dead to-morrow production would neither stop nor be injured.

Present continuous labour, if intermitted, would render the results of past labour useless. Therefore these shareholders (as shareholders), being functionless, have no right of participation, while the labourers, being functionary, have the right.

Capital should give power over Nature, but it also gives present holders power over the worker, present and future. For these reasons the interests of capitalism are directly opposed to those of the workers.

In your interesting article two weeks ago *re* "Leeds Tramways," you stated that it was wrong for profits to be made out of the tram-riding public and distributed over other sections of the public—although the money borrowed by Leeds was on the credit of the whole public, and not the travelling part only.

I agree with you: it *is* wrong for one section of the community which doesn't produce the profits to appropriate the profits produced by another section. That is just my case against shareholding capitalists participating in the profits of labour.

The Socialists should be grateful that "Writer" and his friends the economists have dealt so kindly with them. If there is so little difficulty in showing up the Socialist case, why don't some of them do it? Your "Writer" calmly tells us what Socialist doctrines lead to, and yet in the next sentence admits he hasn't studied the new morality of Socialism. I always understood the Socialists read the economists more than other people, and can argue their case from an economic standpoint.

At any rate, some men who *do* know about Socialist morality—Sir Oliver Lodge, Dr. Alfred Russell Wallace, H. G. Wells, Shaw, and others—don't appear to dread any horrible slavery. Of course, it may be that the economist writers of repute cannot show how these fallacious doctrines lead to anything so horrible, though evidently "Writer" can. Anyhow, Mill didn't think so, nor did "Writer's" friend, Thorold Rogers, if I am not mistaken.

In conclusion, as it seems to be fashionable to give advice, may I say to "Writer" that if he would look a little more at the justness of a right, and less at the legality of it, he would expand his un-economic vision.

Wishing you, sir, and "Writer" and "Staffordian" a pleasant Christmastide—Yours, etc.,

LANCASTRIAN.

SIR,—I think it advisable that for the sake of clearness I should recapitulate a little. This discussion started (Nov. 8 issue) by my calling attention to what I considered an inaccurate statement made in the first article on "The Railway Crisis." It was, "The interests of capital and labour are identical."

I endeavoured to show that what the capitalist took as his share of the proceeds of an undertaking the workers of the concern could not receive in wages, and *vice versâ*; and, as a consequence, conflict of interests and its attendant evils followed inevitably upon a system of private ownership of capital.

The "Writer" at first contested this view, but later in one of the questions he put to me (in the Nov. 22 number) he admitted that such conflict did exist. He asked me to name questions other than that of the division of the wealth produced, on which the interests of capital and labour clashed, clearly implying that on this fundamental point there was a conflict of interests.

That I had gained my point I indicated gently in my letter in the issue of Nov. 29, but, strange to say, this seems to have escaped the notice of the "Writer," for in last week's issue he suggests that this question "of conflict or identity of interest" is the one under discussion. As a matter of fact, it is another question raised by the "Writer" which is at present occupying our attention—the question of the "right of the capitalist to share in the wealth labour has produced by the aid of his capital." He and "Lancastrian" have entered into a theoretical discussion which I will not concern myself with to any extent.

The "Writer" sums up his case by saying "All capital has been saved," and

> Production as seen every day needs, so far as labour is concerned,
> Previously accumulated labour + immediately visible labour.
> Previously accumulated labour = capital.

This proposition is fairly obvious, and I accept it freely, but if we attempt to apply it to practical affairs we find it is very little use.

The capital in the hands of the actual persons whose labour has produced it is a tiny proportion of the whole. The great mass is held by people who have not worked for it. Much has been inherited, much accumulated from rent of land, mining royalties, and the like; a great deal is due to enhanced values following from the growth of industry and the expansion of towns.

If the "Writer" would defend the right of capital to share the products of labour, he must justify these modes of accumulating capital and others less reputable. To say that capital deserves reward because it has some time or

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other been produced by labour is an entirely misleading statement, the more false because it is partly true. It implies that the existing private capitalistic and competitive system is justifiable, whereas in the main it is not only wrong but inefficient, and has not even the excuse of expediency. It is wrong because a man is not secure in the possession of the produce of his labour; he obviously ought to share his produce with the man whose labour and saving have facilitated his work, but the idler who has not produced the wealth he owns has no claim upon him, yet he is able under the system to extort in the form of rent and interest, roughly, one-third of the total wealth created according to the most reliable statisticians.

It is inefficient because of the constant friction and conflict. It is inexpedient because the extremes of riches and poverty which attend it are detrimental to their possessors.

The charges levelled against me of being a follower of the St. Simonians (of whom I had not previously heard), and of being imbued with fallacious views, which, if accepted, would lead to slavery ten times more terrible than any in the world's history, seem rather harsh on one who is only advocating placing industry generally on the same basis as the Navy or the Post Office—*i.e.*, nationalisation.—Yours, etc.,

STAFFORDIAN.

SIR,—I have followed the present controversy with great interest, and would like to congratulate you and your correspondents on having evolved some definite result on a subject so often barren. Though I cannot lay claim to the thorough knowledge and wide outlook which "The Writer of the Crisis" is anxious to inculcate, I would like to question again the validity of his statement that the interests of capital and labour are alike, following his method of trying "to convert one's opponent from his own words." As thus: Granted that the product of previous labour (capital) has a right to a share of value created by present labour, I submit that a portion of capital's share of the value of present labour will be stored up—*i.e.*, present labour produces more capital. This capital has the right to a share of the value which will be created by the application to it of future labour—*i.e.*, future labour will have to pay toll to a portion of the value created by present labour. Therefore, the less capital present labour supplies, the less it will have to pay toll on in the future. It is, therefore, to present labour's interest, on this count alone, to get as big a share as possible of the values it creates now.

You will say at once that such an attitude on the part of labour is suicidal. Exactly. But it is the logical outcome of the present competitive system of producing for profit, which is inherently self-destructive. For if labour commits suicide, it automatically kills capital. This, of course, cannot happen. Labour must either possess capital or capital possess labour. It must be either private monopoly—we are seeing now what even a partial system of monopoly whose end is profit will do in the United States—or public monopoly, whose end should be use, as you are again pointing out in connection with the Leeds tramways. The "Writer" seems to think that, having proved that capital has a right to its share of labour values, he has proved that all is right as right can be. But most Socialists will, if he likes, concede the point, and yet continue to believe that something is very wrong. He will ask and answer further questions. Thus:

Capital, on the "Writer's" showing, is previous accumulation of former labour. Who performed that labour? The whole community of previous generations.

Who ought to possess that labour? It should belong to the true descendants of the men who performed it. The product of the brains and energy of the community of yesterday should belong to the brains and energy of the community of to-day.

Who does possess it? The "'Daily Mail' Year Book" estimates that one-ninth of the population own nineteen-twentieths of the capital of the United Kingdom.

How did they get it, and what are they doing with it? He is confident that an honest answer to these two questions will show that they have done practically nothing for the community in return for the capital it made for them, and that they are using their capital in direct opposition to the best interests of the present community. That though they are keen enough to insist on the right to capital's share, they never admit the moral responsibility of the fact you state—that capital is just stored-up labour, and that its right to share is its own quality, and not the prerogative of him who (as the Socialist thinks) wrongly owns it. He directs attention to his question, "Who ought to possess capital," and his answer—viz., the community. He has a plan for the achievement of this object, and is very anxious to have it studied, and improved if it is right or refuted if it is wrong.

The matter is of vital importance to engineers. We are changing the face of the earth—the conditions of life—with our work. We are making or helping to make the roads on which our descendants must travel. For whom are we doing it, and where do those roads lead to? It is in the hope that some of the patience, and the thought, and the knowledge, and the energy that is given up to our technical problems may be brought to bear here, that I have ventured to push this capital and labour question thus far. For I believe that the technical man is the man who is able to solve the social problem. It is essentially a technical problem, to be settled only by scientific knowledge scientifically used.—Yours, etc.,

MANCUNIAN.

WESTINGHOUSE-BREMER PATENTS.

SIR,—Our attention has been called to a statement issued by Messrs. D. Santoni and Co. (1906), Limited, respecting the infringement of a patent of Hugo Bremer in connection with flame arc lamps, which patent is owned by this company.

Messrs. Santoni and Co. are in error in suggesting that the claim made by us has been finally settled in their favour. The amendment of this patent has been already substantially allowed by the Comptroller-General, whose decision with regard to the mere details of the wording we are daily expecting. As soon as possible thereafter we shall proceed to enforce our claim.—Yours, etc.,

THE BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, LIMITED.

ELECTRICAL TRADES' BENEVOLENT INSTITUTION.

SIR,—I shall be obliged if you will take the opportunity of again reminding your readers at this time of the year of the continued existence of the above institution.

I am glad to say that the above institution is making progress in the collecting of funds, but I could certainly wish that the interest in it was more widespread, and that the funds came from a still greater number of individual members of the industry.

Any of your readers feeling an interest in the matter can obtain the fullest particulars from Mr. W. Davenport, secretary of the National Electrical Manufacturers' Association, 2, Queen Anne's-gate, Westminster, S.W.—Yours, etc.,

ONE OF THE COMMITTEE.

THE PROVINCE OF THE ILLUMINATING ENGINEER.*

BY LEON GASTER.

Until the last few years the question of proper illumination has not received sufficient recognition as being of any special interest or concern of the gas or electrical central-station engineer; his business has been to supply gas or electric energy to the consumer, but not illumination, and it was left to the consumer to make the best he could with the illuminant adopted. Needless to say, the result in most cases was very poor indeed. The object of this paper is to show the means by which this unsatisfactory state of affairs may be improved upon, and to indicate some of the important problems with which the illuminating engineer has to deal, and from the proper solution of which the consumer and the whole lighting industry would benefit in the future.

I must ask your kind indulgence if occasionally I try to explain things which are known to most of you present, but it might help in making clearer some of the points with which I will deal afterwards. The difference between light and illumina-

* Paper read before the Association of Engineers-in-Charge, Dec. 11.

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tion may be defined. Light is the cause, and illumination is the effect. An object on which light falls becomes illuminated, and an object is well illuminated when it can be easily seen without fatigue or strain on the eyes. Good illumination requires, therefore, amongst other conditions, sufficient light to enable one to see clearly and distinctly; avoidance of too much light, which produces a blinding and fatiguing effect on the eyes; avoidance of having a bright light in the field of vision, which cuts down the ability to see clearly things which are less brilliantly illuminated; avoidance of glare due to the light striking an object at such an angle that a large part of the light is reflected directly to the eyes, etc. It will be seen, therefore, that in considering any form of illumination it is absolutely necessary to take into consideration the effect on the eyes. There is, however, also the æsthetic aspect of illumination to be considered, with which the architect is very closely concerned, but which has not received, in many cases, the attention it deserves. It is unquestionably true that the intentions of the architect are frequently defeated by the adoption of some tasteless and defective system of illumination, which quite fails to bring out the æsthetic and architectural features of a room or building to the best advantage. When we take the broad standpoint that it is only by means of light that we are able to see surrounding objects at all, the importance of the careful utilisation of the light is evident. On account of the enormous improvements which have been made during recent years with the different illuminants, the proper application of the above-named principles have somewhat taxed the ordinary lighting contractor, and therefore a great deal of discussion has taken place in the technical Press as to the advisability of establishing a new specialist, to be called "the illuminating engineer." A definition as to what this new professional really is, or what he ought to be, was given in one of the papers some time in August last. According to that and other journals it is obvious that the illuminating engineer will have to be a person of strong will and even temper. He will have to deal with gas, electricity, oil, acetylene, etc., and know how to make the best use of any or all of them. But even these qualifications do not constitute all that is required of the illuminating engineer. He must possess a sound grounding in physics and chemistry, and some knowledge of physiological optics; he must be well up in the science and art of photometry; and, above all, he must have a lively sense of the artistic. The illuminating engineer will have to be possessed of great tact and enormous persuasive powers to wean us from such choice as an artistic but foolish fitting; in other words, the task of the illuminating engineer is not to be passed over lightly. I think that the numerous qualifications required will make it somewhat difficult for obtaining satisfactory references if asked for.

Until recently the engineer who wished to lay out the lighting of a building had so far not sufficient definite rules or formulæ he could make use of. The distribution and intensity of illumination in the neighbourhood of a single source of light can be easily calculated by well-known methods, and plotted in the form of a curve. When, however, the illumination is the result of several sources of light in different directions the question becomes more complicated, and the difficulty is further increased when the diffusion from the walls, etc., of an enclosure has to be considered. The illumination of a room or other enclosure may be divided into two factors—that derived from the direct radiation from the source of light and the diffused light resulting from the combined reflection from the surrounding surfaces, and this varies very considerably. Very recently Dr. Louis Bell, of Boston (see Dr. L. Bell's paper read before the first annual convention of the Illuminating Engineers in Boston, 1907), made a series of tests to determine the coefficients of diffused reflection, obtained by using wall-papers of different finishes and various colours, and I append herewith the table, which differs somewhat from the previous tables used.

TABLE OF COEFFICIENTS OF DIFFUSE REFLECTION.

Kind.		Colour.	Coefficients for skylight.		Inc. lamps.
Plain ceiling	...	Faint greenish	·50	.....	·53
,,	...	Light ecru	·27	.....	·26
,,	...	Very faint grey cream	·53	.....	·64
,,	...	Light grey green	·26	.....	·23
,,	...	Light yellow	·53	.....	·49
,,	...	Faint ecru	·47	.....	·55
,,	...	Faint pinkish	·41	.....	·43
,,	...	Pale bluish white	·42	.....	·31
Crepe	...	Medium green	·25	.....	·19
,,	...	Darkish coffee brown	·08	.....	·06
,,	...	Deep green	·05	.....	·06
,,	...	Deep yellow buff	·41	.....	·41
,,	...	Full green	·06	.....	·06
,,	...	Deep red	·05	.....	·05
,,	...	Medium red	·06	.....	·08
Cartridge	...	Medium green	·15	.....	·11
,	...	Dull green	·11	.....	·07
,,	...	Dull yellowish green	·09	.....	·07
,,	...	Light pinkish brown	·21	.....	·26
,,	...	Light green	·23	.....	·18
,,	...	Light blue	·21	.....	·20
Cartridge	...	Pale grey	·35	.....	·27
,,	...	Faint yellowish green grey	·43	.....	·33
,,	...	Salmon buff	·31	.....	·33
,,	...	Medium light buff	·44	.....	·44
,,	...	Medium full green	·11	.....	·07
,,	...	Medium dull red	·06	.....	·07*
,,	...	Light red	·10	.....	·10
,,	...	Very deep ecru	·18	.....	·15
,,	...	Pale pink	·25	.....	·19
,,	...	Deep yellow grey	·18	.....	·15
Silky finish	...	Medium crimson	·08	.....	·12†
,,	...	Medium grey green	·17	.....	·12
Stripes	...	Deep cream	·56	.....	·60
,,	...	Deep cream silvery	·56	.....	·57
,,	...	Yellow medium	·50	.....	·53
,,	...	Deep buff	·53	.....	·58
,,	...	Medium red	·06	.....	·08
,,	...	Medium red satin	·07	.....	·11
,,	...	Light strawberry pink	·43	.....	·43
,,	...	Light strawberry silvery	·51	.....	·49
,,	...	Light and dark green	·06	.....	·07‡
,,	...	Silvery light green	·13	.....	·14
,,	...	Light green	·36	.....	·26§
,,	...	Silvery light green	·36	.....	·23‖
Miscellaneous	...	Dark green and gold	·24	.....	·19¶
,,	...	Light green and gold	·31	.....	·28
,,	...	Deep and light red	·12	.....	·20
Pique	...	Light bluish	·46	.....	·47
,,	...	Light grey	·38	.....	·38

* Grey red. † Across grain. ‡ Heavily streaked deep green. § Plain. ‖ Corded. ¶ Minute figuring with much gold.

The amount of illumination required for different purposes varies very considerably. I have refrained from giving in this paper any tables, as there are now several books published dealing with illumination in which tables are to be found, and need not be repeated here. I should like also to mention that Mr. G. H. Stickney read a paper last May before the New York Section of the Illuminating Engineers on "Colour Values of Artificial Lamps," in which he gave a very interesting table showing the effect which certain coloured rays produce when falling upon different coloured objects, and he gives also a table showing the predominating colours of many artificial lights, which I reproduce here as useful.

Orange	rays	falling	on	white	make it	appear orange.
,,	,,	,,		red	,,	,, reddish orange.
,,	,,	,,		orange	,,	,, deeper orange.
,,	,,	,,		yellow	,,	,, orange yellow.
,,	,,	,,		green	,,	,, dark yellow green
,,	,,	,,		blue	,,	,, dark reddish grey.
,,	,,	,,		violet	,,	,, dark purplish grey.
,,	,,	,,		black	,,	,, brownish black.
Red	,,	,,		white	,,	,, red.
,,	,,	,,		red	,,	,, deeper red.
,,	,,	,,		orange	,,	,, orange red.
,,	,,	,,		yellow	,,	,, orange.
,,	,,	,,		green	,,	,, yellowish grey.
,,	,,	,,		blue	,,	,, violet.
,,	,,	,,		violet	,,	,, purple.
,,	,,	,,		black	,,	,, rusty black.
Yellow	,,	,,		white	,,	,, yellow.
,,	,,	,,		red	,,	,, orange brown.
,,	,,	,,		orange	,,	,, orange yellow.
,,	,,	,,		yellow	,,	,, deeper yellow.
,,	,,	,,		green	,,	,, yellowish green.
,,	,,	,,		blue	,,	,, slaty grey.
,,	,,	,,		violet	,,	,, purplish grey.
,,	,,	,,		black	,,	,, olive black.
Green	,,	,,		white	,,	,, green.
,,	,,	,,		red	,,	,, yellowish brown.
,,	,,	,,		orange	,,	,, greyish leaf-green.
,,	,,	,,		yellow	,,	,, yellowish green.
,,	,,	,,		green	,,	,, deeper green.
,,	,,	,,		blue	,,	,, bluish green.
,,	,,	,,		violet	,,	,, bluish gray.
,,	,,	,,		black	,,	,, dark greenish grey.
Blue	,,	,,		white	,,	,, blue.
,,	,,	,,		red	,,	,, purple.
,,	,,	,,		orange	,,	,, plum brown.
,,	,,	,,		yellow	,,	,, yellowish grey.
,,	,,	,,		green	,,	,, bluish green.
,,	,,	,,		blue	,,	,, deeper blue.
,,	,,	,,		violet	,,	,, deep bluish violet.
,,	,,	,,		black	,,	,, bluish black.
Violet	,,	,,		white	,,	,, violet.
,,	,,	,,		red	,,	,, purple.
,,	,,	,,		orange	,,	,, reddish grey.
,,	,,	,,		yellow	,,	,, purplish grey.
,,	,,	,,		green		bluish grey.
,,	,,	,,		blue	,,	,, bluish violet.
,,	,,	,,		violet	,,	,, deeper violet.
,,	,,	,,		black	,,	,, violet black.

Predominating Colour of Artificial Light.

Lamp.	Colour.
Enclosed arc—clear globes.	Bluish white.
Enclosed arc—opal globe and selective diffuser	White.
Mercury arc lamp.	Blue green.

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3½-amp. 140-volt direct-current enclosed arc.	Violet (beyond colour correction).
Nernst lamp—new glower.	Pale lemon yellow.
Nernst lamp—seasoned glower.	Deep lemon yellow.
Incandescent—new.	Yellow.
Incandescent—seasoned.	Pale orange yellow.
Welsbach and vapour hydrocarbon—new.	Greenish white.
Welsbach and vapour hydrocarbon—seasoned.	Greenish yellow.
Ordinary gas flame.	Reddish yellow.

Light and its effec , illumination, having to do with the eyes, are peculiarly subject to fallacious misunderstandings. The whole subject has a rather abstruse scientific basis, in consequence of which there is more general ignorance concerning it than any other subject of similar importance. In an article recently published in the *Illuminating Engineer*, entitled "Freaks and Fallacies in Illumination," some schemes of that unscrupulous class of persons who are always ready to profit by the credulity of the public, especially with regard to things scientific, are fully described, and I will here give you only one example of the many cited.

One of the most curious instances of an innocent misconception of the nature of reflected images is to be found in a patent granted about 100 years ago. The invention consisted in a device for "multiplying and increasing the light" of a gas jet, and was to be applied to street-lighting. It consisted of a number of ordinary glass bottles filled with water, which were to be placed round the gas flame at suitable distances. The inventor states that in each of these bottles will appear an image of the flame, nearly as bright as the flame itself, and hence proportionally effective in illuminating the streets. Thus, if four such bottles were used, nearly four times as much illumination would be produced as that given by the bare gas jet. The most amazing part of the performance was the seriousness with which the scheme was exploited. That the city authorities who had the street-lighting in charge at the time considered the invention to be of practical use is evidenced by the fact that the inventor took out a second patent, in which he states that he makes certain modifications to satisfy objections that were made by the lighting commissioners. It is strange that no one was logical enough to follow the argument to its conclusion—namely, that by using enough bottles a single gaslight jet may be made to light up every street in London. The idea that light can be increased by reflection is one of the most persistent fallacies of the whole subject, and devices are by no means unknown to the trade to-day which in reality are based upon this principle, though none may be openly declared. Several other examples are cited where the consumer is mostly abused owing to his ignorance of the laws concerning the questions relating to illumination. The increased knowledge of the laws of light and illumination, which the rapidly-growing movement in illuminating engineering is fostering, must exert a decided check upon the popular misconceptions and fallacies which have so long prevailed.

The new light sources are excessively intense or bright. Take the incandescent electric lamp for example. If you look at such a lamp when it is burning, the image of the filament on the retina is so intensely brilliant that if you cover your eyes with the hand you will continue to see the bright form of the filament floating in a dark field for some time. This shows that the excessive brilliancy of the image strained that part of the retina upon which it fell, so that it required some time to recover. If the strain were continued long enough, the injury would become permanent. There are cases on record where total loss of sight has resulted from such a strain. It may be put down as an established fact in artificial lighting that all modern light sources are too bright to be used uncovered. While the light is to be used for careful vision, such as reading or writing, it should either be enclosed in some sort of globe which will produce a diffused light, or be placed so that the eye cannot see the source of light. If this rule is adhered to, it will be found that none of the modern high-power lights are too hard on the eyes. It was with a view of avoiding serious waste of light that the Holophane globes have been invented. It will suffice to know that these globes are made of the purest crystal glass, having both inner and outer surface formed into series of prismatic rays and flutings accurate to the thousandth part of an inch. These prisms are of such forms as to soften and diffuse the light, and at the same time turn the rays into a useful direction. This is accomplished by forming the prisms in accordance with the established laws of optics. Messrs. Siemens Bros., through the assistance of Mr. Wheat, have been good enough to send me here a series of lantern slides to demonstrate to you by a series of curves taken by unbiassed and authoritative operators the distribution of light obtained by the use of tantalum lamps in combination with the Holophane globes and reflectors. You will be able to see from these curves how the light can be distributed in any direction desired by a suitable construction and combination of the lamp and shade together. While throwing the larger part of the light in the direction required for special use, they allow a sufficient amount to shine in other directions to produce a soft and pleasing general illumination effect. The artistic and decorative effect of the globes and shades used in the home must also be considered as carefully as their utility.

Factory Lighting.

England being an industrial country, I should like to say a few words concerning factory lighting. The average factory requires artificial lighting during 10 to 20 per cent. of the working hours, not including overtime or night work. Therefore, the illumination should be sufficient, and the lamps so arranged that the quality and quantity of work accomplished during these hours should be as well done as that which is performed by daylight. The amount of light required varies with the size of the room, relative position of machines, the general shop conditions, and to a very great deal with the character of work to be done. Is there a more exaggerated case of false economy than that of requiring people to work by poor illumination? In comparison with the cost of labour the cost of light is trifling. Take as an illustration the case of a skilled workman receiving 8s. to 10s. a day—about 1s. an hour. Figure the cost of energy used by a 16-c.p. lamp burning 10 hours, and see how much of the man's time it requires to pay for the light (if current is available at 1d. per unit it works out at less than ½d.). Yet there are thousands of skilled mechanics handicapped by insufficient and ill-directed light. In the case of bad lighting in a factory or workshop the personal inconvenience means a reduction both in quality and quantity of the output, thus producing a loss to which in comparison the entire cost of illumination is trifling. One must bear in mind that the workman is guided in his work almost exclusively by the sense of sight, and the importance of furnishing good illumination is quite apparent, but in many cases this truth is sadly overlooked.

(To be continued.)

TRAMWAYS AND LIGHT RAILWAYS LAID ON PUBLIC ROADS.

Memorandum Regarding Details of Construction and Equipment of New Lines.

The current issue of the *Official Circular* of the Tramways and Light Railways Association contains some correspondence which passed between the secretary of the association and the Board of Trade respecting the new memorandum (a copy of which is given below). The Board of Trade were asked whether any satisfactory designs were submitted with regard to the alteration of standard lifeguards, and, in reply, Mr. G. R. Askwith writes that a spring for holding down the tray of the lifeguard is already provided on some tramway systems. He adds that the spring need not be a very stiff one, and points out that it would only come into use in cases of emergency—*i.e.*, when the guard had dropped! The following is a proof of the revised memorandum concerning the construction and equipment of tramways and light railways which it is proposed to issue at an early date.

1. *Clearance.*—The space between the inner rails of a double line must depend upon the overhang of the cars. It is, however, necessary that there should be at least 15in. between the sides of passing cars and also a similar space between the side of a car and any standing work—such as lamp, telegraph, and trolley wire posts—in a street. The bases of side posts should be placed inside the kerb at a sufficient distance from it to prevent the possibility of road vehicles coming into contact with them. There should be at least 15in. between the side of a car and the kerb, whether on straight or curved roads. The clearance between the top deck of cars and the underside of bridges should not, if possible, be less than 6ft. 6in. Where this clearance cannot be obtained special precautions in working will be required, but in no case will less than 6ft. be accepted with uncovered cars.

2. *Posts and Brackets.*—Centre posts should not be used without the consent in every case of the Board of Trade. The stone kerbing round centre posts should not be such as to enable any person to stand upon it as a refuge, unless the clearance is ample for safety. Where bracket arms 16ft. in length will not suffice, it is desirable that span-wire construction should be used.

3. *Permanent Way.*—The weight of rails should not be less than 90lb. per yard, 100lb. being preferred. The groove of the rail should not exceed 1⅛in. in width, but a groove not exceeding 1¼in. will be accepted on curves of less than 150ft. radius. The details of permanent way and mode of construction as approved by the Board of Trade should not be varied at any time without the Board's consent.

4. *Cars.*—Drawings of the cars intended to be used on a line should be submitted to the Board of Trade for approval before orders for the cars are placed. Staircases of the "reversed" type should be avoided, more especially on narrow-gauge lines. Of existing types, the "trigger" lifeguard is the pattern which

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is preferred. The hanging gate should be as close to the ground as possible, and there should be at least 3ft. between it and the front of the guard. Both the guard and the gate should be at least as wide as the outside of the frame of the truck. The tray of the guard should be provided with a spring, so as to hold the front edge down to the surface of the roadway when the tray is dropped. In order not to interfere with the efficiency of the lifeguard, it is desirable that folding steps should be adopted on all new cars. Where the gauge of the line is 3ft. 6in. or less, top deck covers should not be used without first communicating with the Board of Trade, to enable the circumstances of each such case to be specially considered. Arrangements for sanding each rail may be required at each end of the cars where considered necessary on account of the gradient. Top deck railings should be at least 3ft. 6in. high. All railings should be connected with earth. The trolley standard must be connected with earth by a sufficiently low-resistance connection to prevent any electric shock, and the warning signal should be an electric bell. Where trolley ropes cannot be dispensed with or tied up, precautions must be taken to prevent the "slack" causing accidents. To prevent trolley booms being pulled out or trolley standards broken, "traps" should be minimised and detachable trolley heads provided. No material alterations should be made in cars after inspection, nor any fresh type of car adopted, without the consent of the Board of Trade.

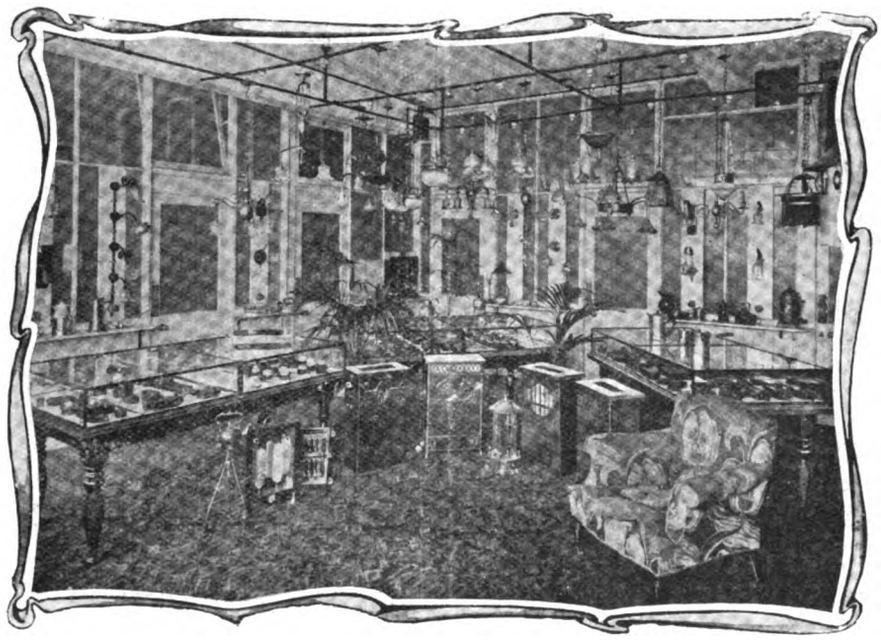
SIMPLEX CONDUITS, LIMITED.

Opening of New London Offices.

The new London branch of Simplex Conduits, Limited, in Charing Cross-road, was officially opened on Tuesday last in the presence of a large number of guests, who included electrical contractors, central-station engineers, fire insurance representatives, and tradesmen.

The new premises have a commanding position in a thoroughfare which is already a very popular one with the electrical trade, and consist of the ground floor and basement of a recently-erected handsome building which has risen on the site of one or two second-hand bookstalls, the total area occupied by the company being nearly 3,500 square feet. The London branch comprises the sales department, which deals with local and South of England requirements generally, and the publicity department. The offices being situated on the ground floor, surround and open into the showroom, which occupies the centre space. The whole of the basement is devoted to store purposes. Larger stocks than hitherto can now be carried, and, with a view to increasing facilities in this direction, the company have excavated a portion to the extent of 3ft. in depth in order that tubes may be stored upright. The extra quantity which can be stowed away in this manner is enormous as compared with the horizontal rack method, which has to be resorted to when it is not possible to obtain lift head room. The capacity is approximately 150,000ft. Fittings are stocked in the usual form of bins. Ample provision is made for rapid packing and dispatch, whilst a work-bench is fitted up with a small drill, vice, screwing apparatus, etc., to facilitate carrying out these operations on the spot in the case of urgent orders. The showroom is equipped with every description of accessory, displayed in a number of glass showcases. The main example of the conduit system is, however, given by the lighting installation of the premises, which has been carried out by the company's own men with the view of combining as much as possible typical examples of "how things should be done." Especially is this noticeable at the main lighting board controlling the ground floor. The whole of the various runs are brought to a point on the ceiling above the board and collected in an adaptable box; from this the circuits are taken down to the board in four tubes. The board itself is a double-pole fuse and a single-pole switch, wood-cased type. The fuses are their special enclosed cartridge pattern, mounted on separate slate bases and controlled by rapid-action switches; it practically represents the highest class of distribution board design. Another interesting piece of work is to be seen in the basement, where the supply company's mains run into the building. Two main fuseboards of different pattern are installed, one controlling the power supply and the second for the basement lighting. The main switches and fuses are of the Simplex "push-on pull-off" type of combined switch fuse.

In the general equipment and arrangement of the showroom flexibility has been the great aim—that is, to facilitate rearrangement of the various samples and fixtures displayed. The value of the constant change in this regard cannot be overestimated. Nothing is calculated to arouse more interest in a customer than the idea that he is seeing something new on each occasion of a call, and it is anticipated that an entirely fresh appearance can be given to the showroom within an hour or so. No apparatus is permanently fixed in position, a circumstance which has been considerably assisted, if not rendered necessary, by the nature of the building itself. All types of electric light pendants and electroliers, of which there are a number, some of unique and striking design, are attached to the cross tubes. They are wired complete to a plug so that they can be readily put into circuit by connection to one of the sockets. The plugs at the two ends of the circuit wires of the tubes are carried down the partitions to another wall socket fixed on a small shelf, which surrounds the showroom at a convenient height. The wall socket is wired directly from the main distribution board. It will be seen that half a dozen fittings can be thus readily lighted up for display purposes, whilst if it is desired to have one only lighted in order to obtain a better idea of its effect, this is easily accomplished by disconnecting the other fittings from the sockets in the same overhead run. As all pendants are attached by S hooks, their position can be altered in a few moments. Brackets and wall fittings are attached to wood panels fixed in the lower frames of the partitions. These panels are all interchangeable, and are arranged so that they can be readily removed and altered. Brackets, etc., are also wired to plugs for connection to the sockets on the shelf before mentioned.



Simplex Conduits New London Showrooms.

The arrangement of the windows is carried out on a similar plan; every piece of lighting or heating apparatus is fixed with a plug for connection to a socket. The latter are arranged in groups of eight, flush sunk in Simplex cast-iron boxes, and controlled directly from the main board. We think that from the point of view of flexibility the arrangement is an excellent one, and strikes out in a somewhat novel line when compared

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with the style on which the general run of showrooms for electrical goods are laid out, although perhaps from the display point of view something is lost owing to the ceiling; but taking into consideration the numerous constructional difficulties met with in the building, the utmost use has been made of the opportunities at the company's disposal. In addition to the well-known tubes, accessories, and distribution boards manufactured by Simplex Conduits, Limited, there is quite a representative display of electric lighting fixtures, heating and cooking apparatus, lamps (including a metallic-filament lamp for series burning of one watt per Hefner candle-power efficiency) and cables. Some of the designs are quite original and tasteful, whilst an innovation is to be found in some "pedestal" form of luminous radiators and one for use on the wall. The cables are British made throughout, and are, we understand, in thorough keeping with the high quality which is synonymous with the name "Simplex."

Finally, it is apparent that the Simplex Company have made the utmost possible out of the space at their disposal, and we advise those interested in installation matters to call and inspect the premises for themselves at an early opportunity.

On Tuesday evening the company entertained a gathering of about 100, among which were representatives of the various branches of the electrical industry and many of the company's agents in this country, to dinner at the Holborn Restaurant. Mr. H. Huggins (chairman of the company) presided, and speeches were made during the course of the evening by Mr. J. E. Lloyd-Barnes, Mr. C. S. Northcote, Mr. J. E. Edgecumbe, Mr. L. M. Waterhouse, the Chairman, and others.

LEGAL INTELLIGENCE.

NORWICH CORPORATION v. TRAMWAYS CO.

On Friday last, before Mr. Justice Bray in the King's Bench Division, the special case of the Mayor and Corporation of Norwich *v.* the Norwich Electric Tramways Co. was concluded. The point in dispute was as to the maintenance of certain portions of the roadway on the routes of the tramways.

His Lordship, in giving judgment, said this case was not free from difficulty, but, on the whole, he had come to the conclusion in favour of the arbitration. The Corporation relied upon Sub-Section 5 of Section 57, and they said that the tramway company had failed to maintain and keep in good condition to the satisfaction of the Corporation the junction of the paving laid and maintained by the company with the surface of the road laid and maintained by the Corporation. It seemed to him that he must come to the conclusion that Sub-Section 5 was intended to give an additional remedy to the Corporation beyond what was given in the other sub-sections. Now, he had to consider what was the meaning of Sub-Section 5. He thought it was intended to cover this case. It did not want any evidence to tell one what would happen where the part of the road maintained by the Corporation was macadam and the part maintained by the tramway company was granite setts. Of course, the macadam would wear down sooner than the granite paving, and without getting out of repair, or wearing into holes, the general level of the macadam would inevitably be lower than the granite sets. That difference of level would be at or almost immediately upon the junction. He did not think it necessary to say that the levelling up should be exactly at the point of junction. He thought that if there was a wearing down, as the umpire stated, of from 2in. to 6in., there would be a wearing down at the junction, and if that continued it would not have been properly maintained in good condition. He did not know whether according to the ordinary state of things that would be an interval of 2in. or not. It might or might not be. He was not quite sure what the arbitrator meant, but even if the level of the macadam were for 2in., in his opinion, construing this section fairly, the junction did not cover merely those 2in., but covered the ground adjacent, so that if there was a groove or ridge caused by the traffic which was not repaired there would be a failure to maintain the junction. One could not help seeing that inevitably that would happen, and it required no straining of the language of Sub-Section 5 to suppose that it was intended to cover that very instance. He must hold that the law as laid down by the arbitrator in the special case was correct, and the Corporation were entitled to the costs of these proceedings.

THE TERM "ELECTROMOBILE."

Dispute between Motor Companies.

In the Court of Appeal on Monday last, before Lord Halsbury, Lord Justice Vaughan-Willians, and Mr. Justice Bigham, the hearing was concluded of the case of the Electromobile Co. *v.* the British Electromobile Co. and others, on the appeal of the plaintiff company from a decision of Mr. Justice Warrington. The case raised the question whether "electromobile" meant any motorcar propelled by electricity or whether it meant an electric car of the plaintiff company. The latter claimed an injunction to restrain the defendant company from using or carrying on business under the style of the British Electromobile Co. or any style or name which so nearly resembled it as to be calculated to deceive and confuse the public, or to induce the belief that the business of the defendant company was the same as or in any way connected with the business of the plaintiffs. The plaintiff company was registered in 1902, and acquired the undertaking of the British Electromobile Co. The defendant company was registered on April 8, 1907. The plaintiff company's case was that the electric carriages manufactured by it had acquired a great reputation, that they were well known in the trade as "electromobiles," and that that name had become so identified with the electric carriages manufactured and sold by the plaintiff company that "electromobile" was understood by the company to mean an electric carriage made by the plaintiff company. The defendant company by its defence said that the word "electromobile" was an ordinary English word in general use, and meant a car or carriage propelled by electrical energy; that the word had not acquired any such meaning as the plaintiff company claimed; and that the latter was not entitled to the exclusive use of the word. Mr. Justice Warrington held that the word "electromobile" was a descriptive term, and did not mean the goods of a particular person, and entered judgment for the defendant company. Hence the present appeal of the plaintiff company.

The Court unanimously dismissed the appeal.

BROWN'S TELEGRAPH PATENTS.

The appeal from the judgment of Mr. Justice Neville upon a petition for the revocation of letters patent granted to Mr. S. G. Brown for improvements in electric telegraph apparatus in relation principally to the working of telegraphic relays at the end of long submarine cables, was concluded last week in a court consisting of the Lord Chief Justice, Lord Justice Buckley, and Lord Justice Kennedy.

The Lord Chief Justice, in giving judgment, said it had been urged by the appellants (the petitioners) that the success of the patent did not depend upon that which Brown found out, but upon the beauty of the manufacture of the instrument and the use of things that were not covered by the patent, but were merely used for making the instrument extremely efficacious and satisfactory. It was said that Mr. Justice Neville had confused discovery with invention; that what Brown claimed as an invention was a known and existing device, and that all that he did was to call the attention of the electrical world to the fact that it could be utilised in this particular instrument. In dealing with those arguments his Lordship thought that a very broad and strong answer was to be found in the fact that cable companies were paying for the use of the invention thousands a year in royalties. Further, the history of electrical engineering showed that the difference between success and failure was sometimes extremely small, and that many attempts at success failed because some very small points had been overlooked or were thought to be immaterial. It was impossible to say that Mr. Justice Neville was wrong in the importance he attached to the evidence on this part of the case. His Lordship then dealt with the parts of the machine which had been attacked, and dealt also in detail with the evidence and contentions relating to various claims of the petitioners. As to each of them he agreed with the conclusion arrived at by Mr. Justice Neville, that the petitioners had failed to establish their objections. He was, therefore, of opinion that the appeal should be dismissed.

Lord Justice Buckley and Lord Justice Kennedy concurred.

COMPANIES' MEETINGS AND REPORTS.

INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS.

The ordinary meeting of the India Rubber, Gutta Percha, and Telegraph Works Co. was held on Tuesday last, the chairman, Major Leonard Darwin, presiding.

In moving the adoption of the report and balance-sheet (*Electrical Engineer*, Dec. 13), the Chairman said it was stated that the price of raw material had fallen, and although prices were at present depressed, it was difficult to form an opinion of any value as to the standard of prices to be adopted by manufacturers. They were all conversant with the results of overtrading which had been slowly developing themselves in America during the year just closing, and with the rumours of a somewhat similar condition in Germany. What effect this state of things would have on traders in this country it was, of course, impossible to predict, and their business could hardly be considered an exception to any rule which should apply to all others. It was suggested, he said, that the countries which were doubtless overstocked would try to liquidate these stocks by placing them on foreign markets at reduced prices. This might occur, but probably not to an alarming extent, because these stocks had been manufactured at the highest possible cost of raw material, and a liquidation at prices any lower than those now ruling would mean so enormous a loss as to shatter completely the remaining credit of the holders. Rather than this, it would be better for them to shut their works down, discharge the workpeople, and hold the stocks until they could realise something approaching their value. If this should be the policy adopted, raw material would be sold at a much lower profit than had been the case during the last few years, whilst it would be the greatest folly on the part of manufacturers to reduce prices for several months to come in face of this extremely uncertain market.

The report was unanimously adopted.

COSTA RICA ELECTRIC LIGHT AND TRACTION.

The report of the Costa Rica Electric Light and Traction Co. for the year ended June 30 last states that the net earnings in Costa Rica amount to £14,303, as against £12,418 the previous year. After payment of debenture interest and administrative expenses, there remains a surplus profit of £3,961, as against £2,474 the previous

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year. This has been applied, first of all, to wipe out the remainder of the deficit from earlier years, amounting to £1,374, leaving a balance of £2,586, of which the directors propose (after setting aside £357 due for manager's commission not yet charged in this year's account) to reserve £1,771 for the redemption of outstanding debentures, and to place the remainder to credit of discount on debenture issue account. The extra power provided by the issue of £10,000 further debentures in 1906 has all been taken up, and a further provision of capital for development of the business and improvement of the service will be necessary in the near future. During the year the gold premium averaged 110 per cent. The auditors (Messrs. Annan Dexter and Co) in their certificate state: "No provision has been made for (*a*) depreciation ; (*b*) writing down the amount of £20,565 discount and commission on issue of debentures ; (*c*) for the creation of a sinking fund in view of the fact that under the terms of the concession dated Nov. 20, 1905, the tramway undertaking is to be handed over to the municipality, without compensation, on Jan. 1, 1956."

UNDERGROUND ELECTRIC RAILWAYS OF LONDON.

The report of the Underground Electric Railways Co. of London to June 30 last, to be submitted to the meeting on the 23rd inst., states that since the date of the last report, with the exception of a short length of line mentioned below, all the construction work undertaken by the Company has been completed, as will be seen from the following summary. Electrical power is now being furnished to the Metropolitan District, the Baker-street and Waterloo, the Great Northern, Piccadilly, and Brompton, and the Charing Cross, Euston, and Hampstead Railway Companies, as well as to a section of the London United Tramways. The average output of the power-house is now about 100 million units per annum, and these are sold at a price which, whilst reasonable from the point of view of the railway companies, yields a satisfactory profit on the expenditure by the Company on their power-house undertaking. In March last another section of the Baker-street and Waterloo line was opened to the Great Central Station, St. Marylebone, and in June a further section to Edgware-road was opened for public traffic. It has been decided to postpone the construction of the further section from Edgware-road to the Great Western Station, Paddington, for the present. The results from the operation of this railway, which was the first to be opened of those constructed by the Company, now show an increase of about 20 per cent. in the mileage receipts over last year, and the directors have every reason to believe that the increase will continue, as the public are appreciating and using more and more the rapid and frequent train service being run on the railway. The Great Northern, Piccadilly, and Brompton line was opened for public traffic on Dec. 15, 1906, the opening ceremony being performed by the Right Hon. David Lloyd-George, M.P., President of the Board of Trade. The traffic receipts have increased month by month, and the directors feel confident that, as in the case of the Baker-street Co., this increase will continue. On Nov. 30 last the last section of the line from Holborn to the Strand was opened to the public. This branch will serve as a feeder from the Strand district to the main line. The Charing Cross, Euston, and Hampstead Railway was opened to the public on June 22 last. The object of this railway, the receipts of which are now about £2,900 per week, was not only to serve the traffic moving along its route but also to open out a new residential district at and beyond Golder's Green, which had no railway connection with London. A growing traffic should also be obtained on the Highgate branch. All the construction work in connection with the Wimbledon extension of the London United Tramways has been completed, and this section has been in operation for some months past. The earnings of this company are increasing, though sufficient time has not yet elapsed for the tramway company to derive the full benefit which must ultimately accrue from new construction and development. In April of this year the directors secured the services of Mr. Albert H. Stanley, who was up to that time general manager of the Public Service Corporation of the State of New Jersey, a railway company operating about 300 route miles of urban and suburban street railways in that state. He is now the general manager of the Underground Electric Railways Co., as well as of the District and the three tube companies above mentioned, by which means co-ordination and uniformity of operation are secured. The very unsettled state of the money markets of the world has seriously hampered the development and operations of the Company, and this unrest still continues. Stocks all over the world have depreciated in price, and those dependent on London traffic have, owing to severe competition and excessive reduction in fares, fallen lower than many securities of intrinsically less value. The competitors for London passenger traffic include the London County Council, on whose growing network of tramways passengers are carried at fares which it is believed are in many cases unremunerative, and the motor-omnibus companies, who have come into the field since the incorporation of the Company, but who can probably not operate profitably on the basis of their existing fares. It seems at last, however, to have been universally recognised that for a large number of companies to carry passengers at a loss is not sound business. The responsible heads of the principal London passenger traffic companies have, therefore, recently constituted a traffic conference under the chairmanship of the Company's managing director, Sir George S. Gibb, for the purpose of discussing the best means by which injurious competition can be, as far as possible, avoided. The Board have been for some time considering (in conjunction with Messrs. Speyer) a plan for dealing with the £7 000,000 notes which will become due on June 1, 1908. It is hoped that within a short time, probably early in 1908, the plan will be published and submitted to the shareholders and noteholders for their approval. In the meantime, Messrs. Speyer offer to purchase at their face value the coupons on the notes due Dec. 1, 1907.

NEW COMPANIES REGISTERED.

Radyr Electric Co., Limited.—Registered Dec. 9. Capital, £2,000 in £1 shares. Objects: to carry on at Radyr, Glam., or elsewhere, the business of electricians, mechanical engineers, manufacturers, and workers of and dealers in electricity, motive power, and light, etc. No initial public issue.

Hampshire Motors, Limited.—Registered Dec. 9. Capital, £1,000 in 900 preference shares of £1 each and 1,000 ordinary shares of 2s. each. Objects: to carry on the business of factors and manufacturers of, agents for, and dealers in motorcars, motor boats and vehicles, motor and other cycles, motor and cycle accessories, etc. No initial public issue. Registered without articles of association.

Regent Engineering Co., Limited.—Registered Dec. 7. Capital, £2,000 in £1 shares. Objects: to acquire from F. J. Cox the business carried on by him at 104, Park-street, Camden Town, N.W., and to carry on the business of engineers, iron and brass founders, boilermakers, millwrights, metalworkers, wire-drawers, iron and steel cable manufacturers, etc. No initial public issue. Registered office: 104, Park-street, Camden Town, N.W.

Denton Electrical Construction Co., Limited.—Registered Nov. 30. Capital, £1,000 in £1 shares. Objects: to carry on the business of electricians, electrical and mechanical engineers, manufacturers of and dealers in dynamos, motors, engines, and any apparatus used in connection with the generation, distribution, supply, and accumulation of electricity, etc. No initial public issue. Registered without articles of association. Registered office: 11, Ashton-road, Denton, near Manchester.

Torquay Tramways Co., Limited.—Registered Dec. 10 by Deacon and Co., 27, Great George-street, S.W. Capital, £120,000 in £1 shares. Objects: to adopt an agreement with the Dolter Electric Traction ; to construct, lay down, equip, and maintain tramways and light or other railways in Great Britain, and in particular the tramways authorised by the Torquay Tramways Act, 1904, or any part thereof ; to work such tramways or railways by electrical, horse, steam, or other power, etc. Registered office: Queen Anne's-chambers, Westminster, S.W.

Liens Registered.

Cone-Jackson Engineering Co., Limited, London.—A debenture, dated Nov. 20, 1907, to secure £165, charged on the company's undertaking, stock, land, premises, and other property and effects, has been registered. Holder: T. Chaplin, Mileston House, Thorpe-road, Norwich.

Victoria Engineering Co., Limited, Tipton.—Issue on Nov. 21 of £120 debentures, bearing interest at £5 per cent., part of series created March 27, 1907, to secure £400. Charged on the company's property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £180.

Underground Electric Railways Co. of London, Limited, London, E.C.—Particulars required by Sub-Section 4, Section 14, Companies' Act, 1900, Dec. 7, series of £400,000 debentures. Certain fully-paid shares and debenture stock in the following companies: Baker-street and Waterloo Railway Co., Great Northern, Piccadilly, and Brompton Railway Co., Charing Cross, Euston, and Hampstead Railway Co., and the London United Tramways. Also on the benefits of various agreements, together with freehold land and buildings at Chelsea, S.W., and unpaid calls amounting to £165,875.

PERSONAL.

Mr. A. H. Stanley, general manager to the Metropolitan District Railway Co., has also been appointed manager of the Underground Electric Railways Co. of London.

The Beckenham Urban District Council have increased the salary of the resident engineer, Mr. Tapper, by £75 per annum. Mr. E. B. Bowmaker, the shift engineer, has also had his wages increased from 30s. to 35s. per week.

We are informed that Messrs. Dorman and Smith have appointed Mr. S. Thomas Pemberton, A.I.E.E., Council-chambers, Colmore-row, Birmingham, to act as their agent in Birmingham and the surrounding district. Also Mr. F. T. Hanks, A.M.I.E.E., 1, Higham-place, Newcastle-on-Tyne, as their agent in that town and the surrounding district.

APPOINTMENTS VACANT.

Armature Winders, Electrical Engineer's Department, Devonport Dockyard. Wages commencing at 36s. for 48-hour week. See advertisement.

Electrical Engineer, Carlisle Corporation. Commencing salary, £300, advancing to £400 per annum. Applications to Mr. A. Collingwood, town clerk, by Dec. 23.

Mains Foreman, City of Birmingham Electric Supply Department. Wages will commence at £2. 5s., rising to £3. 5s. per week. Applications by Dec. 30. See advertisement.

"B" Class Station Supervisor to take charge of electric generating plant and mains at H.M. Dockyard, Haulbowline, co. Cork. Wages, 42s. per week of seven days. See advertisement.

Switchboard Attendant, Stockton-on-Tees Electricity Works. Wages, £1. 7s. 6d. rising to £1. 15s. Applications to Mr. J. J. Smith, borough electrical engineer. See advertisement in last issue.

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Junior Demonstrator in electrical engineering department of the City and Guilds of London Institute, Central Technical College. Salary, £100. Applications to Prof. W. E. Ayrton. See advertisement in last issue.

OPENINGS FOR CONTRACTORS.

ABERDEEN—Houses and shops, Great Western-road, Mr. A. Robinson; cycle shop and garage, South Esplanade, Mr. J. Duncan; alteration to St. Margaret's School, Mr. G. G. Irvine.

ALDERSHOT—Soldiers' quarters at Longmoor, War Department.

ANTRIM—Workmen's dwellings (£20,328), Rural District Council.

APPLEBY—Elementary school, Westmorland County Council.

APPLEY BRIDGE—Houses, Mr. J. Glover.

ATHERTON—Factory (£80,000), Atherton Spinning Co.

ATHLONE—Workmen's dwellings (£23,800), Rural District Council.

BALBY—Enlargement of parish church (£3,000). Mr. T. Moore, architect.

BANHAM—Alterations to Council school, Norfolk Education Committee.

BARTON—Ten houses and one shop, Barton-road, Mr. J. E. Owen.

BASFORD—Church of St. Mark (£6,000). Messrs. Austin and Paley, Lancaster, architects.

BECKENHAM—Six houses, Allen-road, Messrs. Gregg and Detmar; two houses, Westmorland-road, Mr. F. P. Duthoit; two houses, Cromwell-road, Messrs. Luck Bros.; two houses, Arrol-road, Messrs. Keen and Pedgrift; extension of destructor and electric light works, Urban District Council.

BIRMINGHAM—Council school, Leigh-road, City Education Committee.

BISHOPSTOKE—Enlargement of parish church.

BLAGDON—Additions to Council school (£690).

BLAYDON—Elementary schools, Durham County Council.

BLYTH—Hospital, Port Sanitary Authority.

BOLTON—Theatre, Deansgate, Mr. M. Hargreaves, Rochdale; motor houses and offices, Corporation Electricity Department, Messrs. W. Burrow and Son.

BOURNEMOUTH—Church house (£4,000), St. Michael's Churchwardens.

BRADLEY FOLD—Electrical equipment of workshops, Messrs. Dobson and Barlow, Bolton.

BRAINTREE—Additions to Church-street School, Essex Education Committee.

BRIGHTLINGSEA—Police station (£2,593), Essex Standing Joint Committee.

BRIXHAM—Alterations and additions to Congregational church. Mr. W. C. Couldrey, Paignton, architect.

BROADSTAIRS—Public convenience, Clarendon-road, Urban District Council.

BROADWATERS—Mission church, Wolverley parish.

BROOMHILL—Presbyterian church, Mr. G. Reavell, jun., Alnwick.

BURNHAM—Fire brigade premises and public offices, Parish Council.

CARNARVON—Public slaughter-houses (£450), Town Council.

CHADDERTON—Town hall (£1,700), Town Council.

CHEADLE—Slaughter-house, lairage, and stables, Ravenoak-road, Mr. R. Hazeldine.

CHESTER-LE-STREET—Elementary schools, Durham County Council.

CHOPWELL—Thirty-six houses, Consett Iron Co.

CIRENCESTER—Drill hall and 17 houses (£13,950), Urban District Council.

CLACTON—Public conveniences (£1,600), Urban District Council.

CLAPHAM—Secondary school (£25,919), London County Council.

COLCHESTER—Extensions to children's hospital (£2,500). Messrs. Goodey and Cressall, architects.

CORK—Ninety-five houses, Rural District Council.

COVENTRY—Enlargement of Radford Schools, Education Committee.

DARLEY DALE—Houses, North Darley. Mr. C. E. Dawson, architect.

DEVIZES—Three shops and houses, Sidmouth-street. Mr. A. J. Randall, architect.

DRIFFIELD—Additions to elementary school, Education Committee; motor garage, Messrs. Dowson and Son.

DROYLSDEN—Alterations to British School and Technical Institute (£1,501).

DUNDALK—Workmen's dwellings (£112,708), Rural District Council.

DUNDEE—Dwelling-houses, Seymour-street, Mr. J. Lowe; alteration of premises, Ward-road, Ancient Order of Foresters.

DURHAM—College for women students, Durham County Council.

EASTBOURNE—Extension to infirmary (£9,500), Board of Guardians.

EAST HAM—Four houses, Norwich-road, Forest Gate, Messrs. Norman Bros.; 15 houses, Leonard-street, Silvertown, Mr. J. P. Blower; motor-house, Baxter-road, Custom House, Rev. T. Gilbert; alterations and additions, Forest Gate Steam Laundry, Mr. G. J. Hosking.

EAST KERRIER—Seven houses and an hotel. Plans passed by Urban District Council.

ECCLES—Extension of works, British Pluvuisin Co.; 29 houses, Darwell-avenue, Mr. J. E. Owen.

EDINBURGH—Enlargement of Towerbank School, Edinburgh School Board.

ELLAND—Alterations to Town Hall Hotel. Messrs. Jackson and Sons, Bradford, architects.

FARNWORTH—Town hall, Messrs. Coope Bros.

FENCEHOUSES—Extensions to United Methodist Church (£300).

FOLKESTONE—Elementary school, Chart-road, Corporation.

FOVERAN—Session house, Town Authorities.

FRASERBURGH—School of cookery, Fraserburgh School Board.

GOLDERS GREEN, N.W.—Church, Garden Suburb.

GRAVESEND—Villas, Brandon-street, Mr. G. F. Burr; four houses, Suffolk-road, Mr. C. Higgins

GREAT HARWOOD—Elementary school and technical education block, Lancashire Education Committee.

GRIMSBY—Post office, H.M. Commissioners of Public Works.

GUILDFORD—Extension to premises of workhouse.

HADFIELD—Elementary school. Messrs. Ogden and Hoy, Manchester, architect.

HANLEY—Offices, Society of Pottery Workers, Mr. W. Campbell.

HARLOW—Police station (£3,650), Essex Standing Joint Committee.

HIGH SPEN—Twenty houses, Consett Iron Co.

INCE—St. William's Roman Catholic Church, Higher Ince; Primitive Methodist Chapel, Lower Ince.

IPSWICH—Extension of municipal school (£3,500).

KIDWELLY—Houses and shops, Mr. R. H. Isaac; two houses, Messrs. Stephens and Co.

KILKENNY—Workmen's dwellings (£35,000), Rural District Council.

KILPATRICK—Higher-grade school, District Education Committee.

KIRKBY STEPHEN—Alterations to school, Westmorland County Council.

LANGLEY PARK—Ten houses, Consett Iron Co.

LEEDS—Additions to infirmary, Board of Guardians.

LEIGH—80,000-spindle mill, Butts Spinning Co.

LEITH—Extensions to Granton School, Leith School Board.

LIMERICK—Workmen's dwellings (£1,000), Rural District Council.

LINGFIELD—Village hall and library, Parish Council.

LOSSIEMOUTH—Lounge and additions to Stotfield Hotel. Mr. R. B. Pratt, Elgin, architect.

LUTON—Four houses, Dallow-road, Mr. H. Cook; villas, Ashburnham-road, Mr. F. White; houses, Maple-road, Messrs. Brown and Co.; five houses, Newcombe-road, Messrs. Hill Bros.; houses, Frederick-street, Mr. H. Baxter; five houses and shop, Dallow-road, Mr. E. Hillyard; six houses, Clipstone-road, Mr. T. Day; 12 houses, Naseby-road, Mr. C. H. White; four houses, Hartley-road, J. West; two houses, Hitchen-road, Messrs. Irons and Oakeley; three shops, Dunstable-road, Messrs. C. H. White; five houses, Dallow-road, Mr. E. J. Taylor; 18 houses, Clipstone-road, Mr. W. Mardle; extension to mill, Guildford-street, Messrs. W. H. and P. Brown; six houses, Baker-street, Mr. W. F. Mullett; two villas, Brantwood-road, Mr. C. H. White.

LYMINGE—Repairs and alterations to workhouse, Board of Guardians.

MARGATE—Additions to Sea Bathing Hospital (£250).

NEWCASTLE (STAFFS)—Elementary school, Butt-lane, Staffordshire Education Committee.

NEWINGTON, S.E.—Elementary school, London County Council.

NEWQUAY—Alterations to Great Western Hotel. Messrs. Cowell, architects.

NORTHALLERTON—Secondary school, North Riding Education Committee.

NORTHWOOD—Three houses, Chester-road, Mr. W. T. Johnson; houses, Kingsend-avenue, Messrs. Morris and Co.

ORPINGTON—Fire station, Bromley Urban District Council.

PAISLEY—Institute, Cowan Park, Town Council.

PARBOLD—Houses, Tanhouse-lane, Mr. H. Mather and Messrs. Derbyshire and Wilson.

PARTICK—Public baths, Town Council.

PONTYPRIDD—Church of St. Matthew (£3,500). Messrs. Evans, Williams, and Evans, architects.

POPLAR—Elementary school, Dingle-lane, London County Council.

PONTRHYDFENDIGAID—Four houses, Tregaron Rural District Council.

QUORN—Two villas, Nursery-lane, Messrs. Thompson and Gamble.

RADCLIFFE—Vicarage. Messrs. J. Sellers, Son, and Orrell, Bury, architects.

RENFREW—Eight shops, Dumbarton-road, Scotstoun, Mr. A. Fountain, Glasgow.

ROMFORD—Elementary school, London-road, Essex Education Committee.

RUISLIP—Three houses, Chester-road, Mr. W. T. Johnson; houses, Kingsend-avenue, Messrs. Morris and Co.

ST. HELENS—Elementary schools, Borough Council.

ST. LEONARDS—Fire station, Shepherds-street, Corporation.

SALTNEY—Elementary school, Chester Education Committee.

SCARIFF—Workmen's dwellings (£31,500), Rural District Council.

SCUNTHORPE—New hotel. Messrs. Tennant and Collins, architects.

SEAHAM—Lifeboat house (£3,294). Mr. W. T. Douglass, engineer.

SEVEN KINGS—Free library (£6,000), Ilford Urban District Council.

SHAW—Alterations to British School (£1,700), County Education Committee.

SHEFFIELD—Public conveniences, St. Anne's-street and Elsmere-road City Council.

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SIDMOUTH—Police station (£3,000), Devon County Council.

SKIPTON—Additions to infirmary (£3,350).

SLOUGH—Four houses, Montem-road, Mr. A. Cornish; four houses, Arthur-road, Messrs. Barfoot and Butler; three houses, Connaught-road, Mr. T. Perrin.

SMETHWICK—Fire station (£786), Town Council.

SNETTISHAM—Church, Wesleyan Trustees.

SOUTHALL—Church for the parish of St. Paul (£7,000).

STAVELEY—Houses. Mr. W. C. Jackson, Chesterfield, architect.

STOKE-ON-TRENT—Ten houses in Linley-road, Hartshill, Messrs. Jones and Hilton.

STREET—Higher-grade school, Urban District Council.

SUNDERLAND—Extensions to technical college, Town Council.

SWADLINCOTE—Additions to premises, Linton Heath, Netherseal Colliery Co.; houses and shops, Regent-street, Mr. J. T. Evans.

SWAFFHAM—Extensions to children's quarters at the workhouse, Board of Guardians.

SWANAGE—Houses, Victoria-avenue, Mr. H. J. Smith; houses. Newton-road, Mr. J. S. Dete.

TALKE—Elementary school, Staffordshire Education Committee.

TALLISTOWN—Elementary school (£13,943), Education Committee.

TALYSARN—Alterations to post office. Mr. E. F. White, Carnarvon, architect.

TAMWORTH—Clothing factory, Bolehall, Messrs. T. Cooke and Co.

TEBAY—Elementary school, Westmorland County Council.

THORNTON—Houses and shops, Victoria-road, Mr. T. W. Howarth.

THREKELD—Alterations to church. Mr. J. H. Martindale, Carlisle, architect.

TROON—Additions and alterations to Fullarton Public School. Mr. J. Miller, Glasgow, architect.

TYNEMOUTH—Stores and offices, Union-quay, Mr. J. F. Smilie.

WANDSWORTH, S.W. — Elementary school, Hotham-road, London County Council.

WATERHEAD—Mill for 60,000 spindles.

WESTCLIFF-ON-SEA—Police station (£1,998), Essex Standing Joint Committee; addition to Nore Yacht Clubhouse (£400).

WHITEHAVEN—Elementary school (£11,000), Education Committee.

WIDNES - Anglican church (£24,000), Messrs. R. Rathbone and Sons, Atherton.

WILLIAMTHORPE—Shops and houses. Mr. W. C. Jackson, Chesterfield, architect.

WINTON—Temporary chapel, Parrin lane, Baptist Union.

WOKING—Technical institute (£8,000), Urban District Council.

WOMBWELL—Five houses, Mr. F. B. Ward.

WOODHOUSE—Secondary school, West Riding County Council.

WORKSWORTH — Extension to town hall (£460), Urban District Council.

WRECCLESHAM—Elementary school, Surrey Education Committee.

YARMOUTH—Houses, Sussex-road, Messrs. R. W. Bell and Sons; three houses, Station-road, Mr. J. C. Knight; additions to sailors' home, Trustees; four houses, Kitchener-road, Mr. S. Read.

FOREIGN.

ANTWERP (HOLLAND) — Installation of electric light, Municipal Council.

BIRMINGHAM (U.S.A.)—Works for generating electricity and power, Greater Birmingham Electric Co. (196,000dol.).

BUENOS AYRES (SOUTH AMERICA)—Automatic telephone installation, Municipality. Messrs. P. Chambers and Co.

CALCUTTA (INDIA)—Electrical lighting throughout streets, Corporation.

COLUSA (CALIFORNIA) - Construction of water-power electric plant, Snow Mountain Electric Power Co. (250,000dol.).

FORT QU'APPELLE (U.S.A.)—Construction of long-distance telephone, Municipal Council.

GARDEN (MICHIGAN)—Electric light plant, Municipality.

HAMILTON (ONTARIO)—Installation of municipal street lighting (225,000dol.).

LECOMPTE (U.S.A.)—Installation of electric light (10,000dol.), City Engineer.

LEIPZIG (GERMANY)—Electricity works and plant, Hochspannungs Rabellieferung fuer das Elektrizitaetswerk.

LONGWY (FRANCE)—Hippodrome (100,000fr.), Municipality.

LYONS (FRANCE)—Refuse destructor in connection with electricity generation, Corporation.

MADRID (SPAIN)—Construction and working north-west interurban telegraph service (£6,375).

MOSCOW (U.S.A.)—Construction of municipal light plant.

NAPIER (N.Z.)— Lighting and power plant and electric tramway equipment, Municipal Council.

PUNJAUB (INDIA)—Installation of electrical pumping plant for water supply, Council Engineer.

SALT LAKE CITY (UTAH)—Installation of power plant (500,000dol.), Beaver River Power Co.

STELLA (U.S.A.) — Electrically lighting of city, Stella Electric Light Co.

SULPHUR SPRINGS (U.S.A.) — Electric plant and waterworks (25,000dol.), Messrs. Smith and Powers.

TORBROOK (ONTARIO)—Installation of electric system, Londonderry Iron Mining Co. (50,000dol.).

TUCUMAN (SOUTH AMERICA)—Construction of electric tramway, Compania Alemana Transatlantica de Electricidad.

VANCOUVER (B.C.) — Electrification of South Kootenay branch, Columbia and Western Railway.

VICTORIA (B.C.)—Additional plant for generation of electricity, British Columbia Electric Co.

VIERSON (FRANCE)—Improvement of railway station (2,000,000fr.).

CONTRACTS FOR ELECTRICAL SUPPLIES.

Manila.—The Municipality invite tenders for pumps, together with electric motors, for sewage works. Tenders by Jan. 15, 1908.

Swansea.—The Graigola Merthyr Co., Swansea, invites tenders for the annual supply of stores, including electrical goods. Tenders by Dec. 24.

Leyton.—The Urban District Council invite tenders for lamps, etc., in connection with the incandescent electric lighting. Tenders by Dec. 31.

Bourges.—Tenders are invited for one five-ton electrical crane. Particulars from Direction de l'école de pyrotechnie militaire. Tenders by Jan. 11.

Rawtenstall.—The Corporation invite tenders for the supply of three steam dynamos and accessories for the electricity works. Tenders by Dec. 30.

Beckenham.—Tenders are invited by the Urban District Council for the extension of the destructor house at the electricity station. Tenders by Jan. 6.

New South Wales. — The Postmaster-General, Sydney, invites tenders for one branching metallic multiple magneto switchboard. Tenders by Jan. 8, 1908.

Llandudno.—The Urban District Council invite tenders for a traction battery and an automatic reversible booster and necessary switchgear. Tenders by Jan. 4.

South Australia.—The Postmaster-General, Adelaide, invites tenders for one common-battery switchboard, subscribers' telephones, and protectors. Tenders by March 11.

Melbourne.—The Postmaster-General's Department invite tenders for 11 sets and a common-battery switchboard, and 3,000 subscribers' telephones, etc., for the Windsor exchange. Tenders by Jan. 7.

Calcutta.—Tenders are invited for the lighting of the town by gas or electricity. Particulars from Mr. P. N. Mookerjee, secretary to the Corporation. Tenders to the Vice-Chairman by Jan. 2, 1908.

Worcester.—The Corporation invite tenders for the supply of one 400-kw. continuous-current steam generator and balancing dynamo and surface condenser. Tenders by Jan. 6, 1908. See advertisement.

Dublin.—Tenders are invited by the Board of Public Works for electrical works and supplies for the Belfast district. Tenders to Mr. H. Williams, secretary, Office of Public Works, Dublin, by Dec. 23.

Finchley.—The Urban District Council invite tenders for the supply and erection of one 350-kw. high-speed engine and dynamo combined, together with spare parts. Tenders by Jan. 20, 1908. See advertisement.

Punjab (India).—Tenders are invited for electric and pumping plant for water supply. Particulars from the Executive Engineer, Special Work Division, Patiala, Punjab. Deposit £133. 6s. 8d. Tenders by Jan. 6, 1908.

Madrid.—The Public Works Department invite tenders for the construction and working of electric tramway at Vigo. Particulars from the Dirección-General de obras publicas, Ministerio de Fomento. Tenders by Dec. 29.

Buenos Ayres.—Tenders are invited for the construction of underground electric tramways. Particulars from the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London. Tenders by June 1, 1908.

Wigan.—The Tramways Committee invite tenders for the supply of various materials. Particulars from Mr. J. Slevin, tramways engineer and manager, Bradford-place, Wigan. Tenders to the Town Clerk, King-street West, Wigan, by Dec. 23.

Buenos Ayres.—Tenders are invited for (1) the construction of and (2) the concession to work the two principal sections of the underground electric railway. Particulars from the Argentine Legation, 12, Rue van Moer, Brussels. Tenders by May 1, 1908.

Adelaide.—The Deputy Postmaster-General for Queensland invites tenders for a common battery switchboard and 3,000 subscribers' telephones. Specification No. 166. Particulars may be obtained from the Commonwealth Offices, 72, Victoria-street, London, S.W. Tenders by Jan. 8, 1908.

Belfast.—The Harbour Commissioners invite tenders for the construction of a double line of electric tramway, permanent way, electric masts, cables, wiring, lamps, etc., on the co. Down side of the harbour. Tenders to Mr. W. A. Currie, secretary, Harbour Offices, Belfast, by Dec. 28.

Antwerp.—The Municipal Authorities invite tenders for installation of electric light on Quays Nos. 33 and 34 of the Bassin de la Campine. Tenders to Monsieur le Bourgmestre de la Ville, Hotel de Ville, Antwerp, by Dec. 23. A deposit of 400fr. (about £16) will be required to qualify any tender.

Madrid.—Tenders are invited for the construction of an international telephone system with France, and for the working of the interurban service of the North-East. Deposit, 120,000 pesetas (about

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£4,211). Tenders will be received at the Registro de la dirección general de correos y telegrafos, Madrid, by Jan. 3.

Victoria.—The Deputy Postmaster-General at Melbourne invites tenders for the supply and delivery at Melbourne of 11 sections of a common-battery switchboard and 3,000 subscribers' telephones and other apparatus for telephone exchange, Windsor, in accordance with Victorian specification No. 148. Tenders by Jan. 7.

Belfast.—The Harbour Commissioners invite tenders for the supply of about 100 tons of best rolled-steel girder tramway rails, with fishplates and bolts to suit, of which 50 tons are to be delivered on the co. Antrim side and 50 tons on the co. Down side of the river. Tenders to Mr. W. A. Currie, secretary, by Dec. 28.

Adelaide.—Tenders are invited for the supply and delivery, c.i.f. Port Adelaide, of special work, points, and crossings for tramways. Specfication, etc., from the Agent-General for South Australia, Threadneedle House, 28, Bishopsgate-street Within, London, E.C. Tenders to the Chairman, Municipal Tramways Trust, Adelaide, by Feb. 11, 1908.

Prague (Austria-Hungary).—The *Lieferungswesen* (Vienna) of Dec. 5 announces that tenders will be received by the K.K. Staatsbahndirektion at Prague (1) till noon on Dec. 31 for the supply of an electric travelling crane to lift three tons, required by the railway works at Laun; (2) till noon on Jan. 4 for the supply of an electric pump of a capacity of 70 cubic metres per hour, with suction plant and compressed-air boiler, required by the water-power works at the station at Bodenbach. Forms of tender, etc., may be obtained from the K.K. Staatsbahndirektion, Abteilung 4, Prague.

RESULTS OF TENDERS.

Chatham.—The tender of Edison and Swan has been accepted for the supply of incandescent electric lamps.

Lowestoft.—The Town Council have decided to purchase two stokers at £165 and one stoker at £235 from Babcock and Wilcox.

Burslem.—The Town Council have accepted the tender of Callender's Cable and Construction Co., at £459. 10s., for the cable required for the extension of the main to Langport.

Stoke-on-Trent.—The tenders of the Phœnix Dynamo Co., at £267. 10s., for the balancer and booster required in connection with the supply of electricity within the Fenton area, and that of the Switchgear Co., at £98. 17s. 6d., for the supply of switching apparatus in connection with same, are recommended for acceptance.

Luton.—The following tenders have been accepted for additional plant for traction purposes: D.P. Battery Co., Bakewell, batteries (250 cells), £557; Lancashire Dynamo and Motor Co., Trafford Park, Manchester, automatic reversible booster, £245; Johnson and Phillips, Charlton, Kent, switchboard, £257; W. T. Henley's Telegraph Cable Co., 1,000 yards of feeder, 15s. 9d. per yard.

London.—The following tenders have been received for the supply of special track work for the Hammersmith-to-Harlesden tramways, for the London County Council:

Hadfield's Steelfoundry Co., Sheffield*	£1,666	12	6
E. Allen and Co., Sheffield	1,773	0	0

* Recommended for acceptance.

Salford.—The Corporation Tramways Committee have accepted the tender of the Union Electric Car Co. for 20 car bodies for £8,972. 10s.; Hurst, Nelson, and Co., 4 car bodies for £1,835. 10s.; British Westinghouse Co., 24 electrical equipments, including trolley bases, for £6,696; and that of Mountain and Gibson for 23 trucks for £1,483. 10s., and one truck for £110. The tender of the General Electric Co. for electric fittings at the Salford Town Hall has also been accepted.

Hammersmith.—The following tenders for appliances required in connection with the supply of electricity to the Franco-British Exhibition are recommended for acceptance: Electric Construction Co., two 50-h.p. motors, £180, and four 30-h.p. motors, £248; Langdon Davies Co., one 18-h.p. motor, £37. 10s., and three 10-h.p. motors, £94. 10s; British Electric Transformer Co., six 200-kw. transformers, £175 each, and for the hire of six 100-kw. three-phase machines for a period of eight months, £280; Cowan and Co., switchgear, £1,154; General Electric Construction Co., motor-generator, £620.

London.—The London County Council have received the following tenders for the supply of additional sub-station machinery, consisting of one motor-generator:

General Electric Co., Witton, Birmingham*	£1,608
Electric Construction Co., Wolverhampton	1,645
British Westinghouse Electric and Manufacturing Co., London, W.C.	1,733
Dick, Kerr, and Co., London, E.C.	1,780

* Recommended for acceptance.

London.—The London County Council have received the following tenders for the supply of steel underframes for 50 car bodies:

Hurst, Nelson, and Co., Motherwell*	£1,975	0	0
Heenan and Froude, Worcester	2,150	0	0
G. R. Turner, Limited, Langley Mill, Notts	2,275	0	0
De Bergue and Co., Manchester	2,287	10	0
United Electric Car Co., Preston	2,300	0	0
Mountain and Gibson, Bury	2,402	10	0

* Recommended for acceptance.

Bormondsey.—The Electric Committee recommend the acceptance of the tenders of Johnson and Phillips, Old Charlton, for 670 yards ·5 square inch low-tension triple-concentric lead covered cable, £643. 14s.; 180 yards ·5 square inch low-tension triple-concentric lead-covered and steel-armoured cable, £188. 10s.; 670 yards ·2 square inch low-tension triple-concentric lead-covered cable, £292. 5s.; and 180 yards low-tension triple-concentric lead-covered and steel-armoured cable, £88. 8s. The tender of Callender's Cable and Construction Co. for flat twin lead-covered cable is also recommended for acceptance.

London.—The following tenders have been received for the supply and delivery of about 136 tons of flat-bottomed rails and fastenings required for the Bow (first portion), Hammersmith (first portion), and Hackney tramways car-sheds, for the London County Council:

P. and W. MacLellan, Glasgow*	£1,072	18	9
Bolckow, Vaughan, and Co., London, E.C.	1,091	15	0
Barrow Hæmatite Steel Co., London, E.C.	1,084	4	9
Steel, Peech, and Tozer, Sheffield	1,134	16	10
W. Scott, Limited, Leeds	1,135	6	3
Cammell, Laird, and Co., Westminster	1,262	0	0

* Recommended for acceptance.

London.—The following tenders have been received by the London County Council for roadwork and platelaying, etc., in connection with the Hammersmith-to-Harlesden tramways:

Tramway work.

G. Wimpey and Co., Hammersmith*	£32,685	10	3
Dick, Kerr, and Co., London, E.C.	33,814	7	10
G. Hay and Co., Westminster	33,936	14	4
W. Manders, Leyton	34,381	16	10
W. Underwood and Bro., Dukinfield, Cheshire	36,694	7	11
G. Law, Kidderminster and London, E.C.	34,332	13	6
R. W. Blackwell and Co., Westminster	36,577	8	4
J. Mowlem and Co., Westminster	40,164	1	4
W. Griffiths and Co., London, E.C.	39,536	8	7
National Electric Construction Co., Westminster	39,170	15	10
E. Nuttall and Co., Manchester	40,472	19	10
J. G. White and Co., London, E.C.	41,751	16	0
Fry Bros., Greenwich	41,434	10	7
W. Muirhead and Co., London, E.C.	43,318	1	10
J. Moran and Son, Westminster	45,962	1	0

Paving works for street widenings.

G. Wimpey and Co.	6,392	12	11
Dick, Kerr, and Co.	6,338	19	0
G. Hay and Co.	6,443	8	1
W. Manders	6,235	13	8
W. Underwood and Bro.	6,142	19	11
G. Law	8,560	8	4
R. W. Blackwell and Co.	6,772	13	6
J. Mowlem and Co.	6,229	6	5
W. Griffiths and Co.	6,898	7	2
National Electric Construction Co.	7,416	16	2
E. Nuttall and Co.	6,530	9	1
J. G. White and Co.	7,284	14	10
Fry Bros.	8,656	14	9
W. Muirhead and Co.	8,304	0	11
J. Moran and Son	7,899	10	6

* Recommended for acceptance. The street paving works not yet decided upon.

BUSINESS NOTES.

TRACTION.

Geneva Tramways Co. (1906).—The traffic receipts for the month of November, 1907, amounted to 188,351fr., being an increase on the figures of 1906 of 8,024fr.

Manchester.—The City Tramways Committee intend carrying out important tramway extensions at Clayton, which is developing into an important industrial locality.

Bolton.—Despite strenuous opposition from various sections of local ratepayers, the Tramways Committee here have decided to proceed with the laying of lines in the Deane district.

Maidstone.—The Board of Trade have confirmed the Maidstone Corporation Light Railways (Extensions No. 2) Order, 1907, authorising the construction of additional light railways in the borough of Maidstone.

Croydon.—At a meeting of the Council on the 16th inst. the recommendation of the Tramways Committee to run a Sunday service on Christmas Day, paying the employés working at the rate of time and a half, was adopted.

Madras Electric Tramways (1904).—The receipts for the fortnight ended Dec. 15, 1907, totalled 18,348 rupees, an increase of 22·1 per cent. The gross receipts from Jan. 1, 1907, amounted to 396,465 rupees, being an increase of 19·9 per cent.

Buenos Ayres and Belgrano Electric Tramways Co.—The receipts for the week ending Dec. 16, 1907, converted to gold were £3,998; corresponding period, 1906, £3,806—increase, £192. Aggregate from Jan. 1, 1907, £193,747; aggregate from Jan. 1, 1906, £183,343—increase, £10,404.

Brighton.—The Tramways Committee of the Council have informed Councillor Braybon that they are unable to adopt his suggestion that the Queen's Park-road route should be divided into sections for ½d. fares as follows: Upper Rock-gardens to Egremont-place, Egremont-place to Albion-hill, Albion-hill to Down-terrace, Down-terrace to Elm-grove, and Queen's Park-road junction to bottom of Elm-grove.

Ealing.—At a meeting of the Town Council it was resolved that the attention of the Commissioner of Police be drawn to the noise occasioned in the district by the running of the tramcars on the London United Tramway Co.'s service. It was agreed to ask him that licences be refused for cars which are worn and defective, or so constructed as to cause a nuisance in their running. A similar resolution has been passed by the Hampton Wick Council.

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Scottish Provisional Orders.—Applications for the following provisional orders under the Scottish Private Bill Procedure Act were lodged at the Scottish Office on Dec. 17: Ayr Corporation Tramways; Buckie Burgh and Buckie (Tramway) Harbour; Lanarkshire Tramways; Wishaw Burgh Electricity, etc. Six weeks are allowed for the lodging of petitions against these Bills if they are to be opposed.

Rochester.—Plans and sections of the land required from the bridge wardens and the trustees of Watts's Charity for the extension of the tramways to Borstal, as prepared by Mr Rotter, the tramway engineer, has been approved by the Town Council, and the town clerk asked to at once serve notices to treat upon the bridge wardens, the trustees of Watts's Charity, and their tenants, and at the some time suggest that the settlement between all parties should be left to some surveyor, to be agreed upon, who would act for all parties in fixing the compensation.

Bermondsey.—For some months now there has been a feeling that the Borough Council should appeal to the County Council urging upon it the necessity of the electrification of the local tramways. At the last meeting of the General Purposes Committee of the Borough Council a deputation was received from the Rotherhithe Liberal, Radical, and Progressive Association asking it to give this tramway matter careful consideration. The committee, however, considering the question of great importance, has asked the deputation to appear before the Council.

Coventry.—An electric tramcar was proceeding round a corner at rather more than usual speed on Sunday afternoon, when it left the rails and turned completely over on its side. Fortunately, there were only two passengers in the car—a man and his child. Seeing an accident was imminent, the man took the child in arms and jumped from the top of the car, and both escaped with nothing worse than a shaking. The conductor and driver also escaped without injury. A cyclist passing at the time of the accident, had just time to spring off his machine before the car fell on it, completely smashing it.

Portsmouth.—The tramway service to and from Portsea was interfered with for a short time on Tuesday evening owing to a mishap to the plant. The guard wire under the railway arch in Commercial-road fell, and came into contact with the trolley wire, with the result that a short-circuit to earth was established. For a few minutes the whole of the sections were thrown out, but traffic was resumed as soon as possible, the cars making the Gunwharf the temporary terminus. No great inconvenience was caused to passengers, and, thanks to the smartness of the overhead repair staff, there was very little delay, traffic being resumed in about 45 minutes.

Walsall.—Mr. Alderman Cope has been appointed chairman and Mr. Councillor Williams vice-chairman of the Tramways Committee for the ensuing municipal year. The following are some particulars respecting the working of the tramways: Five weeks ending Dec. 1, 1906—number of passengers, 456,738; receipts, £2,510. 14s. 5½d.; car miles run, 58,728; receipts per car mile run, 10·26d. Five weeks ending Nov. 30, 1907—number of passengers, 485,890; receipts, £2,684. 4s. 6d.; car miles run, 60,232; receipts per car mile run, 10·69d. Wages paid (including repair of permanent way)—five weeks ending Nov. 29, 1906, £762. 13s. 9d; five weeks ending Nov. 28, 1907, £779. 12s. 2d.

Leeds.—A new improvement is shortly to be tried in Leeds tramcars. This consists of the provision of a partition or screen dividing the car into two compartments, not necessarily of equal dimensions. This will save inconvenience in more directions than one, and apart from its making it easier for the conductor to seat his passengers, the latter will be largely freed from the annoyance of having to "move up" in a body to accommodate a late arrival. The designs of the new cars are to come before the Traffic Committee at their next meeting. Meanwhile, visits have been paid to various towns with the view of studying the latest types and providing the Leeds public with a car which contains a maximum of convenience and comfort. The new cars are to be made in Leeds at the tramcar workshops.

Birmingham.—The Tramways Committee of the City Council had before them on Tuesday the question of the running of the Corporation tramcars on Christmas Day, against which motormen and conductors had protested. The committee, in view of the amount of tram traffic in other large towns, believed there was a demand for similar facilities on Christmas Day in Birmingham, and consequently decided, as a matter of public convenience, that they could not withdraw their original proposals to run a limited service of cars. The time-table will, however, be so arranged that all the men can be at home to take part in the Christmas festivities at dinner-time. The cars will run at much longer intervals than usual, and the first batch of men on duty will finish their labours by 1.30 p.m., at which time the second batch will come on duty.

London Underground Electric Railways.—With a view to still further facilitating London travel, and to meet a generally felt desire for through tickets, the Central London Railway and the Bakerloo Tube have now decided on a set of cheap through fares between all stations on their respective lines. The former company refrained from any such arrangement until the advent of the Hampstead Tube, when an experiment was made, which has proved so successful that the result may be found in the present decision to grant the same facilities to travellers between the Bakerloo and Central London Tubes also. A short low-level subway connects the platforms of the two tubes at Oxford-circus Station, so that, in changing, a minimum of time is lost, as it is well known that both companies run a continuous service of trains.

Dundee.—The working of Dundee tramways for the half-year ending Nov. 13 has been very successful. The total expenditure for the 26 weeks is £18,604, or £274 above the estimate. With the exception of the cost for electrical energy, which is £323 over estimate, the various items of expenditure are close to the estimate. The receipts show an increase over the corresponding period of last year amounting to £885. The estimated increase for the whole year is £1,688, or £844 for the 26 weeks; this shows that the earnings have exceeded the estimate by £41. During the period since Nov. 13 there have been steady increases, which, if maintained, will more than meet the increased expenditure incurred during the period dealt with in this statement. In view of the fact that the weather during the six months under review has been very unfavourable for high earnings, the results, the manager adds, on the whole may be considered satisfactory.

St. Pancras.—A plan has been deposited with the Borough Council by the London County Council relating to schemes which will be submitted in the ensuing session of Parliament providing for the construction of a new bridge 60ft. wide across the Metropolitan Railway, King's Cross, for traffic between Gray's-inn-road and Caledonian-road, and for the construction of a double line of tramway across such bridge; also for the construction of a single line of tramway from the existing tramways in King's Cross-road along Swinton-street to connect with the tramways in Gray's-inn-road; and also for widening Southampton-road to provide for double lines of tramway along that thoroughfare instead of the present single and loop lines. The Borough Council have refused to contribute towards the cost of the proposed improvements, and the Parliamentary Committee recommend that the Council be returned as formally dissenting from the County Council proposals.

Clydebank Tramways.—The Tramway Committee of Clydebank Town Council and the sub committee of the Tramways Committee of Glasgow Corporation have met to consider the question of when the latter body intend to carry out the Clydebank tramway order in its entirety by constructing the bridges over the canal at Dalmuir and Kilbowie and finishing the laying of the rails to the old burgh boundaries. The meeting was a very amicable one, and the Glasgow committee agreed to recommend to the parent committee and the Council that the Dalmuir bridge and the line to the boundary there should be proceeded with on as early a date as possible. The bridge is to be 30ft. wide, and the proportion of the cost to be paid by Clydebank is as was agreed upon at the beginning—viz., £300. The Kilbowie bridge will not be dealt with at present, but investigations are to be made with a view to ascertaining whether an extension of the tramways by the southern fringe of Radnor Park is not possible.

Lowestoft.—At a meeting of the Tramways Committee the general manager reported that he is requiring 10 sets of points to replace points worn out, and he was authorised to obtain points as required. A letter, dated 19th ult., was read from Mr. P. Huckle with reference to the East Anglian light railways. He asked for particulars of the undertaking, and for the price the Council will accept to sell same if it has been decided not to construct the lines. The town clerk was directed to inform Mr. Huckle that the committee is prepared to consider his letter, and any proposals he has to make. The sub-committee has considered the question of handing over the tramway track to the surveyor, to be maintained by him on behalf of the Roads Committee. It was referred to the General Committee to draw up some definite resolution, and they resolved that the matter of the upkeep of the track be referred to the adjourned meeting of the Roads Committee and themselves for discussion and recommendation.

Perth.—A meeting of the ratepayers of the Jeanfield district was held in the Victoria Institute on the 17th inst. for the purpose of protesting against the action of the Town Council in deciding not to extend the Perth tramways to Dovecoteland. Mr. William Thomson, chairman of the Perth Parish Council, presided over a fair attendance, including Lord Provost Cuthbert, Treasurer Wallace, and ex-Bailies Taylor and Isaac. Treasurer Wallace and ex-Bailies Taylor and Isaac addressed the meeting, and expressed themselves in favour of the extension, as did also ex-Bailie Wright. Mr. George Gellatly moved that the meeting regret that the Town Council had resolved not to include the extension of the tramways to Feus-road and Dovecoteland in the new provisional order about to be applied for, and were of opinion that it would not only be a popular but a good paying part of the tramway system and would materially help to put it on a better basis, and also as a branch it should be constructed prior to any of the two other extensions proposed. Mr. E. Young seconded, and the resolution was unanimously carried. It was agreed that a petition should be got up and signed by the residents for presentation to the Town Council. A committee was appointed to carry out the resolution.

Newcastle.—A meeting of the Tramways Committee of Newcastle Corporation was held on the 12th inst., and a report presented by the sub-committee concerning the motormen in connection with recent accidents was confirmed. The report was to the effect that the driver of the tramcar which ran off the line at the foot of Pilgrim-street had written to the general manager intimating that he was afraid he had made a mistake whilst in charge of the car, and left himself entirely in the hands of Mr. Hatton. The case was then brought before the sub-committee, and it was agreed that the motorman should be restarted in the washing and cleaning department of the tramways, and by good conduct and work should have the opportunity of rising to the position of conductor. The cases of two other motormen were brought before the committee, and they were ordered to be censured by the chairman for having made a statement with respect to the condition of the brakes without having made any remarks bearing upon such on the same day in their time sheets. It was resolved that in future a special column should be included in the time sheets for that purpose, and for any remarks respecting the brakes. Every driver will be expected to report without delay on these sheets.

Edinburgh.—The Tramway Committee at their meeting had submitted to them a request by the Edinburgh and District Tramway Co. that the Corporation should provide a terminal pit at the Tollcross end of the Lauriston route. The committee agreed to leave the subject in abeyance until they received from the dean of faculty his report

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with regard to whether the company are bound to resume running of cars on the circular route. Such a pit could mean that cars could not be run from Lauriston to Marchmont-road. It was resolved to recommend that a strong representation should be sent to the tramway company, pointing out that in the interests of public safety something should be done to raise the railings on the stairs and platforms of the cars. The committee had also under consideration the offer by the Musselburgh Tramway Co. to build a passengers' shelter at the car terminus at Joppa, provided the Corporation gave permission for it to be erected on the street. At the last meeting of the Council the opinion was expressed that accommodation should also be provided for the men, and that Edinburgh should co-operate with the tramway company in building a bigger shelter, but the committee have decided to recommend that the matter be left as the company suggested.

Burslem.—At the last Town Council meeting the Town Clerk said he had received notice from the Potteries Electric Traction Co. of their intention to lay double lines on the Hanley section and to apply for a provisional order to enable them to do so. He had also received a copy of Colonel Druitt's report on his recent inspection of the tramway system. After referring to his criticisms of the track last year, the inspector wrote: "In Burslem the company have only been able to repair the track, and part of it, at the commencement from the Market-place, is in a very bad condition. The company intend to relay the whole of the track of the old tramway in Burslem, about 1¼ miles, as double lines, with heavy rails, but are unable to say when they can make a start. The Corporation ask that some date may be fixed by the company. The state of the tramways is very much better than when I inspected them in March last year and the company have done their best to get the track into good order as far as they could. From the attached summary it will be seen that they have spent £20,000 on the renewal of their lines in this district since last year. They are also buying some new cars and repairing some of the old ones. In Stoke and Burslem I can recommend the Board of Trade to give a further consent for two years, in which time the company should be able to get all the old track relaid." Mr. Gibson said he rode in the special car with Colonel Druitt from the Market-place to the boundary, and asked the inspector whether certain things the Corporation asked for could be made conditional for a renewal of the licence. The inspector said he was sorry that was not possible. Mr. Robinson regarded the report as a condemnation of the whole thing. He thought the £20,000 referred to had not been spent in the Burslem area. The section between Burslem and Hanley was about the worst on the line, and Burslem was being treated worse than either Hanley, Stoke, or Longton by the company. He thought they should have some assurance when this track was going to be relaid. The company could tell them within three months. The cars were not fit to ride in, and they could not get a double car until it suited the convenience of Hanley. He spoke of the existing state of things as a scandal. Mr. Green endorsed Mr. Robinson's remarks, and said he rode in the car with the inspector, and the difference between it and one he rode in the previous night was most marked. The one was like being on a rocking horse, and the other like riding on water by comparison. Mr. Wade moved: "That this Council protests against the renewal of the licence of the tramway company on the ground that the main track is defective, the cars dirty and shaky, and the service quite unsatisfactory." Mr. Robinson seconded the resolution, which was carried.

LIGHTING AND GENERAL

Belper.—The Council have decided to install the telephone in the offices of the surveyor.

Cynwyd.—A private company is being formed locally having for its object the erection of an electricity generating station.

Guisborough.—A special meeting of the Council is to be called in order to consider the lighting of the town with electricity.

Rhodesia.—The suggestion that Victoria Falls should be lighted by electricity at night is meeting with general support in Rhodesia

Emsworth.—The Urban District Council have appointed a committee to consider the advisability of electrically lighting the district.

Edinburgh.—The Town Council have decided to extend the public lighting to the new tramway termini at Collinton-road and Georgie-road.

Madron.—A committee has been formed from the Urban District Council to consider the advisability of installing a lighting system for the district.

Electrical Trades' Union.—We are asked to announce that the general office of this society has been removed to 26, Cannon-street, Manchester.

Post Office Engineering Department.—The annual dinner in connection with the above will be held on Tuesday, Feb. 18, 1908, at the Grand Hotel, Trafalgar-square, W.C.

Beckenham.—The Local Government Board will hold an inquiry into the application of the Council for sanction to borrow £16,000 for their electricity undertaking on Dec. 20.

Robertson's Social and Athletic Club.—The members of this club are holding their annual plain and fancy dress ball on Saturday night, Dec. 21, at Brook-green Works, Hammersmith.

Telephone Co. of Egypt.—We are asked to state that the register of transfers of 4½ per cent. redeemable debenture stock will be closed until Dec. 31, inclusive, for the preparation of warrants for the half-yearly interest due on Jan. 1, 1908.

Lochwinnoch.—Operations were commenced during the week to establish a branch of the National Telephone in the village. This will be gratifying to most of the employers, who have for long felt the want of telephonic communication.

Grimsby.—A gas explosion of a serious nature occurred on the 12th inst. upon the premises of the grocery emporium of Burgons Limited. The shop front and stock were blown into the street, and the premises generally were extensively damaged.

Oriental Telephone and Electric Co.—We are informed that the register of transfers of 4 per cent. redeemable debenture stock is closed until Dec. 31, inclusive, for the preparation of warrants for the half-yearly interest due Jan. 1, 1908.

Release of Trustee.—The *London Gazette* announces that Mr. T. Barton, City-chambers, Catherine-street, Salisbury, has been released from trusteeship in the estate of Mr. F. Williams, electrician, 17, Orchard-road, Bemerton, Salisbury.

St. Pancras.—An additional water-softening plant is to be provided at the Regent's Park generating station of the works owned by the Corporation. Mains are to be extended to supply Aldenham and Seymour streets and Prince of Wales-road.

Westinghouse Electric Co.—It is announced that plans for the rehabilitation of the Westinghouse Electric Co. have been completed. The scheme proposes the issue of new stock to the value of seven million dollars, together with a bond issue of 25 millions.

Whitehaven.—The electrical engineer reported to the Council at its last meeting that during the preceding month there had been added to the main four new consumers and several extensions, having an equivalent of 62 16 c.p. lamps, and also one 2 h.p. motor.

Liquidation.—According to the *London Gazette*, a general meeting of the members of the Kalgoorlie Electric Power and Lighting Corporation will be held at Broad-street House, London, E.C., at 2 p.m. on Jan. 15, 1908, for the purpose of receiving the liquidator's report.

Rusper.—The Postmaster General has given notice of his intention to place a telegraph over and along the public road between the existing line near Ryder's Farm, Northlands-road, and the entrance to the Nunnery, Rusper, *viâ* Channelsbrook-road and the Horsham road.

Knighton.—A serious gas explosion occurred recently at the workhouse, blowing out the dividing wall between the waiting room and the relieving officers' room and completely wrecking the floor of the Board-room. Unhappily, the master was so injured that he died within an hour.

Aberavon.—The Gas Committee of the Council were specially called together on the 6th inst. owing to the almost complete failure of the gas supply to the town. So unsatisfactory have the new gas-works proved that the committee decided to have the old works restarted.

Slough.—On the 8th inst. a serious explosion of gas took place at the residence of Mr. J. James, 89, Park-street. It appears to have been caused by an escape of gas from a water chandelier which became ignited owing to the existence of a by-pass. The front of the house was completely wrecked.

Warmley.—The Council have decided to make application to the Board of Trade for a provisional order extending the time under the Warmley rural electrical order of 1903, and also to empower the Council to transfer the order, under terms to be agreed, to the Kingswood Electrical Supply Co.

Mosgiel (N.Z.).—The Borough Council have given consideration to the proposal of a gas company to install gas as an illuminant for the town. As the result of the deliberations the Council forwarded the following to the contracting firm: "The borough anticipate installing electricity at an early date."

New Zealand.—The Premier of New Zealand is urging the Pacific Cable Board to reduce its Press rates between Australasia and Great Britain from 1s. to 4d. per word. The High Commissioner in London has suggested the use of wireless telegraphy in this connection. The Pacific Cable Board is considering the matter.

Wireless Electric Lighting.—Harry Grout, a youth of 19, living at Worcester, Mass., claims to have perfected a system of wireless transmission of electrical energy for power and lighting. It is announced that with his apparatus he has been able to drive motors and light lamps 900ft. away without the use of cable or wires.

Eastbourne.—In reference to the petition of the frontagers and others in Hove requesting a mitigation of the motor-'bus nuisance, the directors of the company have had an interview with the Watch Committee of the Town Council, and have given assurance that they will continue to do their utmost to meet the wishes of the Corporation.

Leigh (Lancs.).—So unfortunate is the position of the municipal gas undertaking that the Local Government Board have refused to sanction any further borrowing powers for the Corporation until a heavy deficit is cleared off. The Council are considering the position, and find it necessary to levy a special rate of 1s. 6d. in the £ for one year to meet the deficiency.

Shoreham.—The Works Committee have recommended the Town Council to consent to the application of the Postmaster-General to place an overhead telegraphic line along the east side of Sackville-road from the railway bridge to the Old Shoreham-road, it being a condition of this consent that the Postmaster-General will erect ornamental iron poles in such positions as the borough surveyor approves.

Gravesend.—The engineer's report to the Council upon the working for the quarter ending Sept. 30 last was as follows: units supplied to tramway company, 109,375 (corresponding quarter, 1906, 112,695); units supplied to private consumers, 63,772 (50,449); units supplied to public lighting, 31,944 (28,483); units supplied to works, 32,053 (22,689); units unaccounted for, 32,863 (25,833); units generated, 270,007 (240,149).

Oldham.—At the fortnightly meeting of the Electricity Committee the engineer's report for the fortnight ended Dec. 4 stated that during the fortnight 74,171 units were sold for lighting and power, compared with 133,356 for the corresponding fortnight last year; 148,308 for traction, as compared with 133,356; a total of 222,479,

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compared with 195,562. The coal used for the fortnight amounted to 15,862cwt., against 13,750 for the corresponding period last year.

Heywood.—At the last meeting of the Town Council it was intimated that a scheme for the enlargement of the electricity works would be laid before the members of the committee and the Council shortly. Enlargements are necessary because of the enormously increased demand for current for lighting and for tramway purposes.

Cleveland Institution.—The members of the Cleveland Institution of Engineers held the second meeting of their session in the hall of the Cleveland Lit and Phil., Middlesbrough, on Monday last, when an interesting paper on "Limitation to Economy in the Use of Electric Driving" was given by Mr. R. J. Worth, of Stockton. Mr. Worth compared the costs of working various engines by steam and electricity respectively, giving detailed figures to explain his conclusions. A discussion followed.

Luton.—At the last Council meeting the electrical engineer reported that since Oct. 10 220,836 units had been generated, an equivalent of 665 8-c.p. lamps and three motors of 8 h.p. connected, making a total of 24,461 lamps and 210 motors of 1,320 h.p. The number of units generated showed an increase of 65 per cent. over the number generated during the corresponding period of last year. At the present time applications were in for over 1,200 additional lamps and 54 h.p. in motors.

Maidstone.—The Urban District Council have decided to make application to the Local Government Board for sanction to borrow the sum of £1.540 in addition to the sum of £16,900 already applied for in connection with the electricity works, such additional sum being made up as follows: new boiler and mountings, £850; brickwork and flues, £150; mechanical stokers, air duct, and fan, £200; superheater, £150; pipework and valves, £50; contingencies (10 per cent.), £140—total, £1,540.

Dunfermline.—Under the Fife Electric Power Co.'s Act the company are bound to give the burgh of Dunfermline five days' notice of their intention to lay cables in the town. Considerable difficulty has been experienced in securing an inspector on such short notice, and when the subject came to be discussed by the Town Council at its last meeting, Bailie Stewart passed the observation that if the company were only to give five days' notice the Council ought to have a man at hand at their expense. The Council agreed with this opinion.

Bursiem.—The Electric Lighting Committee have recommended the Corporation to enter into an agreement with Messrs. Doulton and Co. for a supply of electricity on the scale of charges fixed by the committee on Aug. 29, 1906. The electrical engineer reported that the number of units generated in November was 47,106, compared with 29,000 in the same month of last year; that the number of 8-c.p. lamps in use, exclusive of street-lighting, was 10,368, compared with 6,500; and that the number of motors in use was 72, compared with 67 in the previous month.

Newport.—At a special meeting of the Newport Electricity Committee it was reported that Colonel Sir Ivor Herbert, M.P., and Mr. Lewis Haslam, M.P., had waited on the Right Hon. John Burns, President of the Local Government Board, with a view to the withdrawal of the objection of the Board to granting a loan to the Newport Corporation for extending their electricity works. Further particulars as to the loan were asked for, and the committee were satisfied that the Board's objection would be withdrawn, and the loan granted in due course. Votes of thanks to the hon. members for their services were passed.

Radcliffe.—At a meeting of the Electricity Committee the electrical engineer reported the laying of their services and applications for terms from several firms, including the Co-operative Society, for their central stores and branch shops if satisfactory. A resolution was passed that users of electricity for power purposes be supplied with electricity for lighting purposes at the same price as that charged to them for power purposes for such a quantity not exceeding 10 per cent. of the quantity taken by them in any quarter for power purposes, the excess quantity taken for lighting purposes to be charged for on the basis of the schedules of prices for lighting.

Oban.—At a meeting of the committee there was submitted a report by the burgh electrical engineer on the rate charged for power, in which he recommended that the following schedule of rebates to consumers of power who do not use their motors between the hours of 6 p.m. and 6 a.m. be adopted—viz.: when the units used per quarter amount to 600, 5 per cent. off; 700, 10 per cent.; 800, 15 per cent.; 900, 20 per cent.; 1,000, 25 per cent.; 1,100, 30 per cent.; 1,200, 35 per cent.; 1,300, 40 per cent.; 1,400, 45 per cent.; 1,500, 50 per cent. It was resolved to recommend that these rebates be approved of, but that they be allowed only for payment within 14 days of the rendering of the quarterly account.

Penybont.—At the last meeting of the Council a letter was read from the clerk to the Llangynwyd Parish Council expressing the hope that that parish should be included in the scheme under the proposed extension of the Bridgend electric light provisional order. The Rev. H. Eynon Lewis said there were several points in connection with this scheme which required consideration. The Bridgend Council were applying for powers over three parishes within the rural district, and while the Penybont Council would not be able to compel Bridgend to supply light to all parts of the parishes, the Bridgend Council could be the means of preventing a private undertaking doing so. The whole question was referred to a committee.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in Boston Consolidated Copper and Gold Mining Co.'s script certificates (50 per cent. paid) for £252,000 7 per cent. first debentures; and New Einasleigh Copper Mines' 74,500 vendors' shares of £1 each, fully paid, Nos. 76,001 to 150,500. The committee has further been asked to allow the following securities to be quoted in the official list: Dunlop Rubber Co.'s 220,000 shares of £1 each, fully paid, Nos. 1 to 220,000 (special application); and Shawinigan Water and Power Co.'s further issue of 48 500dol. 5 per cent. consolidated first mortgage bonds of 500dol. each, Nos. 5,766 to 5,825 and 5,839 to 5,875.

Woolwich.—The Electricity Committee reported to the Council at its last meeting the receipt of a letter from the London County Council asking whether the Council would be prepared to supply them with further energy to an extent not exceeding an additional 100 kw. for that section of the Council's proposed tramways from Abbey Wood to Wickham-lane, and whether the additional supply could be given as an extension to their existing agreement with the Council. A reply in the affirmative was ordered to be sent to the London County Council. The Chairman said he was pleased to be able to state that the London County Council had agreed to extending the whole of the supply for a fixed period of three years.

Greenwich.—Mr. H. W. Kolle, assistant manager of Messrs. Babcock and Wilcox, gave evidence on Wednesday at the Board of Trade inquiry as to the boiler explosion at the works of the South Metropolitan Electric Light and Power Co. in December of last year. His firm were the makers of the thermal storage drum at the end of which the explosion occurred, and he stated that the information that there was a slight crack in the drum-end was conveyed to him on the day before the explosion. He recognised at once that there was some potential danger of explosion in the event of the crack extending, though not immediate danger. When he visited the scene after the explosion and made a cursory examination of the drum-end he came to the conclusion that there had been a brittle plate.

Coventry.—The Town Council decided on Tuesday to make application to the Local Government Board for sanction to loans amounting to £35,000 for purposes of their electrical undertaking. It is proposed to expend £10 000 of this amount on extensions to distributing plant, and the balance on the laying of new mains in the extended area of supply. Drawings are being prepared by the manager for extensions at the works on an extensive scale. The amount last sanctioned by the Local Government Board included very little in respect of distributing plant, and, in addition, the amount of money for the purchase of motors to be let out on hire has been practically exhausted. If the sanction of the Board is obtained, it is only intended to expend the money as and when it became necessary.

D. P. Battery Co.—This company, since the recent extensions of their works and remodelling of the shops, have been enabled to deal much more promptly with the increased number of orders placed with them. Besides the plentiful supply of home orders for lighting trains, for telegraph, and telephone purposes, they have just shipped a large storage battery for one of the latest Nile boats. Other Colonial and foreign orders include battery for Australia, Canada, Italy, New Zealand, Mauritius, Aden, Zanzibar, and South Africa. Amongst the home orders for country-house lighting the company have secured the renewal next year of the storage batteries they installed at Wroxhall Abbey far back in the early nineties, and last week the battery order for the Luton tramway station was placed with them. The company is now represented in Japan and its dependencies by Messrs. E. H. Hunter and Co., of Fenchurch-street and Japan.

Dundee.—Dundee Electrical Contractors' Association and the city electrical engineer are still at variance on the subject of the pushing of the business of the department, and with particular reference and objection on the part of the association to the department issuing specifications on behalf of customers. At a meeting of the Electricity Committee held on Tuesday a communication from the association was submitted asking that before a decision was arrived at by the Town Council in the unfortunate dispute that at present existed an informal meeting might take place between parties with a view of arranging matters. Correspondence between the electrical engineer and the association was submitted, and the committee resolved to adhere to their former decision, and declined to meet the association. The contract for the extra high-tension cables, which is being carried out by the British Insulated and Helsby Cables, Prescot, Lancs., is being pushed on very rapidly. All the streets in the centre of the town will be completed this week, leaving only the outlying districts to do.

Liverpool and District Electrical Association.—Under the auspices of the above association, Mr. J. J. Richardson delivered an interesting lecture on "Electrical Appliances" at the Common Hall, Hackins Hey, Dale-street, Liverpool, on Tuesday, Dec. 17. Mr. S. Frith (the hon. secretary and treasurer) presided over a good attendance. The lecture, which was most profusely illustrated by lantern slides, was both of a scientific and popular character. The lecturer dealt with the evolution of the incandescent electric glow lamp, the plants in large generating stations, and the lighting by means of arc lamps. There were several fine slides of artificial and electrical discharges produced by a large influence machine. Particular notice was drawn by Mr. Richardson to the change in the design of generating stations due to the adoption of turbine-driven units, and slides were shown of different types of generators driven by these units, and the advantages of the turbo-driven units were clearly demonstrated. The next meeting of the association will be held at the Common Hall at 8 p.m. on Jan. 14, 1908. Readers of the *Electrical Engineer* may obtain a card of admission on application to the hon. secretary.

King's Lynn.—At the last meeting of the Town Council the engineer reported that applications had been received from nine additional consumers for 317 lamps of 8 c.p. or equivalent, making a total of 613 private connections and 29,068 lamps. He also reported that the arc lamps at the South Gates were now taken down and required repairing, but before doing so he would like to try lighting by means of high candle-power Osram lamps, which, if satisfactory, would effect a considerable saving in the attendance on the lamps. The recommendation was adopted. A memorial from several ratepayers was

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read calling the attention of the committee to the lighting arrangements at the corner of Norfolk-street, Broad-street, and Chapel-street, and asking the committee to improve the same. A committee was authorised to inspect the locality and report thereon. The engineer submitted the following statement: units generated, October, 1907, 59,163 (October, 1906, 55,042); total units sold to private consumers (lighting and power), 35,851 (32,538); units sold at lighting rates, 21,207 (20,748); units sold at power rates, 14,644 (11,790); cost of fuel, stores, repairs, and wages at station, £179. 7s. 4d. (£153. 12s. 11d.); cost per unit generated, 0·7278d. (0·6699d.); wages of lamplighters and repairs to lamps, mains, and meters, £26. 11s. 3d. (£30. 13s. 9d.).

Cardiff.—Mr. Arthur Ellis, the Corporation electrical engineer and tramways manager, appeared before the Finance Committee of the Council on Monday, and stated that in order to meet the demands of the Great Western Railway Co. and other demands at the Docks district the following items of expenditure should be incurred on the completion of the Docks sub-station: 250-kw. motor converter, £1,000; foundations for same, £50; cable for connecting up switchboards, £70; completion of switchboard, £305; sundry labour connecting up same, £10; small battery booster, £150; new high-tension feeder from Hayes to docks, £755; 300 yards of three-way conduit, £53. 12s. 6d.; laying same and reinstating, £57. 15s. Then for the extension of the Hayes sub-station the following amounts would have to be spent: 500-kw. motor-generator complete, £1,600; labour in connecting up, etc., £80; foundations, £150; extension switchboard, £206; connections between switchboards, £20. The total amount of capital expenditure was £4,507, and this had been approved by the Electric Lighting and Tramways Committee and also by the Local Government Board. Mr. Ellis explained that it would cost £1,000 to lay the cables to the Great Western Station. Those cables were already in existence, but would have to be diverted. The motion to sanction the expenditure was carried.

Lowestoft.—At the meeting of the Electric Lighting Committee the engineer reported that since the last meeting 19 consumers, representing 1,093 8-c.p. lamps, had been connected. There are now connected to the mains 832 consumers and three motors, representing 41,783 8 c.p. lamps. The engineer was directed to offer the stokers at the station a bonus of £10, to be payable if the coal costs are reduced to ·6 of 1d. per unit, and if the costs are reduced to ·5 of 1d. per unit the bonus to be increased to £20. The chief clerk submitted accounts and balance-sheet for the year ending Sept. 30, 1907, showing that, after paying £4,818. 2s. for sinking fund and interest, there was a credit balance of £69. 14s. 6d. This was approved. The engineer submitted a scheme and plans for a proposed siding for the conveyance of coal to the works at an estimated cost of £1,500, and the committee recommended that the scheme be adopted, and that an application be made to the Local Government Board for their sanction to the borrowing of the sum of £1,500 for carrying out the same. The engineer submitted a report, in which he stated that in accordance with instructions received from the Electric Lighting Committee he visited a few stations with reference to mechanical stokers. From the results he obtained he recommended that a Babcock and Wilcox chain-grate coking stoker be fitted to three boilers, one being double drum, and two single drum, and one Bennis stoker to the No. 3 marine boiler. This was agreed to.

Walsall.—The total number of consumers supplied from the Corporation works on Nov. 30 last was 528, as compared with 485 at the same date last year. During the past month the total number of units generated at the station was 212,372, as compared with 194,286 for the same period last year. The total output from the main generators was 206,926 units as compared with 188,935 for the same period last year. The total units registered on the meters was 149,565, as compared with 138,319 units for the same period last year. The machinery was run for 711 hours, as compared with 714 for the same period last year. The wages paid amounted to £161, as against £134 for last year. The committee have considered the question of extending the mains in Birmingham-road beyond Lysways-street, but they cannot see their way to do so, as the income received, as far as they can judge, will not at present justify the outlay. The engineer has reported that on the 3rd inst., at 7 a.m., the lighting supply was interrupted for seven minutes and the traction supply for 15 minutes, but that no damage was done to the plant. On the 22nd ult. a slight short-circuit occurred on No. 2 transformer at the Imperial Hall, and this caused some little damage to the transformer armature, which has since been repaired. An application has been received for an extension of the mains so as to enable St. George's Church to be lighted, but as it would cost about £450 to lay a cable from the Ditch transformer station, which would be the only efficient way, the committee regret that they are unable to accede to the application, as the outlay would not be justified by the income.

Hanley.—At the meeting of the Electric Lighting Committee the electrical engineer reported that in the month of October there had been connected five new lighting consumers, taking 90 lamps; that extensions had been made on the premises of 11 lighting consumers, equivalent to 112 lamps; and that two new heating and two new power consumers had been coupled to the mains, equivalent respectively to 60 lamps and 270 lamps; while two extensions of motors had been connected, equal to 720 lamps. A letter was read from Messrs. Joseph Wright and Co., of Tipton, stating that they would be pleased to arrange to take back the present water purifier free of charge if the Corporation agreed to order the next water-purifying plant from them at reasonable competitive rates. The present plant was charged at £160, which had not yet been paid. It was resolved that the offer be accepted, and Messrs. Wright informed that the next water-purifying plant required will be obtained from them at a reasonable competitive price in consideration of their taking back that now in the electricity works and withdrawing their claim for £160. An extension of mains along Leek-road from Fenton-road to the new works of the Central Potters Mill was approved. The minutes of the committee also contained a report by Mr. Yeaman, the electrical engineer, respecting a breakdown of the light supply on a recent foggy Saturday. Alderman Coates, in moving the adoption of the report, said the breakdown was undoubtedly caused through some gas workmen employed in the particular neighbourhood. They could not tell how it happened, but it did happen. They had a similar case some months previously. He thought waterworks and gasworks employés and their own men when pulling up roads should be given to understand that there were many pipes and cables underneath the ground that they might come into dangerous proximity with at any moment. The engineer, he added, did all he could to meet the emergency. The report was adopted.

PROVISIONAL PATENTS, 1907.

DEC. 6.

26950. Improvements on starting devices for induction motors. Jacob Stotner and Rudolf Herzfeld, 121, Charing Cross-road, London.

26968. Improvements in galvanic-electric batteries. Georges Schauli, 63, Harberton-road, Upper Holloway, London.

26986. New or improved apparatus for guiding the contact pulley on the conducting pole of electrically-propelled tramway cars on to the overhead wire. Thomas Brown, King's Hall, Kean street, London.

26993. Improvements in trolley wheels, such as are used on electric trolley cars. William Phillips Thompson, 6, Lord-street, Liverpool. (Ellsworth Nelson Luburg, Albert H. Smith, and William W. Varney, United States.)

27010. Improvements in telegraphic code condensers. Nobel's Explosives Company, Limited, and Matthew Bain Dickie, 24, Southampton-buildings, London. (Complete specification.)

27034. Improvements in electric arc lamps. William James Davy, 40, Chancery-lane, London.

27038. Improvements in motor-starting devices. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

DEC. 7.

27073. Improvements in or relating to electrical systems or arrangements for driving machinery subject to variable loads. Siemens-Schuckertwerke, G. m. b. H., 139, Queen Victoria-street, London. (Date applied for under Patents Act, 1901, Dec. 8, 1906, being date of application in Germany.) (Complete specification.)

27076. Improvements in or relating to electric incandescent lamps. Ignace Hippolyte Hegner, 16, Place de la République, Paris, France.

27084. Improvements in or relating to electric installations for the interior of drawing-rooms and the like. Ignace Hippolyte Hegner, 16, Place de la République, Paris, France.

27090. Improved bracket for supporting or locating electric cables, pipes, and the like. Ernest Albert Gill, 321 High Holborn, London. (Complete specification.)

27092. Improvements in electric traction. Henry Browse Elliot, 4, South-street, Finsbury, London. (Henry Brown Greenwood, Argentine Republic.) (Complete specification.)

27095. Improvements in electrical welding machines. Michael Bartholomew Ryan, 46, Lincoln's-inn-fields, London. (Complete specification.)

27105. Improvements in or in connection with the method of calibrating or standardising service meters and in apparatus therefor. Edgar Morris Wilkins, 6, Lord-street, Liverpool. (Complete specification.)

27130. Improvements in incandescent electric lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

27131. Improvements in and connected with electric distribution systems. The British Thomson-Houston Company, Limited, and Edmund Basil Wedmore, 83, Cannon-street, London.

27132. Improvements in and relating to arc lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Allgemeine Elektricitäts-Ges., Germany.)

DEC. 9.

27157. Improvements in and relating to electric transformers. Louis Maiche, 2, Boulevard Beaumarchais, Paris, France. (Complete specification.)

27164. Improvements in or relating to induction apparatus. William Hill Nix, John Alfred Harper, and Edith Louisa Lane, 111, Hatton-garden, London.

27177. Improvements in or relating to insulators. John Charles Barclay, 7, Southampton-buildings, London. (Date applied for under Patents Act, 1901, July 27, 1907, being date of application in United States.) (Complete specification.)

27189. Improvements in and relating to telephone apparatus. William Edward Lake, 7, Southampton-buildings, London. (Aktieselskabet Elektrisk Bureau, Norway.) (Complete specification.)

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27200. Improvements in apparatus for producing electrical oscillations. Kristian Birkeland, 46, Lincoln's-inn-fields, London. (Complete specification.)

27208. Improvements in electric rock drills. Oswald Robert Mounsey and Robert Hacking, Broad Sanctuary-chambers, Westminster.

27209. Improvements in controllers for electric motors and the like. Robert Hacking and Oswald Robert Mounsey, Broad Sanctuary-chambers, Westminster.

27223. Improvements in protective devices for electrical systems and apparatus or conductors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

27223. Improvements in electric arc lamp. The British Thomson-Houston Company, Limited, and William Herbert Dalton, 83, Cannon-street, London.

27224. Improvements in electrolytic condensers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

27225. Improvements in electrical protective devices of the type known as lightning arresters. The British Thomson-Houston Company, Limited. 83, Cannon-street, London. (General Electric Company, United States.)

DEC. 10.

27232. Ampere-hour meter provided with an armature rotating in the field of a permanent magnet. Wilhelm Meyerling, 27, Chancery-lane, London. (Date applied for under Patents Act, 1901, April 19, 1907, being date of application in Germany.) (Complete specification.)

27260. New or improved alternating-current machine. Rudolf Goldschmidt, 60, Doughty-street, London. (Complete specification.)

27286. Improved appliance or device for generating and transmitting sound waves. Eugene Victor Gratze, 44, Whitfield-street, London.

27289. Improvements in methods of producing electric oscillations. Roberto Clemens Galletti, 111, Hatton-garden, London.

27293. Improvements in electric motor apparatus applicable to machinery of all kinds requiring force. Thomas James Howell and Edwin Joseph Richardson, Stoneleigh House, Sawbridgeworth, Herts. (Complete specification.)

27298. Contacting device for electrical measuring and indicating instruments. James Yate Johnson, 47, Lincoln's-inn-fields, London. (Firm of W. C. Heraeus, Germany.)

27303. Improvements in and relating to primary batteries. Karl Heintz, 322, High Holborn, London. (Complete specification.)

DEC. 11.

27346. Improvement in alternating-current induction motors. Thomas Harding Churton, Atlas Works, Water-lane, Leeds.

27350. Improvements relating to gas and electric lighting for spinning frames and the like. Henry Mercer Girdwood, 17, St. Ann's-square, Manchester.

27363. Improvements in trolleys or collectors for electric railways and tramways. Henry James Tompkins, Queen Anne's-chambers, Westminster.

27375. Improvements in or relating to tremblers for induction coils. Jules Guenet, 111, Hatton-garden, London. (Complete specification.)

27379. Improvements relating to radio-telephony. The Amalgamated Radio-Telegraph Company, Limited, Southampton-buildings, London. (George Seibt, Germany.) (Complete specification.)

27385. Improvements relating to apparatus for the electro-deposition of metals. Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London. (Complete specification.)

27400. Electrical and other box couplings. John Joseph Rawlings and Robert Tweedy Smith, 34, High Holborn, London. (Complete specification.)

27401. Improved electric fuses. John Joseph Rawlings and Robert Tweedy Smith, 34, High Holborn, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Jan. 2.)

1906.

13126A. Manufacture of metal articles by electro-deposition. Cowper-Coles. (Date applied for under Rule 5, Patents Rules, 1905, Dec. 5, 1906.)

28319. Process for preparing printing plates by means of electrolytic etching. Strecker-Aufermann.

28739. Methods or means of electric braking. Babb, Chapman, and Cockshott.

28775. Method of and means or apparatus for producing metallic incandescence bodies for electric glow lamps. Deutsche Gasglühlicht Act.-Ges. (Auerges). (Date applied for under International Convention, March 27, 1906.)

28846. Electric ignition for internal-combustion engines. Crossley and Jackson.

28897A. Electro-deposition of iron. Cowper-Coles. (Date applied for under Rule 5, Patents Rules, 1905, Dec. 18, 1906.)

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid.		Last price.
	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	½-⅝
—— Ord., 1,125 000	1	..	⅛-¼
Aron Electricity Meter, 6 p.c Cum. Pref. Shares, 1-125,000	1	..	9/16-11/16
—— Ordinary, Nos. 1 125,000	1	..	5/32 9/32
British Aluminium Co., Ordinary, 2,001-40,000	5	..	3¼-4¼
—— 7 per cent. Cum. Pref., 1-40,000	5	..	4½-5
—— "A" 6 per cent. Cum. Pref., 1-20,000	5	..	4¼-4⅝
—— 4 per cent. Funding Certificates, 1-20 000	5	..	3⅜ 4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	100-102
—— 5½ per cent Loch Leven Deb. (Reg.) Red., 1-3,000	100	..	96-98
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6½-7
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5⅝-6¼
—— 4½ per cent. Mortgage Debentures	100	..	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	85-89
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	3	..	¾-1⅛
—— 4 per cent. Mortgage Debenture Stock	100	..	45-55
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	0-½
—— Non. Cum., 6 per cent., Pref.	2	..	⅜-⅝
—— 4½ per cent. 1st Debenture Stock	100	..	83-86
—— 4½ per cent. 2nd Debenture Stock	100	..	65-68
Callender's Cable, Debentures	100	..	105½-107½
—— Ordinary	5	..	9½-10½
—— 5 per cent. Pref.	5	..	5½-5⅝ xd
Consolidated Electrical Co., Ordinary, 1-110,000	1	..	7/16-9/16
Crompton and Co.	3	..	1⅝-1⅞
—— 5 per cent. Debentures	100	..	96-99
Dick, Kerr and Co., Ordinary, 1 260 000	1	..	1⅛-1⅜
—— 6 per cent. Cum. Pref., 1-305,000	1	..	1-1⅛
—— 4½ per cent. Debenture Stock, Red.	100	..	101-104
Edison and Swan United, "A" Shares, 1-99 261	3	..	⅞-1⅛
—— "A" Shares, 01-017,139	5	..	1⅛-2⅛
—— 5 per cent. Debentures	100	..	87-90
—— 4 per cent. Deb. Stock, Red.	100	..	79-82
Electric Construction, Nos. 1 to 112,100	2	..	½-¾
—— 7 per cent. Cumulative Pref.	2	..	⅝-1⅛
—— 4 per cent. Perp. 1st Mort. Deb	100	..	59-64
Electrolytic Alkali Co., Ordinary, 1-202,218	1	..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock. Red	100	..	—
General Electric Company (1900) 5 per cent. Cum. Pref.	10	..	8-8½
—— 4 per cent. 1st Mort. Deb. Stock	100	..	89-92
W. T. Henley's Telegraph Works, Ordinary	5	..	10½-11½
—— 4½ per cent. Preference	5	..	5- ½
—— 4½ per cent. Debentures	100	..	104-106
India Rubber, Gutta Percha, and Telegraph Works	10	..	15½-16¼
—— 4 per cent. Debentures	100	..	96-98
National Electric Construction Co., 1-170,000	1	..	11/16-13/16
Parker, Thos., Limited, Ordinary	10	..	10-10½
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5	..	—
Telegraph Construction and Maintenance	12	..	28½-30½
—— 5 per cent. Bonds	100	..	100-103
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	..	8¼-9¼

Electric Lighting and Supply.—

Name.	Amount paid.		Last price
	£		£
Adelaide Electric Supply Co., 6 p c. Cum. Pref., 1-10,000	5	..	4½-5
Bournemouth and Poole, Ordinary	10	..	9½-10½
—— 4½ per cent. Cum Pref., 7 501-15 000	10	..	9¼-10
—— 6 per cent. Cum Second Pref., 15 001-22,500	10	..	9¼-10⅜
—— 4½ per cent. Debenture Stock, Red.	100	..	100-103
Bromley (Kent) Electric Light and Power Co	5	..	4⅝-5¼
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	96-98
Brompton and Kensington, Ordinary	5	..	7-8
—— 7 per cent. Preference	5	..	7-8
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	..	6-6½
—— Nos. 80,000-100,000	5	..	5⅞-6⅜ xd
Cambridge Electric Supply Company, £10 Ord.	8	..	12½-13½
Canadian General Electric Co., Common Shares	$100	..	98-102
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	..	96-99
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	..	3¼-4⅛
—— 4½ per cent. Cum Pref., 1-80,000	5	..	3¼-4¼
—— 4 per cent. Debenture Stock, Red.	100	..	95-98 xd
—— "City Undertaking," 4½ p c Cum. Pref., 1-40,000	5	..	3⅜-4¼
—— ditto ('905) 40,001-80,000	5	..	3¼-4¼
Chelsea Electricity Supply	5	..	3¼-4¼
—— 4½ per cent. Debentures	100	..	102-105
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000	..	—
City of London, Ordinary	10	..	9½-10½
—— 6 per cent. Cumulative Pref.	10	..	11-12
—— 5 per cent. Debenture Stock	100	..	122-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd)	100	..	95-98
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1 630	50	..	50-53
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100	..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5	..	3½-4½
—— 5 per cent Preference, 1-50,000	5	..	4⅜-4⅝
County of London Elec. Supply, Ordinary	10	..	6¼-7½
—— 6 per cent. Cum Pref.	10	..	10-10⅜
—— 4½ per cent. Debentures Prov. Certs. All pd., Red.	100	..	105-108
—— 4½ per cent. 2nd Debentures Prov Certs	100	..	95-98
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5	..	⅜-⅞
—— 6 per cent. Cum. Pref.	5	..	1-1½
—— 4½ per cent. First Mort. Deb.	100	..	75-80
Electrical Development Co. of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, 10,751-15,750	—	..	74-77 p.c.
Electric Lt. & Traction Co. of Aust., 6 p c. Cm. Pf., 1-30,000	5	..	2¼-2⅝
—— 5 per cent Debenture Stock, Red.	100	..	85½-89½
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red	100	..	94-96
Folkestone Electric Supply, Ord., Nos 1-10 000	5	..	4½-5
—— 5 per cent. Cum. Pref., Nos. 1-10 000	5	..	4¼-5⅛
—— 4½ per cent. First Deb Stock, Red.	100	..	96-99
Hove Electric Lighting, Ord., 1-13,000	5	..	6⅛-6⅜
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red	100	..	101-104
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk., Red	100	..	92-95
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	.	1/16-3/16
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000	5	..	8-9
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100	..	98-102
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9¼-10½

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Name.	Amount paid. £	Last price. £
London Electric, Ordinary	5 ..	1¼-1⅝
—— 6 per cent. Pref.	5 ..	4-4½
—— 4 per cent 1st Mortgage Debenture Stock, Red.	100 ..	87-91 xd
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100 ..	92-95
Metropolitan Ordinary, 100,001-.00,000	5 ..	5⅜-5¾
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	102-.06
—— 4½ per cent. Cum. Pref.	5 ..	4½-5
—— 3½ per cent. Mortgage Debenture, Red	100 ..	87 92
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds 1955, C 1-1,000 ($100), D 1-3,000 ($500), M 1 4,400 ($1,000)	— ..	76-78 p.c.
Mexican Light and Power Co., Capital Stock	$100 ..	41-43
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14,000 ($1,000)	— ..	83-85
Midland Electric Power Dis., 4½ p.c 1st Mort. Deb.	— ..	96½-99½
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009	5 ..	6¼-6⅜
—— do., 57,010-75,000	5 ..	6¼-6⅜
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid	5 ..	6¼-6⅜
—— 5 per cent., Pref., 1-57,009	5 ..	5-5¼
—— do., 75,001-87,500 (issued at 10s. prem., 4s. paid)	5 ..	5-5¼
Notting Hill Electric Lighting	10 ..	10½-11½
—— 4 per cent. First Mort. Debs. Nos. 1 500 (Reg.)	100 ..	95-97
Oxford Electric, Ordinary, 1-96 and 40 14,310	5 ..	5½ 6
—— 4 per cent. Debenture Stock	100 ..	96-97
River Plate Electricity Co., Ord., 1 119 687 & 120,501-120 507	1 ..	9/16-11 16
—— 6 per cent. Non-Cum. Pref., 1-100,000	1 ..	1⁵/16-15/16
—— 5 per cent. Debenture Stock, Red	100 ..	95-98
Rosario Electric Co., 6 per cent. Cum Pref., 1-20 000	5 ..	4⅜ 5¼
—— 6 per cent. Cum 2nd Pref., 1-15,000	5 ..	4⅞-5⅛
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	96 98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	— ..	98-100 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5 ..	½-1½
—— 4 per cent. Debenture Stock	100 ..	71-75
South London, Ordinary	5 ..	2½-3
South Metropolitan Electric Light and Power, Ord.	1 ..	½-¾
—— 7 per cent Cum Pref.	1 ..	15/16-1 3/16
—— 4½ per cent. 1st Mort. Deb.	100 ..	99 102
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	7¼-8¼
—— 7 per cent. Pref.	5 ..	6½-7½
—— 3½ per cent. Deb.	100 ..	87-92
Urban Electric Supply Co., Ordinary, 8-30,007	5 ..	1⅜ 2⅛
—— 5 per cent. Cumulative Preference, 50 001 80,000	5 ..	1¾-2⅞
Westminster, Ordinary	5 ..	7⅜-8⅜
—— 4½ per cent. Cum. Pref., 110,101-133,251	5 ..	4⅝-5⅛

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine, 6 per cent. Cum Pref., 1-200,007	5 ..	5 13 16-6 1/16
—— 10 per cent. Non-Cum 2nd Pref., 200,008-280,007	5 ..	7¼-8¼
—— Permanent 6 per cent Debenture Stock, 1888	100 ..	128-131
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100 ..	105-10⅞
Barcelona Tramways, Ord., 1-20,000	10 ..	—
—— 5 per cent. Cum. Pref. Shares, 1 10,000	10 ..	—
—— 5 per cent Deb., Red., 1-600	100 ..	—
—— 4½ per cent. Red. Deb. Stock	100 ..	—
Bath Elec Tramways, Ld., Pref. Ord. Shares, 75,001-100,606	1 ..	11/16 13/16
—— 5 per cent. Cum. Pref. Shares, 1-75 000	1 ..	1316/-15/16
Birmingham and Midland Trams., 4½ p. c 1st Db. Stk., Red.	100 ..	92-95
Blackpool and Fleetwood Tramroad	10 ..	13⅜-1⅞
Bombay Elec. Supply and Trams. Co., 6 per cent. Cum. Pref.	8 ..	7⅛-7⅞
—— 4½ per cent. Deb. Stock, Red.	100 ..	93-95
Brisbane Tramway Invest., Ord., 1-75,000	5 ..	3 1/16-3 5/16
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4⅜ 4⅞
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	96-100
British Columbia Electric Railway Co., Ord Def.	100 ..	124-127
—— Ord. Pref.	100 ..	107-111
—— 5 per cent. Cum. Perpetual Pref. Stock	100 ..	99-103
—— 4½ per cent. 1st Mt. Debs., Nos. 1 6,250, of £40 each	40 ..	98-101
—— 4½ per cent. Vancouver Power Deb.	100 ..	100-103
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10 ..	1¼-1⅜
—— 6 per cent. Cm Pf., 30,0001-60 000	10 ..	5-5¼
—— 5 per cent. Perpetual Debenture Stock	100 ..	90-93
—— 4½ per cent 2nd Deb. Stock	100 ..	70-75
Bueno Ayres and Belgrano Trams	5 ..	4⅜-4⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	4¼-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	4¾ 5¼
—— 5 per cent. Deb. Stock, Red.	100 ..	105-115
—— Prov. Cert., all paid	100 ..	102-105
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100 ..	91-96
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100 ..	99-103
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100 ..	98-103
Buenos Ayres Lacrcze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	91-94
Calcutta Tramways, Ord., Nos 1-137,610	5 ..	6⅜-6⅞
—— 5 per cent. Cum. Pref., Nos. 1 30,000	5 ..	5 5¼
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	101-105
Cape Electric Tramways, Nos. 1-480,000	1 ..	⅛-¾
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5 ..	4¼-4⅜
—— 4 per cent 1st Mortgage Deb., 1-3 000 (1917)	100 ..	96-99
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5 ..	5-5¼
—— 4 per cent. Deb. Stock, Red. 1985	100 ..	98-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	93-97
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	13-14
—— 6 per cent. Cum. Pref.	10 ..	12⅜-13⅜
—— 4 per cent. Debentures	100 ..	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	12½-13½
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	12⅜-13⅜
—— 3½ per cent. Mort. Debs., 1-3,000 Red.	100 ..	90-95
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100 ..	97-100
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1,000 ..	82-87
Imperial Tramways, Ordinary	all ..	18-19
—— 6 per cent. Cum. Pref.	all ..	14-14½
—— 4½ per cent. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 ..	¼-1⅜
—— 4 per cent. 1st. Mt. Db Stock, Red.	100 ..	67-72
Kalgoorlie Electric Tramways, 1-250,000	1 ..	1/16-⅛
—— 5 per cent. "A" Deb. Stock	100 ..	87-91 xd
—— 6 per cent. "B" Deb. Stock	100 ..	71-75
Kidderminster and District Lighting and Traction, Pref.	5 ..	10-10½
Lancashire United Tramways, Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	94-97
—— £296 500 2nd Mort. Deb. Stock	— ..	—
—— £83,330 Deferred Deb. Stock (all fully paid)	— ..	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1 ..	⅛-1⅛
—— 6 per cent. Cum. Pref., Nos 1-425,553	1 ..	⅛-1⅛
—— 5 per cent. Mort Deb., 1-5,000 Red.	100 ..	92-97
London United Trys. (1901), 5 per cent. Cum. Pref.	10 ..	7½-8½
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100 ..	82-86

Name.	Amount paid. £	Last price. £
Madras Elec. Trams. (1904) 5 per cent. Deb. Stk., Red.	100	96-99
Manila Elec. R.R. and Lightg. Corp., 5 p.c. 1st Lien and Coll Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000 ..	88-92
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 201-21,635 and 23,436-25,000	— ..	4½ 5 xd
—— 4½ per cent 1st Mort. Deb Stock, Red.	100 ..	96-99
Metropolitan Elec Trams., Defd., 1,000,001-1 314 016	1 ..	1/16 3/16
—— 5 per cent. Cum Pref., 500,001-1,000 000	1 ..	13/16-15/16
—— 4½ per cent. Deb. Stock, Red.	100 ..	93-96
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	— ..	80-82 p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con. Mort Bonds, 1926 1-5,500 and 7,001-8,000	$1,000 ..	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 201-2,000 1922	100 ..	101-103
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34 001-74,000	5 ..	¾-1⅛
Oldham, Ashton, and Hyde Tramway, Ordinary	10 ..	2
—— 5 per cent. Cum. Pref.	10 ..	8¾-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100 ..	99-103
Potteries Electric Traction, Ordinary, 1-245,000	1 ..	5/16-9/16
—— 5 per cent Cum Pref., 300,001-545 000	1 ..	½-¾
—— 4½ per cent Debenture Stock	100 ..	93-96
Provincial Tramways Co., Ordinary, 1-24 912	10 ..	4-5¼ xd
—— 6 per cent. Cum. Pref., 1-10,000	10 ..	10¼-11¼
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-20,000	5 ..	5-5¼
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100 ..	97-99
Sao Paulo Tramway, Light, and Power Co.	$100 ..	117-121
—— 5 per cent. 1st Mort Deb., Red. 1929, 1-11,000	$500 ..	91-93 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1 ..	⅞-1¼
—— 4 per cent. Deb Stock, Red. 1940	100 ..	80-84
Sunderland District Electric Tramways, 5 p.c 1st Mort. Debs., Red., 1-1 600	100 ..	80-84
Yorkshire (West Riding) Elec Tram. Co., Ord., 70,001-110,000	5 ..	1-1½
—— 6 per cent. Cum. Pref., 1-46,261	5 ..	3¼-3⅝
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	84-87

Electric Railways.—

Name.	Amount paid £	Last price. £
Central London, Ordinary	100 ..	62-65
—— 4 per cent. Pref.	100 ..	83-85
—— " deferred	100 ..	41-44
—— 4 p c Deb. Stock (Prov. Script Certs., fully paid)	100 ..	101-104
City and South London, Consolidated Ordinary	100 ..	43-45
—— 4 per cent Debenture Stock	100 ..	100-103
—— 5 per cent. Pref. Stock '91	100 ..	116-119
—— " " " '96	100 ..	113-116
—— " " " '01	100 ..	113-116
—— " " " '05	100 ..	108-111
Liverpool Overhead, 5 per cent. Pref.	10 ..	10-10½
—— Ordinary, 1-50,000	10 ..	3¾-4¼
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	— ..	35-39

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price. £
Amazon Telegraph Co., 1-25,000	10 ..	2¼-3¼
—— 5 per cent. Debs., Red., within 1-1,069	100 ..	85-88
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000	$1 000 ..	88-90
Anglo-American Telegraph Co., Ordinary	100 ..	55-58
—— 6 per cent. Preferred Ordinary	100 ..	99-101
—— Deferred Ordinary	100 ..	15-15½
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	99-102
Chili Telephone Co., 1-44,000	5 ..	6¾-7¼
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100 ..	82-86
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10 ..	6-7
—— 10 per cent Preference, 1-6,000	10 ..	15-16
Direct Spanish Telegraph Co., Ordinary	5 ..	3¼-2¼
—— 10 per cent. Cum. Preference	5 ..	8¼-8⅜
—— 4½ per cent. Debs., 1 600	50 ..	98-101
Direct United States Cable Co.	20 ..	13¼-13½
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100 ..	100-102
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100 ..	98-101
—— 4 per cent. Reg. Mort. Debs. (Mauritius subsidy), 1-8 000, 1913	25 ..	9⅞-10⅛
Eastern Extension, Australasia and China, 1-300,000	10 ..	12⅜-12⅝
—— 4 per cent. Mort. Deb. Stock, Perp.	100 ..	99¼-102¼
Eastern Telegraph Co., Ordinary Stock	100 ..	129-134
—— 3½ per cent. Preference Stock	100 ..	83-86
—— 4 per cent. Mortgage Debenture Stock	100 ..	99-102
Great Northern Telegraph Co. (of Copenhagen)	10 ..	30½-32½
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1,200, Red.	100 ..	99-10
Indo-European Telegraph Co.	25 ..	52-55
Marconi's Wireless Telegraph Co., Nos. 255,128-284,190	1 ..	9/16-11/16
Monte Video Telephone Co., Ordinary, 1-72,680	1 ..	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492	— ..	⅛-¼
National Telephone, Preferred	100 ..	108-110
—— Deferred Stock	100 ..	106-108
—— 6 per cent. Cum. First Pref.	10 ..	10½-12½
—— 6 per cent Cum. Second Pref.	10 ..	10-12
—— 5 per cent. Non Cum. Third Pref.	5 ..	5 3/16-5 7/16
—— 3½ per cent. Deb. Stock, Red.	100 ..	97-99
—— 4 per cent. Deb. Stock, Red.	100 ..	100-102
Oriental Telephone and Electric Company	1 ..	1 1/16-1 3/16
—— 6 per cent. Cum. Pref.	1 ..	1 1/16-1 3/16
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100 ..	97-100
United River Plate Tele. Co., Ordinary, 1-100,000	5 ..	6⅜-7⅛
—— 5 per cent. Cum. Pref., 1-40,000	5 ..	4⅞-5⅛
—— 5 per cent. Debenture Stock, Red.	100 ..	—
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100 ..	98-101
West African Telegraph Co.	10 ..	10-10½
West Coast of America, 1-30,000 and 53 001-53,008	2½ ..	1¼-1⅜
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100 ..	97-100
West India and Panama Telegraph Co., Ordinary	10 ..	⅜-½
—— 6 per cent. Cum. 1st Preference	10 ..	7-7½
—— 6 per cent. Cum 2nd Preference	10 ..	7-7½
—— 5 per cent. Debs., Red., 1-800	100 ..	99-102
Western Telegraph Co., 1-207,930	10 ..	12⅛-13½ xd
—— 4 per cent. Debenture Stock, Red.	100 ..	98½-101½

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1907.	1906.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Mile of track. Pass'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Dec. 11	1,192	1,158	+ 33	— *h*	25½	25	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	Nov. 17	1,019	966	+ 53	— 176	8	8	,, 15	14,328	3,316,380	353,945	1	9·71	1,830	5·16
Baker Street and Waterloo Ry.	Dec. 14	3,105	2,230	+ 875	+ 20,830	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 15	993	954	+ 39	+ 2	23·53	24·53	March 31	55,025	11,145,531	1,309,903	1 18	10·08	2,338*b*	6·03
Birmingham Corporation	,, 14	6,378	—	—	—	56½	—	,, 31	17,133	4,709,798	266,526	·86	14·5	8,866	—
Blackburn Corporation	,, 11	1,002	868	+ 133	+ 2,844	24	24	,, 25	48,875	8,661,720	986 953	1·35	11 89	2,036	7·44
Blackpool Corporation	,, 12	322	287	+ 35	- 1,284	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	Oct. 26	311	279	+ 32	- 1,139	16½	16½	Dec. 31	31,846	2,325,677	579,264	3·28	13 19	—	7·27
Bolton Corporation	Dec. 15	2 031	1,847	+ 244	+ 5,233	42	40	March 31	95 766	20,205,196	2,161,130	1·13	10·63	2,39	6·14
Bournemouth Corporation	,, 11	1,537	1,173	+ 154	+ 1,343	17·41	16·82	,, 31	55,276	10,058,288	1,121,623	1·32	11·83	3,22	7·19
Bradford Corporation	,, 14	4,159	3,914	+ 215	+ 3,477	95	95	,, 31	230,085	47,108,000	5,053,392	1·172	10 927	2,396	—
Brighton Corporation	,, 15	678	654	+ 24	- 3,026	9½	9½	,, 31	50,339	11,321,160	1,152,82	1·06	10·48	,914·8	8·0·4
Bristol Tramway Company	,, 13	4 462	4,543	- 81	—	51½	51½	Dec. 31	259,799	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	,, 14	1,187	1 154	+ 33	—	40	40	March 31	57,992	11,092,704	1,197,772	1·31	11·61	5,388	8·17
Burton Corporation	,, 15	255	—	+ 5	- 518	8½	8½	,, 31	17,950	3,878,269	454,082	1 07	9·21	2,06	6·76
Cardiff Corporation	—	—	—	—	—	32·62	†32·26	,, 31	112,209	24,134,363	2,770,049	1·12	9·72	3,782	9·44
Carlisle Tramways Company	,, 14	167	144	+ 23	- 521	8·5	8·5	Dec. 31	10,713	2,935 002	359,756	—	7·14	—	5.18
Central London Railway	,, 14	6,173	7,096	- 923	- 19,279	6	6	,, 31	347,588	4,875,547	1,281,214	1·86	65·10	57,931	35·80
Charing X, Euston, & Hamp. Ry.	,, 14	2,950	—	—	—	8	—	—	—	—	—	—	—	—	
City and South London Railway	,, 15	3,658	3 370	+ 288	+10,303	6¼	6¼	,, 31	—	—	—	—	—		
Colchester Corporation	,, 11	160	160	—	—	8	8	March 3	10,588	2,457,553	220,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	,, 12	343	339	- 6	- 885	15½	15½	Dec. 31	24,895	5,814,376	882,256	1·01	6·64	—	4·69
Croydon Corporation	,, 13	1,275	—	+ 91	- 1,938	12 *c*	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 13	248	230	+ 18	- 15	7 23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	,, 14	170	170	—	- 1,121	4½	4½	,, 31	11,250	2,853,200	284,343	·94	9·49	2,500	
Dublin and Lucan Electric Ry.	,, 13	87	93	- 6	+ 216*h*	6¾	6¾	Dec 31	6,358	402,511	110,738	3·79	13·78	942	7·33
Dublin U.T.	,, 13	4,777	4,617	+ 160	+ 31 079	48½	48½	,, 31	267,489	50,050,949	7,077,372	1·28	9 07	691	5 55
Dundee City Tramways	,, 11	1,071	1,000	+ 71	+ 1,041	22	22	May 15	50,154	13 086,396	1,005 911	·906	1·96	2,180	7·42
East Ham Corporation	,, 14	837	754	+ 83	+ 103	14	14	March 31	56,652	3,689,658	863,816	·64	10·18	2,994	6 79
Glasgow Corporation	,, 14	16,850	15,932	+ 918	+14,276*h*	79½	79½	May 31	756,480	195,767,519	17,945,595	—	10 12		—
Gloucester Corporation	,, 4	223	226	- 3	—	15	15	March 31	15,466	3,902,077	563,595	·90	6·58	999	5·32
G.N., Piccadilly and Brompton	,, 14	5 225	—	—	—	9	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	37	37	,, 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 14	1,440	1,377	+ 63	+ 2,669	35	35	,, 31	69,938	12,838,150	1,665,262	1·24	9·71	1,923	—
Hull Corporation	,, 14	2 466	2,226	+ 240	+ 5,035	26	26	,, 31	112,651	27,102,921	2,910,698	1	9·29		—
Ilford Corporation	—	—	—	—	—	10½	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 11	127	114	+ 13	+ 310	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	11,586	3,626,656	419,800	·737	6 62	1,480	5·22
Lancashire United Tramways	,, 11	1,153	935	+ 197	+ 14,082	39	38	—	—	—	—	—	—	—	—
Leeds Corporation	,, 7	6,213	5,957	+ 256	+ 9,633	89½	89½	March 25	298,233	64,223,666	7,121,038	1 10	10 02	351	—
Leicester Corporation	,, 14	2,123	2 013	+ 115	—	42	42	Dec. 31	26,011	12,039,252	1,229,507	1	9·79	—	4·82
Liverpool Corporation	,, 7	10,560	10,641	- 81	+ 7 583	104	104	,, 31	547,625	116,642 663	12,166 419	—	—	—	—
Liverpool Overhead Railway	,, 15	1,344	1,341	+ 3	+ 1,743*h*	6·65	6 65	June 30	81,302	11,171,865	1,024 275	—	—	—	—
London County Council	,, 7	20 357	25,650	+4,707	+187,352	98	98	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 14	150	135	+ 15	+ 4	6	6	Sept. 30	14,511	3,128,867	359,435	1·08	9·68	630	6·48
Maidstone Corporation	—	—	—	—	—	2	2	March 31	4,740	850,121	112,227	1 33	10 13	370	
Manchester Corporation	,, 14	14,123	13,165	+ 958	+ 37,782	149	149	,, 31	631,956	126,900,875	14,123,124	1·19	10 73	4,299	6·99
Metropolitan District Railway	,, 14	8,678	8,372	+ 306	+ 636	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 15	16,404	16 166	+ 238	+ 6,504	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 14	124	130	- 6	- 29	2¾	2¾	,, 31	6,159	1,992,647	206,358	82	7 14	2,239	—
Newcastle-on-Tyne Corporation	,, 14	3,928	3,876	+ 52	+ 589	50	50	,, 31	197,849	43,063,934	4,326,152	1·07	10·98	3,957	7·0
Newport (Mon.) Corporation	,, 7	622	566	+ 56	+ 1.880	15¼	15¼	,, 31	30,356	7,252,535	783 435	—	9 29	—	6·4
Oldham Corporation	,, 8	1,805	1,744	+ 61	+ 4,550	34	34	,, 25	65,553	13,466,245	1,504,740	1 16	10·45	1,886	—
Portsmouth Corporation	May 25	2,330	1,578	+ 752	+ 632	28½	28½	,, 31	95,702	19,625,329	197,499	1·17	11·63	—	—
Reading Corporation	Dec. 5	567	553	+ 9	- 788	33½	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	11·29	21·29	,, 31	14,881	2,837,110	386,547	1·24	9·24	1,102	7 92
Rotherham Corporation	—	—	—	—	—	9½	9½	,, 31	23,569	5,251,472	593,054	1 07	9 53	2,612	7·49
Salford Corporation	,, 16	4,338	4,098	+ 240	+ 4,730	70¾	70¾	,, 31	214,111	39,213,560	4,894,590	1·28	10 29	—	—
Scarborough Tramways Co.	—	—	—	—	—	4½	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 8	5,425	5,340	+ 85	+ 9,405	35¾	35¾	,, 25	240,565	63,952,283	,049,899	·903	9 543	3,653	5·94
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,365	9,294,771	1,108,369	1·27	11·02	—	7 83
Southend-on-Sea Corporation	,, 11	265	216	+ 19	- 17	9	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	,, 31	39,550	6,766,031	1,027,730	—	9 23	—	4·75
Sunderland Corporation	,, 15	1,203	1,193	+ 15	- 1,119	20	20	,, 31	64,858	15,364,463	1,495,685	1·004	10·36	—	6 37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	4,937	1,315,757	102,751	0·87	11 53	1,37	—
Torquay Tramways	Dec. 5	177	—	—	—	5·16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 14	747	732	+ 5	+ 689	12 68	12·43	,, 31	43,607	7,995,451	862,12	9·27	12·14	3,1	7·5
Warrington Corporation	—	—	—	—	—	9	9	,, 31	17,057	4,418 225	403 363	—	9 85	—	6·33
West Ham Corporation	,, 12	2,177	2,034	+ 143	+ 1,656	14·7	14 7	,, 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	,, 11	805	785	+ 20	+ 213	20	20	,, 31	41,905	8,847,066	950,338	—	10 583	2,0	6·1o

And 98 miles of interlacing track. **a** Train mile. **b** Per mile of single track. **c** Mile of route. **h** Half-year's figure **k** Double track

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NOTES.

The Local Sections.—At the last meeting of the Birmingham Local Section the chairman (Prof. Kapp) announced a somewhat new departure in connection with the work of the local section. It had been pointed out that many members living in neighbouring towns found it very inconvenient to attend meetings owing to the difficulty of returning the same night, and that the attendance at meetings suffered on this account. Several members living in Birmingham had kindly offered to accommodate gentlemen living out of town by putting them up for the night. The committee now appealed to the members in the hope that others would come forward with the same offer. It was proposed that each member who volunteered in this way should hand to the secretary a list of names of gentlemen whom he would like to see, and who might, of course, be personal friends of his own. The visits could be arranged through the secretary prior to each meeting. It was hoped that members would enter into the spirit of this proposal, which would increase the attendance at meetings and add to the usefulness of the local section.

Publications Received. — "Electric Railways," vol. ii., by Sidney W. Ashe (New York: D. Van Noostrand Company, and London: Archibald Constable and Co., Limited. Price, 10s. 6d. net). Following upon vol. i. of the theoretical treatise on electric railways, in which the author and Mr. Keiley dealt with rolling-stock, we have now the second volume, treating of "Engineering Preliminaries and Direct-Current Sub-Station Operation." This volume differs somewhat in arrangement from that of the preceding one, inasmuch as it embodies a number of problems, tables, and operating data, thus restricting the descriptive matter pertaining to apparatus, and, we consider, increasing its value as a reference. The ten chapters into which it is divided deal mainly with the determination of required motor capacity (comparing various methods of determination), the preparation of schedules and load diagrams. Power-house and sub-station features, arrangements, and equipments are fully dealt with also. Numerous diagrams and illustrations are included in the book.—"Die Drahtlose Telegraphie im internen Recht und Völkrecht," by Dr. F. Meili, professor of international law at the University of Zürich (Verlag: Art. Institut Orell Füssli, Zürich). This small book deals with many of the novel problems in international law raised by the practical adoption of wireless telegraphy, and should awaken interest in all who are concerned with wireless, no matter whether in the scientific, commercial, or financial aspects.

Halifax Tramway Accident.—The report of the Board of Trade inquiry into the circumstances of the accident which occurred on Oct. 15 on the Halifax Corporation tramways has now been issued. It is unnecessary to recount the circumstances at present, as these were given fully in these columns shortly after the accident. The accident presents many features in common with other tramway accidents that have occurred, and Colonel Druitt, who conducted the Board of Trade inquiry, says in his report that the driver of the ill-fated car must be regarded as having been careless. If it is impossible to have only one form of motor equipment on cars, the inspector suggests that motormen should be employed as far as possible on cars with the same type of controller, as mistakes can so easily be made. Colonel Druitt points out that the car should not have gained speed so rapidly if the slipper brake had been applied as soon as possible after the current failed, and evidently the motorman could not have done so. Unfortunately, too, the conductor was collecting fares at the time, so that he could not apply sand at once and help to put on the slipper brake from his end of the car, and the car had acquired considerable speed before he did so. The inspector recommends the Halifax Corporation to equip the cars for service on the very steep gradients with a form of slipper brake that can be fully applied instantaneously, and he also considers that while cars are on very steep gradients the conductor should be on the rear platform, ready at any moment to assist the motorman by applying the slipper brake and dropping sand in case of a car running back.

The Late Lord Kelvin. — Some acknowledgment is due to the Dean and Chapter of Westminster for so readily responding to the unanimous wish of the scientific world to have the remains of its late master—Kelvin—interred within the walls of the sacred and historic abbey which has provided a resting place for the nation's genius throughout the past ages. We expressed the hope that this would be the case in the leading article in our last week's issue, and soon after our lines were written the announcement of the consent of the authorities was made. The Institution of Electrical Engineers' arrangements for their meeting of the 19th inst. were abandoned in consequence of the death of Lord Kelvin. There had been no time to prevent the meeting, however, which unanimously agreed that the following message be sent to Lady Kelvin: "The Council and the members of the Institution of Electrical Engineers desire to convey to your ladyship an expression of their great sorrow at the death of your illustrious husband, their revered president and honorary member, and to assure you of their deep sympathy in your sad bereavement." Amid a profound silence Mr. C. P. Sparks, who was in the chair, read the following telegram which had been received by the Institution: "Deeply affected by announcement of Lord Kelvin's death, we partake to grief of colleagues of England and of the whole world, who honoured him as the greatest genius of contemporary physics, and who admired his great qualities of mind and heart. We beg you to represent our association at the funeral of our only foreign honorary member.—Jona, president, Associazione Elettrotecnica Italiana." The meeting, which lasted but a few minutes, thereupon adjourned till Jan. 9, 1908.

Standard Notation for Engineering Formulæ.—The experience of engineers and others who have frequent occasion to use engineering formulæ is that much inconvenience, loss of time, and unnecessary mental effort and many mistakes are caused by the prevailing lack of uniformity in the symbols employed by authorities for denoting various factors occurring in the formulæ and calculations relating to all branches of engineering work. Realising the desirability of drawing attention to this question and of affording to all who are interested in it an opportunity of expressing their views, the president and council of the Civil and Mechanical Engineers' Society have arranged to devote the ordinary meeting at Caxton Hall, at 8 p m., on Jan. 2, 1908, to a discussion, to be opened briefly by the president, on the subject of "Standard Notation for Engineering Formulæ," in the hope that the opinions and suggestions then brought forward may pave the way for a conference under the auspices of all the leading engineering institutions, societies, and associations, and that the ultimate result may be a reform the practical value of which it would be difficult to overestimate. A circular letter has been sent out by Mr. A. S. E. Ackermann asking engineers to co-operate with the council in the movement by contributing a written statement of their views, accompanied by a schedule of the standard symbols which are recommended. If a sufficient number of the schedules of symbols are received, it may be possible for the organisers

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of the movement to get out a tentative "standard schedule" of symbols, each of which has received the largest number of "votes" for its particular purpose or purposes, for some symbols have more than one well recognised use, owing to the necessity of providing for the formulæ belonging to different branches of engineering.

Prevention of Sparking in Alternating-Current Commutator Machines.—A patent granted to the Siemens-Schuckertwerke Ges. describes an arrangement of field magnets with a view to preventing sparking. In an alternating-current commutator machine in which the compensating winding is provided with an auxiliary winding to produce a commutating field, the auxiliary winding is fed simultaneously from adjustable parts of the exciting winding and of the compensating winding. A portion of the compensating winding fed with current from the field-magnet winding may be employed as the auxiliary winding. The motor with the field-magnet winding, e (Fig. 1), and compensating winding, k, is provided with an auxiliary winding, h, connected between a point of the exciting winding e, and a point of the compensating winding, k, so as to be fed by both. The shunt circuit contains an adjustable non-inductive resistance, w, so that by varying the relative amounts of inductive and non-inductive resistance, the power factor of the current supplied to the winding, h, may be controlled. The auxiliary winding, h, may be dispensed with, and a portion or the whole of the compensating winding, energised from a portion of the field-magnet winding, may be used in its place. The auxiliary winding or its equivalent may be energised from the

FIG. 1.

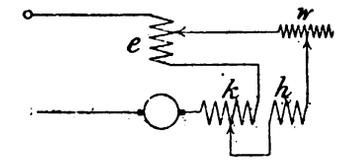
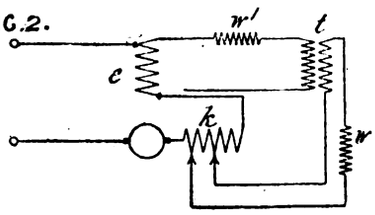


FIG. 2.



secondary of a transformer, t (Fig. 2), the primary of which is connected across the field magnets, e, a resistance, w^1, w being inserted in the primary and in the secondary of the auxiliary circuit, or in either.

The Training of Engineering Apprentices.—At a time when so much is being written and spoken on the question of training engineering apprentices, a practical scheme adopted in the North-East of England deserves to be carefully noted by the manufacturing and educational sides of electrical engineering. There appears in another column a paper which Mr. W. G. Spence read before the North-East Coast Institution of Engineers and Shipbuilders, in which he gives an account of the working of the institution's educational committee's recommendations on the training of engineering apprentices. Evening class work does not show up very favourably in the tabulated results, and this is hardly to be wondered at when we consider all the circumstances. But the most important feature in the paper is that which shows the success of the committee's aim in recommending that special facilities should be given to "selected" youths. A glance at the curves appearing elsewhere is sufficient to justify the committee's policy in giving encouragement and financial assistance to those who prove that they are thoroughly deserving of especial recognition, and who give enough promise of turning that assistance to the advantage of themselves and to the industry in which they serve. The committee's policy has had our approval from the outset, and we are, indeed, gratified at being able to record the success of a scheme for the training of engineering apprentices, which we recommended to the consideration of other technical societies. We quite agree with Mr. Spence in thinking that the attention of those responsible for the allocation of educational grants should be specially directed to seeing that such grants are so arranged that the small percentage of exceptionally able and hardworking youths are granted facilities for passing on to the higher technical schools and colleges, and that the chief business of evening classes "should not be in the production of a light crop over a large area," but rather the giving of assistance, enabling a few to raise themselves above the average and to pass on to further advancement.

Air-Gap Reluctance in Dynamos.—Mr. T. F. Wall's valuable paper before the Manchester Local Section on the reluctance of the air-gap in dynamo machines should be of general interest, but particularly to those concerned in the design or manufacture of induction machines. There appears to be a scarcity of experimental data concerning the reluctance of the air-gap in dynamo machines with slotted armatures, and also as to the distribution of the flux over the surface of the pole-shoes and on the surfaces of the teeth themselves. Although the estimation of the reluctance of the gap is of great importance in the design of machines, the only experiments which appear to have been made in this direction are those of Hele-Shaw, Hay, and Powell. Now Mr. Wall gives us in his paper the results of some measurements which were carried out this year in the Electrotechnical Institute, Karlsruhe. These measurements have been employed to find the increase of the reluctance of the air-gap due to slotting the armature, and a comparison has been made of the values so found with those given by the methods generally used. After describing experiments on the surface of polar projections, and experiments with the slotted side of the armature and smooth side of the pole-piece, Mr. Wall shows how they may be used to find the effect of slotting the armature on the reluctance of the air-gap. When both the stator and rotor are slotted, as in an induction motor, the flux distribution curve for the air-gap becomes very complex, and, moreover, changes its shape in proceeding from the stator surface across the gap to the rotor surface. Further, the curve of flux distribution on the stator periphery has a period of pulsation corresponding to the movement of the rotor over a distance equal to the pitch of the rotor teeth, and the curve of flux distribution on the rotor periphery has a period of pulsation corresponding to the movement of the rotor over a distance equal to the pitch of the stator teeth. In order to find the reluctance of the air-gap in induction motors, we may say that if the reluctance is unity when the rotor and stator surfaces are smooth, suppose k_1 is the coefficient when the rotor alone has slots—*i.e.*, the reluctance of the gap with slotted rotor and smooth stator is k_1. Suppose, further, the gap coefficient to be k_2 when the stator is slotted and the rotor has a smooth surface. Then the reluctance of the gap when the stator and rotor are both slotted will be given without any great error by the product $k_1 \cdot k_2$. Now k_1 and k_2 can be found by the method previously described, from the dimensions of the teeth, slots, and air-gaps, and, therefore, the reluctance of the gap can be at once determined.

Domestic Electric Heating.—Great progress has been made in the field of electric heating, to which we have referred on previous occasions. The rate of progress made in this country, however, has hardly been so satisfactory as that made in the United States. The factors upon which

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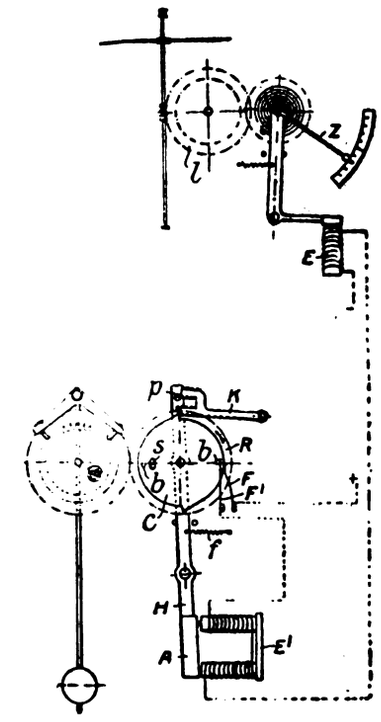
the expansion of this branch of business depend may be said to be a vigorous compaign of publicity work carried on by the central stations throughout the country, and improvements made by the manufacturers in the apparatus and devices. We read in a report presented to the Association of Edison Illuminating Companies some interesting particulars as to the cost of electric heating for domestic purposes, and we have extracted some figures from a daily cooking record which was taken over one week. There were in use: two 8in. stoves, consuming 1,625 watts; one 6in. stove, consuming 440 watts; one 9in. by 12in. broiler, consuming 1,300 watts; one oven, consuming 1,500 watts; one plate warmer (12 × 14 × 20), consuming 300 watts, taking altogether 5,165 watts. The total cooking consumption was 58·1 kilowatt-hours; the watts per person per meal, 631 watts; ironing, 2·9 kilowatt-hours. The number of meals served was 92; the lighting consumption 5·63 kilowatt-hours, and milk warmer 1·63 kilowatt-hours. Ironing forms one of the most popular forms of domestic use of electricity, and a chart presented with the report showed the current consumed and the time of consumption for a 7lb. iron which was used to do the work of six persons, exclusive of collars and cuffs and starched shirts. The ironing extended over two days of the week because of an extra amount of work that week. In this case the current consumption was about 4·3 kilowatt-hours for the week's work. The report continues that, although there were calls for an iron which was disconnected at the iron terminal, it was found that there was so much trouble arising from weakness at that point that an iron was advised which did not disconnect at the iron terminal, but depended upon a pull type of plug for its disconnection. A keyless socket was suggested for this work. Care should be taken to see that the iron is adapted to the voltage of the circuit to which it is connected. If an iron is made for 115 volts and is used on a 104-volt circuit, it will not be hot enough for steady work, and *vice versâ*.

Manganese Ores. — The increasing demand for manganese ores and the recent diminution in the output from Russia has led to a largely increased market for the manganese ores of other countries. A good deal of new information has recently come to light regarding the Indian deposits, and prospecting has been actively carried on in other parts of the world. In Brazil, for instance, the manganese industry, which is of comparatively recent origin, is rapidly increasing in magnitude. Many of the deposits are situated at a considerable distance from the coast, but they can be profitably worked on account of the high grade of the ore. In 1903 the value of the exports from that country amounted to £248,010, which in 1904 increased to £306,799, and in 1905 to £332,827, the latter amount representing exports of 224,377 metric tons. Russia is by far the greatest producer of manganese ore, nearly one-half of the world's output coming from that country; and from statistics that appear in the *Bulletin* of the Imperial Institute it is evident that Russia has ample reserves of ore, sufficient to enable her to maintain for a long time to come an important position as a producer of high-grade ore. The chief producing areas are the Caucasus, South Russia, and to a less degree the Urals. The development of the industry is hampered by the lack of transport facilities, which prevents the opening up of new deposits, and also by the high rail charges to the port of shipment. The methods of mining employed are primitive, and as there are no professional miners, occasional labour only is employed. Much interest is attached to the mining of manganese ore in India, which though a comparatively new industry is already of large dimensions. According to statistics published in the *Bulletin*, the exports in 1905 reached a total of 257,970 tons, bearing a value of £248,309. In 1904 152,707 tons were exported, the value being £129,632; while in 1903 the exports were 174,562 tons, valued at £151,530. The greater portion of the output is obtained from an extensive series of deposits in the Central Provinces and Central India. In most localities the ore occurs as lenticular masses and bands in quartzites, schists, and gneisses. The ore bodies, which are sometimes several miles in length, consists of a mixture of braunite and psilomelane. The ore exported contains over 50 per cent. of metallic manganese. The cost of transport, however, is considerable, and renders the working of any but the highest-grade ore almost impossible. The production of manganese ore in the United Kingdom is of little consequence; the ore is low and very variable. The most important deposits occur in Carnarvon, Merioneth, Devon, Cornwall, and Shropshire. In 1905 the value at the mines of the 14,706 tons of ore raised was £11,634.

Electricity - Measuring Apparatus.—A patent granted to the A.E.G. relates to motor meters with maximum-demand indicators. Referring to the illustration, the driving wheel of a non-return pointer, Z, is periodically disengaged from the meter train, *l*, by the action of an electromagnet, E, controlled by a contact device operated by a clock. To avoid erroneous indications arising from failure of the current supply, the contact device is held in gear with the clockwork by electric and mechanical means alternately. A cam, *c*, carrying pins, *b*, to press the contact springs, F F¹, together, is connected to a gear



wheel, R, by a pin and slot, *s*, and both are mounted upon a lever, H, carrying the armature, A, of an electromagnet, E¹. Normally, the wheel, R, is held in gear with the controlling clock by a pin, *p*, on the lever, H, resting against the end of a pivoted stop, K, but twice in each revolution the cam, *c*, lifts the stop, K, so that a spring, *f*, shifts the lever and puts the wheels out of gear, unless the lever is then retained in its normal position by passage of current through an electromagnet, E¹, in circuit with the springs, F F¹. If there is no current, the springs, F F¹, remain in contact, and the maximum indicator remains out of action.

The Magnetic Arc.—On account of the interest that is being taken at the present time in the development of the flaming arc lamp, the result of some investigations

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conducted by Mr. G. M. Dyott with metallic arcs, and communicated by him to the *Electrical World* of New York, may be of interest to those who are making a study of the more recent methods of lighting. Mr. Dyott shows some of the peculiarities of the arc, and the effect upon its behaviour of certain substances incorporated in the electrodes. It has been found that a very satisfactory negative electrode for experimental purposes can be made out of the following materials: magnetic iron ore, Fe_3O_4; chrome iron ore, $FeCr_2O_4$; titanium oxide, TiO_2. For commercial work it is necessary to add other substances such as arc-steadying compounds. The bulk of the electrodes consists of magnetite, the percentage used varying over a wide range, like the other ingredients, according to the conditions under which the final mixture must subsequently be used. Its most important function is to act as a carrier in the arc. The slag formed by it is a conductor when cold, and hence difficulties encountered in starting the arc are eliminated. Its high luminous efficiency also makes it a very desirable substance to use. Ordinary magnetite is much too impure to prove satisfactory, and special arrangements should be made to obtain it free from all silica, lime, magnesia, etc. An arc maintained between electrodes of pure magnetite is very rich in blue and ultra-violet rays. The arc appears to issue from the surface of the negative as a high-velocity blast impinging on the copper positive, and since the majority of the light is emitted at the negative end of the vapour bridge a reflector should be used in order to secure the best results. Mr. Dyott concludes from this that considerable gain in efficiency can be secured by burning the arc reversed—that is to say, with the negative in the upper holder of the lamp. Heretofore this arrangement has been beset with so many mechanical difficulties that it has received very little consideration despite its many attractive features, but in a lamp recently put on the market this type of construction has been used with remarkable results. While the characteristics of the arc are dependent on the negative electrode, Mr. Dyott found that most of the difficulties centre round the positive. They may be briefly stated as follows: (1) after continuous service fumes are deposited on the positive electrode, which adhere to it and hang down over the arc, sometimes entirely cutting off the light; (2) materials used for the positive are liable to oxidise owing to the heat of arc and form oxides which are insulators when cold—the arc is thereby prevented from starting; (3) globules of molten matter are taken up by the positive from the negative, which affects somewhat the burning of the arc. As far as the result of experiment goes the choice of material for the positive seems to be limited to copper, iron, alloys, or mechanical combinations of these metals. Copper scales off under great heat, and its surface has a very rough appearance, due to the copper oxide scales which cause the scales to adhere to it. Iron by itself consumes too rapidly. Brass appears to be very satisfactory; it always has a clean, smooth surface, and any globules that may adhere to it at its lower extremity crack off and fall into the pan below when the light is extinguished. Further experiments, however, might disclose objections to its use. Attempts have been made to use laminated electrodes, consisting of metals and alloys in successive layers, with encouraging results. Of course, the expense of making such electrodes might prevent their commercial use.

Predetermination of Train Resistance.—The paper under this heading which Mr. C. A. Carus-Wilson recently presented to the Institution of Civil Engineers is of interest to electrical engineers engaged in traction work. The author considers the different elements of train resistance—namely, journal friction, rolling friction, track resistance, flange action, and air resistance. Each element of resistance is given in terms of the known variables, and existing experimental results bearing on the question are reviewed. The conclusion is arrived at that the component parts of train resistance may be divided into three groups distinguished by their relation to the speed: (1) in which the resistances are independent of the speed, and include journal friction, rolling friction, and track resistance; (2) the resistance caused by flange action, which varies as the first power of the speed; (3) all forms of air resistance, which vary as the square of the speed. The resistance equation is thus shown to be of the form $R = A + Bv + Cv^2$ (v = velocity) For the purpose of determining the constants A, B, and C the author selects the tests made by Mr. Barbier on the Northern Railway of France, which were made on four-wheel and bogie coaches. These constants depend upon the type of rolling-stock under test, and formulæ are deduced by which the constants for any given type of rolling-stock may be obtained. The tests considered by the author were of bogie coaches on the L. and Y. Railway (these coaches differ materially from those tested by Mr. Barbier. The curve obtained by the application of the formulæ shows a close agreement with the test results, the mean difference at eight selected speeds from 10 to 80 miles per hour being 3 per cent.); on eight-wheel bogie goods wagons on the New York, Ontario, and Western Railway; of eight-wheel electric motor coaches made by the St. Louis Electric Railway Test Commission; and of 12-wheel high-speed bogie coaches at Zossen. The results differed up to about 8½ per cent. from what was expected. The following are among the practical conclusions arrived at by Mr. Carus-Wilson: The value of roller bearings in railway traction lies in the reduction of running resistance and consequent saving of energy, and not in the reduction of starting effort. The resistance of a coach depends largely upon the wheel base of the truck, and the relation of the weight of the bogie trucks to that of the whole coach; the weight of the motors and the extra weight of the motor trucks in electrically-driven coaches increases the flange action and the total resistance of such coaches. The resistance of electrical motor coaches is in some cases as much as 54 per cent. greater than that of trailing coaches running at the same speed under similar conditions, but the influence of the bogie on train resistance is shown to be greatest in the case of goods wagons. The energy expended in overcoming flange resistance is represented by the wear of tyres and rails. It is shown that by giving the bogie a lead, as is done in Timmis's bogie lead, the flange action of the bogie can be reduced, and the saving depends upon the ratio of the bogie wheel base to the distance between the bogie centres, and also upon the ratio of the bogie weight to the total weight. The amount of play between the flanges and the rails is an important factor in train resistance. The want of uniformity in current railway practice in this matter is illustrated by a table giving the amount of side play adopted on 13 different railways in Great Britain, in the United States, and on the Continent. The increased resistance and wear occasioned by large flange play suggests the importance of a reduction of the play to a standard $\frac{3}{8}$in., as on the London and South-Western and other railways. The resistance of the air with a train of bogie coaches running at 60 miles per hour amounts to about one-half of the total tractive effort required to haul the train. The experiments conducted by the St. Louis Electric Railway Test Commission show that a large reduction can be made in the front and rear air resistance by shaping the ends, and that by this means a saving can be effected of 10 per cent. of the total tractive effort with a long passenger train, and 30 per cent. with a single coach.

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AUTOMATIC CAB-SIGNALLING ON LOCOMOTIVES.*

BY J. PIGG, MEMBER.

(Continued from page 878.)

RAVEN'S ELECTRICAL SYSTEM OF CAB-SIGNALLING.

Actuation of Apparatus.—As already stated, this system is electrical, and it is designed to collect indications by the rubbing of metallic brushes (Fig. 10) carried on the engine over metallic bars (Figs. 15 and 16) placed on the line. This method of collection is not essential to the system, since it is capable of being operated equally well without contact, by causing electromagnets on the line to influence magnets on the engine. This method of collection is not now being put forward.

Characters of Indications.—The system is one which uses visual and audible signals. The visual signals are (1) a small semaphore arm by which the "condition of line" signals are given; and (2) two small pointers showing 1-2 and 3-4 respectively, which are the "route" indicators. The audible signals, which are of the nature of "call attention" signals, are given by a bell. Besides these indicators, the instrument carried on the engine includes a visual "failure" indicator, by which the condition of the apparatus can be gauged. Figs. 6, 7, and 8 show several forms in which the indicator on the engine has been made, the circular form being the latest. Fig. 9 shows in diagrammatic form the complete equipment of engine and

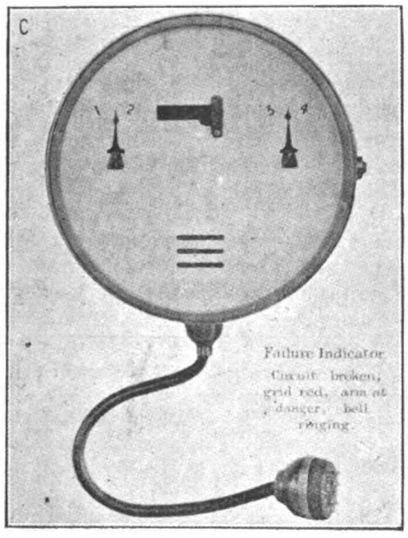

FIG. 6.

line circuits, the latter being for a three-way diverging junction. Fig. 11 is a photograph of the back of the engine indicator with the cover removed to expose the apparatus.

Details of Indicator.—The action of the apparatus is of the simplest possible character, the main principle being the invariable operation of the apparatus at certain points by the natural action of certain parts without the aid of either the signalman or the driver, and the subsequent continuance of the indications resulting from the natural operations until they are stopped or reversed by the action of the signalman.

Considering Fig. 9, and leaving, for the present, consideration of the line of bars out of the centre of the space between the running rails, it will be found that the short-circuiting of brushes 1 and 2 on, say, bar A, causes a current to pass through the main magnet, A^1, by which its armature is raised, putting the semaphore arm to "danger." At the same time the armature closes the circuit of the springs, *c d*, diverting the current direct back to the battery after passing through A^1. Hence the armature of the latter will remain attracted to the poles as long as may be necessary for the purposes of the apparatus. Besides passing through A^1 and the brushes, the initial current passes through the bell relay, C^1, during the continuance of the short-circuiting of the brushes 1 and 2; the armature is attracted and breaks the circuit through the spring contact, *e*. This contact forms part of the bell circuit, which itself is connected in shunt across the electromagnet, A^1. Hence, when the armature of A^1 is raised, the current from the engine battery tends to divide, part passing by A^1 and part by the bell. The connections, however, are such that current only passes to the bell when C^1 is unenergised, and this condition only obtains when the brushes 1 and 2 are not short-circuited. When the brushes are on a metallic bar, say A, therefore, the bell is silent, but as soon as they pass off the bars it commences to ring. In addition to passing through the electromagnets, A^1 and C^1, as described, the current to the brush, 1, passes through the springs, c^1 d^1, and c^2 d^2, each pair of which is normally

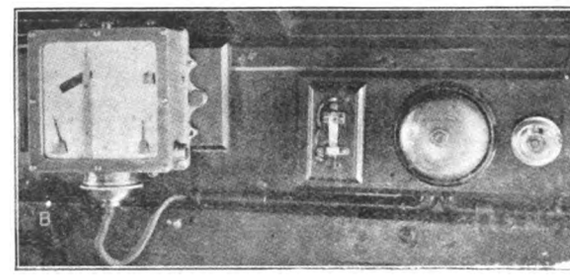

FIG. 7.—"Off and "Route" Indications.

in contact. These springs are opened by the raising of the armatures of D^1 and D^2 respectively. Opening the circuit at either $c^1 d^1$ or $c^2 d^2$ obviously releases the armature of A^1, and, as a consequence, stops the ringing of the bell and lowers the semaphore arm. Currents passing through D^1 are collected from the line by the brush 2, currents passing through D^2 are collected from the line by one or the other of the brushes, 3 and 4. Between the poles of D^1 and D^2 are placed magnetised needles, *n*, n^1, pivoted to turn under the polarity of the poles when the electromagnets are energised. The spindles carry the pointers shown in Fig. 6. Each spindle also carries a small metal sector, slotted as shown by Figs. 9 and 11, in which rides a small metallic loop, pivoted at the other end. The passage of a current through, say, D^1 deflects the needle to one side, and the loop drops into a recess at the end of the slot, and locks the needle and pointer on the front of the instrument in the deflected position. At the same time that this occurs, the lifting of the armature of D^1 breaks the contact, c^1 d^1, and lowers the semaphore arm, and stops the bell as already stated.

Auxiliary Apparatus on Engine.—The engine carries, in addition to the apparatus described, two rotary switches, of which further details are shown in Figs. 12 and 13. Each switch consists of a cast-steel wheel free to rotate, the spindle of which carries a two-part commutator, on which bear two springs. The wheel is weighted so as to take up a normal position. In this position the springs bearing on

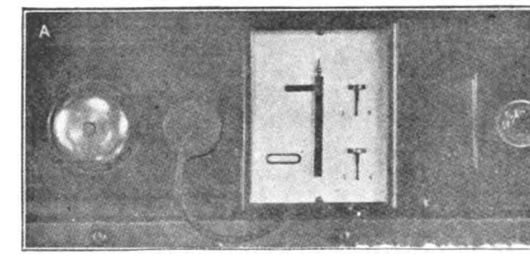

FIG. 8.—"Warning" and "On" Indications (Bell Ringing)

the commutator are insulated from each other, but when the wheel is rotated they are connected through the commutator. The springs are connected with the brushes 1 and 2 respectively, and each rotary switch, when turned from its normal position, connects the brushes in the same way as the latter are connected when on the bar A, or any subsequent bar of those shown in Fig. 9.

Track Apparatus.—The rotary switches 5 and 6 run over fixed bars on the line side of the general form shown on the diagram, and of which more detail is shown by Fig. 14. These bars are fixed in close proximity to the bar A, as shown by Fig. 15. Hence the rotary switches are only actuated at or near the bar A. Turning now to the line equipment, the point represented as being

* Paper read before the Institution of Electrical Engineers.

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approached is, as already stated, a three-way diverging junction. The six levers shown represent the "home" and "advance" signals for each of the diverging lines. Each "home" lever is fitted with a double-pole and each "advance" lever with a single-pole switch, which are operated by the levers in the ordinary movement for operating the signals. The "home" and "advance" levers for the lines marked Nos. 1 and 2 connect the battery in the cabin with the bars B, C, D, E, placed in the centre of the track, the only difference being that the levers marked 1 apply the positive pole of the battery to these bars, and the levers marked 2 apply the negative pole to the same bars. The two levers, No. 3, connect the battery in the cabin to the supplementary bars, and if the junction was a four-way one, other levers would reverse the polarity precisely as is done by levers No. 2. As will be seen, the battery is not applied to the bars unless both the "home" and the "advance" signal levers are pulled over. The mechanical interlocking prevents the levers for more than one line being pulled over at once, or the "home" signal for one line and the "advance" for another, and, therefore, in the case under consideration there is no need for more than one battery. A view of the bar, A, is shown in Fig. 15. It is mounted on wood blocks, which are in turn mounted on stoneware reels. The insulation is not high, as there is no need to aim at a high degree of insulation for this bar. Fig. 16 shows the arrangement for mounting the bars, B, C, D, E, and a side elevation and end section of these bars. It is necessary that these bars should be well insulated, and they are, therefore, mounted upon double shed porcelain insulators of the ordinary telegraph pattern.

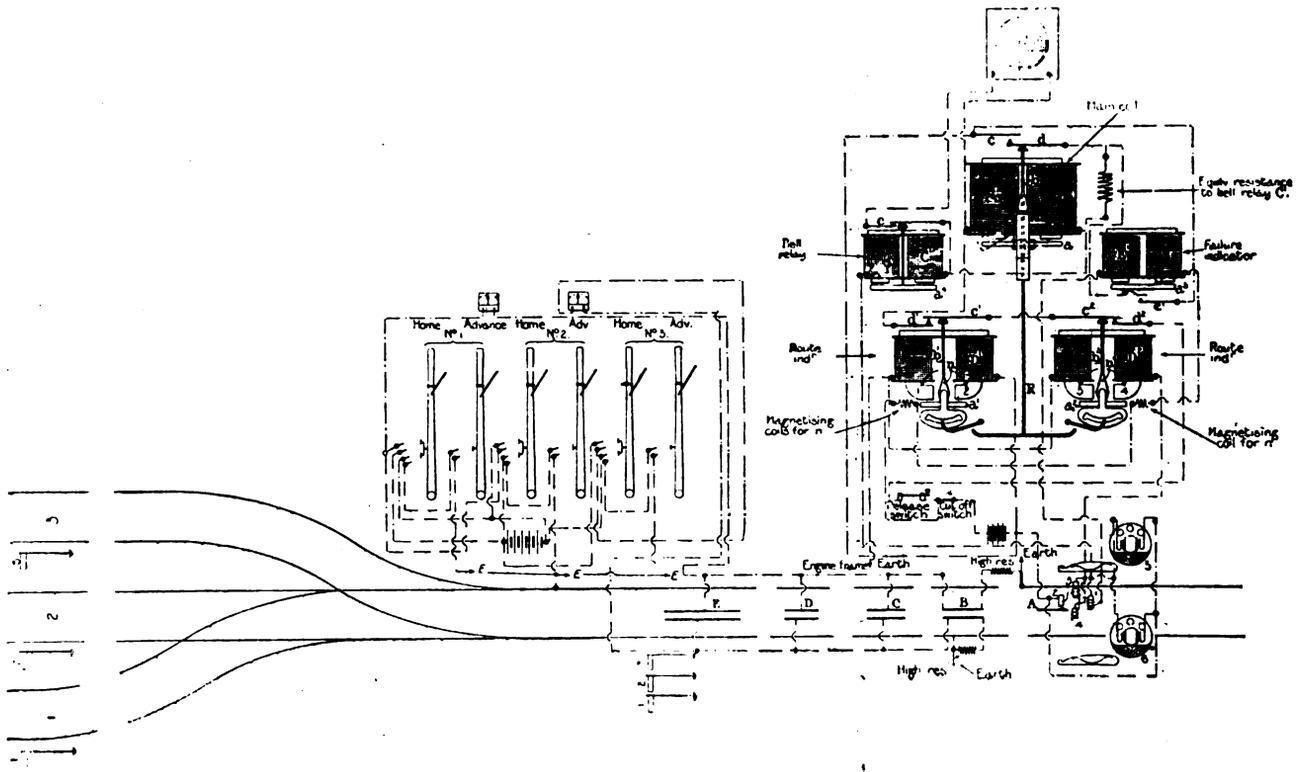

FIG. 9.—Diagram of Engine and Line Circuits.

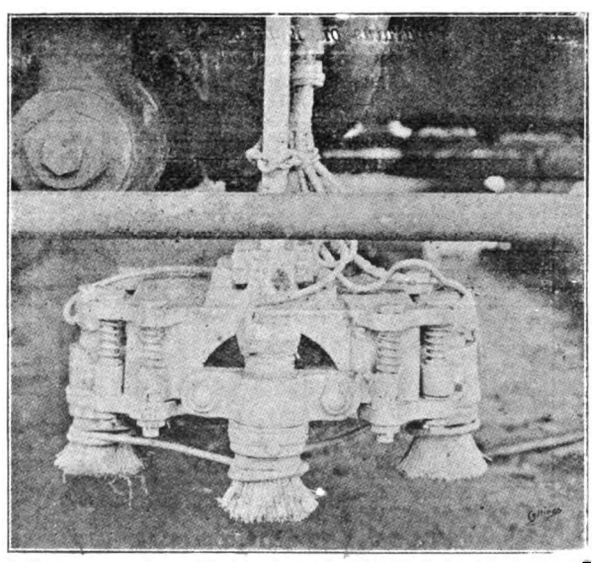

FIG. 10.—Steel Wire Brushes, 1, 2, 3, and 4, carried on Engine, showing "Failure" Indicator Circuit Wire wrapped around brushes.

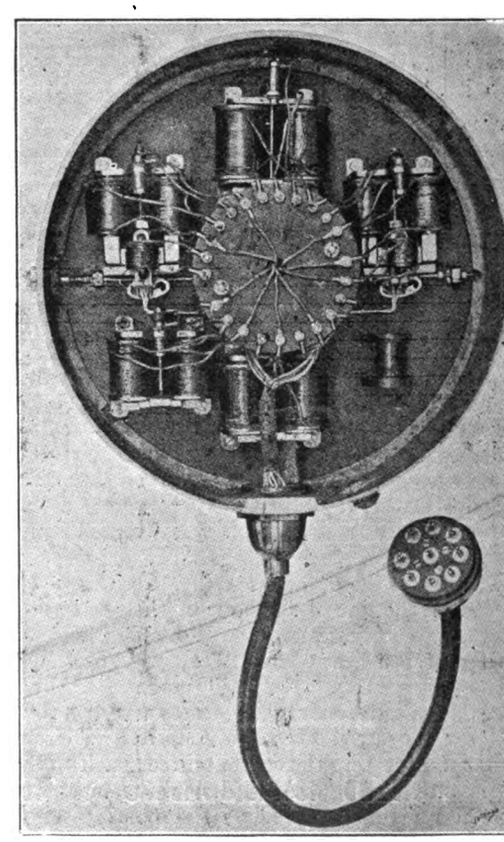

FIG. 11.—Back of Circular Type of Indicator. Cover removed exposing Apparatus.

A further consideration of Fig. 9 will show that the preparations made for signalling to trains are indicated in the signal cabin. The two indicators required in the case of a three-way or four-way diverging junction are shown in

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Fig. 9, and fuller views of the indicator are given by Fig. 17. When the levers are pulled over the current passes through a high resistance fixed at bar, B (a box containing this resistance is shown fixed to a telegraph pole in Fig. 16), which limits the current passing before and after the engine reaches the signalling bars, but which, being in shunt with the engine circuits when signals are being given, does not affect the current to the comparatively low-resistance circuits of the engine. The resistance of the indicator is kept low with the same object The permanent

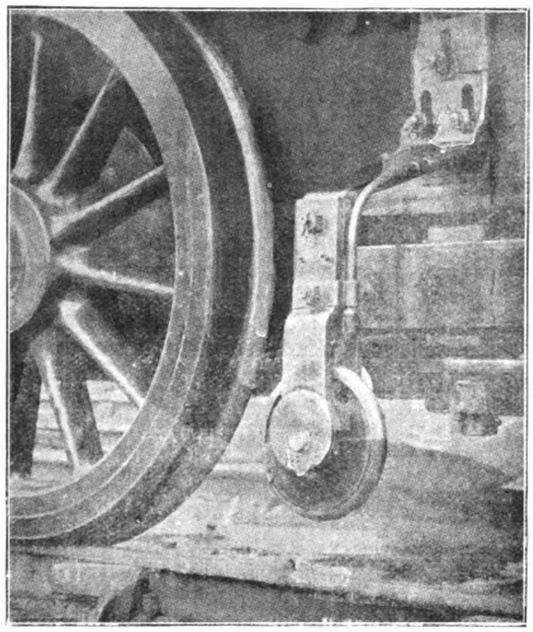

FIG. 12.—Rotary Switch fixed on Engine Bogie, showing Serrated Plate for convenience of adjustment.

deflection is comparatively small. When the signals are being given the deflection is increased, and it can be used as an indicator to the signalman (1) of the position of the train which is approaching, and (2) whether the signals are being *given* on the engine.

Consecutive Operations.—Consider now in further detail what takes place in a typical instance. Assume that an engine is approaching the junction shown in Fig. 9, and that line No. 1 has been prepared for it to pass forward. The "home" and "advance" signal levers No. 1 are both in the "off" position, and the battery in the cabin is connected positive to line. All the bars, E, D, C, and B, are connected to the battery. Bar A is never connected to the battery, and is in no way under the signalman's control. When brushes 1 and 2 are on bar A the current from the engine battery passes through c^2 d^2, c^1 d^1, A^1, C^1, brush 1, brush 2, and to the battery. At practically the same instant the same circuit is separately established by each of the rotary switches, 5 and 6. The semaphore arm is put to danger, and as soon as the brushes are clear of the bar, the bell commences to ring. Ordinarily the time occupied in passing over the bar is from one-third to one second, so that the bell practically begins to ring simultaneously with the raising of the semaphore arm. The visual and audible indications given at bar A continue until the brushes, or brush 2, comes into contact with the bar B. A current then passes from the bar B to brush 2, thence to the coils of D^1, and the engine frame, and the rails, etc., to the battery in the cabin. The armature of a^1 D^1 is raised and breaks the circuit through the springs c^1 d^1, lowering the semaphore arm and causing

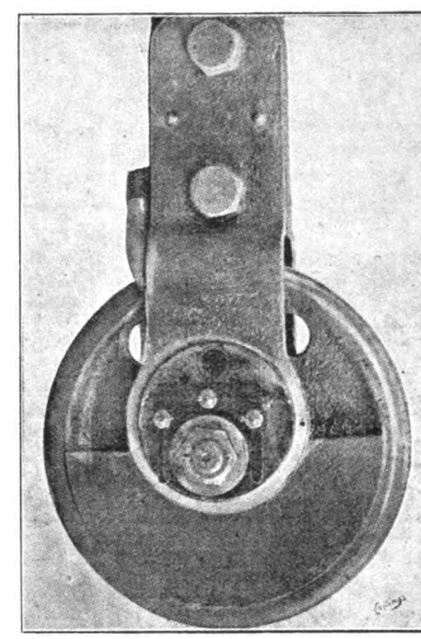

FIG. 13.—Rotary Switch with Cover Removed, showing Commutator and Springs.

the bell to stop ringing. At the same time the polarised needle, *n*, is deflected so that its pointer indicates 1, and the wire loop drops into the depression and locks the pointer in the position it has taken up (Fig. 18). The visual and audible signal given at bar A is a "warning" signal indicating locality with reference to the signalling point being approached: the reversal of the "warning" signal is the "off" signal. If the further passage of the train on its journey to the "home" signal be followed, it will be found that the bell will ring momentarily at the instant the engine passes over each of the bars C, D, E, but no change is made in the character of the visual indication. The indicator now shows the "off" signal by the semaphore arm, and route 1 by the pointer. These indications continue until the next signalling point is reached, and are a reminder of the last signal received. Assume that the engine has reached another bar, A. The same actions take place as described for the previous signalling point, but, in addition to raising the semaphore arm, the electromagnet A, by the rod, R (Fig. 9), raises the wire loop out of its recess, and allows the pointer to assume its normal position.

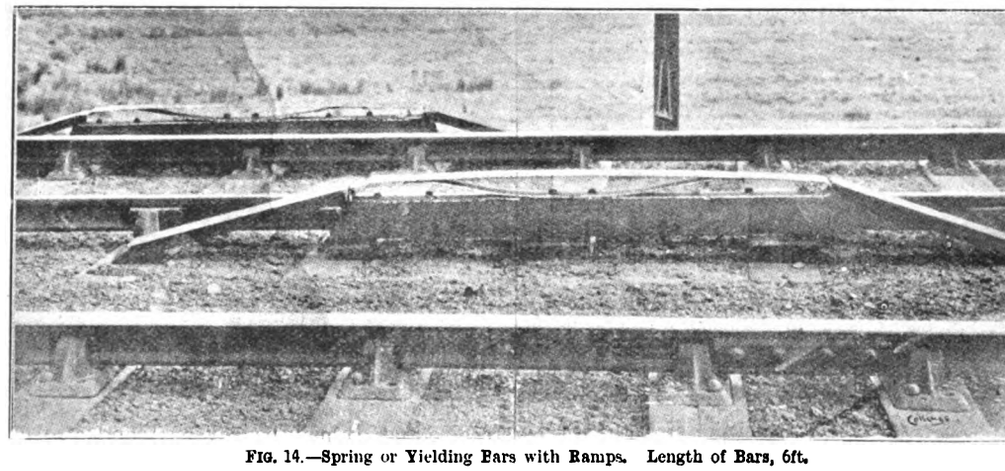

FIG. 14.—Spring or Yielding Bars with Ramps. Length of Bars, 6ft.

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We assume again, also, that the road has been prepared for the train to pass forward, but in this case it is the right-hand road of a two-way diverging junction. On reaching the bar, B, the same operations are carried out with the exception that No. 2 route is shown. It happens, however, say, that at the time the engine obtains the "off" signal, and "route" indication, 1,000 yards away

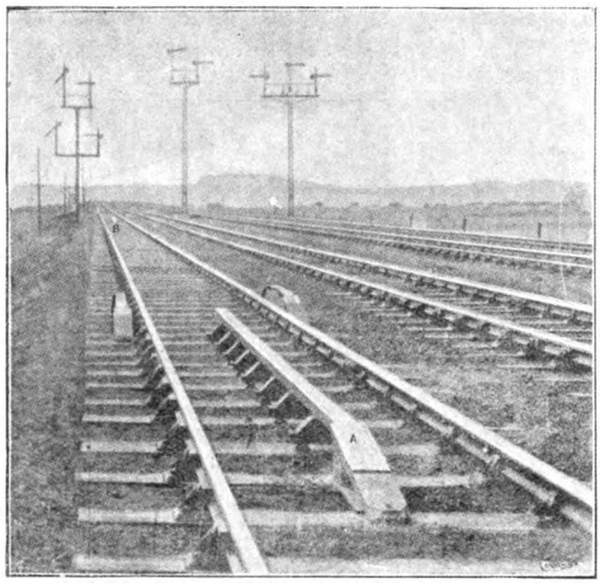
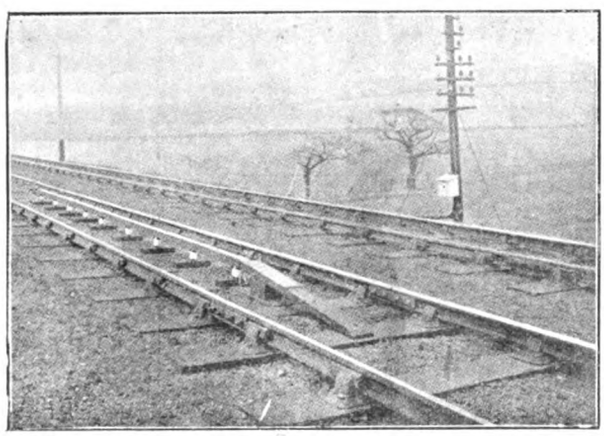


FIG. 15.—Bar A in centre of track. Spring or Yielding Bars in advance. Bar B in centre of track in distance. Distance between A and B, 100 yards "Distant" Signals (in duplicate) "Off" for "Route" 1. Length of Bars A, B, C, D, 30ft. Length of Bar E, 60ft.

from the cabin, the signalman is being informed of a circumstance which makes it imperative for him to stop the train if possible, and he instantly throws his "home" signal to danger, and immediately afterwards the "advance." The engine at the moment is just reaching bar C, say, and on passing on to it the "off" signal shown by the semaphore arm is reversed and danger shown, the "route" indicator is displaced, and the bell commences to ring as soon as



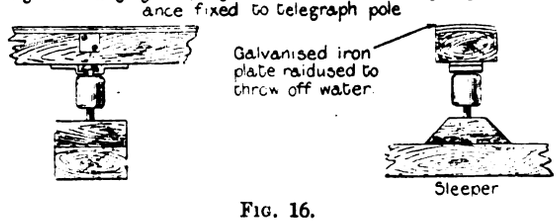

Bar B Mounted on telegraph insulators with ramp for protecting from hanging coupling chains, box containing high resistance fixed to telegraph pole
Galvanised iron plate raidused to throw off water
Sleeper

FIG. 16.

the engine is completely over the bar. These indications will continue as long as may be necessary. These actions constitute the receipt of a "warning" signal, the "off" and "route" indications and an "emergency" signal, calculated to avert a disaster from circumstances which have suddenly arisen. Assume, now, that another bar, A, belonging to another signalling point such as is shown by Fig. 1, has been reached. Precisely the same effects are produced there as have been already described. The line, however, has not been prepared for the passage of the train. On arriving at bar B the bell stops ringing momentarily, but the semaphore arm remains at danger. Immediately the brushes have left the bar the bell recommences. The same effects are produced at bars C, D, and E if no other signal is obtained at either of those points. The last bar is placed close to the "home" signal and is double the length of the other bars, to allow of the train being brought to a stand easily with the brushes on

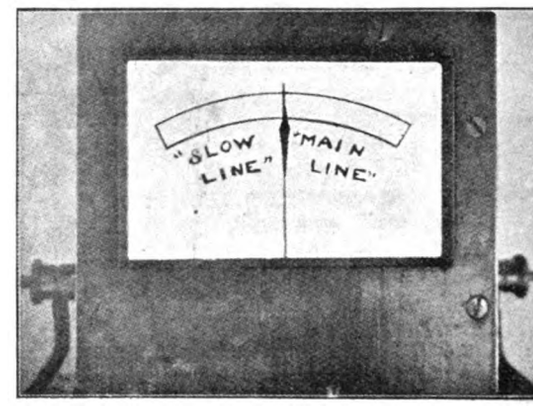


FIG. 17.—Cabin Indicator.

the bar. Hence the "on" signal is obtained by the continuance of the "warning" signal after the engine has passed over bar B, and that indication is continued until a subsequent indication is given by the signalman. The "on" signal, moreover, is of such a character, considered in view of the momentary stoppages of the bell by the intermediate bars, as to enable the driver to locate his position between the point at which he obtained the "warning" signal and the "home" signal at which he must be prepared to stop. The indication afforded under these circumstances is shown by Fig. 8. Assume that as the engine approaches the bar, D, the signalman lowers the "home" and "advance"

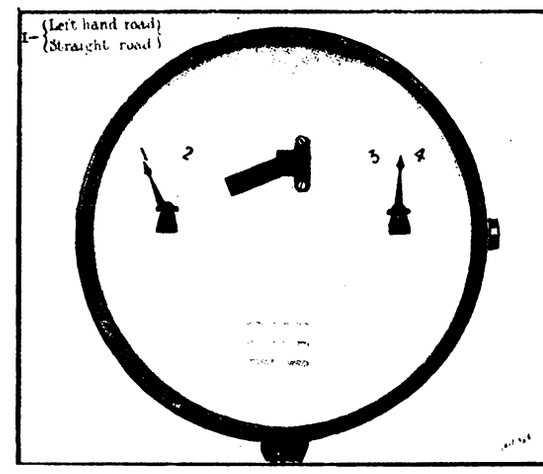


FIG. 18.—1 {Left-Hand Road at Diverging Junction. Straight Road.

signals. When the brushes come upon the bar the "off" signal and "route indication" 1 will be received precisely as already explained. Hence the "on" signal originally received at B may be reversed, and an "off" signal may be obtained at points between B and the first "stop" signal just in the same way as the driver sees the line signal lowered before he reaches it in clear weather by the projection of his vision. Making another assumption, suppose that the engine has been brought to a stand on bar E close to the "home" signal, and is waiting for the receipt of an "off" indication. The semaphore arm is at "danger," but the bell is silent. The signalman lowers the "home" and "advance" line signals for the train to proceed. Immediately the semaphore arm on the engine is lowered the "route indication" 1 appears, and the bell commences to ring, and continues to do so until the brushes have left the

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bar. Hence the receipt of the "off" signal when standing at the "home" line signal is given, and the driver's attention is called to the change by the bell commencing and continuing to ring. Suppose, now, that instead of sending the train straight away after bringing it to a stand at the "home" signal, the signalman wishes merely to call the train forward to communicate with the driver, or to bring the train forward to the "advance" signal, the signalman lowers the "home" signal and works the "advance" signal lever back and forward. The semaphore arm on the engine will be worked up and down, and the bell will ring intermittently and call the driver's attention to the character of the indication given. Hence a cautionary or "calling on" signal can be given to trains standing at the "home" signal, and the indication is of a different character to other signals obtained in that position. In the foregoing description the signals have been given for a two-way diverging junction, or for a straight road. Suppose a train travelling to the signalling point in Fig. 9, and that road No. 3 has been prepared for it. The brushes 3 and 4 are connected together so that either is

"Failure" Indicator on Engine.—The means for testing the condition of the circuits and battery on the engine have not yet been referred to. The actual indicator is a small disc (Figs. 7 and 8) or a grid (Fig. 6) appearing at an opening in the front of the instrument, which is white when the engine battery is in operation, and red if the battery fails or is cut off. The "failure indicator" circuit is independent of the other apparatus. Current is taken to the coils of E^1 from one end of the battery and thence to the brush 2, which completes the circuit. Interposed in this circuit are two small electromagnets, the poles of which embrace the polarised needles, n n^1, and tend to preserve their magnetism. As the "failure" indicator is always in action when the engine is in work, there is a constant current available for this purpose. In carrying the "failure indicator" to brush 2, the insulated wire is wrapped around all four brushes as shown in Figs. 9 and 10. Hence any obstruction on the line which displaces the brushes will break the "failure" indicator circuit and bring it into action. The "failure" indicator magnet, E^1, has a back contact, e^1, which is open

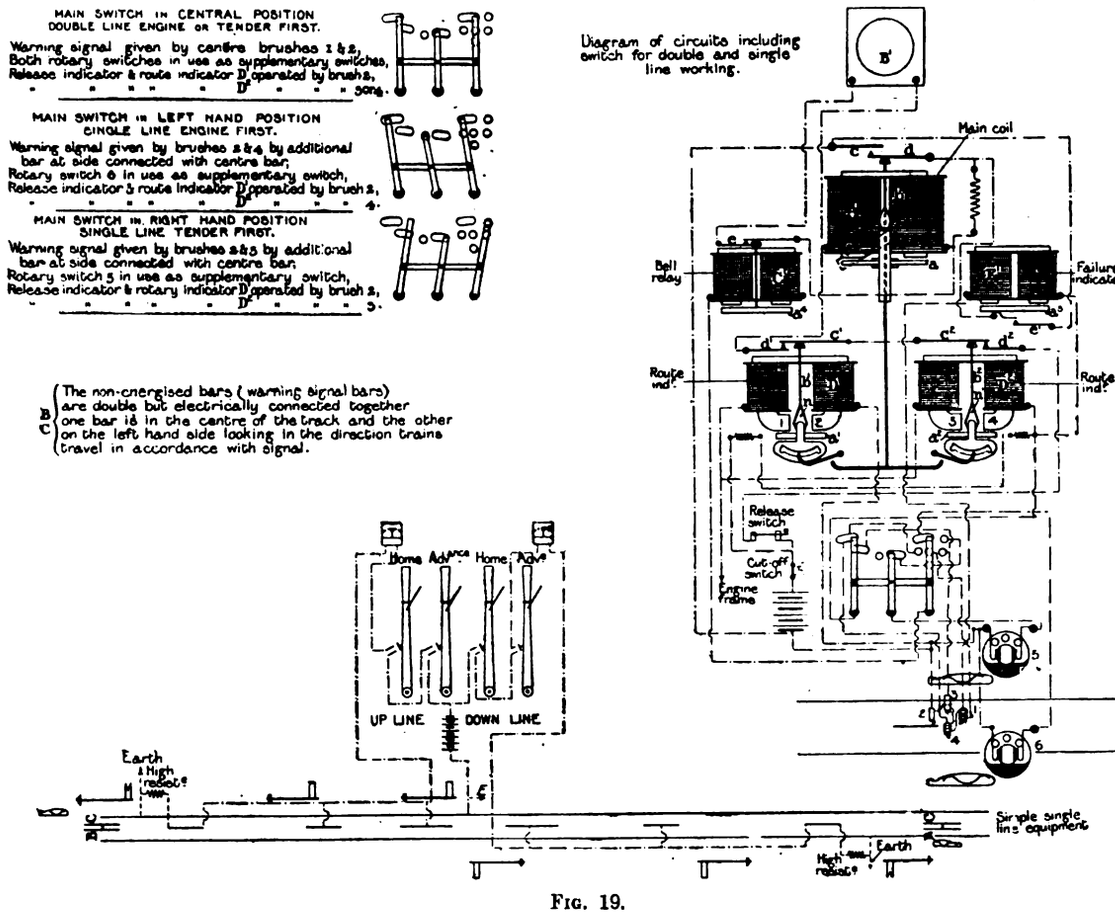
MAIN SWITCH IN CENTRAL POSITION
DOUBLE LINE ENGINE OR TENDER FIRST.
Warning signal given by centre brushes 1 & 2,
Both rotary switches in use as supplementary switches,
Release indicator & route indicator D operated by brush 3.
MAIN SWITCH IN LEFT HAND POSITION
SINGLE LINE ENGINE FIRST.
Warning signal given by brushes 3 & 4 by additional bar at side connected with centre bar;
Rotary switch 6 in use as supplementary switch,
Release indicator & route indicator D operated by brush 2,
MAIN SWITCH IN RIGHT HAND POSITION
SINGLE LINE TENDER FIRST.
Warning signal given by brushes 3 & 3 by additional bar at side connected with centre bar;
Rotary switch 5 in use as supplementary switch,
Release indicator & rotary indicator D operated by brush 2,
B C The non-energised bars (warning signal bars) are double but electrically connected together one bar is in the centre of the track and the other on the left hand side looking in the direction trains travel in accordance with signal.
Diagram of circuits including switch for double and single line working.
Main coil
Bell relay
Failure indicator
Route ind.
Release switch
Cut-off switch
Engine frame
Home
Advance
UP LINE
DOWN LINE
Earth
High resist.
Simple single line equipment

FIG. 19.

available for the same purpose. As shown by the diagram, brush 4 will engage with the bars parallel to B, C, D, and E. The "warning" signal is given by brushes 1 and 2 on A as before. On the arrival of the engine at B, the brush 4 take the current from the bar, after which it passes through the coils, D^2, deflecting the needle, n^1, to 3, and by the raising of the armature breaks the contacts, c^2 d^2. The wire loop drops into the recess at the end of the slot in the sector, and locks the "route" indicator in the position required. The net result is precisely the same as described for the "route indications" 1 and 2, with the exception that the first of another pair of such indications is given. Had the junction been a four-way one, the action of the levers for the signals for the fourth line would reverse the polarity of the bars and the indication 4 would be obtained. The next operation of the electromagnet, A, frees the "route indicators," 3-4, precisely as described for 1-2. The double brush, 3-4, is to enable signals to be obtained whether the engine is running engine or tender first towards a three-way or four-way junction, and it is also used in connection with single-line working, to be described later.

when E^1 is energised, but is closed if the armature, a^3, is released. This contact simply bridges the open springs, c d, of A^1, and if the armature, a^3, is released, through the breaking of the circuit of E^1, the semaphore arm rises to danger, the bell commences to ring, and the disc or grid (Fig. 6) shows red. When the battery fails the disc or grid shows red

Single-Line Working.—Fig. 19 shows the engine equipment available for single or double line working. It only differs from Fig. 9 in the addition of a small three-pole three-way switch. It is, perhaps, unnecessary to describe this in detail, as the side references afford sufficient information to follow the connections. In the centre position of the switch the apparatus is ready for double-line working, engine or tender first. In the left-hand position it is available for single-line working, engine first, and in the right-hand position for single-line working, tender first. The peculiarities of single-line working require modifications of the track apparatus to obviate the receiving of signals on an engine proceeding in one direction from the track apparatus provided for traffic proceeding in the opposite direction on the same pair of rails. A simple form of

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single-line equipment is shown in Fig. 19, an examination of which will show that the bars, A, are double, but connected together electrically, and that only one spring bar for operating the rotary switches is provided near A, instead of two as in double-line working as described. The additional bar connected to A is always on the left-hand side of the latter looking in the direction in which traffic passes for which the line signals are provided. Similarly the spring bars for the rotary switches are always on the left-hand side. An examination of the switch circuits will also show that the operation of the switch to right or left always cuts out of use the right-hand rotary switch and the right-hand brush (3 or 4) looking in the direction in which the engine is travelling. It also puts out of action brush 1. Hence only the left-hand rotary switch and the left-hand brush (3 or 4 according to whether the engine is running engine first or tender first) are operative, and whilst the right-hand rotary will be turned by the spring bars for trains going in the other direction, the brush 1 will always bear upon the centre bars, and the right-hand brush (3 or 4) will always bear on the right-hand bars, their usual functions are in abeyance in consequence of the position of the switch. The "warning" signal is given by the short-circuiting of the brushes 2-3 (or 4) and the rotation of the left-hand rotary. The "off" signals are taken up by the brush 2 for the "route indicators" 1-2, and by the brush 3 (or 4) from supplementary bars for the "route indicators" 3-4. All other operations remain as described. Hence a simple movement of the switch to one side or the other, according as the engine is running engine or tender first, is all that is necessary in passing from double to single lines, or *vice versâ*.

Recording Indications Obtained.—The system lends itself readily to the adoption of means by which the "condition of line" signals obtained may be easily recorded for each signalling point. The length of time during which the semaphore arm is maintained at "danger" differs in accordance with the condition of the line. If an "off" signal is obtained at B the time is short; if the "on" signal is received the time will be longer, and will depend upon the point at which the "off" signal is ultimately received. In any case the difference is appreciable. This difference may be utilised in order to produce marks of corresponding length upon a cylinder which rotates and travels longitudinally at the same time by adding a marking pen or pencil to the rod, *b*, of A^1, so that a mark is made as long as the armature, *a*, is raised. The motion of the cylinder causes the marks to form a spiral. For places where the "off" signal is obtained at the bar B the mark is a dot only. Where the "on" signal is obtained at B the mark is a line of greater or less length, according to the time that elapses before the "off" signal is obtained. The drum carrying the paper cylinder is driven by clockwork, and is under the control of the signalling apparatus, so that it is only running when marks are to be made, and the driving mechanism and the marking cylinder are, therefore, kept of quite moderate dimensions. Arrangements are made by which the driver can produce a space longer than that provided by the design of the apparatus, and so distinguish between the marks made during one journey and the next.

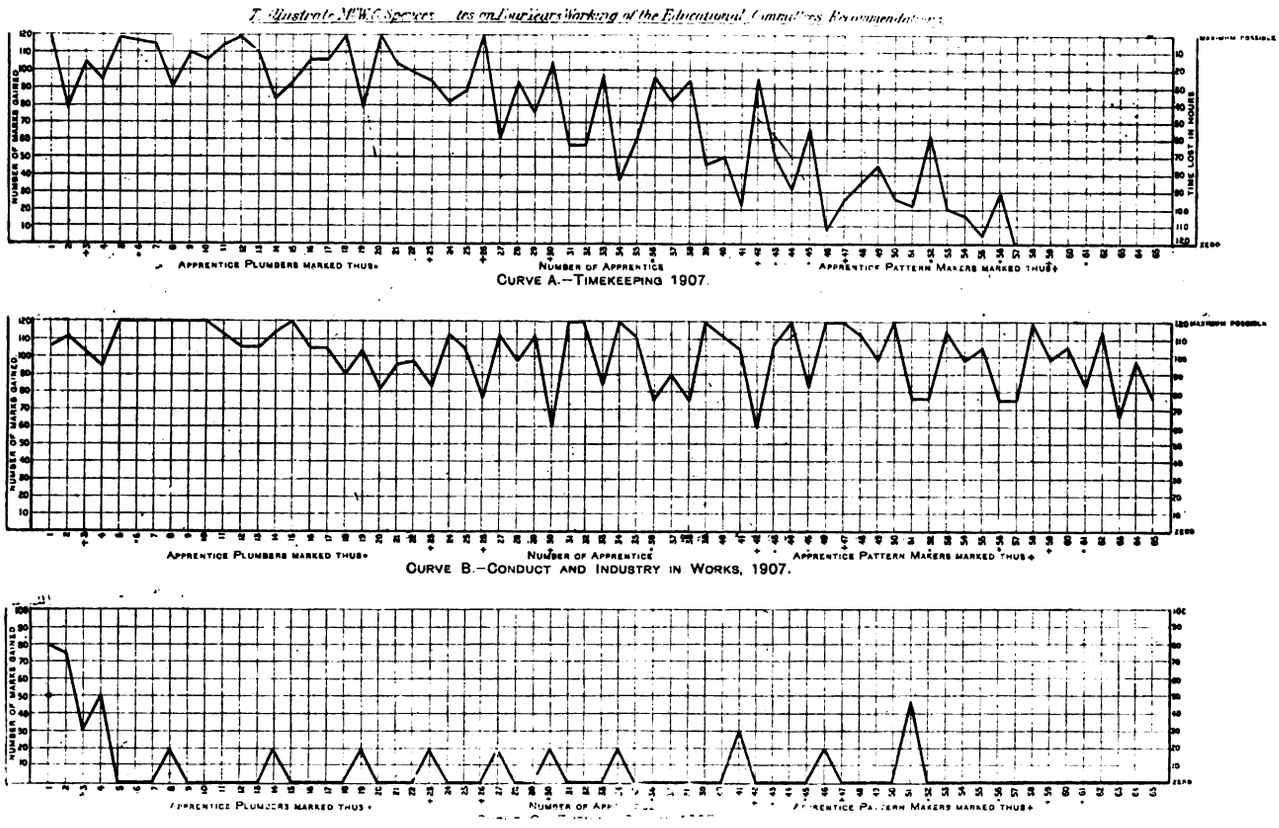
(To be continued.)

NOTES FROM FOUR YEARS' WORKING OF THE EDUCATIONAL COMMITTEE'S RECOMMENDATIONS.*

BY W. G. SPENCE, VICE-PRESIDENT.

In the month of December, 1903, a committee of this institution recommended the adoption of a system of marking for recording the timekeeping, industry, and evening study of engineering apprentices. The system was recommended by the committee on general lines, each firm being at liberty to make such amendments as might better suit the special conditions obtaining at their works. Four years having elapsed since the committee's report was issued, it has occurred to the writer to submit to the institution certain data, in the form of curves, showing the result of the four years' practical working of the system at the Neptune Engine Works. These curves, together with the deductions drawn therefrom, he hopes may be of interest to the members, and lead to results of practical value.

Details of the arrangement of marks suggested in the committee's report will be found on pp. 56 and 57, vol. xx., of our *Transactions*. The marking adopted at the Neptune Works differs from the suggested schedule in some details. Marks are awarded on a graduated scale for examination passes; details of the scale will be found in the appendix at the end of this paper. The results of each apprentice's



Curve A.—Timekeeping 1907.

Curve B.—Conduct and Industry in Works, 1907.

* Paper read before the North-East Coast Institution of Engineer and Shipbuilders, Dec. 20.

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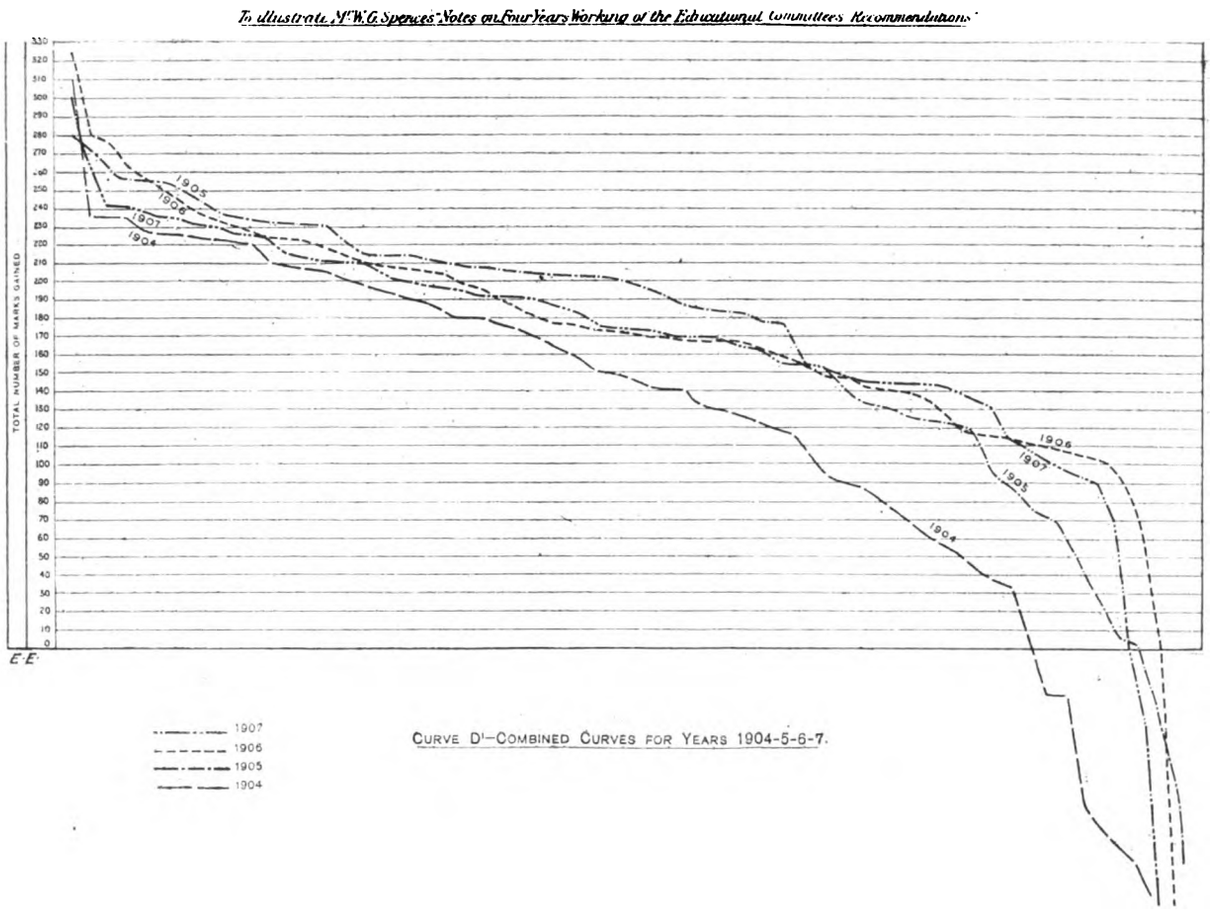
timekeeping, industry in works, and evening study for 1907 will be found in Curves A, B, and C respectively.

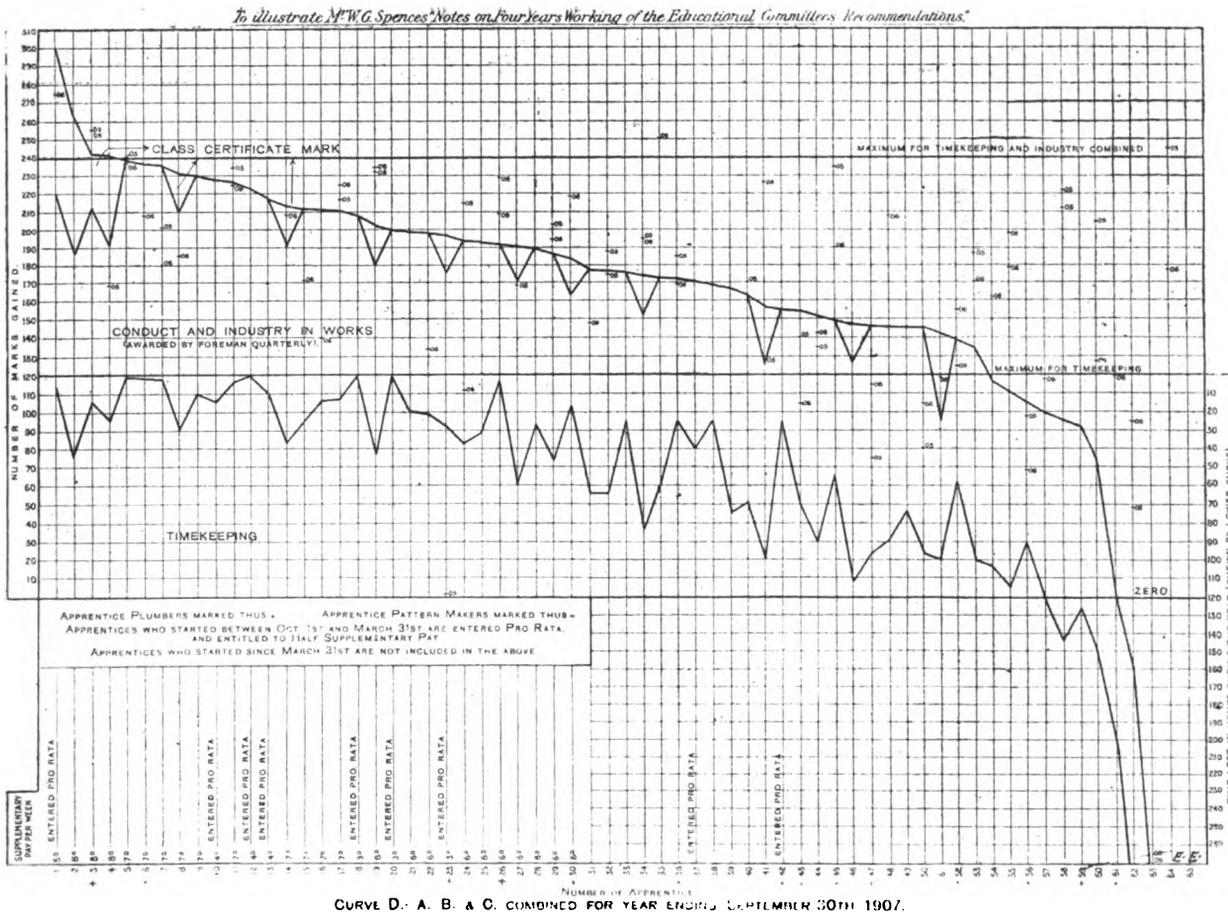
spots above or below his position on the curve). A framed copy of this diagram is hung up in each department of the



CURVE D.—COMBINED CURVES FOR YEARS 1904-5-6-7.

These three curves are combined in one curve, D, which shows at a glance, above the name of each apprentice, his

works, and remains on exhibition until replaced by the following year's results. These curves are at best only


To illustrate W. G. Spences' Notes on Four Years Working of the Educational Committees Recommendations.
CLASS CERTIFICATE MARK
MAXIMUM FOR TIMEKEEPING AND INDUSTRY COMBINED
CONDUCT AND INDUSTRY IN WORKS
(AWARDED BY FOREMAN QUARTERLY)
MAXIMUM FOR TIMEKEEPING
TIMEKEEPING
ZERO
NUMBER OF MARKS GAINED
TIME LOST IN HOURS DURING THE YEAR (SHOWN BY LOWER CURVE)
APPRENTICE PLUMBERS MARKED THUS +
APPRENTICE PATTERN MAKERS MARKED THUS +
APPRENTICES WHO STARTED BETWEEN OCT. 1ST AND MARCH 31ST ARE ENTERED PRO RATA, AND ENTITLED TO HALF SUPPLEMENTARY PAY.
APPRENTICES WHO STARTED SINCE MARCH 31ST ARE NOT INCLUDED IN THE ABOVE
SUPPLEMENTARY PAY PER WEEK
ENTERED PRO RATA
NUMBER OF APPRENTICE
E.E.

CURVE D.—A. B. & C. COMBINED FOR YEAR ENDING SEPTEMBER 30TH 1907.

exact relative position in order of merit, the weekly rate of supplementary pay he has earned for the current year, and the marks he gained in each preceding year (shown by

an imperfect indication of "character," and character, or "gumption," to use a shop phrase, is probably the most important ingredient in anyone's composition, and

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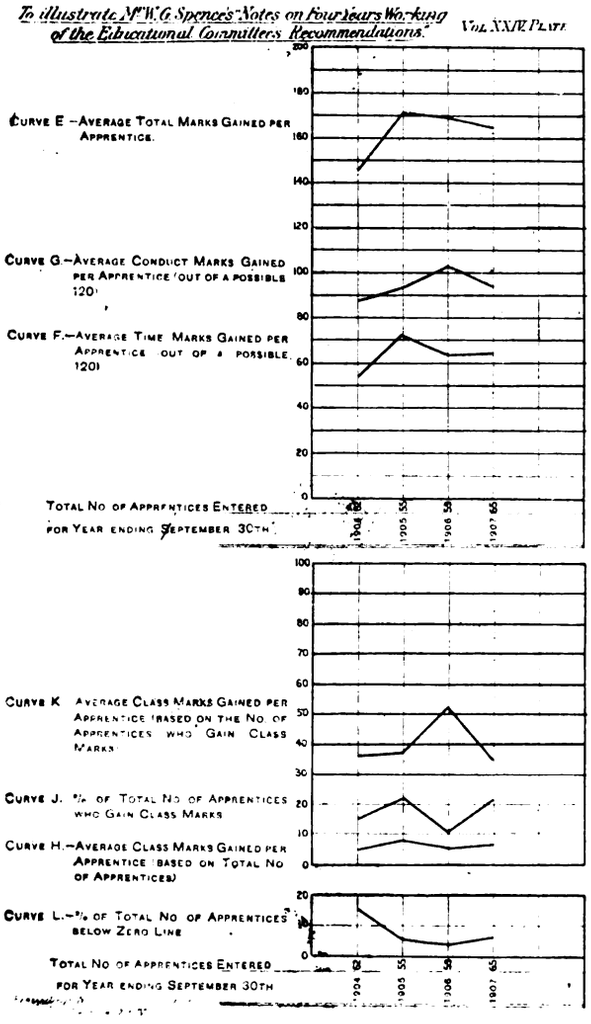
one which often develops late. They form, however, to some extent an indication thereof, and the relative position of each youth, measured on this basis, is easily noted.

In order to analyse these records for the years 1904-5-6-7, and to show the annual variation, the Curves D', E, F, G, H, J, K, L have been constructed. Curve D' shows the combined curve, D, for the years 1904-5-6-7. This has been plotted with a view of ascertaining if the yearly variations recorded in Curves E to L arise from any marked deviation in the form of the curves. It will be noted that, generally speaking, while the whole curve has been raised, this is especially so in regard to the portion towards its lower extremity. Curve E shows the average total number of marks gained per apprentice in each yearly period. It is perhaps somewhat premature to attempt the deduction of general conclusions from only four years' data, but, so far as it goes, this curve appears to show that the introduction of the system caused a general and very creditable "bucking-up" among the youths. As the novelty of the


To illustrate M^r W. G. Spence's Notes on Four Years Working of the Educational Committee's Recommendations.
Vol. XXIV. Plate
Curve E.—Average Total Marks Gained per Apprentice.
Curve G.—Average Conduct Marks Gained per Apprentice (out of a possible 120)
Curve F.—Average Time Marks Gained per Apprentice (out of a possible 120)
Total No. of Apprentices Entered for Year ending September 30th
Curve K. Average Class Marks Gained per Apprentice (based on the No. of Apprentices who Gain Class Marks)
Curve J. % of Total No. of Apprentices who Gain Class Marks
Curve H.—Average Class Marks Gained per Apprentice (based on Total No. of Apprentices)
Curve L.—% of Total No. of Apprentices below Zero Line
Total No. of Apprentices Entered for Year ending September 30th
1904
1905
1906
1907

system wore off, the human tendency to backslide appears to have asserted itself to some extent, and it is probable the eventual mean will be found to be somewhere above 1904 and below 1905. This curve seems to the writer to indicate that, up to the present, the introduction of the system has been justified.

Curve F shows the average number of timekeeping marks gained by each apprentice out of a total possible of 120. This curve indicates a distinct improvement in timekeeping. The importance of timekeeping is, in the writer's opinion, considerable, quite apart from its assistance in the maintenance of discipline and production of work. As a rule, he considers it a fair indication of character, and the training in character induced by having to turn out of bed early, especially in winter, is a distinct asset in a youth's apprenticeship. Curve G shows the average number of conduct marks gained in each year per apprentice, the possible maximum being 120. These marks are awarded quarterly by the respective foremen, and are intended to indicate the relative industry and ability in the works shown by each apprentice. This idea is good in principle, but its practical application is affected by the introduction of the human factor. The foremen undoubtedly endeavour to allocate their marks conscientiously, but there is naturally a wish on the part of every foreman to see the names of the young men under his charge well up on the list, which is liable to bias the judicial faculty, and it is extremely difficult for anyone to place each youth in correct perspective. Curve H shows the average evening study marks gained per apprentice. Curve J gives the percentage of the total number of apprentices who gain any class marks. Curve K shows the average class marks gained by each of these apprentices who actually gain any class marks.

It will, perhaps, be more convenient to consider these three curves together, as J and K are really based on H and intended as an analysis of the latter. The Curve J is intended to indicate the percentage of youths who show any results at all from their evening study. The Curve K is plotted with a view to indicating the quality of such work. The impression the writer gathers from a study of these three curves is that the number of apprentices who do efficient evening classwork forms a very small percentage of the whole, and that, except in a few exceptional cases, the work is of quite a rudimentary character. It will be noted that little more than one out of every five apprentices show any results at all. One has heard much of late years as to the dangers attached to over-attention to bookwork. The results indicated by these curves should permit those who fear we are going to perdition from this cause to slumber in peace. Incidentally, the writer considers the curves indicate a justification for the argument that the attention of those responsible for the allocation of educational grants should be specially directed to seeing that such grants are so arranged that the small percentage of specially able and hard-working youths are granted facilities for passing on to the higher technical schools and colleges, and that the chief business of evening classes should not be the production of a light crop over a large area, but rather the giving of assistance enabling a few to raise themselves above the average and to pass on to further advancement. This was clearly the aim of your committee when they recommended that special facilities should be given to "selected" youths. It is a waste of labour to try to polish lead, but if the small percentage of silver contained in the lead be extracted a high polish can with advantage be given to the rarer metal. The scholarship about to be founded by our institution is a right step in this direction.

Only a very exceptional youth, strong both mentally and physically, can make any great headway by evening study and at the same time work regularly and well in the works from 6 a.m. to 5 p.m. With a view to minimising this difficulty in favour of the really deserving, it is now arranged at the Neptune Works that the apprentice at the head of the curve each year shall between Oct. 1 and May 31 next succeeding winter commence work at 9 a.m. instead of 6 a.m., full-time pay being credited over this period. Should the same youth or youths be leading for a second or a third year in succession they will retain their privilege, and, in addition, the next in order will obtain it. In other words, the head apprentice of those required to attend at 6 a.m. will always be selected in each year. Curve L indicates the percentage of the total number of apprentices who fall below the zero line—in other words gained no marks whatever. It will be seen that since the introduction of the system there has been a healthy decrease in the numbers under this category. The "scallywag" we have always with us, and while the extinction of this species is unattainable, its reduction is desirable. The above-described system of marking and curve records is in operation in both the engine department and boiler department, but each is kept distinct, and the curves from the former department only have been dealt with in this paper, Apprentices after commencing in the drawing office are not included in the curve.

In conclusion, the writer wishes to state that he is satisfied that the exhibition of these curves in the works is a healthy stimulus to the apprentices, and he hopes their submission to this institution may lead to a useful discussion.

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APPENDIX.—*Neptune Engine Works.*

At the end of September in each year each apprentice will be awarded marks as follows: For each approved examination in science or in mathematics (not exceeding three in number) passed during the year, see Schedule A;

SCHEDULE A.—Evening Science and Art Classes.

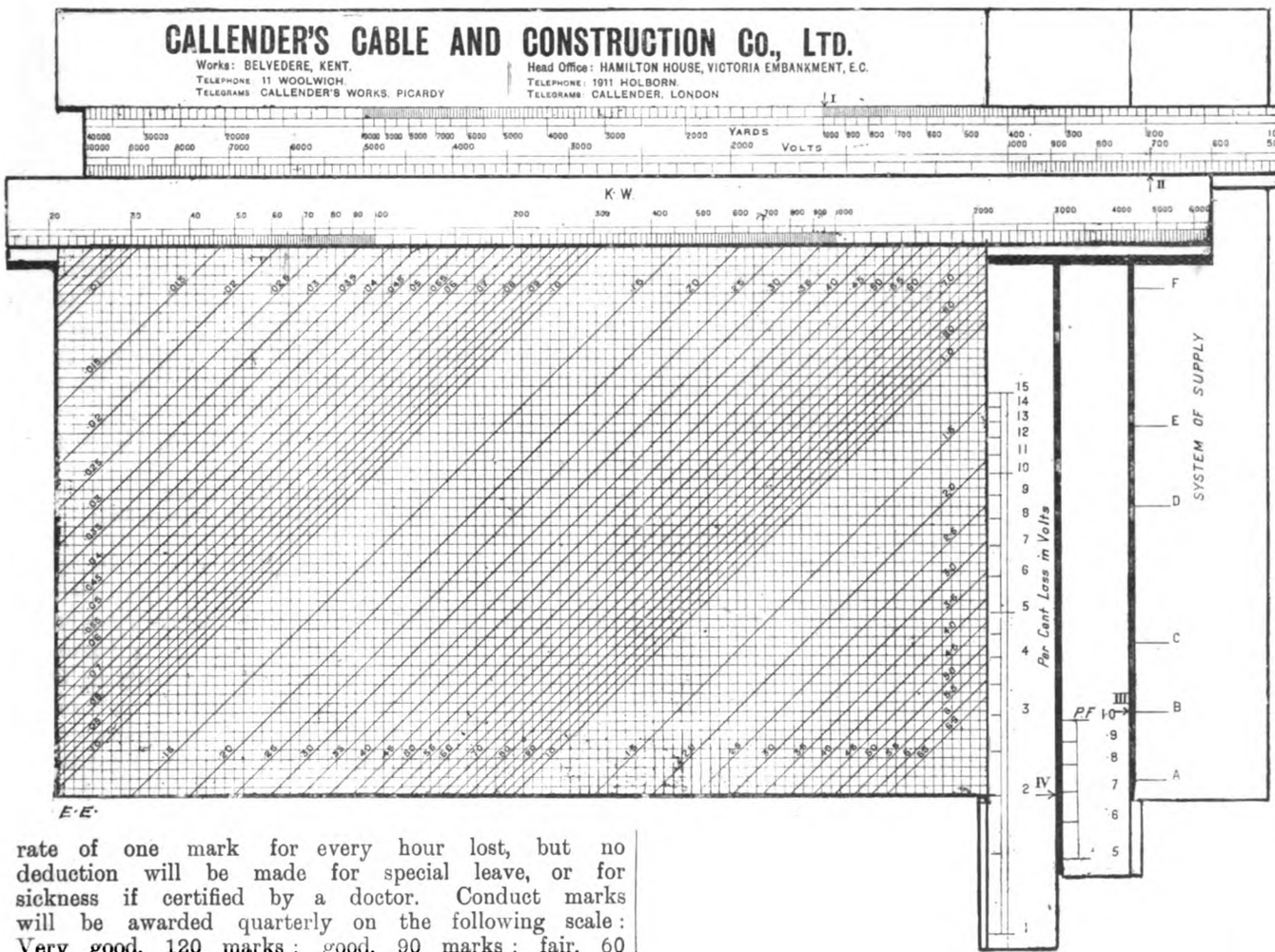
		Marks. 1st class.	Marks. 2nd class.
Board of Education, South Kensington—			
Science subjects	Stage 1	30	20
,, ,,	,, 2	50	30
,, ,,	,, 3	85	50
,, ,,	Honours	110	70
Mathematics—Division I.	Stage 1	30	20
,, ,,	,, 2	50	30
,, ,,	,, 3	85	50
,, ,,	,, 4	85	50
,, ,,	Honours	140	80
,, Division II.	Stage 5	85	50
,, ,,	,, 6	85	50
,, ,,	,, 7	110	70
,, ,,	Honours	170	100
Freehand drawing	—	36	—
City and Guilds—			
Science subjects—Preliminary	—	30	20
,, ,, Ordinary	—	50	30
,, ,, Honours	—	85	50

Armstrong College (evening classes)— Division...	I.	II.	III.	IV.
Elementary stage	30	20	15	10
Senior stage	50	35	25	15
Advanced stage	100	70	50	30

for timekeeping, a maximum of 120; for good conduct, industry, and progress in the workshops, a maximum of 120. Marks for timekeeping will be deducted at the rate of one mark for every hour lost, but no deduction will be made for special leave, or for sickness if certified by a doctor. Conduct marks will be awarded quarterly on the following scale: Very good, 120 marks; good, 90 marks; fair, 60 marks; moderate, 30 marks. An apprentice obtaining 180 marks in the aggregate will have the sum of 6d. added to his weekly rate of pay for the ensuing year, for marks in excess of 180 his rate will be proportionately increased. No payment under this scheme will be made to apprentices obtaining less than 180 marks, and apprentices who fail to obtain a reasonable number of marks for timekeeping, good conduct, industry, and progress will be subject to dismissal. Apprentices commencing their apprenticeship between Oct. 1 and March 31 will be entitled to half rates for their first year. Marks will only be given for examinations passed in the year for which the certificate is issued, except in the case of those students who sit for the "honours" examination having already passed the advanced stage in some previous year; such students, in case of failure to pass the "honours" examination, will be allowed to count the marks they earned previously at the advanced examination. This is done with a view to encourage apprentices to take the higher courses of study. Students will be expected to show improvement each year in the results of their examinations, and the full marks allowed for any given pass can only be obtained in one year. Should the student only succeed in obtaining the same pass a second time the marks obtainable will be reduced by 10 per cent.

CALLENDER'S SLIDE RULE.

We have received from Callender's Cable and Construction Company, Limited, a very ingenious form of slide rule for rapidly and accurately determining the sectional area of a cable for use under given conditions. The instrument consists of a rectangular block of cardboard measuring about 13in. by 7½in., on which move two vertical slides and two horizontal slides. The horizontal slides are divided in yards, volts, and kilowatts, and the vertical slides in values of power factor and loss per cent. The rest of the block is covered with a series of curves connecting load in kilowatts and loss per cent. in volts, for sections of conductor up to 6·5 square inches. The slide rule is readily adapted for use with any system of supply, continuous current or alternating.



The method of use is very simple. The two horizontal slides are set to the given distance and voltage, and the vertical slides are set for the system of supply and the power factor. One vertical and one horizontal slide now form the scales for the table of curves, from which the required section of conductor for any given load and loss per cent. can be read direct. The slide rule is obviously suitable for finding any one of the six factors involved when the necessary data are given. A very concise card of directions is supplied with the slide rule, and the whole affair is so simple and convenient that it will doubtless be welcomed by all who have to make many calculations of this description

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TO CORRESPONDENTS.

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SIGNALS.

What with ætheric telegraphy and ætheric telephony we are apt to take for granted that signalling from a distance has always been part and parcel of the world's method of intercommunication. It is not so, and in this particular direction, if not in architecture or art, the last century has made gigantic strides. Steam and electricity have altered within one short century all the world's procedure that depends upon celerity of communication. What had we till the first half of the nineteenth century? Herodotus tells us that Xerxes invented a quicker method of communication by means of horse relays. We read, "Nothing human can exceed the velocity of these messengers." Probably the average distance per day was from sixty to eighty miles, because later on the Roman emperors improved the system, and by its means "it was easy to travel a hundred miles in a day along the Roman roads." It may not be generally known, but it is pretty well proved that the Romans had something akin to the modern speaking tube, so that they could converse or signal from one tower of the wall to the next, and so on. These were aural signals, but in addition there were the sounds of trumpets and other instruments, as well as the visible signals by means of torches, beacons, etc. Thus Medea to Jason "made signals from the palace to the watch-tower on the sea-shore by means of smoke in the day and of fire in the night." Isaiah speaks of "a beacon on the top of a mountain." Probably prior to the time of the horse relays the value of quick communication was well understood, and in order to get it Cleomedes tells us that men were "stationed from Athens to Susa" in such a manner as to send by voice intelligence "from Greece into Persia in two days and nights." Consider the magnitude of such an operation and its cost, not to speak of the large number of men necessary, and thus gain an insight of the value placed on quick intelligence by the nations of old. Much of the plot and incident of the tragedy of Æschylus' "Agamemnon" is founded on a preconcerted signal by the king to Clytemnestra, by which she was to know that Troy had fallen. This was visual by means of fire. As Clytemnestra explains:

> "The fire, that from the height of Ida sent
> Its streaming light, as from the announcing flame
> Torch blazed to torch," etc.

Of course, all the signalling of these early times was connected with warlike operations, and at first dealt with simple preconcerted matters, and the signals were unable to inform as to other events. The Carthaginians extended the capacity of such a system. Before ravaging Sicily they inscribed on two similar dials almost or quite all the wants they conceived possible. The inscriptions on the dial divisions corresponded. The dials were affixed to two clepsydras of equal magnitude, one of which was kept in Sicily, the other sent to Carthage. The watchman at Carthage looked out for the blazing beacon signal, and set his clepsydra going. When he saw the second beacon signal, he noticed the division on the dial which the pointer indicated, and this told if "a fresh supply of forage," or "money," or "more ships of war," or "more horsemen," or "footmen," etc., was wanted, so that the Carthaginians in Sicily obtained a speedy supply of whatever was required. Cleoxanus or Democlitus invented a very flexible system to convey signals of any event or to give any information. To describe fully would be waste of space, but the alphabet was divided among numbered tablets. These tablets were multiplied as need be. The number of the tablet was indicated by an equivalent number of torches, say on the left hand; thus three torches signified third tablet. The

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position of the letter on the tablet was signified by torches on the right hand; thus two torches, second figure. A very flexible system, and slow. Smith, an Englishman, during the siege of Olumpagh by the Turks devised a somewhat similar and successful method of signalling. Thus the first known system of signalling or telegraphy was for preconcerted events; then came a variety of events prearranged, and, finally, the alphabetical method, allowing any event to be signalled. But let us pass on, just mentioning Godwin, Bishop of Hereford, who about 1583 is said to have invented a system of signalling and was accused of witchcraft. Then the Marquess of Worcester, in his "Century of Invention," refers to a visual method of signalling and so on. Strada, in his "Prolusiones Academicæ," first refers to the use of magnets for signalling. Late in the eighteenth century telegraphy by means of semaphores came into being probably in the first place by smugglers manipulating the arms of windmills, then the same being followed in military operations, and, finally, the scheme of two arms upon tall masts was adopted, more or less perfected and in common use till the introduction of the electric telegraph in the third decade of last century. Since then electric developments have revolutionised all methods of signalling.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE DEVELOPMENT OF TURBO-GENERATORS.

SIR,—In the above paper by Dr. R. Pohl (abstracted in your issue of Nov. 29) the author says that he has found a new method of automatically adjusting the compensating current in a direct-current dynamo by using a "shunt parallel to the commutating poles, the resistance of which increases rapidly with increasing load." It may be of interest that I have invented this arrangement in April, 1905, and successfully applied it on a 500-kw. generator supplied by the Felten und Guilleaume Lahmeyerwerke A.G. to the city electric light works, Dortmund

I have before me a report dated April 17, 1905, of which the following is an extract: "The compensating current was equal to the armature current up to 1,500 amperes (three-quarter load); for 2,000 amperes, however, a compensating current of 260 amperes was required to obtain sparkless running. The compensating coils (which were all in parallel) were then connected in two groups in series, and shunted by an iron resistance worked at high temperature. It was found that the compensating current increased automatically with increasing load, and by properly adjusting the shunt the necessary ratio of increase was obtained. The losses in the shunt amounted to about 1 per cent."

It need hardly be mentioned that this way of obtaining sparkless commutation represents only a good makeshift to correct faults after completion. There are now other methods available to obtain the desired results without such artificial means and without sacrifice of efficiency.—Yours, etc., L. SCHULER.

RE QUESTION 1,019—SINGLE-PHASE CURRENT FROM THREE-PHASE CIRCUITS.

SIR,—As both the answers printed in yours of the 13th inst. contain errors, will you please allow me to point them out to your readers.

It is not possible either by means of transformer or by means of one-armature rotary to obtain balanced or nearly balanced loads on three-phase circuits taking only single-phase load. If the current at a given output balanced three-phase is 100 per cent. in each lead and the same output is taken single-phase from the same circuit, either two of the three-phase leads will have 173 per cent. current and the third lead no current, or one of the leads will have 200 per cent. current and the two others each have 100 per cent. flowing through them.

The first result is obtained when the load is taken off one phase by means of one single-phase transformer. The second load is obtained if in the Scott connection the one phase (transformer A) only is loaded. Transformer B would then work as an auto-transformer for one-half of the high-tension current of transformer A (see Fig. 1).

Conditions between those stated above can be obtained by connecting the transformer A to another point than the middle point of transformer B; for instance, as shown in Fig. 2. The approximate distribution of current would in that case be: in lead 1, 192 per cent.; in lead 2, 144 per cent.; in lead 3, 48 per cent.

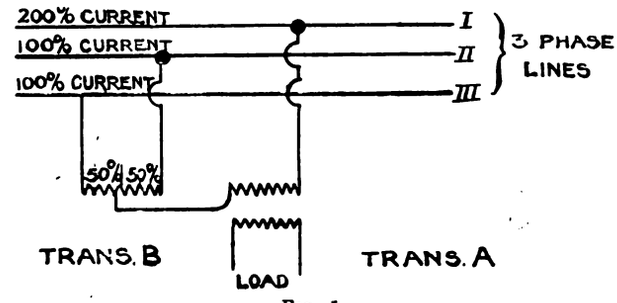


FIG. 1.

The same results can be obtained by one armature rotary, and nothing better (as tests bears out), because the flywheel action mentioned in the beginning of "Q's" answer cannot take place. The transformer method as described by "Q" with the primary in star connection would give the same current distribution as described for the S ott connection, only with the difference that the voltage drop due to the unbalanced ampere-turns on the phases when the load comes on makes the scheme absolutely unworkable. If the primary is delta connected, the current distribution would be as when only one phase is loaded by means of a single-phase transformer. In the above figures the no-load current which will be added to the load currents given above is not taken into consideration.

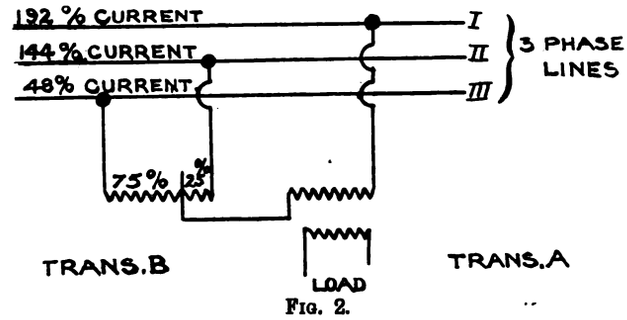
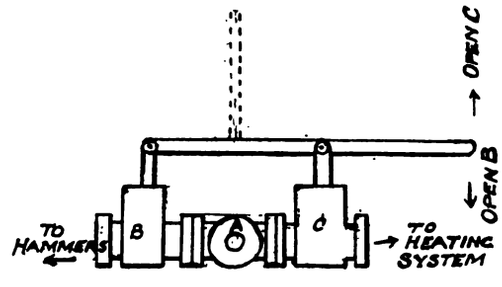


FIG. 2.

The only possible way, therefore, of taking single-phase current from a three-phase supply and obtaining balanced load is by means of some motor-generator set.—Yours, etc., K. FAYE-HANSEN.

EXHAUST-STEAM HEATING.

SIR,—In answer to the inquiry from "A. H. B." in your issue of the 13th inst. the following may be of use (see sketch): Steam from boiler is admitted to the T-piece, A,



the two valves, B and C, being of the "full-way" type, worked by a lever in place of handwheel and screw. In opening or shutting either valve the other is used as the fulcrum of the lever. As this type of valve is held on the

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seat by a pressure equal to its area × steam pressure, there is no fear of one opening before the other is shut. The lever may be as shown by the dotted line, if more convenient. "A. H. B." will require a reducing valve between the live steam and the heating system, as the hammer exhaust will be about 25lb. per square inch. By putting the pressure up to 100lb. suddenly, a serious water hammer in the pipes would be almost a certainty. The system should have a gradual fall, and the drainage returned to the feed pump as close to the pump as possible to gain the advantage of the warm water.

An economical heating arrangement may be arranged as follows: Steam is taken at boiler pressure to pipes above the water-level in the boiler, and a return pipe taken back to the boiler through a non return valve below water-level. This arrangement is in use, and works satisfactorily. If the hammers are not used the greater part of the time, it might pay "A. H. B." to use this method He may find the back pressure, due to long pipes of the heating arrangement, seriously reduce the power of the hammers unless large pipes are used, which should be cast with ribs on where heating is required.—Yours, etc,

E. A. SCARBOROUGH.

FUNERAL OF LORD KELVIN.

At noon on Monday, in the presence of a distinguished congregation, the mortal remains of William Thomson, Lord Kelvin, were laid to rest in the nave of Westminster Abbey, next to the grave of Sir Isaac Newton. The pall-bearers were Lord Rayleigh, Admiral Sir Edward Seymour, Mr. John Morley, M. Gaston Darboux (permanent secretary of the Academy of Sciences of France), Sir Archibald Geikie (president of the Geological Society), Lord Strathcona, Prof. A. Crum Brown (Royal Society of Edinburgh), Sir George Darwin, K.C.B. (University of Cambridge), the Master of Peterhouse, Cambridge, Dr. M'Alister (principal of the University of Glasgow), Sir John Wolfe Barry, K.C.B. (Institution of Civil Engineers), Dr. R. T. Glazebrook (Institution of Electrical Engineers). The chief mourners were Dr. J. T. Bottomley, F.R.S., Mr. G. King, Mr. W. Crum, Mr. James Thomson, Mr. W. Bottomley, Sir Alex. Brown, together with four grand-nephews (Mr. D. King and Mr. J. F., Mr. W., and Mr. G. Bottomley).

In the cloisters was stationed a guard of the Electrical Engineers Volunteers (of which Lord Kelvin was colonel-in-chief) under Colonel Crompton.

The coffin bore the inscription: "William Thomson, Baron Kelvin of Largs, P.C., O.M., G.C.V.O., F.R.S., F.R.S.E., LL.D., D.C.L., born 26th June, 1824; died 17th December, 1907."

The King was represented by the Duke of Argyll, Sir Arthur Bigge attended on behalf of the Prince of Wales, and Major Green Wilkinson represented the Duke of Connaught. There were also present the Russian and Italian Ambassadors, and representatives from the American, German, and Japanese embassies, and the Lord Mayor of London, and others.

The First Lord of the Admiralty, Lord Tweedmouth, accompanied by his secretaries, attended to represent the Board of Admiralty. The Lord President of the Council was represented by Mr. Almeric FitzRoy. A delegation from Glasgow University included the vice-chancellor, Sir William Bilsland (who as Lord Provost also represented the city), Mr. H. G. Gordon, of Aikenhead, the late chancellor's assessor, representatives of the senate, of the general council, and of the students' representative council, and the bedellus of the university bearing the draped mace. The University of Cambridge was represented by the vice-chancellor, and Lord Kelvin's old college (Peterhouse), by the master and fellows; Oxford University was represented by the vice-chancellor, Prof. W. Osler, and Prof. H. A. Meers,

From Lord Kelvin's business firm were Mr. J. T. Bottomley and Mr. W. Bottomley (nephews), and the Institution of Electrical Engineers, of which Lord Kelvin was president when he died, were represented by Sir John Gavey, Dr. R. T. Glazebrook, Mr. R. Kaye Gray, Sir Henry Mance, Sir William Preece, Mr. Alexander Siemens (all past presidents), and by Mr. F. Gill, Prof. G. Kapp, Mr. C. P. Sparks, Mr. W. M. Mordey, Mr. W. H. Patchell, and Mr. R. Hammond, also Colonel Crompton.

A large number of wreaths were sent. Three of these were placed upon the uncovered coffin, those of Lady Kelvin, that of the Royal Society, with its "homage and affection," and a little bouquet from "Homes he blest," sent by "A. and E."

THE RAILWAY CRISIS.

I think we have made a little headway, but "Staffordian" claims just a shade too much. We are agreed that this discussion is upon the point, "the interests of capital and labour are identical." "Staffordian" thinks that a question (Nov. 22) of mine admitted the statement to be a mistake. The question admitted nothing of the kind, and I still adhere most emphatically to my original statement. It is somewhat difficult to find a convincing analogy, but what has "Staffordian" to say to this:

> Two men are dying of thirst.
> Is it not their "identity of interest" to find water?
> Assume they find two quarts and a gill.
> Is that "identity of interest" lost because each takes a quart and they quarrel over the gill?

I do not know how "Staffordian" will answer these questions, but to me the answer to the first is "Yes," the answer to the second "No"; hence the quarrel over the minor point does not interfere with the "identity of interest." Now take:

> Two men (one with capital, one with labour).
> Mutual combination is necessary if something is to be produced.
> It is the interest of both to produce, and divide the production in accord with the proportional weight of each in the production.
> In fact, the identity of interest is to use in combination what each possesses to produce something to the best advantage.
> That identity of interest is not lost because they haggle about the exact point where the result of production is to be divided.

It was denied that previous labour—*i.e*, capital—should participate at all in the division of results, hence I had to attempt to show that as a right it expects its share, and my opponents now practically agree. The number of questions raised by the letters is far too great for me to deal with now. I am only concerned with one point at a time. "Lancastrian" agrees that "land, labour, and capital are necessary to modern production," but, admitting these factors, he still contends that only "labour" is to "have the say"; hence I have to emphasise the view that the other factor is entitled as a right to have its say. "Staffordian," who admits production to come from a combination, in saying "I accept it freely" fails to see that our difference now is merely the equivalent to the quarrel about the "gill" of water. The result obtained is from combination, hence the factors of the combination should each share in the result. Perhaps, now, I shall shock some of my readers when I say that for the abstract question and the abstract right of capital I do not care one iota as to how that capital was obtained or who holds it. My opponents all hold that capital is held by the wrong parties. That is a far larger and more complicated question than "identity of interests," though identity of interests, if duly acknowledged, is the one point that would save an intolerable amount of suffering, worry, and loss. It is a comparatively easy matter

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to find out which factor in the production receives (if it does so) more than its fair share in the produce. Let us agree absolutely on this one thing first. There is just one analogy I would like "Lancastrian" to ponder over this festive season. He, like George, will not have it that capital is advanced. A grain of wheat may be capital. It is put into the ground, and an ear of corn results; capital + labour + natural agents = result. Surely the original grain (capital) is absolutely advanced and lost, to be returned again by the result (produce). This is analogous to what is meant by capital being advanced. George says, "Political economy is not a set of dogmas (true). It is the explanation of a certain set of facts" (true again). Unfortunately, George is unable to understand what are facts and what are fictions. He cannot—or I should say will not—admit that Brown, who is in business, buys corn which he sells to Smith for seed. If Smith does not pay him on the nail, and Brown has paid for the corn he sells, most certainly it is a fact that Brown has advanced capital Just so the stone in a wall may in the end give the equivalent return to capital, but meanwhile capital is advanced. I did not want to impart complicated cases, but to stick to first principles, which need not trouble about appropriated lands, or rent, or all the things which render the economic problem more complex. Begin with the simple, then add condition after condition, and consider the effect of each addition. I would like to point out some of the mistakes into which "Mancunian" has fallen, and also to discuss the particular example of Leeds tramways with him and "Lancastrian." It is, however, not a case which would tell in their favour. It is impossible to discuss monopolies under the flag, "identity of interests." Gentlemen, I heartily reciprocate "Lancastrian's" good wishes, and give you "The Compliments of the Season."

WRITER ON THE CRISIS

CHOLLEY.

Ginger is our fiery little red-haired switchboard attendant, whose chief worry is that his chest measurement is too small for him to join the London Rifles. At times and seasons, when all things are running smoothly, he waxes reminiscent. Imagine him, then, clothed for comfort as regards the upper man in grey flannel shirt and flamingo braces—a collar being regarded only as a concession to civilisation when "mashing" the cook—as regards the nether region in breeches of disreputable age and worn-out clouts. On one side of him, as he sits on an old box—he prefers it to the switchboard stool—is an ancient beer-can regenerated into a teapot, on the other a half-sheet of the *Star* containing a composition of bread and bloater.

* * * * *

Speakin' generally, I ain't often done in. I know what's what almost as well as the cat. F'rinstance, w'en a bloke comes into the station ter look rahnd I can generally tell w'ether 'e's good fer a tanner or seems ter be one o' them bumble-bees that's full of greasy politeness an' 'asn't any small change abaht 'im. Ain't no good arsking them sort for a fag neither, 'cause they'd most likely give yer a match instead. I was fairly done once, though—not entirely my own fault, mind yer—you'd ha' been sucked in just the sime if you'd seen the chap.

I was sittin' on the box here, sime as you see me now, with a couple o' doorsteps an' a bag o' mystery, twisting em in as fast as I could swaller, because I didn't know how soon the load would come up. In strolls a 'owling toff, and looks rahnd soopercilliously is if he'd bought the leasehold. The engineer wasn't abaht, so I steps dahn to 'im and says, "Arfternoon. W'at can we do fer yer?"

"Oh!" says he in a sort of wire-drawn voice, "is this the generating station?"

"Depends on w'at effec' of civilisation you refer to," says I, stiff-like. "If it's chickens, the incubator shop is 'alf wye down the 'igh-street; if its juice, 'ere yer are."

"Oh!" he says, "I've heard that joke about the incubator before, at the Empire."

That upset me! "Look 'ere, young man," I says, "You just be careful 'ow you mishandle the truth, or else w'en yer go ter 'ell you'll be chucked art agen fer tellin' lies! W'at d'yer want 'ere? Are yer the Board of Trade inspector?" I says, sarcastic.

"Ho no," he says, as soft as ever, "I'm the Premium Pupil."

Yer could ha' hit me over by corfing at me w'en I 'eard that. "A Premium Pupil," I gausps. "A bloomin' Pup in this place! Oh Mariar!"

'E didn't take no offence, neither, but kept on smilin' in 's silly wye that exawsperated me.

"Come in!" I says. "Come inside an' learn 'ow ter run the bloomin' styshun. An' it won't be like goin' ter 'eaven in a 'and-basket, neither."

And then 'e said in that sleepy sort of wye 'e 'ad, "You're rather a rum sort of stick, don't you think?"

"Stick yerself!" I sharts at 'im, fergettin' myself fer a minute. "Garn! If I'd got a fice like yours I'd pawn it—an' lose the ticket"

With that 'e lawfs agen an' says, "'Adn't you better find the engineer for me?" So I goes awye properly mad, an' tells the engineer there was a blorsted ijit come ter run the styshun.

Well, that was the wye Cholley came inter the works. Cholley is short for Chawles, which was 'is nime, an' w'ich 'e didn't like, w'ich is w'y we called 'im it. 'E was abaht the biggest mug you ever saw—never been in a works before! W'y, one dye I sez to 'im causually, "Cholley, yer might just go dahn ter the fitter in' awsk 'im fer an elawstic crowbar an' likewise a long stand," pretending I was busy, you see. Well, the silly noodle, 'e goes dahn ter the fitter, an' the fitter 'e nearly busts 'isself trying to keep strite. Arfter keepin' Cholley standin' abart fer a quarter of an hour an' explinin' confidenshully ter the navvies w'ot a young turnip 'e was, 'e stuffs 'im that the elawstic crowbar was on the centre girder underneath the coolin' towers. And I'm blest if the silly young fool didn't go an' get hisself wet under the towers tryin' ter find that elawstic crowbar.

Awfter that we reckoned we could do w'ot we liked with 'im. One dye I ses ter 'im, "Cholley, d'you know 'ow to mike a suction jint?" "A suction joint," ses 'e, "what's that?" "Ho!" sez I, "it ain't very difficult ter mike if yer know 'ow. If yer'll send out fer a 'alf pint I'll show yer." So 'e sends out fer a tonic an sits dahn on the box alongside me w'ile I kids 'im abart this 'ere suction jint. Presently up comes the beer, an' Cholley's eye it glistens like a doodrop, for 'e could put awye the milk, 'e could, sime as any of us. But bein' perlite, an' wishin' ter know 'ow ter mike a suction jint, 'e 'ands me the can furst. Well, a 'alf pint is nothin' ter a man wot knows 'ow ter tike a breath before 'e swigs, so before Cholley could stop 'is eye from bulgin' I'd got that 'alf pint dahn my neck an' was smackin' my lips.

"There!" I ses, "I reckon that's the neatest suction jint you ever saw." Larf! To see the look on 'is egspreshun w'en 'e saw the empty beer-can was as good as eatin' faggits.

Strange ter sye, arrever, while the quiff would work sometimes, it wouldn't always. F'rinstance, one dye I got the oil funnel an' stuck it in me weskit; then I borrowed a penny off Bill, the driver, and placed it on me forred. Then I worked it dahn me nose—needed some doin' that did—an' dropped it inter the funnel. Then I ses ter Cholley, "Bet yer don't do that!" Well, 'e'd got funnel fixed all right an' was putting the penny on 'is 'ead, w'en I reached out my 'and too sudden fer my beer-can o' water. Cholley drops 'is penny, tikes out the funnel an' looks at me very steady, while the smile on Bill's fice gives wye ter a look of disappointment.

"Nah then, miserable!" I says, tryin' ter buck 'im up. "The quickness of the 'and deceives the heye. Let's see yer conjure with that penny." An' what d'yer think 'e ses ter me?

"Ginger, yer randy, little red-haired Cockney," says he. "If yer hadn't been in such a hurry yer could have got me interested in the penny before yer reached for the water. As it is yer've spoilt the trick, and I've got yer measure."

And from that time 'e really began to get a bit artful.

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F'rinstance, one dye 'e came in from the stokehole with a fice like a mile 'o bad road, an' 'e ses ter me :

"Ginger," says 'e, "w'en I went out inter the boiler-house just now, I found all the stokers on their knees praying!"

"Wot!" I shrieks, me hair risin' on end owin' ter thinkin' fer a moment that 'e was tellin' the truth.

"Yes!" 'e says very solemn. "The chief's just gone inter the coal bunkers, and the stokers are praying that a lump of coal will roll down an' brain 'im."

But I never really got ter understand the chap till the dye we 'ad the 'ot big end on the large set. Me an' Cholley was on the board, an' as usual Cholley was makin' a fool of 'isself with 'is pipe, tikin' three draws an' thirty-three spits—'e was a 'orrid wet smoker, was Cholley—w'en suddenly 'e jumps up with "'Ear that noise, Ginger?"

"Garn, big feet!" I sez, because I'd got the spur at 'is kicking my cawfee over in 'is 'urry. "You've been drinkin', Cholley, or else you ain't washed yer ears out this mornin'! Yer can't 'ear strite."

But before I'd finished 'e was blowin' 'is whistle like blizes an' signalling up the two small sets. An' then I miffed a hot-oil smell an' knewed which of us was the fool. 'E'd got 'is synchronisin' plug in, an' the lamp was comin' up beautiful, w'en I took a back cast of the eye at the big set an' saw smoke. That finished me! The second engine was coming up ter speed, an' I jammed 'er field on an' put *my* synchronisin' plug in likewise, w'ich is to sye, on the sime bar 'as 'is. Not fer long, though! There was a roar like forty lions, an' I hiked my plug back. Then there was a 50-million candle-power right in my eyes, an' I felt Cholley's elbow in my stummick an' Cholley's voice in my ear, sayin' "Sit down, fathead!" An' wot with the loose lightnin' an' wot with Colley's elbow, I just sat down an' looked silly. There was Cholley shyin' a coat at the arc, an' luckily 'ittin' it out. Then—I can't sye 'ow 'e did it—'e got 'is first set in, blorsted the driver till Bill 'ad got over the fright of the flash an' fetched the second engine up, smashed 'er in, rammed the load over, shut the big 'un down, an' then turned 'is attention ter me, sittin', as I said before, on the floor lookin' silly.

"Ginger, you ——" Good 'evins! 'E did go off—like a Brock's benefit! I don't know 'ow 'e thought of it in 'alf a minute, w'ich is all 'e took. 'E used just the sime words we alwyse used ter, but 'e fitted 'em onter me till my face lost five colours o' dirt through fright at listenin' ter him.

W'en 'e'd slowed down a bit I said very 'umble, "I'm sorry for yer coat, Cholley, me boy."

An' would yer believe it, 'e went off worse than ever! "My coat, yer ——! Don't yer think I can look arter meself better than that? It was *your* coat, you juggins!"

An' w'en I came to look at it, it was!

* * * * *

"And what report did Cholley make of the occurrence to the chief," I asked Ginger.

"Went an' told 'im a blimed lie. Said 'e'd told me to 'urry up, w'ich was the cause of the accident, an' orferred ter pye fer the damage. Chief was knocked so silly at 'is cheek 'e fergot ter kick 'im out of the office.

THE PROVINCE OF THE ILLUMINATING ENGINEER.*

BY LEON GASTER.

(Concluded from page 887.)

While the greatest possible use should be made of daylight illumination, artificial illumination is an absolute necessity to a greater or less extent, and in the arrangement of the lighting installation no pains should be spared to secure the best results which modern science has rendered possible. To furnish the most up-to-date machinery and tools and to pay the present high prices for labour, and then to handicap the workmen by insufficient or improperly placed light, is a fallacy. In many cases a lighting installation which would be adequate if properly maintained, is allowed to run down and become seriously defective for lack of care. Very often one sees electric lamps and reflectors taken from machine shops with the reflector absolutely black from accumulated soot and grease, and the lamp showing hardly any light on account of the age. The maintenance of the lighting system should not be left to the individual workman. The expense of the necessary lamps to be regularly inspected, cleaned, and kept in order would be a mere trifle compared with the loss of time of the higher paid labour of the operatives in keeping it in order, or the loss in efficiency of the same operatives due to neglect to maintain the system at its proper efficiency.

Mr. W. H. Patchell, in his presidential address before your association, rightly remarked that good illumination is conducive to economy in both engine and boiler rooms, as plant in a badly-lit room never gets properly looked after or cleaned. Why should it? asked Mr. Patchell, as no credit is given to the cleaner if it cannot be seen Dirt is about the worst disease a plant can suffer from, as it invariably means neglect of small indications and warnings, timely attention to which would prevent the otherwise inevitable breakdown. Not only is the plant better cared for, but men all work better in cheerful surroundings and lose less time through sickness. I have repeated these few observations, as they contribute to prove the value of the remarks made previously when dealing with the advantages to be derived from proper factory lighting.

Shop-Window Lighting.

There is, perhaps, no case in which light is so ineffectively squandered as the lighting of the shop windows in our streets. It is not too much to say that one cannot walk down the best streets of London without constantly seeing light not only wasted, but actually defeating its own object. Brilliant lights are frequently distributed either in the front of the window, or among the contents of it, in such a way that the prospective customer cannot gaze into the window without discomfort. Everybody has experienced the temporary blindness which follows an attempt to look steadily at an intensely bright object, and has noticed how impossible it is to see into a background behind the light of this description. Whenever one looks at such an object, the pupil orifice and retina of the eye adjust themselves in such a manner as to protect the eye from the excessively brilliant illumination, and in so doing causes all moderately illuminated objects to become almost indistinguishable. The shopman, therefore, who places any such light in his window not only wastes his light, but actually defeats his own object by making it difficult for the customer to see what it is in the window. This illumination seems to have arisen through a confusion between two separate and distinct objects which the illumination of shop premises has in view. Firstly, to attract the attention of the purchaser; and, secondly, to exhibit the contents of the shop window to him, when he has been attracted. Unfortunately, the two objects are not kept distinct. The salesman who crowds a row of flame arcs or intense gas incandescent lights into a frontage of about 20ft., and fills his window with naked glow lamps with the object of attracting customers, also paralyses their power of observation when they have arrived If intense brilliancy is to serve as an attraction, this intense light should be arranged so as to be only visible to the destined customer, and not to obstruct his view of the window.

Library Lighting.

Although shop-lighting at present offers a glaring example of the misuse of lighting, the same confusion as to the exact purpose for which the light is installed, and the same defect of placing brilliant sources of light between the observer and the objects they are intended to illuminate, is apparent everywhere. I will only draw attention to another example, the very unsatisfactory methods of illumination in use at many libraries. The lights are often so arranged as to brilliantly illuminate the gangway, where in reality only sufficient illumination is desired to find our way about in comfort, and the illumination of the reading tables is less than insufficient. In a library light should serve three chief purposes—it should enable the worker to read, it should illuminate the shelves of books so that the titles are easily recognisable, and it should also, of course, illuminate the surroundings with a subdued illumination sufficiently strong, however, to enable the reader to find his way about. Moreover, when we consider what a serious task for the eye continuous reading of this description must frequently be, even under the best conditions, the importance of an adequate illumination, and of the subdued restful surroundings for the reader, must be acknowledged. The illuminating engineer can do much useful work to improve matters.

Many of the members of this society are often put in charge of existing installations of which they had no previous knowledge or had anything to say regarding the distribution of lights or wiring arrangements, and are, therefore, at a loss to trace the circuits on account of the common fault of not possessing the necessary plans, showing the method of the wiring adopted, so as to enable him to trace the entire distribution and arrangements of circuits. I would recommend you most strongly to adopt the rule of keeping proper plans of the complete wiring installation, so that any additional alterations which are to be made could safely be undertaken. On many occasions I have noticed overloaded circuits which were quite dangerous for fire risks; probably same would not have been overloaded

* Paper read before the Association of Engineers-in-Charge, Dec. 11.

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if the size of the wires used would have been known to the engineer-in-charge. Bearing in mind the difficulty the engineers-in-charge have often of testing the value of the lamps ordered, I would recommend them to take advantage of the carbon-lamp specification drawn up by the Engineering Standard Committee, and by doing so they will obtain the right sort of lamp, with a guaranteed useful life and a certain efficiency, securing thereby great savings for their employers and give them greater satisfaction. The proper study of the recent improvements in the manufacture of lamps has become rather important in the last few years on account of the enormous number of inventions, and although the metal-filament lamps, of which much has been heard in the last few years, have now become commercial articles, there are still a great number of drawbacks which retard their general introduction—viz., the brittleness in handling, high prices, etc. The question of properly placing of lamps and the designing of entire illuminating schemes may not be a very difficult task for those who have devoted attention to the subject, but when one bears in mind the fact that the requirements for proper illumination are not only concerned with efficiency as regards current or gas consumption, but we have to study the physiological and the æsthetical effects produced, the problem becomes a little more complicated, and to answer satisfactorily to all those questions I am contending that the work of the illuminating engineer is very valuable. The enormous progress which is constantly being made with the different methods of illumination brings the necessity for a closer study of the relative merits and faults of these methods employed. It is not hereby meant that the illuminating engineer as a specialist is to be called in for every little lighting installation, but his services will be more important in assisting the architect and the consumer, not only in the selection of the proper type of lamp to be used, but also to advise impartially as to the proper method of the illumination to be adopted, and which gives the best results from every point of view. I know of many cases where gas and electricity are used side by side, each in its proper place, giving the consumer the best possible result under the circumstances. It is useless to deny that this new specialist, if he has made a thorough study of the different illuminants, and is not identified with any illuminant in any shape or form, or connected with the sale of accessories applied thereto, will be a very welcome element, acting as a connecting link between the architect, contractors, central-station engineer, and consumer. The illuminating engineer ought to be responsible to the consumer for the ultimate result obtained in the scheme of illumination adopted at his recommendation. As I mentioned before, the consumer has a right to see that he gets value for his money, and as illumination is an absolute necessity, the question under consideration is how to determine the correct quantity and quality required for different purposes, and who is to do it.

The purchase and selling of light has from the beginning presented a curious anomaly of commerce, says Mr. E. L. Elliott in one of his recent articles published in the *Illuminating Engineer*. Its correlative money value has never been based upon a measurement of the thing itself, but upon the measurement of the commodity from which the light is produced. To bring about a better understanding and a proper recognition that light and illumination are two distinct, though correlated, things is one of the aims of illuminating engineering as a new branch of applied sciences. The two important steps intervening between the delivery of the illuminant and the production of illumination have been entirely neglected. The whole question reduced itself to the one simple proposition, can illumination be measured with sufficient accuracy and with sufficiently simple apparatus to make it a practical basis for money values? I believe that the present state of the science and art of illuminating engineering justifies an encouraging reply. The technical side of the question has been receiving a great deal of attention during the past year, and a number of new illuminometers have already been brought out with a promise of others to come in the near future. It may be said that the widest errors of the best instruments are far less than the actual discrepancies in illumination which are common results of the illogical practice which now reigns. The only way in which illuminometers can be improved is by their practical use. If we are to wait until they are perfected before use, then we may as well dismiss the matter altogether. Assuming, then, that we have an instrument by which illumination can be measured at any given point, and on a plane in any position, what measurement should be taken as a basis of the payment for illumination? This is a matter upon which the illuminating engineers will have to decide afterwards—immaterial whether it refers to street or indoor illumination. I did not describe any photometers or illuminometers, as I understand that Mr. Edgecumbe will describe some of the instruments at the next lecture following mine.

Thanks are due to the president of to-night (Sir W. H. Preece) and to Mr. Trotter, who were amongst the first in this country to devise illuminometers. In one of the papers read by Mr. Trotter before the Institution of Civil Engineers as far back as 1892 he states that the art of illumination is a matter which comes into the province of the civil engineer, being the art of directing this candle-power for the use and convenience of man. To-day he would say it is the province of the illuminating engineer. He rightly stated that the study of light belongs to the science of optics, but very little information is available on matters of illumination, and emphasised that when illumination is required it ought to be possible to express intelligibly how much is wanted, and if a specification is given it ought to be known how to execute it. Why the suggestion then made has not been put into general practice is simple to explain, not only because there were no satisfactory illuminometers manufactured, but there were no authorities who could state definitely the amount of illumination required for the different purposes. The position to-day is a little better, but far from satisfactory. How will those data which are most essential for our guidance ever be obtained, and how would the recommendation made receive the necessary acknowledgment by those who have to apply them? The reply may be given by securing a freer exchange of opinion and a friendly intercourse between the gas and electric lighting engineers. Attempts have been made to bring this desired result in the United States by the formation of a society which they called the Illuminating Engineering Society. About 89 members joined it early in December, 1905, and though it is hardly two years since the society was formed, it has increased to over 1,000 members, and has five sections, which work satisfactorily. It held its first annual convention at Boston, where an enormous number of papers were read representing the different kinds of illuminants used, and the scientific discussions which followed those papers augur well for the prosperity of this association and for the good work the members are performing. During my visit this year to the States I had an opportunity to examine, together with Dr. Louis Bell, in Boston the building of the Edison Electric Illumination Company; and what did I see there? On nearly every floor of this 10-storey house different schemes of illumination have been employed. In this way the methods employed were practically tested. The scheme has been arranged by a committee composed of three illuminating engineers of repute—Mr. L. B. Marks, Dr. L. Bell, and Mr. W. D'A. Ryan. This building acts as a model installation to the would-be consumer. But what is also important to notice was the arrangement in one of the rooms, where, in order to study the influence the different-coloured wall-papers may have upon the illumination adopted or recommended to be used, means are available for actually changing the wall-paper in that room so as to study the desired effect under actual, practical experience.

The attitude of the Press in this country regarding the formation of illuminating engineering as a new profession was, on the whole, I am gratified to say, satisfactory. In one of the recent numbers the following quotation was made: "Day by day the question of scientific illumination becomes of greater importance. There can be no doubt that this point has not in the past received that careful attention which the subject deserves; but with the introduction of high-efficiency lamps, installation engineers all over the country are rapidly coming to recognise illuminating engineering as a most important branch of installation work."

What is the answer to the question, How will you make the value of the illuminating engineer known? One way is to read papers before such societies as I have the privilege to address to-night, but another way, which has been found to cover a much wider ground, is the issuing of a special publication devoted to the science and art of illumination. In this paper the different experts representative of the different illuminants will have an opportunity of expressing their opinion without being in any way hampered or interfered with, and so assist in fulfilling the missionary work which we have as yet to carry out in order to convince the people of the necessity of this new specialist. I may add that during my visit in the States I was given to understand that when the illuminating engineer specialist started he was received somewhat with suspicion, but did not take long to receive due recognition. To-day we not only see the architect taking advantage of his services by working with him, but even Government has given him recognition by appointing an independent expert to act as an illuminating engineer for the Congress building, and for the public libraries one has been appointed to assist the architect on all the illuminating questions. It might interest you, perhaps, to know the opinion of a few of the most prominent men in the States regarding the necessity of putting illumination on a scientific basis. I will quote some of the remarks made at the inaugural meeting of the Society of Illuminating Engineers:

"Some said that the general subject of illuminating engineering might come between the provinces of several other institutes, such as the Institute of Electrical Engineers or to that of the Gaslight Institute. To this one must answer that the special field of work which has been mapped out for the Illuminating Engineering Society is well defined, being concerned purely with the subject of illumination, and by such specialisation the

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advances of the art and science can best be furthered, as illumination forms only a very small part of the field which is covered by the Institution of Electrical Engineers or the Gas Institute or other kindred societies, and which are mostly concerned with the question of generation and distribution rather than the utilisation of the light produced."

Dr. Elliott, of the Consolidated Gas Company, mentioned that, as a rule, in his experience the average householder gets only about two-thirds of the light value of the gas he ought, and no doubt much less from the electric light. He believes that there is a field for education amongst consumers by inducing them to put in good burners, have the burners properly distributed in the house, and also take reasonable care of them. Mr. Martin, the editor of the *Electrical World*, agreed that the proper study of illumination is a tremendously important subject, and is of as much importance to the public as to the technical community.

Prof. Chandler was most emphatic in expressing his opinion as to the value of this profession. Mr. E. L. Elliott, editor of the *Illuminating Engineer* of New York, emphasises the fact that there is a great waste in the use of light sources, and it is unquestionably desirable that not only should this waste be avoided, but that a better quality of illumination should be produced. "To this end," he says, "all the various interests concerned in illumination must be harmonised, and work together to a common end." "The architect works, as a rule, from a certain basis, the decorator very often from another, the purchaser of gas and electric current works still from another basis, and it is the particular province of the illuminating engineer to harmonise all those, and to bring them together, so that the total of all their efforts should lead to a result which should be generally satisfactory. One important point is also raised by Mr. Elliott, and that is there is a tendency of those producing illuminants to look askance at improvements in the way of economics as lessening their income, which is erroneous. Every improvement towards cheapening of light will, in the long run, increase the amount of light used, so that it seems there need be no reasonable objection or hesitation to introduce the very best illumination possible at the minimum cost, because a satisfactory consumer is the greatest achievement and is the best advertisement for the illumination method adopted.

Mr. D'A. Ryan, illuminating engineer to the General Electric Company, emphasised that, after a few years constant hard work, the architect has gradually been converted to understand that the subject of lighting is not merely a question of placing a lamp here and there, but it is a special branch of engineering, and in his department. The General Electric Company have now six assistants, and all are very busy. The General Electric Company is going to put up a laboratory, so that any time an architect or engineer is desirous to see a certain effect that effect will be reproduced, so as to form a basis for drawing up the final specification.

Mr. Campbell spoke very appreciatively on behalf of the public, saying that no one would welcome more the illuminating engineer than the general public. It is known, as a rule, that the public takes any information, no matter how accurate it may be, with a great deal of suspicion, thinking that there is something concealed. When the public as a whole can feel that there is an able organisation available upon which they can depend for information, much good will accrue to the lighting industry and to the consumer at large.

In conclusion, let me say that in my opinion the engineers-in-charge could be easily educated on the general principles of illumination if they only could afford the time for it. I hope that they will in the future pay more attention to this subject than, perhaps, many have been able to do before. By the co-operation of the ophthalmists, architects, gas and electrical engineers, many of the illuminating engineering problems could be solved, and some better understanding arrived at as to the relative merits and faults of the different illuminants, and to determine their proper sphere of usefulness to the benefit of all concerned. The necessity for this new professional has only been felt during the last few years, and I hope that I have made it pretty clear to you that the subject of illuminating engineering is one of great consequence to the nation at large, by assisting us to preserve our sight, and for making economies without sacrificing either the requirements of the architects or any sanitary considerations. A bureau composed of expert gas, electric, oil lighting engineers, architects, physiologists, and opticians has been established in the States, and it is expected that the advice obtained from such a bureau of independent and impartial experts can only be of the greatest assistance in guiding us in the future towards betterment of illumination and towards beautifying our homes, public buildings, parks, and streets. What the public want is best illumination for the money spent, and it is quite unconcerned whether this is produced by gas or electricity, with arcs or incandescent, or what not. For street-lighting or lighting of public buildings which are lit at the expense of ratepayers, this is of great economic importance. Ignorance of artificial conditions may for a time restrain the march of progress, but the fittest will always survive and come to the front. A reform, therefore, which works to the advantage of all parties and to the disadvantage of none, is worthy of at least a most careful and serious consideration. That there is ample need of reform in the general practice of illumination, both professionals and laymen must agree. I know that the subject of illumination is a very complex one, and I could hardly do justice in an hour's lecture to the important points which are to be raised in connection therewith. I hope, however, that I have been able to show you that there is yet a great deal to be done, not only in the reduction of the waste which is going on in the conversion of energy into light, but in the utilisation of the illuminants so as to produce the best and most satisfactory illumination from every point of view. To draw attention to an existent evil is useful, to indicate the remedy is a progress, but much more remains to be done by the concerted action of the engineers, architects, oculists, and the consumer and the illuminating engineer.

LEGAL INTELLIGENCE.

RHONDDA TRAMWAY CO.'S CLAIM.

In the Court of Appeal on the 19th inst., before the Lord Chief Justice, the President of the Probate, Divorce, and Admiralty Division, and Lord Justice Buckley, the appeal was heard in the matter of an arbitration between the Rhondda Tramways Co. and the Taff Vale Railway Co.

Mr. ELDON BANKES, K.C., said the Council obtained powers to construct a tramway along certain roads, and in some portions of their course the roads crossed the lines of the railway company. The roads crossed the railways at right angles, and at varying heights from the ground there were a great number of telegraph wires. It was left to the Council to decide what form of traction they should adopt, and they decided upon the trolley system. The telegraph wires which crossed the three railway bridges—Llwynpia, Wattstown, and Pontygwaith—were not a sufficient distance from the ground to enable the cables to pass under, and the Council thought there were sections in the Tramways Act which enabled them to deal with the situation, and they claimed that the matter in dispute should be settled by arbitration. The Council contended that their case came under Section 30 of the Tramways Act, and he contended that they had mistaken their powers in this respect. The case was taken from the arbitrator to Mr. Justice Bray, for his Lordship to decide whether the arbitrator was right in deciding in favour of the Council, and saying the case came under the Tramways Act and not under the general powers. Mr. Justice Bray decided in favour of the Council that they had power to alter the wires when necessary, and that it was expedient for the Council to do this work, and that they had power to go upon the railway company's land to carry out such work. It was against this decision that they now appealed. The learned counsel (continuing) said the question really at issue was whether the Council had the right to go upon the railway company's land when and how they pleased.

Without calling upon counsel for the respondents, the LORD CHIEF JUSTICE said the appeal must be dismissed on all material points, and in the questions reserved for Mr. Justice Bray he had decided against the railway company. It was not right to say that the decision of the Court below infringed the rights of the railway company. He quite agreed with Mr. Justice Bray.

The other Lords Justices agreed, and the appeal was dismissed with costs.

EAST HAM TRAMWAY ACCIDENT.

In the King's Bench Division, before Mr. Justice Lawrence and a common jury, the action was heard last week in which Mr. J. J. Dredge claimed damages against the East Ham Corporation tramways in respect of an accident which took place in October last. Plaintiff was in a laundry van, and had stopped for a moment to get a paper from a boy in the street, when a Corporation electric tramcar came up behind and dashed into his vehicle, as the result of which plaintiff alleged that he sustained serious internal injuries.

The Corporation admitted negligence on the part of their servant, and the only question for the jury was as to what compensation should be granted.

On the jury intimating that they awarded plaintiff £100 damages, counsel for the Corporation asked for judgment for his clients on the ground that that sum had already been paid into court and taken out by the other side.

Judgment was accordingly given for defendants, with costs.

COMPANIES' MEETINGS AND REPORTS.

UNDERGROUND ELECTRIC RAILWAYS OF LONDON.

The annual general meeting of the Underground Electric Railways Co. of London was held on Monday at Hamilton House, Embankment, London, E.C., Sir Edgar Speyer presiding.

In moving the adoption of the report (*Electrical Engineer*, Dec. 21), the CHAIRMAN said that the directors hoped early in the new year to put before the shareholders a scheme dealing with the Company's finances. Under these circumstances it was in the best interests of the Company that he should reserve his remarks until then, and that this meeting should be adjourned until the date when they had to consider the scheme in question.

The report was adopted.

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NEW COMPANIES REGISTERED.

Premier Accumulator Co.—Registered Dec. 18. Capital, £25,000, £24 500 £1 participating preference shares and 10,000 1s. ordinary. Objects: to acquire business carried on by A. Schanschieff and H. Stephens at Northampton as Premier Accumulator Co. Registered office: Cattle Market-road, Northampton.

Chipping Norton Electric Light and Power Co., Limited.—Registered Dec. 16. Capital, £2,000 in £1 shares Objects: to carry on the business of suppliers of electricity for light, power, or other purposes, electricians, electrical engineers, manufacturers of and dealers in electrical apparatus, etc., and to adopt an agreement with R. S. Bunting. No initial public issue. Registered office: Bunford-road, Chipping Norton.

PERSONAL.

Messrs. Morris-Hawkins state that on and after Jan. 1, 1908, the head office will be at their works, Dagenham, Essex.

Mr. F. Smart, who for many years was connected with the General Electric Co.'s Newcastle branch as assistant manager, has been appointed manager of the Newcastle branch.

Mr. A. Duffield has been appointed second-class draughtsman at the Admiralty. Mr. F. J. Austen also goes as a second-class draughtsman in the electrical department at the Admiralty.

Mr. W. A. Turnbull, the works superintendent at the York electricity works, was last week presented with a case of silver tea knives, on the occasion of his forthcoming marriage, by Mr. Home, the city electrical engineer, on behalf of the staff.

Messrs. Johnson and Phillips inform us that the agreement they had with Messrs. Welding and Co., of 64, Stanley-street, Liverpool, and 233, Deansgate, Manchester, to represent them in the counties of Lancashire and Cheshire has been terminated, and that all inquiries and orders should in future be sent direct to Victoria Works, Charlton.

In connection with the Venice Exhibition, wherein the selection of Ediswan materials and lamps received the Royal commendation, we have pleasure in noting that the Royal approval has been further extended, and the exhibiting firm (Messrs. Rossetto and Romanin) have received a gold medal and diploma for their stand of "Ediswan material."

OPENINGS FOR CONTRACTORS.

ABERDEEN—Two houses, Willowbank-road, Mr. Duncan Hodge, architect; two dwelling-houses, Willowbank-road, Messrs. W. Henderson and Son, architects; reconstruction of premises, 21, Spring-garden, Mr. William Smith, architect; dwelling-house, Polmuir-road, Caledonian Railway Co.; additions engine-house, North Esplanade, Mr. Duncan Hodge, architect; offices and stores, Albert-quay, Mr. Thomas Davidson.

ALRESFORD—School buildings, Governors of Perin's Grammar School.

ANERLEY, S.E.—Residence for the Managers of the North Surrey District School.

ANNFIELD PLAIN—Houses, Northgate-street, Mr. J. E. Johnson; eight houses, Wesley-terrace, Mr. J. Dunn; elementary school, Annfield-place, Durham County Council.

AUDLEY—Elementary school, Staffordshire Education Committee.

BARNSLEY—Two houses, Queen's-avenue, Mr. Elliott; 11 houses, Blenheim-road, Mr. C. Woodruffe; storeroom, Pontefract-road, Messrs. Wilson and Co.; three shops, Shambles-street, Mr. P. A. Hinchcliffe; three shops and Y.M.C.A. buildings, Eldon-street, Trustees.

BARNSTAPLE—Secondary school, Devon County Council.

BARROW-IN-FURNESS—Cattle market and public abattoirs, Town Council.

BATTERSEA, S.W.—Additions to Bolingbroke School, London County Council.

BEXHILL—Additions to parish church. Mr. W. Tapper, architect.

BILSTON—Elementary school, Bullholes, Bilston Education Committee.

BIRMINGHAM—Building to accommodate male paupers (£3,00), Board of Guardians; Council school, Leigh-road, Education Committee.

BISHOP'S STORTFORD—Extension to engine-house at waterworks, Urban District Council.

BLAYDON—Elementary school, Durham County Council.

BOGNOR—Infectious diseases hospital (£2,000), Town Council.

BOOTLE—Four houses, Duddon Bridge, Mr. Rawlingson.

BRENTFORD—Enlargement of Council school, Middlesex Education Committee.

BRIDGNORTH—Secondary school to accommodate 200 pupils, Salop County Council.

BRISLEY—Enlargement and improvement to schools for the Managers of Brisley Church of England Schools. Rev. — Lowe, Brisley Rectory, East Dereham.

BRISTOL—Porter's lodge, Eastville Workhouse. Mr. J. J. Simpson, clerk.

BURGHEAD—Additions to church, Messrs. Wilson and Walker, Aberdeen, architects.

CAMBERWELL, S.E.—Alterations at Palace of Varieties, Denmark-hill, Mr. L. Sharp.

CAMBRIDGE—Three houses, Halingway, Messrs. Clark and Sons; studio, Pemberton-terrace, Mr. Green, Harston; shop, Market-street, Messrs. Eaden, Lilley, and Co.

CASTLEFORD—New school (£4,320), West Riding Education Committee.

CHESHIRE—Training college for teachers, Education Committee.

CHESTER LE-STREET—Elementary school, Durham County Council.

COCKFIELD—Temperance institute. Mr. J. Howe, architect.

CONSETT Iron school (£300), Education Committee.

COOKSTOWN—Labourers' dwellings (£1,000), Rural District Council.

COVENTRY—Corn Exchange, Smithfield-street, Town Council.

CROFTON—Alteration and additions to elementary school, West Riding Education Committee.

CYNWYD—Electricity generating station, local private company.

DOWNPATRICK—Three hundred cottages (£54,332), Town Council.

DUBLIN—Buildings at Dean Grange Cemetery, Burial Board.

EAST GARFORD—Alterations and additions to elementary school, West Riding Education Committee.

EDINBURGH—Additions to Craiglockhart Poorhouse. Mr. R. M. Cameron, architect.

ETON—Alterations and additions to The Elms, Iver, Messrs. Chadwell; six shops, Oak End Waye, Mr. P. A. Hopkins; house, Bulstrode Waye, Mr. Smith.

EXETER—Shops, offices, and flats, High-street. Mr. J. Crocker, architect.

FALMOUTH—Block of houses, Bar-road, executors of Mr. A. Smith.

FISHGUARD—School for the Pembrokeshire Education Committee. Mr. D. Edward-Thomas, Haverfordwest, architect.

FRASERBURGH—Alterations to Council schools. Mr. D. McMillan, architect.

FULMER—Elementary school, Bucks County Education Committee.

GLASGOW—Conversion of Baptist church in North Frederick-street into warehouses and office, Mr. G. Eadie, architect; five houses, Ravenswood drive, Mr. James Alexander.

GOOLE—Elementary school and caretaker's house, Governors of Goole secondary school.

GRAYS THURROCK—Depot (£420), Urban District Council.

GRIMSBY—Alterations to municipal college, Education Authority.

GRINDLEFORD—Parish church (£8,000). Mr. E. R. Sutton, architect.

GUISBOROUGH—Electric lighting scheme, Town Council.

HACKNEY, N.E.—Conversion of the Brentwood schools into workhouse, Board of Guardians.

HAMPSTEAD, N.W.—Extensions to electricity works (£8,155), Borough Council.

HEMEL HEMPSTEAD—Mission-room, High-street Green, Rev. L. H. Bostrall; house, Chipperfield-road, Mr. T. C. Gold.

HOLMFIRTH—Alterations, etc., to the technical institute (£2,150), West Riding Education Committee.

HORNSEY—Moravian church, Priory-road. Messrs. W. D. Church and Son, Finsbury, architects.

HULL—Shops and offices, Victoria-square. Mr. W. Bell, York, architect.

ILLOGAN—Wesleyan church (£2,057). Mr. S. Hill, architect.

ILFORD—Emergency hospital, Governors of Hospital Board.

ISLINGTON, N.—Alterations at Grand Theatre, High-street, Messrs. F. Matcham and Co.

KILKENNY—Public library for the Corporation. Messrs. E. S. Lowrey and Son and Messrs. Tyars and Jago, Dublin, architects.

LAMBETH, S.E.—Municipal offices (£10,000), Borough Council.

LANCASTER—Y.M.C.A. building, China-street Mr. Spencer E. Barrow, Liverpool Bank-chambers, architect.

LEICESTER—Extensions fire brigade station (£1,784), Town Council.

LLANFAIRFECHAN—Council school, Education Committee.

LOUGHBOROUGH—Congregational church (£5,000). Messrs. Parrow-cliffe and Allcock, architects.

MAIDSTONE—Extensions to electricity undertaking (£1,540), Urban District Council.

MANCHESTER—Art gallery and reference library on the site of the Royal Infirmary in Piccadilly, City Council.

MERTHYR TYDFIL—Additions and alterations to Penydarren Council Schools, Merthyr Tydfil Education Committee.

MEXBOROUGH—Fire station (£424), Urban District Council.

MORECAMBE—Six houses, Arnside-road, Mr. J. Tordoff.

MORLEY—Alterations Peel-street School (£1,450), Education Committee.

NEWBURN—Council school, Northumberland Education Committee.

NEWCASTLE-ON-TYNE—Shops, Newmarket-street, Messrs. Millican and Co.

NEWCASTLE UNDER-LYME—Extensions to St. George's Church. Messrs. R. Scrivener and Sons, architects.

NORTHALLERTON—Elementary school, North Riding Education Committee.

NORWICH—Shelter, etc., Priory-yard (£625), enlargement of servants' hall at the isolation hospital (£152), alterations at public mortuary (£67), Town Council.

OMAGH—Erection of labourers' dwellings, Rural District Council.

PAISLEY—Recreation hall, Ince-street, Mr. H. Sale,

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PANT—Additions and alterations to Council school, Merthyr Tydfil Education Committee.

PEMBERTON—Weaving shed, Pemberton Manufacturing Co.

PENISTONE—Cattle market, Urban District Council.

PORTSMOUTH—Reception station and recruiting office, War Office.

PUTNEY, S.W.—Houses, Hazelwood-road Mr. J. C. Radford.

RADCLIFFE—Municipal offices, Urban District Council.

RAWMARSH—New school (£5,760), West Riding Education Committee.

READING—Residence at Manor Farm, Whitley Corporation.

REDLAND—Presbyterian church. Messrs. P. Munro and Son, Bristol, architects.

RISHTON—Thirty-one houses, Stourton-street, Messrs. Butler.

RISHWORTH—Houses and residential villas. Messrs. Walsh and Graham, architects.

ST. HELENS—Elementary school, Borough Education Committee.

ST. LEONARDS—Fire station, Hastings Town Council.

SANDHURST—Additions to Military College, War Office.

SANDSEND—Additions to villa residences. Mr. E. H. Smales, Whitby, architect.

SHEEPBRIDGE—Extension to stores of Equitable Industrial Society. Mr. J. Berry, architect.

SHERWOOD RISE—Primitive Methodist chapel (£2,500). Mr. H. Harper, architect.

SHOREDITCH, E.—Additions to Standard Theatre, High-street, Messrs. F. Matcham and Co.

SNETTISHAM—Wesleyan church. Messrs. Gordon and Gunton, architects.

SOUTH BANK—Club premises, Unionist Association. Mr. F. Walshall, architect.

SOUTH ELMSALL—Branch stores, Pontefract Industrial Society.

SOUTHEND—Erection of shelters on Southchurch Beach Parade (£225), pavilions, etc., at Pier Head (£5,200), Town Council.

STANLEY FERRY—Elementary school, County Council.

SUNDERLAND—Extensions to technical college. Mr. J. W. Monour, engineer.

SURBITON—Electric lighting works (£20,000), Urban District Council.

SWANSEA—Housing scheme (£23,000), Corporation.

SWINDON—Additions to Victoria Hospital. Messrs. Ainsworth and Pilcher, architects.

TALKE—Elementary school, Staffordshire Education Committee.

TAPLOW—Six houses, Ellington-road, Mr. F. Summers.

TEMPLENEWSAM—Alterations and additions to elementary school, West Riding Education Committee.

TICKHILL—Public library (£1,267), Urban District Council.

TINSLEY—Elementary school, West Riding Education Committee.

TYRONE—Technical school in Strabane (£1 700), County Council.

USWORTH—Forty-one houses, Usworth Colliery Co., Mr. Douglas.

WAKEFIELD—Enlargement of Post Office, H.M. Commissioners of Public Works.

WALTHAMSTOW—Additional plant electricity station (£17,349), Urban District Council.

WANDSWORTH, S.W.—Houses, Swaby-road, Messrs. Holloway Bros.

WATFORD—Two houses, Pinner-road, Messrs. H. G. Cartwright; conversion of cottages into warehouse, Butcher's-yard, Mr. S. H. Timms; two houses, Sussex-road, Mr. Brightman; two houses, Monmouth-road, Messrs. Rogers and Wood; conversion of house into shop, Market-street, Mr. Wren; theatre of varieties, Clarendon-road, Watford Hippodrome Co.

WELLINGBOROUGH—Two shops and house, Midland-road, Mr. H. S. Lilley; two houses, Finedon-road, Wellingborough Iron Co.; two houses, Albert-road, Mr. S. G. Whitehouse.

WHALLEY—Asylum, Lancashire County Council.

WITNEY—Alterations and additions to grammar school, Governors of technical school.

WOKING—Technical institute in High-street, Urban District Council.

WORSBOROUGH DALE—School (£1,440) for the West Riding Education Committee.

WREXHAM—Extensions to electric lighting (£3,100), Town Council.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Leyton.—The Urban District Council invite tenders for lamps, etc., in connection with the incandescent electric lighting. Tenders by Dec. 31.

Rawtenstall.—The Corporation invite tenders for the supply of three steam dynamos and accessories for the electricity works. Tenders by Dec. 30.

Beckenham.—Tenders are invited by the Urban District Council for the extension of the destructor house at the electricity station. Tenders by Jan. 6.

New South Wales.—The Postmaster-General, Sydney, invites tenders for one branching metallic multiple magneto switchboard. Tenders by Jan. 8, 1908.

Llandudno.—The Urban District Council invite tenders for a traction battery and an automatic reversible booster and necessary switchgear. Tenders by Jan. 4.

South Australia.—The Postmaster-General, Adelaide, invites tenders for one common-battery switchboard, subscribers' telephones, and protectors. Tenders by March 11.

Melbourne.—The Postmaster-General's Department invite tenders for 11 sets and a common-battery switchboard, and 3,000 subscribers' telephones, etc., for the Windsor exchange. Tenders by Jan. 7.

Calcutta.—Tenders are invited for the lighting of the town by gas or electricity. Particulars from Mr. P. N. Mookerjee, secretary to the Corporation. Tenders to the Vice-Chairman by Jan. 2, 1908.

Worcester.—The Corporation invite tenders for the supply of one 400-kw. continuous-current steam generator and balancing dynamo and surface condenser. Tenders by Jan. 6, 1908. See advertisement in last issue.

Punjab (India).—Tenders are invited for electric and pumping plant for water supply. Particulars from the Executive Engineer, Special Work Division, Patiala, Punjab. Deposit £133. 6s. 8d. Tenders by Jan. 6, 1908.

Madrid.—The Public Works Department invite tenders for the construction and working of electric tramway at Vigo. Particulars from the Dirección-General de obras publicas, Ministerio de Fomento. Tenders by Dec. 29.

London, S.W.—The Metropolitan Asylums Board invite tenders for the installation of electric lighting, etc., in the motor workshops and yard at the Mead ambulance station, Carnwathe-road, Fulham. Tenders by Jan. 8, 1908.

Buenos Ayres.—Tenders are invited for the construction of underground electric tramways. Particulars from the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London. Tenders by June 1, 1908.

Finchley.—The Urban District Council invite tenders for the supply and erection of one 350-kw. high-speed engine and dynamo combined, together with spare parts. Tenders by Jan. 20, 1908. See advertisement in last issue.

Pontypridd.—The Corporation invite tenders for the supply of washed steam nut coal for the six months ending June 30, 1908, or alternatively for 12 months ending Dec. 30, 1908, for the electric light and tramways departments.

Buenos Ayres.—Tenders are invited for (1) the construction of and (2) the concession to work the two principal sections of the underground electric railway. Particulars from the Argentine Legation, 12, Rue van Moer, Brussels. Tenders by May 1, 1908.

Adelaide.—The Deputy Postmaster-General for Queensland invites tenders for a common battery switchboard and 3,000 subscribers' telephones. Specification No. 166. Particulars may be obtained from the Commonwealth Offices, 72, Victoria-street, London, S.W. Tenders by Jan. 8, 1908.

Belfast.—The Harbour Commissioners invite tenders for the construction of a double line of electric tramway, permanent way, electric masts, cables, wiring, lamps, etc., on the co. Down side of the harbour. Tenders to Mr. W. A. Currie, secretary, Harbour Offices, Belfast, by Dec. 28.

Madrid.—Tenders are invited for the construction of an international telephone system with France, and for the working of the interurban service of the North-East. Deposit, 120,000 pesetas (about £4,211). Tenders will be received at the Registro de la dirección general de correos y telegrafos, Madrid, by Jan. 3.

Victoria.—The Deputy Postmaster-General at Melbourne invites tenders for the supply and delivery at Melbourne of 11 sections of a common-battery switchboard and 3,000 subscribers' telephones and other apparatus for telephone exchange, Windsor, in accordance with Victorian specification No. 148. Tenders by Jan. 7.

Belfast.—The Harbour Commissioners invite tenders for the supply of about 100 tons of best rolled-steel girder tramway rails, with fishplates and bolts to suit, of which 50 tons are to be delivered on the co. Antrim side and 50 tons on the co. Down side of the river. Tenders to Mr. W. A. Currie, secretary, by Dec. 28.

Adelaide.—Tenders are invited for the supply and delivery, c.i.f. Port Adelaide, of special work, points, and crossings for tramways. Specification, etc., from the Agent-General for South Australia, Threadneedle House, 28, Bishopsgate-street Within, London, E.C. Tenders to the Chairman, Municipal Tramways Trust, Adelaide, by Feb. 11, 1908.

Manchester.—Tenders are invited for the supply of hard-drawn copper trolley wire, for the Tramways Committee of the Manchester Corporation. Specifications and forms of tender may be obtained on application to Mr. J. M. M'Elroy, general manager, Tramways Department, 55, Piccadilly, Manchester. Tenders to the Chairman of the Tramways Committee by Dec. 31.

Prague (Austria-Hungary).—The *Lieferungswesen* (Vienna) of Dec. 5 announces that tenders will be received by the K.K. Staatsbahndirektion at Prague (1) till noon on Dec. 31 for the supply of an electric travelling crane to lift three tons, required by the railway works at Laun; (2) till noon on Jan. 4 for the supply of an electric pump of a capacity of 70 cubic metres per hour, with suction plant and compressed-air boiler, required by the water-power works at the station at Bodenbach. Forms of tender, etc., may be obtained from the K.K. Staatsbahndirektion, Abteilung 4, Prague.

RESULTS OF TENDERS.

Falkirk.—The Town Council have accepted the tenders of Ferranti Limited, Hollinwood, and Venner and Co., Old Queen-street, Westminster, for the supply of meters.

Lancaster.—The Council have accepted the tender of Mr. Wilson for wiring in metal tubing and fixing the electric lights at the Storey Institute for £240, and for fixing electric bells for £18.

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BUSINESS NOTES.

TRACTION.

Huddersfield.—The Tramways Committee have agreed to a plan for doubling the tramrails and track on St. John's-road.

Newark.—Messrs. W. and W. M. Bell, of Westminster, are applying for an extension of the Newark and District Light Railways order.

Falkirk.—The North British Railway Co. have asked the Town Council to supply electricity for the cabins and signals at Grahamston new lines.

Denbigh.—The County Council have confirmed the terms arranged for with the Tanat Valley and Cambrian Railways Co. as to extending the time under the Tanat Valley Light Railway agreement for three months from the end of the year.

Haslingden.—The Town Council have decided to take over and run the existing steam tramway system at the beginning of the new year, to commence converting the same on April 1, and to generate their own electricity for the system.

Pontypridd.—Colonel Druitt, of the Local Government Board, on Friday morning inspected the new viaduct constructed in connection with the Rhondda route of the Pontypridd tramways, and has given provisional sanction for running cars over it. The viaduct will afford a direct connection between Trehafod and the main route of the tramways between Pontypridd, Cilfynydd, and Treforest.

Southport.—The Corporation Tramways Committee have decided to extend the penny stage on the Blowick section from Maple-street to Oak-street. This is the first street after the distance of 1 mile 500 yards from town, which is the usual distance of the penny stage in Southport. The committee have also decided to purchase two covers for the electric cars on the High Park route. If the covered cars prove as successful as is anticipated, the number will be increased and other routes supplied.

Stoke-on-Trent.—At a meeting of the Town Council a letter was received from the Board of Trade, enclosing extract from a report by Colonel Druitt of his inspection of the tramways within the borough in November last, and notifying the Council that, in accordance with such report, the Board had granted a certificate for the electrical working of the lines for a further period of two years from Nov. 17. The town clerk drew attention to a parliamentary notice of an intended application to the Board of Trade by the Potteries Electric Traction Co. and the North Staffordshire Tramways Co. for a provisional order under the Tramways Act with respect to the alteration of tramways, maintenance, and user of altered lines, amendment of orders, etc. He was instructed to obtain a copy of the proposed Bill, and report again on the matter.

Erith.—At the last Council meeting the tramway manager reported that the traffic receipts for the previous four weeks, as compared with the corresponding weeks of last year, were as follows: 1907, £576. 14s. 3·d.; 1906, £691. 5s.; decrease, £114. 10s. 8½d. He also submitted a report containing traffic statistics for the 13 weeks ending Sept. 28 last. The total receipts for the three quarters were £1.262. 12s. 2d. below the corresponding period of last year, and the heaviest decrease occurred in the penny ordinary tickets. The average fare paid by users of ordinary tickets during the above period was ·978d. per passenger this year, but last year, when no halfpenny fares were in operation on the main line, the average reached 1·116d. In regard to workmen's tickets the sales this year have dropped considerably, the decrease for the three quarters being £151. 8s. 9½d., £114. 0s. 1d., and £125. 8s. 10½d. respectively.

Kirkcaldy.—Mr. Francis, burgh electrical engineer, has submitted to the Tramway Committee of the Town Council a report dealing with the running of the tramway cars during the past four weeks under the system suggested by the arbitrator for the joint running of the Kirkcaldy and Wemyss cars. The report states that, as compared with the same period of last year, the cars have run 5,016 less car miles, and have taken £26. 14s. 4½d. more in receipts, while they have also carried 4,254 more passengers, so that there had been a net gain for the period mentioned of £120, which was at the rate of £1,560 per annum. From these figures it was apparent that the new system was giving a greater convenience to the travelling public than the old system, since they were carrying a larger number of passengers. He recommended the committee to give the present system a trial during all the various seasons of the year. There was no doubt that if the present receipts were maintained throughout the year, the Kirkcaldy tramway and electric lighting undertakings would both become paying concerns.

Edinburgh.—Judge M'Michael at the last meeting of the Town Council, in regard to the proposal by the Tramway Committee recommending no action on the letter from Mr. Norman A. Thompson as to the electrification of the tramway, said the worst of the objection to the proposal was that it contemplated handing over the Edinburgh tramway system to a private company for the next 60 years. That was in itself a very serious objection, most of them, he thought, thinking that the patience of the citizens of Edinburgh would be sufficiently tried and the public interests sufficiently prejudiced during the remaining years of the present lease without giving any consideration to another lease. As a matter of fact, many of them felt that the present arrangement was one that should not be perpetuated indefinitely. Much as some of them desired to see a change in their system of tramway haulage, and see what was proposed—an extension of nearly 50 per cent. of their tramway mileage—they could not see their way to purchase these at the cost of having another private tramway company in Edinburgh for the long period of 60 years.

Oxford.—In accordance with the decision of the General Purposes Committee of the Council, a large number of members of the City Council paid a visit to Hastings on Monday week to form an opinion of the running of the Dolter trams on the esplanade there. The party were entertained to lunch, after which the chairman of the Hastings Tramways Committee, in a general speech of welcome, said that he had no fault whatever to find with the Dolter system and that the feeling generally was strongly in their favour. The party then proceeded to the front and boarded the trams employed on the regular traffic, taking their seats among the local passengers. The whole length of the track was traversed, and a return was made on foot alongside the track for an inspection of the sheds, paving, points and general condition of the tramway. Some of the councillors called upon residents and shopkeepers along the route and obtained their private opinion, while others in the evening repeated the inspection with a view to noting the behaviour of the lights and skates in the matter of constancy and sparking. At a meeting of the General Purposes Committee of the City Council it was resolved, for reasons that were stated, to recommend the Council that the committee were not satisfied the Dolter trams were working successfully.

Perth.—The Town Council have had under consideration reports by Mr. Lambert, manager of the tramways, and Councillor Crystal, late convener of the Tramways Committee. It was agreed that Mr. Lambert should furnish a report as to what he considered the best situation for a central car depôt. Mr. Lambert's report in favour of the abolition of halfpenny fares, except on the Dunkeld-road at meal hours, was next taken up, when by a large majority the committee agreed that no alteration should take place. The committee agreed to issue through tickets from Fitzroy-terrace and Main-street to the General Station entrance, Glasgow-road, and *vice versa*. They also agreed, in regard to the charge for electric current given by the electric department to the tramways, that in future the Tramway Committee should get the credit, in fixing the sum, for the amount they had spent on the cables conveying current from the electricity station to the tramways. This sum amounts to £4,000. The committee requested the manager to consider whether he should not adopt a system of giving bonuses to the drivers for saving the current in running the cars. The question of the reduction of the staff was also discussed, but such a course was opposed by the tramway management. It was agreed that during the winter months a modified service should be adopted after the New Year.

Dundee.—Under the Dundee provisional order, which received the Royal assent this year, the Corporation obtained power to extend the tramway system from Fairmuir to Downfield. Preparations had been made with the view of having the work carried through with expedition, and so successfully have these been worked out that on Dec. 19 a Board of Trade official was able to travel to the terminus and pass the extension as ready for use. Lieutenant-Colonel von Donop, R.E., who was the inspecting officer, was early on the ground. Met at the Town House at 9.30 a.m. by ex-Bailie Speed, convener of the Tramways Committee, several members of Council, and Mr. Fisher, the tramway manager; Mr. James Thomson, city engineer; Mr. J. H. Shepherd, manager of Monifieth tramways; and Mr. David Horsburgh, contractor, Lieutenant-Colonel von Donop proceeded to the new part of the system in a special car, which was decorated for the occasion. After inspecting the new line he expressed himself highly satisfied, and passed the section from the terminus at Baldovan-road to Gelly Burn at a speed of 10 miles per hour, and from Gelly Burn to the junction at Fairmuir at 14 miles per hour with no compulsory stop. He also inspected the new junction at Main-street and Hilltown, and indicated his willingness to consider as to revising the speed on the Constitution-road section of the tramway system. The new part of the system is now open for public traffic.

LIGHTING AND GENERAL.

Dewsbury.—The Corporation are now laying electric cables to Messrs. E. Fox and Sons' shoddy factory, Watergate, Dewsbury.

Egham.—The Council having received an application to place telephone poles within the borders of the parish, have resolved not to consent to the application.

Brighton.—The gas company have decided upon an increase in the price of gas, and a substantial increase in the consumption of electricity as a result is anticipated.

Farnworth.—The Lancashire Electric Power Co. are supplying current to Messrs. T. Nuttall and Sons' and Messrs. Faulkner's cotton mills in the Farnworth and Worsley districts.

Blackburn.—On the morning of the 19th inst. the Canal Factory, an old cotton spinning mill, now used as a paper manufactory, was wrecked by an explosion of gas. Several men had narrow escapes.

Liverpool Electric Cable Co.—The annual general meeting of the company was held at Liverpool on Friday, the 20th inst., when a dividend of 7½ per cent. was declared, payable that day.

Notice of Dividend.—The *London Gazette* announces that a first and final dividend of 1s. 5½d. in the £ has been declared in the estate of A. Matson, electrical engineer, 10, Hardwick-terrace, Stockton-on-Tees.

Walthamstow.—The Local Government Board have held an inquiry into the application of the Council for sanction to the borrowing of £17,349 for the provision of additional plant at the electricity generating station.

Frodingham.—In reply to a letter of the Council asking for a year's extension of the electric lighting order, the Board of Trade have written stating that they are willing to defer the consideration of the matter until June 30 next.

Armorduct Manufacturing Co.—This company have recently purchased the patent obtained by Mr. H. C. Pearson, of Manchester,

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for his Grip fitting, which provides for electrical continuity, and the device will shortly be placed upon the market.

Stoke.—The electrical engineer, Mr. Tiddeman, in presenting his report for November to the Electricity and Destructor Committee of the Town Council, stated that 37.140 units were supplied, an increase on the corresponding period of last year of 50 per cent., and the number of consumers on the books was 338.

Stirling.—The report by the electrical engineer to the Town Council showed that during November 41,755 units were generated at the power station, as compared with 41 055 for the corresponding period last year. The total connections in equivalent 8-c.p. lamps were 23 844 as compared with 21,463 last year.

Beckenham.—Mr. E. A. Sandford Fawcett, M I.C.E., inspector of the Local Government Board, held a public inquiry on the 20th inst. into the application of the Urban District Council for sanction to borrow £16,000 for the purpose of extending the electric lighting works and laying down additional machinery. There was no opposition.

Electricity and Plant Life.—In order to extend the experiments in plant culture by electricity in the Royal Botanic Society's glass-houses at Regent's Park, a committee representative of the council of the Society of Scientific Botany and Practical Horticulture has been formed Regular observation will be made and the results tabulated day by day.

Manitoba.—The Bell Telephone Co. is at present negotiating with the Government of Manitoba with a view to selling the telephone system in this province. The Provincial Government recently decided to establish its own system of telephone. and it is probable that the company's lines will be purchased outright in preference to setting up a new system.

Tamworth.—The Town Council have resolved to accept the offer by the British Electric Traction Co. of £300 to be released from the obligation to the Corporation incurred by the Shropshire Electric Power Co. The provisional electric lighting order will, therefore, now revert to the Town Council, but £300 is not likely to cover the whole of the costs.

Poulsen Wireless Telegraphy.—The Amalgamated Radiotelegraph Co., of London and Copenhagen, owners of the Poulsen system of wireless telegraphy and telephony, announces that experiments made during the last few days show that the wireless Poulsen telegrams between Newcastle and Copenhagen and Berlin and Copenhagen can be written directly from the receiver with ink in as sure a way as with telegraphy by wire.

Newcastle.—At a meeting of the City Lighting Committee the question of the lighting of Westgate-road was settled, the offer of the Tramway Committee, through Sir Joseph Baxter Ellis, to light the road from the top of Westgate-road on to Bentinck-road by 20 arc lamps at or about the same price as gas being accepted. The electric lighting will be 15,000 c.p. as against 8,500 c.p. per gas. The offer was accepted.

Cambridge.—The Town Council have given their consent to the Postmaster-General placing underground telegraphic lines along certain streets. subject to the conditions that the surface of the ground should be restored by the borough surveyor at the cost of the Postmaster-General, and that it be understood that no liability shall attach to the Corporation in respect of any damage which might occur through any subsidence of the trenches.

Kingston.—The Lighting Committee of the Town Council have agreed to post a notice at the central electricity station to the effect that, to ensure safety no person other than a member of the Corporation should be allowed in the engine-room without the authority of the officer in charge at the station, and that members of the Corporation, other than members of the Lighting Committee, be requested to notify the officer in charge before entering the engine-room.

Chertsey.—At the Urban District Council reference was made to the resolution passed at the last meeting approving of the Woking Electricity Supply Co. including Thorpe in their area of supply, providing the mains were brought as far as the parish church within one year. The time limit was expunged from the minutes and it was agreed that the mains should be brought as far as Thorpe parish church within five years, failing which the permission of the Council would be revoked.

Sunbury.—At the last meeting of the Urban District Council the clerk raised the question of the electric lighting order which was obtained in 1904 by the Twickenham and Teddington Electric Supply Co. The time had elapsed in which that order could be taken up, and he thought the Council should move to have it revoked, as such an order hanging over the district might keep other companies out. The Council concurred with this view, and the clerk was asked to move in the matter.

Cleethorpes.—At the last meeting of the Urban District Council the clerk read a letter from the National Telephone Co. in reply to a communication from the Council offering to allow the company to put down underground wires at an annual rental of £10. The company stated that they considered the charge of £10 excessive, and offered £4, and agreed to pay the surveyor a fee of £5 for inspecting the work. The chairman strongly favoured standing out for £10, and this proposal was carried *nem. con.*

St. Austell.—On a discussion concerning the light supplied to the public lamps by the electric lighting company it was stated at the Urban District Council that at present there was quite three times as much light in the town as when gas was the illuminant. In the area immediately outside the town the light was very different. St. Austell light was far superior to that at Lostwithiel, and better than Truro, which was lighted by gas. The chairman said he thought the gas people served them well, but they charged them well.

Wireless Telephony.—Another triumph has been won by the wireless telephonic system of the Amalgamated Radiotelegraph Co. During last week the company have been able to keep up regular telephonic communication between the station at Weissensee, in Berlin, and one of the Danish stations at Lyngby, 12 miles north of Copenhagen. The distance thus covered is 260 miles across North Germany, the Baltic, and part of Denmark. as far as ships equipped with the best systems of spark telegraphy can communicate with the shore. Experiments are shortly to be commenced over much longer distances. and when the company's Transatlantic radiotelegraphic system is being installed a number of wireless telephonic experiments will also be made.

Watford.—At the last meeting of the Council Electricity Committee the electrical engineer reported that 12 consumers had been connected to the system during the past month, making a total of 577 connected. He also reported that, owing to the increased demands in the neighbourhood of Vicarage and Alexandra roads, it is necessary for underground sub-stations to be built and equipped in these roads, that the work in connection with the Vicarage-road sub-station should be proceeded with at once, and that the other should follow immediately afterwards. He further stated that these proposed sub-stations are two of the four that were included in the last loan. The committee recommend that the two sub-stations be erected by the electrical engineer, and that the complete cost of the same. in detail, be furnished to the committee as soon as they are completed.

Stock Exchange.—The Stock Exchange Committee have appointed Jan. 8 a special settling day in New York Motor Cab Co.'s 240,000 preferred participating ordinary shares of £1 each, fully paid. Nos. 1 to 240.000, and 60,000 deferred shares of 1s. each, fully paid, Nos. 300,001 to 360,000; and Rosenhaugh Tea and Rubber Co.'s 79 900 ordinary shares of £1 each (issued at £1. 4s. per share), 9s. paid (5s. capital and 4s. premium). Nos. 1 to 7 and 224,108 to 304,000, 224,100 ordinary shares of £1 each, fully paid, Nos. 8 to 224,107, and 180,000 6 per cent. cumulative preference shares of £1 each, fully paid, Nos. 1 to 180,000. The committee have also ordered the undermentioned securities to be quoted in the official list: Shanghai Electric Construction Co.'s 32,000 shares of £10 each, fully paid, Nos. 1 to 32,000; Shawinigan Water and Power Co.'s further issue of 48,500dol. 5 per cent. consolidated first mortgage bonds of 500dol. each, Nos. 5,766 to 5,825 and 5,839 to 5 875.

St. Marylebone.—The chairman of the Electric Supply Committee of the Council, replying to criticisms on the local electric undertaking and an allegation that the committee had only £8,000 with which to meet £100,000 interest and sinking fund charges to the end of the working year, March 31, 1908, has stated that by Dec. 31 the sum of £69,792 will have been paid on this account. It was estimated that there would be a clear net profit, after paying interest and sinking fund charges, of £11,000 at the close of the working year, but with a fall in price of electrical units this may not be fully realised. The overdraft at the bankers on Dec. 31 is calculated at £58,048, against which there would be due from consumers £44,000. Expenditure on capital account is set down approximately at £1,991.500. Loans received totalled £1 974.920. An estimate of increased sales for the year of 7·5 has been exceeded in the two summer quarters, the actual increase being 7·9. The chairman asks for deferred judgment on the year's working until the accounts are fully before the Council.

Robertson Social and Athletic Club.—The Robertson Social and Athletic Club held their second annual fancy dress ball on the 21st inst. in the large hall at Brook Green Works. There were about 350 people present, including Mr. and Mrs. C. Wilson, Messrs. M. and D. Wilson, Master H. Wilson, Mr. and Mrs. Robertson, Mr. and Mrs. Scolding, Messrs. Driver, Shepherd, Heden, Pring, Vankuisburgh, Saville, and C. Miller, Misses Kimpton, Morgan, Bailey, and Addy, Mr. and Mrs. Beaven. Fancy dresses were much in evidence, prizes being awarded to Mr. J. Minson as "Snowman," Mr. Bert Crump as "Chinaman," Miss D. Dallender as "Christmas Tree," and Miss L. Price as "A Gleaner." Mr. C. Wilson presented Mr. F. Pluck with a watch and chain during the evening for his services as M.C. The arrangements for the evening were successfully carried out by Mr. Geo. H. Freeman, the honorary secretary, while Mr. Richards's Scarlet Bohemian Band provided excellent music.—Robertson's met the G E.C. in a football match on their private ground at Acton on Saturday, and after a hard game Robertson's retired winners by two goals to one. The lampmakers are having a successful season, having scored 81 goals against 14, and are leaders in their division of the league.

Pontypridd.—The finances of the Council's electrical undertakings during the past year are dealt with in a comprehensive report issued by the accountant, Mr. L. R. Williams. Dealing with the electric light department, Mr. Williams states that the total capital expenditure up to March last, including free wiring. was £52.531. 8s. 5d., leaving an amount of £1,468. 11s. 7d. to be still expended before exhausting the existing borrowing powers. The revenue account for the year shows a gross increase of income amounting to £1,809. 6s. 9d., with a gross profit on the year's working of £1,202. 18s. 10d., or equivalent to a percentage of 2·28 on the capital expenditure to the end of the year. After obligations in respect of interest on loans and repayments and contributions to sinking fund have been made, the net revenue account shows a debit balance for the year of £2,582. 3s. 7d. The accountant adds that when the Council put down their generating plant it was recognised that a profit could not be made until the end of the third year. This period is practically at an end, and the accountant estimates that by March next the deficit on the undertaking will be reduced to £1.324. Upon this the engineer (Mr. Teasdel) appears to be more sanguine, and expresses the opinion that the deficit will be reduced below the figure named.

Bury.—At a meeting of the General Purposes Committee of the Corporation on Wednesday week the minutes of a special meeting of

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the Electricity Committee were considered. These minutes dealt with the consideration of the question of placing the electricity undertaking in a position to meet the demands from large power consumers, and also the normal growth of the undertaking. A special report by the electrical engineer was also submitted, and after some discussion it was decided to recommend the Council to adopt the Electricity Committee's proposals, which are to take a plot of land at Chamber Hall, on account of its advantage with regard to water and coaling facilities, and to put down new works and generate electricity on the alternating system. The electrical engineer estimated that the initial capital expenditure would be about £70,000. This sum would include the cost of the generating station, two steam alternators (each of 2,500 h.p.), boilers, switchboards, and other auxiliaries, but is exclusive of the cost of the land and the coaling facilities. It, however, includes the cost of mains and converters to supplement the direct-current supply at the existing works. The engineer added that an additional sum of £15,000 would be required to supply alternating current to the large consumers, but it was not intended to spend this amount now.

Dundee.—A special meeting of the Town Council was held on the 20th inst. to arrange for the scheme of electrical extension implied by the erection of the new generating station. The clerk explained that when the provisional order extending the city boundaries was promoted it contained a clause extending the electric lighting area, so as to make it co-extensive with the extended boundaries. That provisional order was a provisional order to the Secretary for Scotland, and the electric lighting clauses had to be left out, as the Board of Trade took up the position that the Secretary for Scotland had no power to deal with electric lighting, which was a departmental matter. The Electricity Committee at its March meeting, and the Town Council at its April meeting, resolved to promote the necessary provisional order to the Board of Trade for this purpose, and the clerk was instructed to prepare and adjust clauses and to proceed with the order. That had been done. Under the Electric Lighting Act of 1882 it was provided that no application of the kind could be made without a special resolution of the local authority, called upon a month's notice. Hence the Council had been summoned together. The convener of the Electricity Committee moved that the Dundee Gas Commissioners, being the local authority, resolve to take the necessary steps to obtain a provisional order from the Board of Trade to extend the area of the supply of electricity so as to make it co-extensive with the enlarged boundaries of the city, and the motion was unanimously adopted.

Wrexham.—The Corporation having applied for the sanction of the Local Government Board to the borrowing of the sum of £575 for the erection of a 60-kw. set at the electricity works, an inquiry has been held, at which it was stated by the town clerk that the works were provided under the provision of the Electric Lighting Order Confirmation (No. 1) Act, 1892. The proposed 60-kw. set had been found necessary on account of the increased demand for electricity. The last extension of the works took place in 1903, and was carried out in order to enable the Corporation to supply energy for traction purposes to the Wrexham and district tramways, which were owned by a private company. As showing the necessity for the proposed set, the total number of units of electrical energy sold for private lighting, street-lighting, and traction in each of the past five financial years had been as follows: 1902-3, 132,815; 1903-4, 306,268; 1904-5, 318,387; 1905-6, 380,166; 1906-7, 409,727. The loans raised for electricity purposes amounted to £36,896, and in respect of these loans the total debt outstanding was £30,969. The plant at the electricity works consisted at present of three 120-kw. and one 30-kw. steam dynamos, with two 250-h.p. and one 500-h.p. boilers. There was also a refuse destructor worked in conjunction with the electricity works. The tender of the Lancashire Dynamo Co. had been provisionally accepted for the erection and delivery of the set at the sum of £545. The borough electrical engineer and the borough surveyor gave evidence in support of the application.

Tewkesbury.—A meeting of the Town Council was held on Monday last to ratify a formal resolution made at the last Council meeting and to confirm the minutes dealing with the conditions of the transfer of the electric lighting provisional order to Mr. John Parker, of Hereford. The chief heads of agreement laid down by the committee, consisting of the whole Council, were as follows: payment of costs of the order already obtained, not exceeding in the whole £300; the Council to have the option of purchasing the undertaking at the end of the first 14 or 21 years, or any subsequent period of seven years, at its fair market value, or at a sum equal to the capital expended, with the addition of a sum equivalent to a 7 per cent. dividend during the operation of the undertaking by the company; all openings in the streets other than the original laying of cables to be done under the supervision of the borough surveyor; the maximum price for supply to public buildings, street-lighting, etc., not to exceed 4d. per unit; the undertaker to be prepared to supply in 12 months the compulsory area, and the remainder of the area within three years; prices charged to be reduced 5 per cent. for every 1 per cent. paid in dividends above a 6 per cent. dividend, and 4 per cent. to be the limit placed to a reserve fund; a free wiring system to be adopted, whereby persons may have the necessary wires and fittings placed in their houses free of charge, but subject to a rental not exceeding 1d. per unit on current supplied or 1s. per lamp yearly; should the company liquidate, the Council to have the option of purchase within three months upon the terms stated. The town clerk having read the particulars of the transfer, the Council decided to approve the draft order, and to seal the memorial to the Board of Trade.

Hammersmith.—At the last meeting of the Borough Council the Law and Parliamentary Committee reported as follows: "We have received from the Electricity and Lighting Committee the draft of an agreement, the terms of which have been settled between the committee and Mr. Imre Kiralfy, acting on behalf of the Franco-British Exhibition Incorporated, for giving effect to the resolution of the Council of July 24 last, to supply electrical current to the exhibition in Wood-lane. The conditions of supply attached by the Council to its resolutions are embodied in the agreement with the following modifications: (*a*) the period within which the guaranted minimum payment of £10,000 has to be made—viz., between May 1 and Oct. 31, 1908—is extended, with the concurrence of the Electricity Committee, to between Jan. 1 and Dec. 31, 1908; and (*b*) provision is made for lighting the approach from the main entrance to the exhibition in Uxbridge-road, with a separate supply of low-tension alternating current for a maximum demand not exceeding 100 kw. This is in addition to the agreed provision for the delivery of current in bulk at the boundary of the exhibition grounds adjoining the Wood-lane entrance. As there appeared to be some doubt as to whether this addition had been approved by the Electricity Committee, we have referred the question back to it for further consideration. We have carefully considered in detail the whole of the clauses in the draft agreement, and, subject to the Electricity Committee being satisfied on the point above referred to, are of opinion that the conditions thereof are such as can be accepted by the Council, and we have, therefore, approved of the same, and recommend that the seal of the Council be affixed to the engrossment of the agreement." To this the Council agreed.

Southend.—At the last meeting of the Town Council a letter was submitted from Messrs. Beadel, Wood, and Co. asking what arrangements the Corporation would make to extend the electric light to the new estate being developed by them on behalf of Colonel Burges at Thorpe Hall, Southchurch, and the electrical engineer was instructed to submit an estimate to the next meeting of the committee of the cost of providing and laying the necessary cables for the supply of electricity to that part of the borough. The Electricity Committee have considered the alternative tenders obtained by the electrical engineer for the provision of one or two 500-kw. sets, the first for delivery in June, and the remaining one at any time upon six months' notice from the electrical engineer for that purpose. They recommended that the tender of the British Thomson-Houston Co. for the provision and erection of a B.T.H.-Belliss steam dynamo, at a price amounting to £3,034, be accepted, subject to their agreeing to supply a similar set if required by the Corporation within 12 months from this date at a price less by £10 than the above-mentioned sum. The latter price was based upon the understanding that the second dynamo would be fitted with interpoles, but if one without interpoles was selected, no reduction would be allowed; also that the price of copper at the time the order was placed was not more than 5 per cent. above the market price to-day, and in the event of the price being higher than this, then for each 5 per cent. increase an increase equal to 1 per cent. would be made in the price of the generator. The present price of the latter was £750 without and £680 with interpoles. They also recommended that the offer of Messrs. Callender's to supply all copper cables required at £63 per ton for a period of one year be accepted. The committee adopted the report, and recommended the Council to enter into the contracts necessary. The recommendation was adopted.

PROVISIONAL PATENTS, 1907.

DEC. 12.

27412. Improvements in electric arc lamps. Henry Bevis and Arthur Ernest Angold, Peel Works, Adelphi, Salford.

27422. Device to release tramcar hand brakes when the magnetic or rheostatic brakes are applied. Archibald William Malcolm, Westdene, Lambert-road, North Finchley, London.

27436. Automatic electrical transmission of a fire-alarm signal to a fire officially recognised, or other station. John Tatlock and Adam Garson Horne, 154, St. Vincent-street, Glasgow.

27447. Improved safety devices for electric winding plants. Siemens Bros. Dynamo Works, Limited, and Arthur Stebbings Clift, Queen Anne's-chambers, Broadway, Westminster. (Complete specification.)

27453. Improved diaphragm transmitter for telephones and the like. Karel Ort, Joseph Rieger, and Joseph Karel Ort, 8, Quality-court, Chancery-lane, London. (Complete specification.)

27457. Improvements in or applicable to electric bells. Carl Herrde, 1, Great James-street, Bedford-row, London.

27486. Improvements in or connected with electric current transformers. James William Davy, 40, Chancery-lane, London.

DEC. 13.

27497. Improved method for producing metallic incandescent bodies for electric glow lamps. Harold Walter Purle, 17, Denver-road, Stamford Hill, London.

27541. Improvements in and relating to electric incandescent filament lamps. Charles Pauli, 20, High Holborn, London. (Complete specification.)

27543. Improvements in springs particularly applicable to the manufacture of electric incandescence lamps. Edward Alfred Gimingham, Birkbeck Bank-chambers, Southampton-buildings, London.

27555. Improvements in telephone station apparatus applicable for indicating subscribers' call numbers and other purposes. George Ambrose Powell and John Taylor, 6, Lord-street, Liverpool. (Philip Cuddon Powell, Canada.)

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27559. Improved electrode for use in the purification of water and other liquids. John McLeod Murphy, 11, Southampton-buildings, London.

27560. Improved apparatus for use in the purification of water and other liquids by electricity. John McLeod Murphy, 11, Southampton-buildings, London.

27561. Improved filter. John McLeod Murphy, 11, Southampton-buildings, London.

27562. Device for controlling the electric current in an apparatus for purifying liquids. John McLeod Murphy, 11, Southampton-buildings, London.

27566. Improvements in the method of and means for controlling the electric circuits of illuminated signs for advertising and similar purposes. James Albert Seager, 31, Bedford-street, Strand, London.

27569. Improvements in connection with electric resistance thermometers. James Yate Johnson, 47, Lincoln's-inn-fields, London. (Firm of W. C. Heraeus, Germany.)

27570. New or improved method of electrical telescopy and apparatus therefor. Boris Rosing, 47, Lincoln's-inn-fields, London. (Complete specification.)

27578. Improvements in and relating to electric coils. Charles Frederick Caxton Wilkins and Muirhead and Co., Limited, 322, High Holborn, London.

DEC. 14.

27582. Improved construction of combined electric switch and fuse holder. Vernon Hope, 55, Market-street, Manchester.

27591. Improvements in or relating to the electro-deposition of metals and alloys on aluminium and other metals. Charles Mason, Gough-chambers, Savile-street, Hull.

27596. Improvements in and relating to dynamo-electric machines. Mather and Platt, Limited, Anthony Cathcart Conbrough, and Julius Frith, Salford Ironworks, Manchester.

27605. Improvements in or relating to magneto-ignition machines. John Dalrymple Bell, 18, Hertford-street, Coventry.

27608. Electric thermostat. Harry Grant Geissinger, 1, Broad-street-buildings, Liverpool-street, London. (Date applied for under Patents Act, 1901, May 29, 1907, being date of application in United States.) (Complete specification.)

27611. Improvements in electrically-controlled locks and latches. Thomas Oldbury Summers, Oliver John Wootton, Thomas Hill, and William Henry Green, trading as the Reliable Lock and Brassfoundry Company, 75, Chancery-lane, London.

27614. Improvements in conduits and casings for wires and cables used for electrical purposes. Reginald Harry Fry, 95, Acre-lane, Brixton, London.

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Jan. 2.)

1907.

316. Commutators for dynamo-electric machines. Rhodes and Rhodes Motors, Limited.

1358. Electric switches. Ambler.

1945. Gravity escapements and electric clocks. Cunynghame and Hope-Jones.

2227. Overload electric circuit breakers and the like. Siemens Bros. Dynamo Works and Palairet.

3724. Electrical generators for flour-bleaching and subsidiary purposes. Loring.

4172. Electrical distribution systems with the aid of storage batteries. Wuillot and Feron.

6280. Electric telegraphy. Kitsee.

6849. Electric fuse boxes and fuse holders therefor. Grose.

8838. Electro-mechanical toys. Ruhl.

9176. Safety electric cable. Land- und Seekabelwerke Akt.-Ges. (Date applied for under International Convention, Aug. 3, 1906.)

9358. Conduit threaders. Dieter, Bowsher, and Davis.

9833. Telephone systems and apparatus therefor. Turner. (Date applied for under International Convention, May 12, 1906.)

10837. Fittings for gas, electric, and other lights. Stern.

11123. Electric conductors. Hungerford.

13074. End pivots for the spindles of electric meters. Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, March 14, 1907.)

16514. Synchronising apparatus for dynamo-electric machines. MacGahan. (Date applied for under International Convention, July 28, 1906.)

16675. Magnetic ore separator. Lundberg and Holmberg.

18498. Operative system electric locomotives. Böhm. (Date applied for under International Convention, Aug 18, 1906.).

18793. Double-wire overhead electric trolley systems. Von Kando.

22404. Dynamo-electric machines. Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, Oct. 22, 1906.)

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £		Last price. £
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70 000	1	..	½ ⅝
—— Ord., 1,125 000	1	..	⅛ ¼
Aron Electricity Meter, 6 p.c Cum. Pref. Shares, 1-125 000	1	..	9/16 11/16
—— Ordinary Nos 1 12 ,000	1	..	5/32 9/32
British Aluminium Co., Ordinary, 2 001 40 000	5	..	3½-4½
—— 7 per cent. Cum. Pref., 1-40 000	5	..	4½ 5
—— "A" 6 per cent. Cum. Pref., 1-20 000	5	..	4½ 4¾
—— 4 per cent. Funding Certificates, 1-20 000	5	..	3¾ 4½
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	100 102
—— 5 per cent Loch Leven Deb. (Reg.) Red., 1-3 000	100	..	96 98
British Insulated and Helsby Cable Ord., 1-100 000	5	..	6½-7
—— 6 per cent. Cum. Pref., 1-100 000	5	..	5⅞ 6⅛
—— 4½ per cent. Mortgage Debentures	100	..	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	85 89
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375 000	3	..	3-1½
—— 4 per cent. Mortgage Debenture Stock	100	..	45-55
Brush Electrical Engineering, Ordinary, Nos. 1-105,751	2	..	0-½
—— Non. Cum., 6 per cent., Pref.	2	..	⅜-½
—— 4½ per cent 1st Debenture Stock	100	..	83-86
—— 4½ per cent. 2nd Debenture Stock	100	..	65-68
Callender's Cable, Debentures	100	..	105½-107½
—— Ordinary	5	..	9½ 10½
—— 5 per cent. Pref.	5	..	5½ 5⅝ xd
Consolidated Electrical Co., Ordinary, 1-110,000	1	..	7/16-9/16
Crompton and Co.	3	..	1-1⅛
—— 5 per cent Debentures	100	..	96-99
Dick, Kerr and Co., Ordinary, 1 260 000	1	..	1⅛-1⅜
—— 6 per cent. Cum. Pref., 1-305,000	1	..	1-1⅛
—— 4½ per cent. Debenture Stock Red.	100	..	101 104
Edison and Swan United, "A" Shares, 1-79 261	5	..	⅞-1⅛
—— "A" Shares 01-017,139	5	..	1⅛-2⅛
—— 5 per cent. Debentures	100	..	87-90
—— 4 per cent. Deb. Stock, Red.	100	..	79-82
Electric Construction, Nos. 1 to 112 100	2	..	½-⅝
—— 7 per cent. Cumulative Pref.	2	..	⅝-1⅛
—— 4 per cent. Perp. 1st Mort. Deb	100	..	59-64
Electrolytic Alkali Co., Ordinary, 1-202,218	1	..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock Red	100	..	—
General Electric Company (1900) 5 per cent. Cum. Pref.	10	..	8-8½
—— 4 per cent. 1st Mort. Deb Stock	100	..	89-92
W. T. Henley's Telegraph Works, Ordinary	5	..	10½-11½
—— 4½ per cent. Preference	5	..	5-⅛
—— 4½ per cent. Debentures	100	..	104-106
India Rubber, Gutta Percha, and Telegraph Works	10	..	15½-16½
—— 4 per cent. Debentures	100	..	6-8
National Electric Construction Co., 1-170,000	1	..	11/16-15/16
Parker, Thos., Limited, Ordinary	10	..	10-10½
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5	..	—
Telegraph Construction and Maintenance	12	..	28½-30½
—— 5 per cent Bonds	100	..	100-103
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	..	84-94

Electric Lighting and Supply.—

Name.	Amount paid. £		Last price £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10.000	5	..	4½-5
Bournemouth and Poole, Ordinary	10	..	9½-10½
—— 4½ per cent. Cum Pref., 7 501-15 000	10	..	9½-10
—— 6 per cent. Cum Second Pref., 15 001-22,500	10	..	9½ 10¼
—— 4½ per cent. Debenture Stock, Red.	100	..	100-105
Bromley (Kent) Electric Light and Power Co	5	..	4⅜-5½
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	96-98
Brompton and Kensington, Ordinary	5	..	7-8
—— 7 per cent. Preference	5	..	7-8
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	..	6-6½
—— Nos. 80,000-100.000	5	..	5½-6½ xd
Cambridge Electric Supply Company, £10 Ord.	8	..	12½-13½
Canadian General Electric Co., Common Shares	$100	..	98-102
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	..	96-99
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	..	3¼-4⅜
—— 4½ per cent. Cum Pref., 1-80 000	5	..	3⅜-4¼
—— 4 per cent. Debenture Stock, Red.	100	..	95-98 xd
—— "City Undertaking," 4½ p.c Cum. Pref., 1-40,000	5	..	3⅜-4¼
—— ditto (905) 40,001-80 000	5	..	3¼-4¼
Chelsea Electricity Supply	5	..	3¼ 4¼
—— 4½ per cent. Debentures	100	..	102-105
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000	..	—
City of London, Ordinary	10	..	9½-10½
—— 6 per cent. Cumulative Pref	10	..	11-12
—— 5 per cent. Debenture Stock	100	..	122-125
—— 4½ per cent 2nd Deb. Stk. Prov. Certs (all pd.)	100	..	95-98
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1 630	50	..	50-53
Cordoba Light and Power Co., 1st Mt. stl. 5 per cent. Bds., Red., 1-1,000	100	..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10 001-50.000	5	..	3½-4½
—— 5 per cent Preference, 1-50,000	5	..	4⅛-4⅝
County of London Elec. Supply, Ordinary	10	..	6½-7½
—— 6 per cent. Cum Pref.	10	..	10-10½
—— 4½ per cent. Debentures Prov Certs. All pd., Red.	100	..	105-108
—— 4½ per cent. 2nd Debentures Prov Certs	100	..	95-98
Edmundson's Electricity Corporation, Ordinary, 1-50 000	5	..	⅞-1
—— 6 per cent. Cum Pref.	5	..	¾-1⅛
—— 4½ per cent. First Mort. Deb	100	..	75-80
Electrical Development Co. of Ontario 5 per cent. 1st Mort. 20-year Gold Bonds, 10 751-15 750	—	..	74-77 p.c.
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm Pf., 1-30,000	5	..	2½-2¾
—— 5 per cent Debenture Stock, Red	100	..	85½-89½
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red	100	..	94-96
Folkestone Electric Supply, Ord., Nos 1-10 000	5	..	4½-5
—— 5 per cent. Cum Pref., Nos. 1-10 000	5	..	4⅞-5⅛
—— 4½ per cent. First Deb Stock Red.	100	..	96-99
Hove Electric Lighting, Ord., 1-13 000	5	..	6⅜-6⅞
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100	..	101-104
Isle of Wight Elec. Lt. and Pr., 4½ p.c. Db. Stk., Red	100	..	92-96
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref. 1-150,000	1	..	1/16 3/16
Kensington and Knightsbridge Elec. Lt., Ord, 1-21,000	5	..	8-9
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100	..	98-102
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9½-10½

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Name.	Amount paid.	Last price.
	£	£
London Electric, Ordinary	3	1¼-1⅜
—— 6 per cent. Pref.	5	4-4½
—— 4 per cent 1st Mortgage Debenture Stock, Red.	100	87-91 xd
Madras Electric Supply Corporation 5 per cent. Construction Deb. stock, Red (Prov. Certs), all paid	100	92-95
Metropolitan Ordinary, 100,001-.00,000	5	5⅜-5⅝
—— 4½ per cent. First Mortgage Debenture Stock	100	102 106
—— 4½ per cent. Cum. Pref.	5	4½-5
—— 4½ per cent. Mortgage Debenture, Red.	100	87-92
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds. 1933, C 1-1,000 ($100), D 1-5,000 ($500), M 1-4,400 ($1 000)	—	76-78 p.c.
Mexican Light and Power Co., Capital Stock	$100	41-43
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14 000 ($1,000)	—	83-85
Midland Electric Power Dist., 4½ p.c 1st Mort. Deb.	—	96½ 99½
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009	5	6⅛-6⅜
—— do., 57,010-75 000	5	6⅛-6⅜
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid)	5	6⅛-6⅜
—— 5 per cent., Pref., 1-57,009	5	5-5½
—— do., 75,001-87,500 (issued at 10s. prem., 4s paid)	5	5-5⅛
Notting Hill Electric Lighting	10	10½-11½
—— 4 per cent. First Mort. Debs. Nos. 1 500 (Reg.)	100	95-97
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	5½ 6
—— 4 per cent. Debenture Stock	100	95-97
River Plate Electricity Co., Ord., 1-119 687 & 120,501-120 507	1	9/16-11 16
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	13/16-15/16
—— 5 per cent. Debenture Stock, Red.	100	95-98
Rosario Electric Co., 6 per cent. Cum Pref., 1-20 000	5	4⅜ 5½
—— 6 per cent. Cum 2nd Pref., 1-15,000	5	4⅞-5⅛
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	96 98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	—	98-100 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5	⅛-1⅛
—— 4 per cent. Debenture Stock	100	71-75
South London Ordinary	5	2⅛-3
South Metropolitan Electric Light and Power, Ord.	1	⅛-⅜
—— 7 per cent Cum Pref.	1	15/16 1 3/16
—— 4½ per cent 1st Mort. Deb.	100	99 102
St. James's and Pall Mall, Ordinary, 101-20,080	5	7½ 8½
—— 7 per cent. Pref.	5	6½-7½
—— 3½ per cent. Deb.	100	87-92
Urban Electric Supply Co., Ordinary, 8-30 007	5	1⅜ 2⅛
—— 5 per cent. Cumulative Preference, 50 001 80,000	5	1⅝-2⅝
Westminster, Ordinary	5	7⅜-8⅜
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	4⅜-5⅛

Electric Tramways.—

Name.	Amount paid.	Last price.
	£	£
Anglo-Argentine, 6 per cent. Cum Pref., 1-280 007	5	5 13 16-6 1/16
—— 10 per cent. Non-Cum 2nd Pref., 280 008-280,007	5	7⅛-8¼
—— Permanent 6 per cent Debenture Stock, 1888	100	128-131
Auckland Elec Trams, 5 p.c. 1s Mor. Deb. Stk, Red.	100	103-105
Barcelona Tramways, Ord, 1-20 000	10	—
—— 5 per cent. Cum. Pref Shares, 1-10 000	10	—
—— 5 per cent Deb., Red., 1-600	100	—
—— 4½ per cent. Red. Deb Stock	100	—
Bath Elec Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1	11/16 13/16
—— 5 per cent. Cum. Pref. Shares, 1-75 000	1	13 16/-15/16
Birmingham and Midland Trams., 4½ p. c 1st Db. Stk, Red.	100	92-95
Blackpool and Fleetwood Tramroad	10	13⅜ 1⅝
Bombay Elec. Supply and Trams Co., 6 per cent. Cum. Pref.	8	7⅜-7⅝
—— 4½ per cent. Deb. Stock, Red.	100	93-95
Brisbane Tramway Invest., Ord., 1-75,000	5	3 1/16 3 5/16
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4⅜ 4⅝
—— 4½ per cent. Deb. Stk, Red., Prov. Certs. all pd.	100	96-100
British Columbia Electric Railway Co., Ord Def.	100	124-127
—— Ord. Pref.	100	107 111
—— 5 per cent. Cum. Perpetual Pref. Stock	100	99 103
—— 4½ per cent. 1st Mt. Debs., Nos. 1 6,250, of £40 each	40	98-101
—— 4½ per cent. Vancouver Power Deb.	100	100-103
British Electric Traction, Ord. 1-300 000 & 60 001-90,000	10	1¼-1⅜
—— 6 per cent. Cm Pf., 30,0001-60 000	10	5 5½
—— 5 per cent. Perpetual Debenture Stock	100	90-93
—— 4½ per cent 2nd Deb. Stock	100	70-75
Bueno Ayres and Belgrano Trams	5	4⅜-4⅝
—— "A" 6 per cent. Cm. Pf., 1-4 ,000	5	4⅜-5¼
—— "B" 6 per cent. Cm. Pf., 1-27 500	5	4⅜ 5¼
—— 5 per cent. Deb. Stock, Red.	100	105-115
—— Prov. Cert., all paid	100	104-105
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100	91-96
Buenos Ayres Gd Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100	99-103
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	98-103
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	91-94
Calcutta Tramways, Ord., Nos 1-137,610	5	6⅜-6⅞
—— 5 per cent. Cum. Pref., Nos. 1 30 000	5	5 5½
—— 4½ per cent. 1st Deb. Stock, Red.	100	101 105
Cape Electric Tramways, Nos. 1-480,000	1	⅝-¾
City of Birmingham Tramways, 5 per cent. Cum Pref.	5	4¼-4⅜
—— 4 per cent 1st Mortgage Deb., 1-3 000 (1917)	100	96-99
City of Buenos Ayres Trams. Co. (1 04), 1-248,000	5	5-5¼
—— 4 per cent. Deb. Stock, Red 1-85	100	98-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	93-97
Cork Electric Tramway and Lighting Co., Ordinary	10	13-14
—— 6 per cent. Cum Pref.	10	12¼-13½
—— 4 per cent. Debentures	100	90-95
Dublin United Tramways (1896), Ord, Nos 1-60 000	10	12½-13½
—— 6 per cent. Pref., Nos. within 1-60 000	10	12½-13½
—— 3½ per cent. Mort. Debs., 1-3,000 Red	100	90-95
Hastings and Dist. Elec. Tram Co., 4½ p.c. Deb. Stk, Red.	100	97-100
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1,000	82-87
Imperial Tramways Ordinary	all	18-19
—— 6 per cent. Cum. Pref.	all	14-14½
—— 4½ per cent. Deb. Stock	100	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref, Nos. 30 001-60 000	5	⅛-1⅛
—— 4 per cent. 1st. Mt. Db Stock, Red.	100	67-72
Kalgoorlie Electric Tramways, 1-250,000	1	1/-6⅛
—— 5 per cent "A" Deb. Stock	100	87-91 xd
—— 6 per cent "B" Deb. Stock	100	71-75
Kidderminster and District Lighting and Traction, Pref.	5	10-10½
Lancashire United Tramways, Limited, 5 per cent Prior Lien Deb. Stock, Red.	100	94-97
—— £296 500 2nd Mort Deb. Stock	—	—
—— £83, 30 Deferred Deb. Stock (all fully paid)	—	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1	⅛-1⅛
—— 6 per cent. Cum. Pref., Nos 1-425 553	1	⅛-1⅛
—— 5 per cent. Mort Deb., 1-5,000 Red.	100	92-97
London United Trys. (1901), 5 per cent. Cum. Pref.	10	7⅛-8¼
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100	82-86

Name.	Amount paid.	Last price.
	£	£
Madras Elec Trams. (1904) 5 per cent. Deb. Stk., Red.	100	96-99
Manila Elec. R.R. and Lightg. Corp., 5 p.c 1st Lien and Coll Tr Stkg. Fund Gold Bonds of 1953, Red., 1-,635	$1 000	88-92
Manx Elec. Railway Co., 5¼ p.c. Cum. Pref., 201-21 635 and 23,436 25 000	—	4½ 5 xd
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100	96-99
Metropolitan Elec Trams., Defd., 1 000 001-1 314 016	1	1/16 3/16
—— 5 per cent. Cum Pref., 600,001 1,000 000	1	13/16- 15/16
—— 4½ per cent. Deb. Stock, Red.	100	93-96
Mexico Trams. Co., Gen. Cons 1st Mort. 50-year 5 per cent. Gold Bonds	—	80-82 p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con. Mort Bonds, 1926 1-5,500 and 7,001-8,000	$1,000	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., £01-2,000 1922	100	101-103
New General Traction, 6 per cent. Cum Pref., 1-10 000 and 34 001-74 000	5	⅜-1⅜
Oldham, Ashton, and Hyde Tramway, Ordinary	10	2
—— 5 per cent. Cum. Pref.	10	8¾-9
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk.	100	99-103
Potteries Electric Traction, Ordinary, 1-245 000	1	5/16-9/16
—— 5 per cent Cum Pref., 300 001-545 000	1	⅜-½
—— 4½ per cent Debenture Stock	100	93-96
Provincial Tramways Co., Ordinary, 1-24 912	10	4-5⅛ xd
—— 6 per cent. Cum. Pref., 1-10,000	10	10¼-11¼
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-20,000	5	5-5½
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100	97-99
Sao Paulo Tramway, Light, and Power Co.	$100	117-121
—— 5 per cent. 1st Mort Deb., Red. 1929, 1-11,000	$500	91-93 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent Cum. Pref., 19,571-169,570, Prov. Certs.	1	⅛-1⅛
—— 4 per cent. Deb St ck, Red. 1-40	100	80-84
Sunderland District Electric Tramways, 5 p.c 1st Mort. Debs, Red., 1-1 600	100	80-84
Yorkshire (West Riding) Elec Tram. Co., Ord., 70 001-110,000	5	1-1⅛
—— 6 per cent Cum Pref., 1-46,261	5	3⅛ 3⅝
—— 4½ per cent. 1st Deb. Stock, Red.	100	84-87

Electric Railways.—

Name.	Amount paid	Last price.
	£	£
Central London, Ordinary	100	62-65
—— 4 per cent. Pref.	100	83-85
—— " " deferred	100	41-44
—— 4 p c Deb. Stock (Prov. Script Certs, fully paid)	100	10 -10⅛
City and South London, Consolidated Ordinary	100	43-45
—— 4 per cent Debenture Stock	100	100-103
—— 5 per cent. Pref. Stock '91	100	116-119
—— " " " '96	100	113-116
—— " " " '01	100	113 116
—— " " " '05	100	108-111
Liverpool Overhead, 5 per cent. Pref	10	10-10¼
—— Ordinary, 1-50 000	10	3¾-4⅛
—— 4 per cent. Mortgage Debentures, Red, 1-1 700	—	94-96
Underground Electric Railways of London, 5 per cent. Profit-sharing Secured Notes	—	35-39

Telegraphs and Telephones.—

Name.	Amount paid.	Last price.
	£	£
Amazon Telegraph Co., 1-25,000	10	2½-3½
—— 5 per cent. Debs., Red., within 1-1,069	100	85-88
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28 000 and 53 001-78 000	$1 000	88-90
Anglo-American Telegraph Co., Ordinary	100	55-58
—— 6 per cent. Preferred Ordinary	100	99-101
—— Deferred Ordinary	100	15-15½
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100	99-102
Chili Telephone Co., 1-44 000	5	6⅜-7¼
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100	82-86
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	6-7
—— 10 per cent Preference, 1-6 000	10	15-16
Direct Spanish Telegraph Co., Ordinary	5	3¼-3½
—— 10 per cent. Cum. Preference	5	8¼-8⅜
—— 4½ per cent Debs, 1-600	50	98-101
Direct United States Cable Co.	20	13¼-13½
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100	100-102
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100	98-101
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8 000 1913	25	9⅜-10⅛
Eastern Extension, Australasia and China, 1-300 000	10	12⅜-12⅝
—— 4 per cent. Mort. Deb Stock, Perp.	100	99¼-100⅛
Eastern Telegraph Co., Ordinary Stock	100	129-134
—— 3½ per cent. Preference Stock	100	83-86
—— 4 per cent. Mortgage Debenture Stock	100	99-102
Great Northern Telegraph Co. (of Copenhagen)	10	30¼-32½
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs, within 1-1,200, Red.	100	99-10
Indo-European Telegraph Co.	25	52-55
Marconi's Wireless Telegraph Co., Nos 255,128-284,190	1	9 16-11/16
Monte Video Telephone Co., Ordinary 1-72,680	1	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492	—	⅛-1
National Telephone, Preferred	100	108-110
—— Deferred Stock	100	106-108
—— 6 per cent Cum. First Pref.	10	10¼-12¼
—— 6 per cent Cum. Second Pref.	10	10-12
—— 5 per cent Non Cum. Third Pref.	5	5 3 16-5 7/16
—— 3½ per cent. Deb. Stock, Red.	100	97-99
—— 4 per cent Deb. Stock, Red.	100	100-102
Oriental Telephone and Electric Company	1	1 1/16-1 3/16
—— 6 per cent. Cum Pref	1	1 1/16-1 3/16
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1 000	100	97-100
United River Plate Tele. Co., Ordinary, 1-100 000	5	6⅜-7⅛
—— 5 per cent. Cum. Pref., 1-40,000	5	4⅜-5⅜
—— 5 per cent. Debenture Stock, Red	100	—
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	98-101
West African Telegraph Co.	10	10-10¼
West Coast of America, 1-30 000 and 53 001-53,008	2½	1-1⅛
—— 4 p.c. Debs., 1-1,500 guar. by Western Telegraph	100	97-100
West India and Panama Telegraph Co., Ordinary	10	⅜-½
—— 6 per cent. Cum. 1st Preference	10	7-7½
—— 6 per cent. Cum 2nd Preference	10	7-7½
—— 5 per cent. Debs., Red., 1-800	100	98-102
Western Telegraph Co., 1-207,930	10	12⅜-13½ xd
—— 4 per cent. Debenture Stock, Red.	100	98½-101⅛

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.							Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1907.	1906.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Mile of track. Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Dec. 18	1,182	1,125	+ 56	— h	25½	25	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	Nov. 17	1,019	965	+ 53	− 176	8	8	,, 15	14,528	3,316,380	353,945	1	9·71	1,830	5·16
Baker Street and Waterloo Ry	Dec. 21	3,105	2,300	+ 805	+ 21,635	—	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 15	993	954	+ 39	+ 2	23·53	23·53	March 31	55,025	11,145,531	1,309,903	1·18	10·08	2,338b	6·03
Birmingham Corporation	,, 14	6,378	—	—	—	56½	—	,, 31	17,133	4,709,798	266,526	·86	14·5	8,866	—
Blackburn Corporation	,, 11	1,002	868	+ 133	+ 2,844	24	24	,, 25	48,875	8,661,720	986,953	1·35	11·89	2,036	7·44
Blackpool Corporation	,, 19	297	297	—	+ 1,284	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	Oct. 26	311	279	+ 32	− 1,139	16½	16½	Dec. 31	31,846	2,325,677	579,264	3·28	13·19	—	7·27
Bolton Corporation	Dec. 15	2 031	1,847	+ 244	+ 5,233	42	40	March 31	95 766	20,205,196	2,161,130	1·13	10·63	2,39	6·14
Bournemouth Corporation	,, 18	1,304	1,241	+ 63	+ 1,406	17·41	16·82	,, 31	55,276	10,058,288	1,121,623	1·32	11·83	3,22	7·19
Bradford Corporation	,, 14	4,159	3,944	+ 215	+ 3,477	95	95	,, 31	230,085	47,108,000	5,053,392	1·172	10 927	2,396	—
Brighton Corporation	,, 15	678	654	+ 24	− 3,026	9½	9½	,, 31	50,339	11,321,160	1,152,82	1 06	10·48	,914·8	8·014
Bristol Tramway Company	,, 10	4 989	5,036	− 47	—	51½	51½	Dec. 31	259,799	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	,, 14	1,187	1 154	+ 33	—	40	40	March 31	97,992	11,092,704	1,197,772	1·31	11·61	5,388	8·17
Burton Corporation	,, 15	255	—	+ 5	− 518	8½	8½	,, 31	17 950	3,878,269	454,082	·07	9·21	2,06	6·76
Cardiff Corporation	—	—	—	—	—	32·62	†32·26	,, 31	112,209	24,134,363	2,770,049	1·12	9·72	3,782	9·44
Carlisle Tramways Company	,, 14	167	144	+ 23	− 521	8·5	8·5	Dec. 31	10,713	2,935 002	359,756	—	7·14	—	5 18
Central London Railway	,, 14	6,173	7,096	− 923	− 19,279	6	6	,, 31	347,588	4,875,547	1,281,214	1·86	65·10	57,931	35·80
Charing X, Euston, & Hamp. Ry	,, 21	3 010	—	—	—	8	—	—	—	—	—	—	—	—	—
City and South London Railway	,, 22	3,329	3,188	+ 141	+10.444	6¼	6¼	,, 31	—	—	—	—	—		
Colchester Corporation	,, 11	160	160	—	—	8	8	March 31	10,588	2,457,553	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	,, 19	432	444	- 12	+ 898	15¼	15¼	Dec 31	24,895	5,814,376	882,256	1 01	6·64	—	4 69
Croydon Corporation	,, 13	1,275	—	+ 91	− 1,9 8	12 c	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 13	248	230	+ 18	− 15	7 23	7·23	March 3	—	—	—	—	—	—	—
Dover Corporation	,, 14	170	170	—	− 1,121	4½	4½	,, 31	11,250	2,853,200	284,343	·94	9·49	2,500	
Dublin and Lucan Electric Ry.	,, 20	95	97	- 2	+ 214h	6¾	6¾	Dec 31	6,358	402,511	110,738	3 79	13·78	942	7·33
Dublin U.T.	,, 13	4,777	4,617	+ 160	+ 31 079	48½	48½	,, 31	267,489	50,050,949	7,077,372	1·28	9 07	691	5 55
Dundee City Tramways	,, 18	1,076	932	+ 85	+ 1,128	22	22	May 15	50,154	13 086,396	1,005,911	·906	11·96	2,180	7·42
East Ham Corporation	,, 21	882	801	+ 81	+ 189	14	14	March 31	56,652	3,689,658	863,816	64	10·18	2,994	6 79
Glasgow Corporation	,, 14	16,850	15,932	+ 918	+14,276h	79½	79½	May 31	756,490	195,767,519	17,945,595	—	10 12	—	—
Gloucester Corporation	,, 18	229	228	+ 1	—	15	15	March 31	15,466	3,902,077	563,595	·60	6·58	999	5·32
G.N., Piccadilly and Brompton	,, 21	5,330	3,180	+2,150	—	9	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	37	37	,, 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 14	1,440	1,377	+ 63	+ 2,669	35	35	,, 31	69,938	12,838,150	1 665,262	1·24	9 71	1,923	—
Hull Corporation	,, 21	2 603	2,442	+ 161	+ 5,255	26	26	,, 31	112,651	27,102,921	2,910,698	1	9·29		—
Ilford Corporation	—	—	—	—	—	10½	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 18	125	109	+ 16	+ 327	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	11,586	3,626,656	419,800	·737	6 62	1,480	5·22
Lancashire United Tramways	,, 18	1,105	909	+ 196	+ 14,278	39	38	—	—	—	—	—	—	—	—
Leeds Corporation	,, 14	6,250	5 830	+ 420	+ 9,931	89½	89½	March 25	298,233	64,223,666	7,121,038	1 10	10·02	351	—
Leicester Corporation	,, 21	2,200	2,143	+ 56	—	42	42	Dec. 31	26,011	12 039,252	1,229,507	1	9·79	—	4·82
Liverpool Corporation	,, 7	10,560	10,641	− 81	+ 7 583	104	104	,, 31	547 625	116,642 663	12.166 419	—	—	—	—
Liverpool Overhead Railway	,, 15	1,344	1,341	+ 3	+ 1,743h	6·65	6 65	June 30	81,302	11.171,865	1,024,275	—	—	—	—
London County Council	,, 7	10 357	25,650	+4,707	+187,352	98	98	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 21	163	165	− 3	+ 1	6	6	Sept. 30	14,511	3,128 867	359,435	1·08	9 68	630	6 48
Maidstone Corporation	,, 19	139	81	+ 57	—	2	2	March 31	4,740	850 121	112,227	1 33	10 1	370	—
Manchester Corporation	,, 14	14,125	13.165	+ 958	+ 37,782	149	149	,, 31	631,956	126,900,875	14,123,124	1·19	10 73	4,299	6 99
Metropolitan District Railway	,, 21	8,924	8,211	+ 713	+ 1,349	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 15	16,404	16 166	+ 238	+ 6,504	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 14	124	130	− 6	− 29	2¾	2¾	,, 31	6,159	1,992,647	206,358	82	7 14	2,239	—
Newcastle-on-Tyne Corporation	,, 14	3,928	3,876	+ 52	+ 589	50	50	,, 31	197,849	43,06 ,934	4,326,152	1 07	10 98	3,957	7·0
Newport (Mon.) Corporation	,, 7	672	566	+ 55	+ 1 880	15¼	15¼	,, 31	30,356	7,252,535	783 435	—	9 29	—	6·4
Oldham Corporation	,, 8	1 805	1,744	+ 61	+ 4,550	34	34	,, 25	65 553	13,466,245	1,504,740	1·16	10·45	1,886	—
Portsmouth Corporation	May 25	2,330	1 578	+ 752	+ 632	28½	28½	,, 31	95,702	19,625,329	197,499	1·17	11·63	—	—
Reading Corporation	Dec. 5	567	558	+ 9	− 788	33½	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	11·29	21·29	,, 31	14,881	2,837,110	386,547	1·24	9·24	1,102	7·92
Rotherham Corporation	—	—	—	—	—	9½	9½	,, 31	23,569	5,251,472	593,054	1 07	9 53	2,612	7·49
Salford Corporation	,, 16	4,338	4,038	+ 240	+ 4,730	70¾	70¾	,, 31	214,111	39,213,560	4,894,590	1·28	10 29	—	—
Scarborough Tramways Co.	—	—	—	—	—	4½	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 15	5,507	5,192	+ 315	+ 9,720	35¾	35¾	,, 25	240,565	63 952,283	,049,899	903	9 543	3,653	5·94
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,365	9 294,771	1,108,369	1·27	11·02	—	7 83
Southend-on-Sea Corporation	,, 18	262	240	+ 22	—	9	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	,, 31	39,550	6,766,031	1,027,730	—	9 23	—	4·75
Sunderland Corporation	,, 15	1,203	1,193	+ 15	− 1,119	20	20	,, 31	64,858	15.364 463	1,495,685	1·004	10·36	—	6 37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	4,937	1,315,757	102,751	0·87	11 53	1,3	—
Torquay Tramways	Dec. 5	177	—	—	—	5 16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 14	747	742	+ 5	+ 689	12 68	12·43	,, 31	43,607	7,995,451	862,12	9·27	12·14	3,1	7·5
Warrington Corporation	—	—	—	—	—	9	9	,, 31	17,057	4,418 225	403 363	—	9 83	—	6·33
West Ham Corporation	,, 19	2,269	2,179	+ 90	+ 1,747	14·7	14 7	,, 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	,, 18	789	831	− 42	+ 170	20	20	,, 31	41,905	8,847,066	950,338	—	10 583	2,0	6·1o

And 98 miles of interlacing track. a Train mile. b Per mile of single track. c Mile of route. h Half-year's figure k Double track

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers.

QUESTIONS.

985. Discuss the advisability or necessity of providing an inverted rotary converter with separate excitation supplied by a direct-driven unsaturated exciter.—P. R. BOULTON.

ANSWERS.

Question No. 974.—In a factory there is at present installed a number of motors of all sizes, both series, shunt, and compound wound, used on a 300-volt circuit. It has been decided to change over to 500 volts. Would it be necessary to rewind both armatures and field coils? Explain fully what would have to be done so that the old machines could be used, and also give approximate cost of altering any one machine.

Best Answer to No. 974 (awarded 10s.).—An alteration in the voltage of supply, such as outlined above, is generally accompanied by considerable expenditure, as it would be necessary to rewind the field coils and armatures of the existing motors in order to obtain satisfactory operation and efficiency on the higher voltage. In the case of a factory having a considerable number of motors installed, this rewinding is a very serious item, and in some cases the supply company have found it to their advantage to install converting plant, so that the original motors and controllers may be used. Considering the case of the above factory, the following combinations are possible, so that the increased supply voltage may be dealt with: (1) installation of converting plant, consisting of either (*a*) motor-generator set or (*b*) combination of balancers and booster; (2) rewinding the armatures of motors, but using

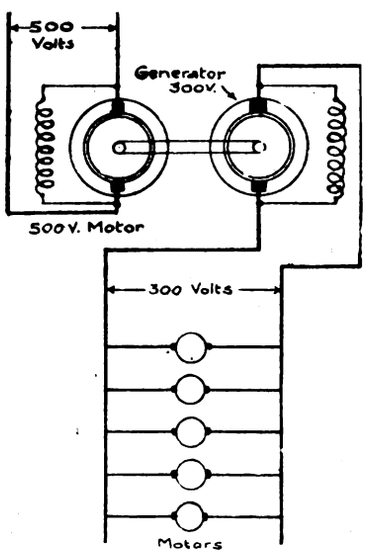

FIG. 1A.

existing field coils, with a resistance to cut down the voltage across field down to 300 volts; (3) rewinding both armature and field coils for 500 volts.

1. *Converting Plant.*—With a large number of motors it would probably be more economical to install converting plant than to rewind the motors, since, if the latter procedure be adopted, the starting apparatus for the motors will also have to be modified for operation on 500 volts. The scheme (*a*), Fig. 1A, of a motor-generator would involve the installation of a pair of somewhat large machines, as the generator of the set would have to be capable of supplying the whole of the motors at 300 volts. This generator would, of course, be driven by a 500-volt motor preferably direct-coupled, the full-load efficiency of such a set being from about 75 to 83 per cent. according to the size of the machines. With the arrangement (*b*), shown in Figs. 1B and 1C, the converting plant is of a smaller size than a motor-generator set, but an additional machine is required. The set shown in Fig. 1C comprises a balancer, consisting of two special machines wound for 300 and 200 volts respectively, together with a booster, the latter

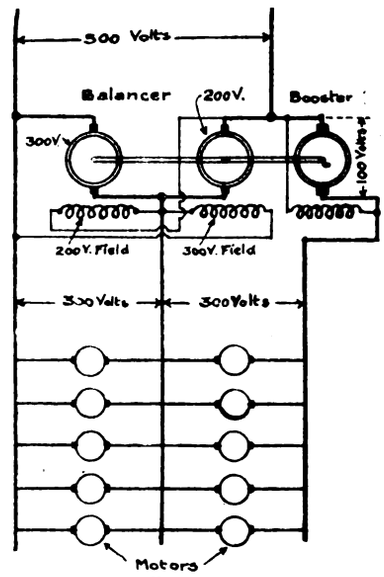

FIG. 1B.

being capable of dealing with the heaviest current on one side of the system. The scheme of Fig. 1C is, however, to be preferred, although a slightly larger booster is required, since in this case the balancers are similar machines. With such a three-wire system it will be necessary to carefully group the motors on each side, so that the out-of-balance current may be as small as possible, thereby reducing the size of the balancer. If, however, there is a possibility of no motors being run on one side, then the balancer will have to be capable of dealing with the out-of-

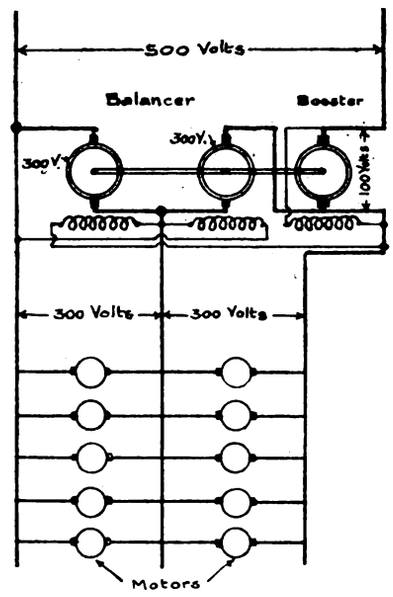

FIG. 1C.

balance current corresponding to the number of motors running on the other side at the same time. With the above schemes the motors will be operated under existing conditions at 300 volts per motor. If the motors are conservatively rated, an alternative scheme, dispensing with the booster, would be to run the motors at 250 volts on a three-wire system, the only addition necessary being a balancer. This arrangement would, however, result in a slightly decreased motor efficiency, and also a somewhat greater armature heating, since, in order to work the

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motors up to their full-load output at 200 volts, the current taken would be 20 per cent. greater than the full-load current at 300 volts. The speed of the motors would also be about 10 per cent. lower than the normal when running at 250 volts.

2. *Partly Rewinding the Motors.*—If the above schemes cannot be put into operation, the next scheme would be to rewind the armatures of the shunt and compound motors for 500 volts, exciting the shunt fields at this voltage with a resistance in series to cut the field current down to the normal, corresponding to 300-volt excitation. This will require a knowledge of the field resistance, and it would, therefore, be advisable to measure the shunt field current at 300 volts when the motors are cold. If this current be c, then the hot field resistance will be approximately $\frac{1{\cdot}2 \times 300}{c}$. The additional resistance, r, to be inserted in series with the shunt field when excited from 500 volts will, therefore, be given by $\frac{1{\cdot}2 \times 300}{c} + r = \frac{500}{{\cdot}833\,c}$, giving r as $\frac{240}{c}$. (This expression is based on a zero temperature coefficient for r.) This arrangement of exciting the existing fields from 500 volts leads to a slight decrease in the efficiency of the motors, but this decrease is very small, as will be seen from Fig. 2, which gives the full-load efficiency of motors under normal conditions, and also the loss in the additional field resistance. Fig. 2 shows also the approximate value of the additional

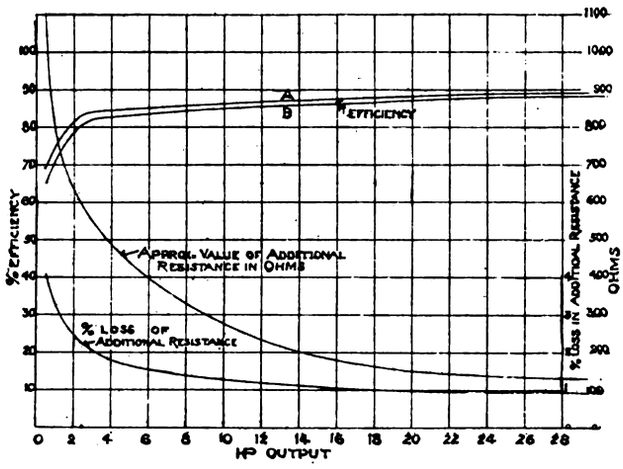

FIG 2.—Full-Load Efficiency Curves for various sizes of Motors. A, Efficiency Curves for normal conditions (300 volts) B, efficiency Curves when fields are excited from 500 volts with a resistance in series The value of this additional resistance and the per cent loss on it (reckoned on the full load of motor) are given in the lower curves.

resistance, r, for various sizes of *shunt* motors. The armatures will, however, have to be entirely rewound, as with the present armatures running on 500 volts the speed would be 66 per cent. higher than normal. The voltage between commutator segments, and also the reactance voltage, would be increased in the same proportion. It is the practice of several manufacturers to use the same commutators on small motors for voltages between 200 and 500, thus reducing the number of "stock parts," the number of segments being determined for 500 volts, and the active length for 200 volts. The number of segments in the commutator is determined from the permissible values for the voltage per segment, which is given by $\frac{V \cdot p}{n}$, where V is the voltage between brushes, p the number of poles, and n the number of segments. The voltage per segment should not exceed 12 to 15 volts for small 500-volt shunt motors, and a lower limit should be fixed for larger motors. In rewinding the armatures for 500 volts, assuming that the same commutators may be used, the new armature conductors will have to carry 40 per cent. less current than the present ones, and will require to be increased in number by 66 per cent. of the conductors at present on the armature. The nearest approach to these conditions, where the number of turns per coil is odd, and not a multiple of three, would be to wind one half of the new coils with one more turn per coil than the other half, thus increasing the number of turns on the armature by 50 per cent. (see Table I.). The speed of the motor in this case will be thereby increased by 16 per cent. above normal, and if this is not permissible, the only alternative is to rebuild the commutator, putting in 16 per cent. more segments.

TABLE I.—Showing number of conductors per slot for the 500-volt armatures, using the present 300-volt commutators.

Number of turns per coil on present 300-volt armature.	1	2	3	4	5	6	8	9	10	12
Number of turns per coil for 500-volt armatures, and same speed as 300-volt armature.	—	—	5	—	—	10	—	15	—	20
Number of turns per coil for 500-volt armatures, when 66 per cent. increased turns are not possible.	2 and 1 *	3	—	6	7 and 8 *	—	12	—	15	—

* One-half of the coils to be wound with one more turn than the other half, and assembled alternately on armature core.

Compound-Wound Motors.—If the present spools on these motors are used, the amount of compounding will be reduced by about 40 per cent. when running on 500 volts—*i.e.*, if the drop in speed from no load to full load is 25 per cent. of the full-load speed when running on 300 volts, this will be reduced to about 15 per cent. when developing full load on 500 volts. The torque available from the motor is thus slightly reduced, which should not be objectionable unless the load has heavy fluctuations, in which case more series turns would have to be added to the field coils.

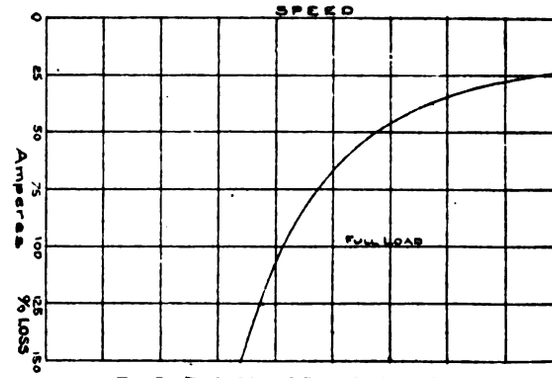

FIG. 3.—Typical Speed Curve for Series Motor.

3. *Totally Rewinding the Motors.*—This involves dismantling the motors completely, and is a very expensive procedure where the number of motors is considerable. The armatures will be rewound in the same way as for scheme 2.

Shunt Spools.—If the exciting spools have N turns, and the conductor has a sectional area a, then the new spools will be wound with 66·6 per cent. more turns, and a conductor having a sectional area of ·6 a, or a diameter of ·775 d, where d is the diameter of the wire on existing spools. It has been assumed, in obtaining this ratio, that the mean length of turn is the same in both the existing and new spools.

Compound Spools.—The shunt winding will be modified as shown above. The new series winding will have 66·6 per cent. more turns than existing spools, the cross-section of the conductor being only 60 per cent. of that on present spools.

Series Motors.—The armatures and field coils would both require rewinding in any case for the present motors to run on 500 volts. The armatures will be rewound as in scheme 2. Before rewinding the fields it would be preferable to obtain a speed curve on the motor, similar to that in Fig. 3. The flux can be deduced from such a curve by the expression: M [flux in megalines per pole] =

$$\frac{3{,}000\,[V - C\,(R_a + R_m)]}{T \cdot N \cdot p},$$

where V is the terminal voltage; C the current; R_a, R_m the resistances of the armature and field respectively; T the number of turns in series between the brushes; p the number of poles; and N the speed in revolutions per minute. When the flux has been determined, the number

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of turns on the new spools may be computed, so that the full-load speed of the motor may be the same when running on 500 volts as on 300 volts.

Cost.—The cost of rewinding will largely depend on the type of armature, spools, etc., so that it is practically impossible to give any predetermined costs. The curves of Figs. 4A and 4B are of interest in this connection, the former giving the cost of various sizes of motors, together with that of the armature, field coils, and commutator, and the latter the cost of armature, commutator, and field coils

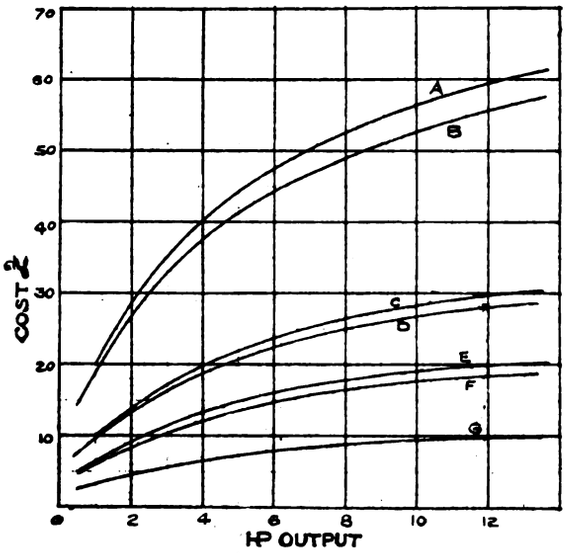

FIG. 4A.—Comparative Costs of Various Parts of Small Motors. A, total cost of 500 volt motors; B, total cost of 300-volt motors; C, cost of complete armature of 500-volt motor; D, cost of complete armature of 300-volt motor; E, cost of complete field coils of 500-volt motor; F, cost of complete field coils of 300-volt motor; G, cost of commutator (complete)

as a percentage of the total cost of the motor. The drop in the curve for spools (Fig. 4B) above 10 h.p. is due to a different type of motor. The curves of Fig. 4A must only be taken as comparative, as the cost will depend largely on the speed and type of motor. From these curves, however,

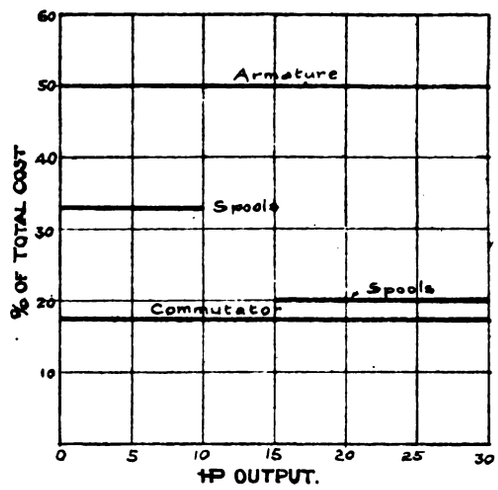

FIG. 4B.—Cost of Complete Armature, Commutator, and Spools in per cent. of total cost of motor (all voltages).

an approximate idea of the cost of rewinding can be obtained.—A. E. T.

Question No. 975.—In a tramway station using negative boosters (series machines) an automatic device is arranged so that in the case of the armature circuit of the booster motor being opened, a relay opens the booster circuit. What is the object of this? Would the booster have any tendency to run away if the relay did not operate?

Best Answer to No. 975 (awarded 10s.).—In all plants where low-voltage boosters are installed there should be ample provision made to disconnect the booster from the supply in case the circuit of the driving motor be opened. The result attending the non-observance of this rule generally leads to the destruction of both motor and booster, as when the motor circuit is opened the booster becomes a motor, and, being unloaded and in series with the supply, the counter E.M.F. of its armature gradually reduces the line current, thereby increasing the voltage applied to the armature, until finally (assuming that the armature does not burst) the booster armature has practically the full-line voltage across it. If the normal voltage of the booster is, say, 10 per cent. of the line voltage, then the speed under these conditions would be approximately 10 times normal speed, even if the booster be separately excited to normal flux. It is, of course, obvious that the armatures would burst before this speed was attained, thereby resulting in the wreck of the booster and any other apparatus in the immediate vicinity. A consideration of a specific case will lead to a clearer understanding of the above phenomena. We will, therefore, consider two schemes, both of which are largely used in tramway stations—viz.: (*a*) the positive or line booster, which raises the voltage of the generators and compensates for the "drop"

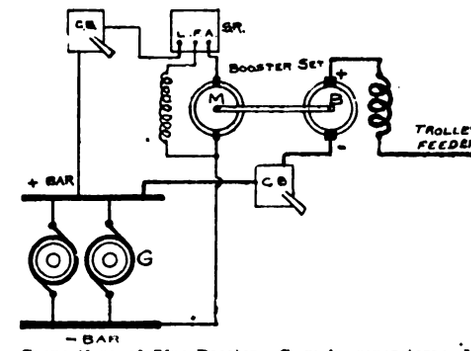

FIG. 1.—Connections of Line Booster. G, main generators; M, booster motor; B, booster; C B, circuit breaker; S R, starting rheostat.

in the feeders; (*b*) the negative booster, used for reducing the "drop" in the return.

(*a*) The diagram of Fig. 1 shows the connections for a line booster as used in traction work. The booster is a series-wound generator, the armature and field being in series, so that the voltage booster is (until the saturation of the magnetic circuit is reached) practically proportional to the outgoing current. The voltage of the booster at a certain current is arranged to equal the drop in the feeder at that

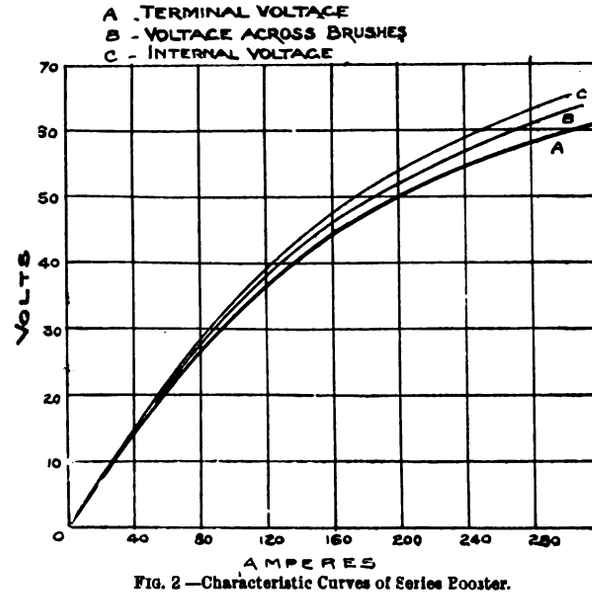

FIG. 2.—Characteristic Curves of Series Booster.

current, thereby maintaining a practically constant line potential at the far end for all loads. The booster is usually driven by a shunt-wound motor running off the 500-volt line. For the purpose of this discussion we may assume that the booster has the following rating: 10 kw., 50 volts, 200 amperes, 1,000 r.p.m., for which Fig. 2 represents the saturation and characteristic curves. We will also assume that the load circuit contains no counter E.M.F., so that the current is proportional to the applied E.M.F., thereby simplifying matters. Consider now the effect of opening the circuit of the driving motor. If there be no current flowing through the booster, then the set will slow down in speed, and finally stop. If, however, the booster is loaded, then we shall observe the following phenomena. The booster set will slow down and come to rest, when it will immediately start off in the other direction of rotation at an

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ever-increasing speed, the booster now running as a motor. The voltage across the booster armature will decrease as the set slows down, and, passing through zero, will increase in the negative direction, the rate of negative increase being dependent on the speed and flux. Under these conditions the back E.M.F. generated in the armature will oppose the voltage of supply, thereby decreasing the current and increasing the voltage applied to the armature, therefore the speed and back E.M.F. This state of affairs will continue until there is practically the whole voltage of supply across the booster armature, but with series boosters the bursting stage is reached long before these conditions are approached. The curves of Fig. 3 are of interest, however, as showing a hypothetical case for the above booster, when the driving motor is shut down with the booster working at full load.

(*b*) With negative boosters operated as track boosters, we have slightly different conditions from the above case just considered. The diagram of Fig. 4 shows the scheme generally adopted. In this case it is usual to connect the series field of the booster in with the trolley feeder nearest the point of the track to which the booster armature is connected. The booster is, therefore, separately excited, but

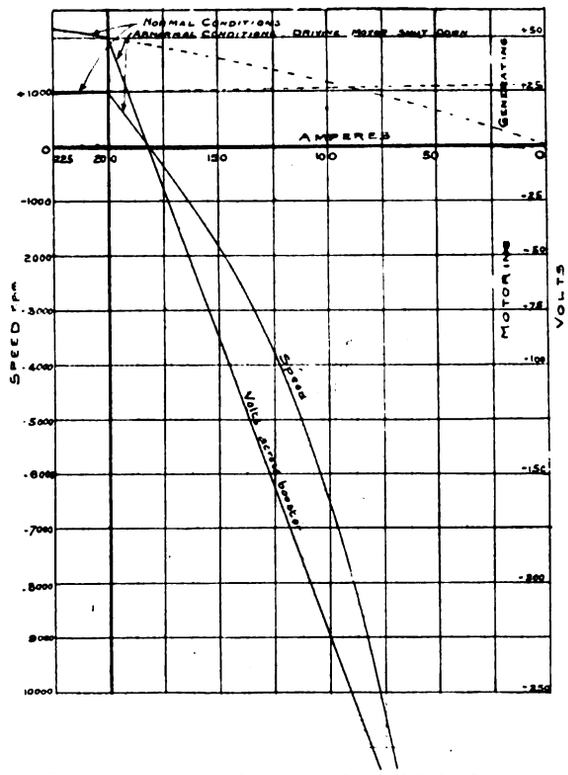

FIG. 3.—Curves showing Rise in Speed and Voltage of Series Booster (working on full load) when the circuit of the driving motor is opened, but booster still remaining on the line.

at a varying excitation, depending upon the load on the trolley feeder. Generally the series field is shunted by an adjustable diverter, so that different compensations may be obtained for the rail drop with a given current in the trolley feeder. At its normal load the magnetic circuit of the booster is worked below saturation, so that the voltage generated is practically proportional to the current in the field coils. When the booster is in operation, the E.M.F. generated in its armature opposes the voltage due to the current returning by the track rails, allowing, however, a resultant of seven volts in favour of the track rails under the maximum station load, thereby fulfilling Rule 7 of the Board of Trade. Part of the current, therefore, returns through the track, but generally the greater part returns through the booster.

On opening the circuit of the driving motor, we should find that the booster would slow down, stop, and reverse, running as a motor on the voltage due to the drop in the track rails, since the counter E.M.F. of the booster armature now tends to force the current into the rails. The speed of the booster, even with normal full-load excitation on the fields, would, therefore, be higher than normal, due to the voltage applied to the armature being higher than the normal full-load voltage as a result of the excessive drop in the track rails. If, however, the field excitation decreases, there is a considerable danger of the booster reaching a dangerous speed, since the voltage drop in the track would probably not decrease in the same ratio as the field excitation.

It is, therefore, necessary to provide a device that will in all cases disconnect the booster should the circuit of the driving motor be opened. Various devices are in use to fulfil these conditions, a general one being a centrifugal attachment fitted to the shaft of the booster, and adjusted

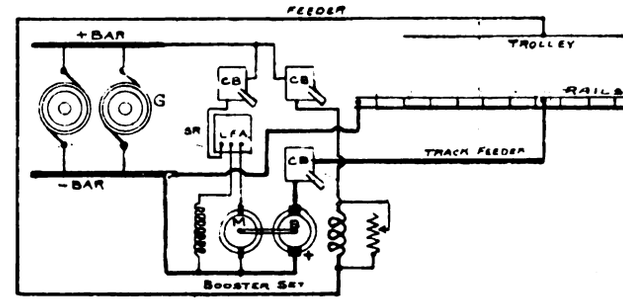

FIG. 4.—Connections of Negative Booster. G, main generators; B, booster; M, booster motor; C B, circuit breaker; S R, starting rheostat.

to close the circuit of a shunt trip coil fitted to the booster circuit breaker when the booster reaches a predetermined speed. Another device consists in interlocking the circuit breakers of motor and booster, either mechanically or electrically. In the latter case the opening of the motor circuit breaker closes a small auxiliary switch, which either closes the circuit of a shunt trip coil on the booster circuit breaker or short-circuits a no-voltage release coil attached to this circuit breaker. The connections for these devices are shown in Figs. 5 A, B, C, the first and second examples showing the centrifugal device operating respectively a shunt trip coil and a no-voltage release coil attached to the booster circuit breaker. The no-voltage release coil is, of course, operated on the 500-volt circuit, a

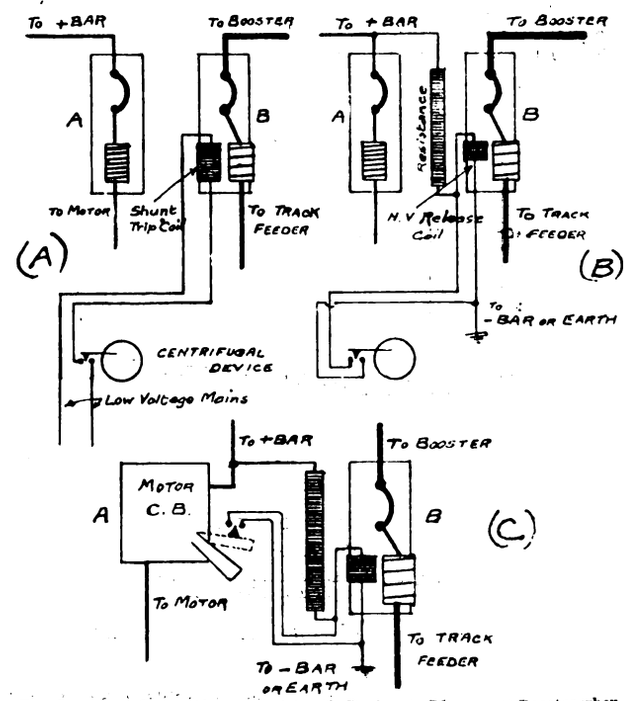

FIG. 5 A, B, C.—Connections of Automatic Devices to Disconnect Booster when driving motor is shut down. A, motor circuit breaker; B, booster circuit breaker.

high resistance being in series with it, but the shunt trip coil should preferably be excited from a circuit of lower voltage. The diagram of Fig. 5C shows an electrical interlocking arrangement, an auxiliary switch being closed by the opening of the motor circuit breaker, thereby short-circuiting the no-voltage release coil on the booster circuit breaker. In the latter case the booster circuit breaker cannot be closed unless the motor circuit breaker is already closed.—A. E. T.

[Other replies to Question No. 975 will be given in our next issue.—ED. *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

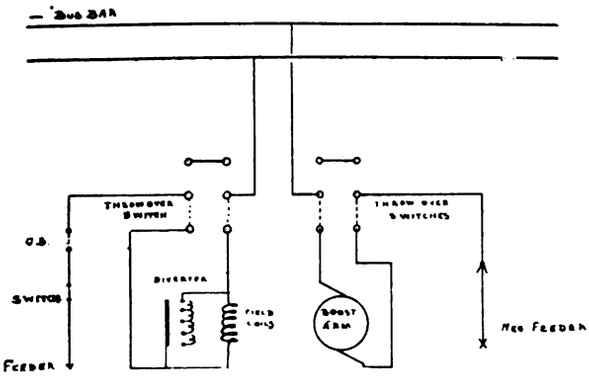
QUESTIONS.

986. Give a description of condensers for static ground detectors for alternating-current high-tension circuits, with sketches showing details of construction (of condensers) and connections to the circuit.—O. L. R.

ANSWERS.

Question No. 975.—In a tramway station using negative boosters (series machines) an automatic device is arranged so that in the case of the armature circuit of the booster motor being opened, a relay opens the booster circuit. What is the object of this? Would the booster have any tendency to run away if the relay did not operate?

Answer to No. 975 (awarded 5s.).—The object of having a relay arranged to open the booster circuit in the event of the motor circuit being opened is to prevent the possibility of the machine reversing and racing. Negative boosters are generally connected up so that the positive feeder or feeders for a certain area go through the booster field coils, and the negative feeder or feeders for the corresponding area through the booster armature. As the load on the positive feeder for that area increases, so also the booster field strength increases, which increases the armature volts so as to draw the current from that area back through the negative feeder for that area. As to whether the machine would reverse and race or not depends on the current in the armature and field coils. The current in the field coils varies as the demand on the positive feeder. The factor on which reversal and racing greatly depend is the proportion of the return (armature) current to the outgoing (field coil) current when the machine is not boosting, which at one time may be high enough to cause the machine to reverse and race, and at another time it may not, just according to circumstances.



Now, suppose in a station where there are a number of negative boosters—say three—which are connected up as described above, each booster having a separate area of its own. All three negative boosters are running, and No. 2 booster motor circuit breaker trips (no relay for opening booster circuit being fitted). If when the machine is not boosting there is only a small percentage of the positive feeder (F coil) current returning through No. 2 negative feeder (armature), the machine will probably not even move. But should the percentage of armature current get at all high, as might be the case if all three negative boosters cut out together, causing No. 2 negative feeder to take its share of the return current, the machine will reverse and possibly race. But the following is when the machine is most likely to race. If No. 2 negative booster has a diverter connected across its field coils, as shown in the diagram, should the load on No. 2 negative feeder at any time get so heavy as to cause overloading of No. 2 negative booster motor, then part of the booster field current can be diverted from the field coils, thus weakening the booster field and reducing the booster volts, thereby reducing the load on the booster motor. With a large proportion of the field current diverted the booster field is weakened, so with a heavy armature current (which it is possible to get if all three boosters cut out) and a weak field the machine will race, of course running in the reverse direction. Hence the object of the relay which you mention is to prevent reversal and racing.—J. C. H.

Answer to No. 975 (awarded 5s.).—The object of the relay is, as suggested, to prevent the booster being converted into a series motor, and running away in case the motor current is cut off. The connections of such a booster are shown in Fig. 1. A part of the tramway current

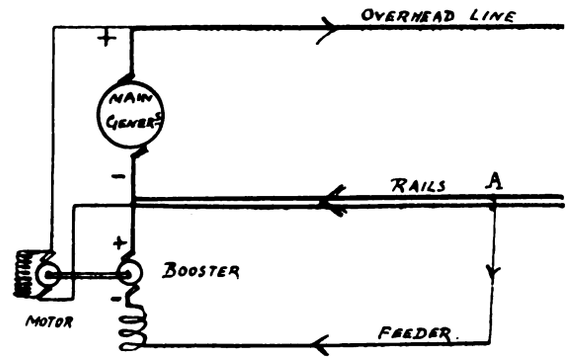


FIG. 1.

returns to the station 'bus bar through the booster under the action of the booster E M.F. less the voltage drop between the feeding point, A, and the 'bus bar. If, now, the booster motor ceases to supply energy, the first direct result will be a fall in the speed of the set. This lowers the booster volts, and the amount of current returning by the feeder falls. The booster set very soon pulls up, and its condition for an instant then is that of a series dynamo at rest, with a current passing through it under the action of the voltage difference existing between A and the 'bus bars, when the rails carry practically all the return current. The booster will, therefore, at once start up as a series motor, running in the reverse direction from the normal, because the direction of current, both in field and armature, is the same as when the machine was generating. The speed will increase until the back volts set up in the booster armature are practically equal to the volts between A and the – 'bus bar. Since the current passing through the booster will then only be that required to drive it and its motor light, the booster field will be very weak, and the speed reached will be excessive, especially if the normal voltage for which the booster is designed is equal to or less than the voltage drop to A. The fact that the rails have to carry not only their normal share of the return current, but also that portion which would usually return by the feeder, increases the volts between A and the 'bus bar, and adds to the danger of an excessive speed being reached.—Q.

Answer to No. 975 (awarded 5s.).—Perhaps the best way to answer "L. C. C.'s" question is to state what actually occurred in the writer's experience, and let the facts speak for themselves The negative booster in question was connected up as shown in the diagram, the only safety device of any sort being the automatic cut-out protecting the booster motor armature. This machine had been running without trouble for some time, until one day the motor automatic breaker operated for some reason or other (which does not actually affect the point in view). The machine suddenly pulled up dead, reversed, and attained a

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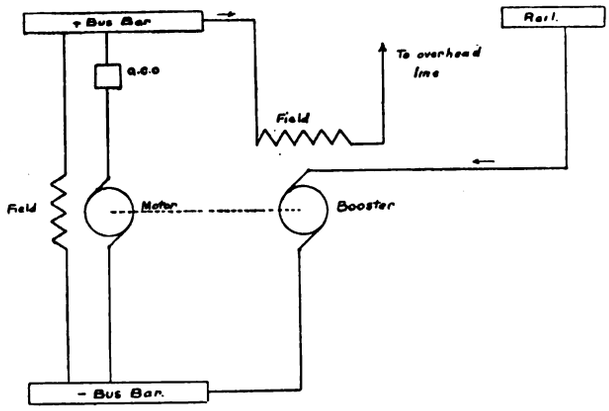
very high speed, and almost before the situation could be grasped the armature burst and scattered all over the engine-room. The reason for this is not very far to seek. The current returning from the rail through the booster armature tends to resist the rotation of the latter, the machine being nothing more or less than a series dynamo.



Now for some reason or other the source of motive power is taken away, due to the motor automatic breaker operating. The booster armature is now free to act to the dictates of its field; the machine pulls up dead and then reverses, and we now have the phenomena common to a series motor which has suddenly lost its load. This, then, makes apparent the necessity of providing a relay to open the booster circuit, to be automatically operated in the event of the motor breaker coming out.—S. ROSEVEARE.

Question No. 976.—In the design and construction of series transformers for use with relays, meters, or instruments, what are the salient points to look after to obtain the same ratio between primary and secondary currents from one-twentieth of full load to 50 per cent. overload? How much can the external resistance (in the secondary circuit) be varied without altering the ratio more than 2 per cent. on a well-designed series transformer? Give sketches showing shape of punchings, and also the best saturation of the iron to work at at full load.

Best Answer to No. 976 (awarded 10s.).—The vector diagram for the series or current transformer when working at full load is shown in Fig. 1, where O C_s represents the

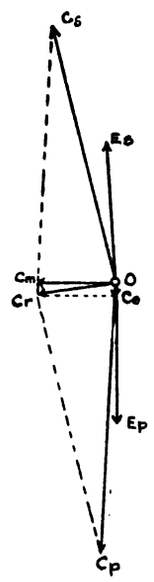


FIG. 1.

secondary current corresponding to full-load working conditions; O C_p, the primary current at normal load; O C_m the magnetising current; O C_e, the core loss current; O C_r, the resultant of magnetising and core loss currents; O E_p, the primary E.M.F.; O E_s, the E.M.F. of the secondary winding corresponding to the full-load secondary current.

The secondary current is not quite 180deg. behind the primary current on account of the magnetising and core loss currents, which introduce an error in the ratio, the magnitude of the error being $\frac{O\,C_p - O\,C_s}{O\,C_p}$. With given values for the magnetising and core loss currents, the minimum error will be introduced when O E_s is in phase with O C_s—*i.e.*, when there is no phase displacement of the secondary current, or, in other words, when the reactance of the transformer is zero. We have, therefore, three quantities affecting the ratio of the series transformer—viz.: (1) the magnetising current; (2) the core loss; and (3) the phase displacement of the secondary E.M.F. due to the impedance of the secondary circuit. In order that the error in ratio may be a minimum from the first two causes, we must have a minimum core loss and magnetising current. The core loss is made up of the hysteresis loss and the eddy-current loss, the former being given by: hysteresis loss in ergs per cycle and per cubic centimetre of core = $\eta\, B^{1\cdot6}$, or hysteresis loss in watts = $B^{1\cdot6}$. V . $\sim \times 3 \times 10^{-10}$, B being the maximum density in C.G.S. lines per square centimetre, V the volume of the core in cubic centimetres, and $\sim$ the frequency in cycles per second. The eddy current loss in watts is given by

$$V \,.\, B^2 \,.\, \sim^2 \,.\, t^2 \times \frac{1{\cdot}65 \times 10^{-11}}{1 + {\cdot}0045\,\theta},$$

which takes into account the temperature, θ, of the core, t being the thickness of the punchings in centimetres. This formula only takes into account the eddy-current loss in the separate laminations, and assumes that the laminations are insulated from each other. The total core loss is, therefore, given by

$$V \,.\, \sim \times 10^{-10}\left\{3\ B^{1\cdot6} + B^2 \sim t^2 \times \frac{1{\cdot}65 \times 10^{-1}}{(1 + {\cdot}0045\,\theta)}\right\} \text{ watts.}$$

In order that this may be a minimum, B, V, and t must be reduced to their limiting values, which generally results in working at a low density in the core rather than increasing the density and obtaining a decrease in the volume, as the core loss is proportional to the second power of the induction, B. A careful selection of the iron is, therefore, necessary, which should be of a thickness not exceeding ·014in. (·55mm.), and especial attention should be given to the chemical composition in order to avoid troubles due to "ageing."

The magnetising current, O C_m (Fig. 1), is given by

$$C_m = \frac{\Phi\,R}{\sqrt{2}\,.\,N} \times \frac{10}{4\,\pi} = \frac{{\cdot}567\,\Phi\,R}{N},$$

where Φ is the minimum value of the flux, N the number of turns in the primary, and R the magnetic reluctance of the circuit. Since $R = \frac{l}{a\,.\,\mu}$, the expression for magnetising current may, therefore, be written $\frac{C_m = {\cdot}567\ \Phi\,.\,l}{N\,.\,a\,.\,\mu}$, l, a, being the length and cross-section respectively of the magnetic circuit, and μ the permeability of the iron at the flux, N. This expression, incorporating the reluctance in terms of $\frac{l}{a\,.\,\mu}$, assumes that the circuit is jointless. The effect of a joint is equivalent to a very small air-gap, and if the length of this be $\delta\,l$, then the corrected value for the reluctance becomes

$$\left(\frac{l - \delta\,l}{a\,.\,\mu} + \frac{\delta\,l}{a}\right) \text{ or } \frac{l + \delta\,l\,(\mu - 1)}{a\,\mu}.$$

In order that the magnetising current may be a minimum the magnetic circuit must be jointless, and of such a shape that a minimum value is obtained for l, which conditions lead to the design of a ring type of transformer. The secondary winding is wound next to the core, and should be uniformly distributed. For transformers of different ratio, the number of secondary turns should be divisible by as many whole numbers as possible, so that the ratio may be varied by altering the number of primary turns.

The change in the ratio of the series transformer for different values of the secondary impedance is a very important point, and one of primary importance where accurate results are required. The increased impedance of the secondary, due to the introduction of external resistance or reactance, necessitates an increase of secondary voltage, and, therefore, of flux in the core. This increased flux increases the core loss and magnetising current. The increase of the latter, however, may be counteracted by working the core at a very low density, so that the

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increased flux does not require a proportionate increase in the magnetising current.

The ratio in the neighbourhood of full load is less subject to error from the increase of the secondary impedance than at lower loads, since the permeability of the iron is not constant, and, therefore, the angle of lag of secondary current behind the secondary E.M.F. does not decrease in proportion to the load. This variation in ratio has been investigated by Mr. H. B. Taylor in a recent number of the *Electric Journal** (vol. iv., p. 234), and the curves of Fig. 2 are compiled from the results of some experiments which he made on a series transformer under various conditions of external secondary impedance. Of course, such a severe treatment is not likely to occur in ordinary practice, as the number of instruments operated by one transformer

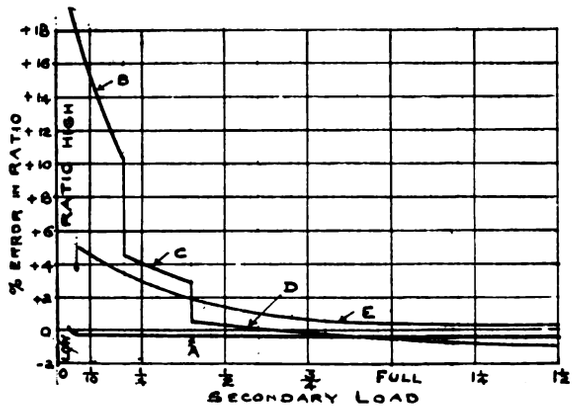

FIG. 2.—Variation of Ratio of Series Transformer with Different Impedances in Secondary. Curve A, integrating wattmeter in secondary circuit; B, 1-ampere ammeter in secondary circuit; C, 2-ampere ammeter in secondary circuit; D, 10-ampere ammeter in secondary circuit; E, secondary impedance constant and equal to that of 2·5-ampere ammeter.

is generally limited. The curves of Fig. 2 are also of interest as showing that, as the condition of a short-circuited secondary is approached, the ratio of the series transformer is more correct over its maximum range. The impedance of the series coil of the integrating wattmeter used in Fig. 2 was much lower than that of the ammeters used, while the impedance of the latter may be considered to vary in the inverse proportion to the square of the capacity for instruments of the same type. It is, therefore, considered the best practice in switchboard work to install separate series transformers for operating the integrating wattmeters, thereby maintaining a constant ratio over the whole range of loads through which the wattmeter is designed for. In order to avoid the additional cost of separate transformers for the wattmeters, a type of series transformer is now made having one primary and two secondary windings, each

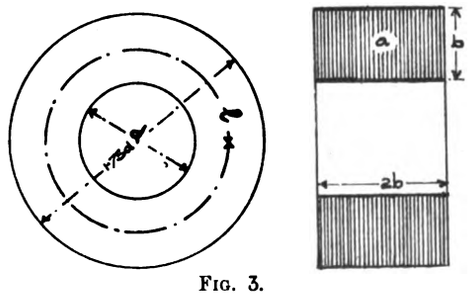

FIG. 3.

secondary being wound on an independent core, so that the ratio of one side is not affected by the load on the other.

The effect on the ratio of the insertion of resistance or reactance into the secondary of a series transformer can be calculated when the magnetising current and core loss curve have been determined, the secondary winding being open-circuited for these tests. The secondary voltage necessary in order to give the normal full-load secondary current through the external resistance and the impedance of the secondary winding is calculated in the ordinary way, and the magnetising current and core loss obtained from the curves for this voltage. A vector diagram is constructed to correspond to full-load conditions, when the ratio may be determined. Series transformers intended for working with a high secondary resistance necessarily differ from those intended for a low resistance, but it is possible to design a transformer to work with a secondary external resistance of as much as 300 ohms, in which the ratio at full load with this resistance is only 4 per cent. higher than that with the secondary winding short-circuited. With 100 ohms external resistance, the error at full load is reduced to less than 2 per cent.

The salient features in the design of a series transformer are, therefore, (1) minimum core loss and magnetising current—*i.e*, first quality iron—and punchings carefully japanned; (2) magnetic circuit to be jointless and to have as short a length as possible; (3) the iron to be worked at a very low saturation, the density at full load being about

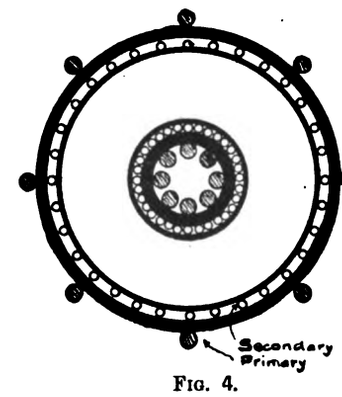

FIG. 4.

500 C.G.S. lines per square centimetre; (4) the secondary winding to be wound next to the core and uniformly distributed; (5) the current density in the windings to be as high as is consistent with safety, so that the space occupied may be a minimum, thereby reducing the length of the magnetic path; (6) the impedance of the secondary to be a minimum, and the secondary to be operated at as near short-circuit conditions as possible.

The punchings are generally of the ring type as shown in Fig. 3, where appropriate proportions are given, while Fig. 4 shows the arrangement of primary and secondary windings.—C. T.

Answer to No. 976 (awarded 7s. 6d.).—It is impossible to get in practice a series transformer on which the ratio is absolutely constant from one-twentieth to 50 per cent. overload, but it is possible to get one on which the error between the loads stated is negligible. The following are the salient points to be looked after in designing a series transformer on which the error in ratio of transformation is negligible between the loads given. (1) The iron loss should be small; this means a small weight of iron, a suitable density, and quality of iron. (2) The magnetising current must be small; this means that the mean magnetic path must be small, as few joints as possible, and where they do occur they must be well made. (3) The primary and secondary windings must be placed relative to one another so that magnetic leakage is reduced to a minimum. (4) The watts lost in the windings must be small, densities of the order of 1,000 to 1,250 per square inch of copper being good practice. These are the points to be watched in order to get correct ratio at the loads given. There are three other points that should be looked after in addition to the above, which are of great importance. These are: (5) The insulation must be good, and there should be no chance of a breakdown between primary and secondary, when the voltage of the system to which the transformers are connected is high. (6) The primary and secondary currents should have as nearly as possible a phase difference of 180deg.; this is highly important on transformers for the operation of wattmeters, especially when the wattmeters are not calibrated with the series transformers. If the phase relationship differs from 180deg., it will be seen that the secondary current would be out of phase with the voltage across the wattmeter terminals when the wattmeter is connected to a circuit whose power factor was 1, thus introducing an error. This is not so important when the transformer is to operate an ammeter, which can be calibrated with its transformer. (7) The design should be

* See also a short note in the *Electrical Engineer*, May 24, 1907, 710.

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one which can be cheaply manufactured; this is important when manufacturing for the market. There are two types of transformers—the shell and core types. The core type is the one generally adopted, as it fulfils items (1) and (2) easier than the shell type.

The impedance which can be put on the secondary side of a series transformer without introducing an error of more than 2 per cent. depends on what the transformer is designed for. For example, in a set of well-designed transformers, with 300 to 500 ampere-turns they will operate at 50 periods instruments and apparatus which do not require more than 10 volt-amperes, without introducing an error of more than 2 per cent.; with 700 to 900 ampere-turns, instruments and apparatus which do not require more than 50 volt-amperes, without introducing an error of more than 2 per cent.; with 1,200 to 1,800 ampere-turns, instruments and apparatus which do not require more than 150 volt-amperes, without introducing an error of more than 2 per cent. The variation in ampere-turns depends on the primary current. Thus 300 to 500 ampere-turns size, for a primary current of 200 amperes, two primary turns would be put on, for 500 amperes one turn, and so on.

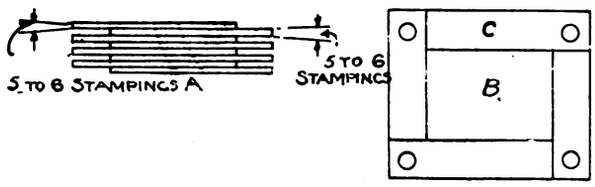

FIG. 1.

The best saturation to employ depends to a large extent on the quality of iron employed, but densities of the order of 3,500 to 6,000 have given good results on 50-period transformers in practice. Series transformers are manufactured for use on circuits of 25 to 100 periods; it will thus be seen that if the transformers were rated at the same output on all these periodicities, the saturation would vary considerably. Thus at 25 periods it would be double what it was at 50 periods, and thus, if transformer was satisfactory at 50 periods, it would be unsatisfactory at 25 periods. To meet this, manufacturers rate their transformers lower on the lower periodicities; being rated at 25 periods at about two-thirds of the full load they will operate at 50 periods. This was brought to the writer's notice by the following incident: A transformer with 450 ampere-turns operated a 50-period induction instrument satisfactorily, but when used on a 25-period one, which required the same volt-amperes, there was an error in ratio of transformation of 10 per cent. low. By doubling the ampere-turns the transformer operated both instruments satisfactory. This was due to the fact that the saturation was halved on both periodicities by doubling the ampere-turns.

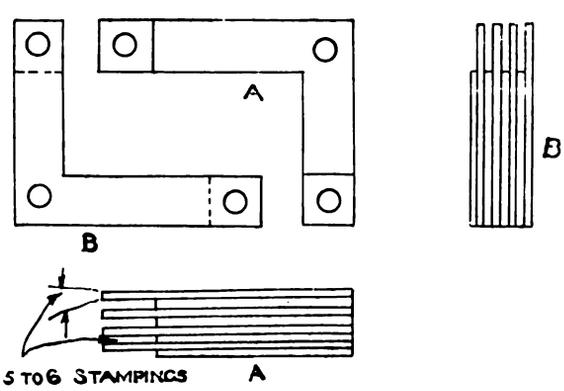

FIG. 2.

The best type of joint to employ is the imbricated one, as a good butt joint cannot be made without machining. It is more expensive to make an imbricated joint than an unmachined butt joint, but it gives considerably better results in operation. Fig. 1 shows the cheapest form of making the joint. It consists of four blocks of stampings like A; the windings are placed on one block, C, and the other three blocks interleaved at the corners to form a core, B, it being held together by four corner bolts; the blocks are built up in batches of five or six stampings, as shown. If the core is square in view, B, it will be seen that only one stamping is required, but if rectangular, two stampings will be required.

Fig. 2 shows a better but more expensive way of building up the core, better because it does away with two joints, but more expensive because it has to be punched out, whereas in Fig. 1 stampings can be cut on a guillotine, thus not wasting so much as stampings. It consists of two blocks, A and B, built up in batches of five or six long and short stampings as shown; the windings are put on limb B and corners interleaved similar to core in Fig. 1, the core being held together by corner bolts. It will be seen that two stampings are required, one short and one long.

Fig. 3 shows three good methods of arranging the windings so as to fulfil item 3 with regard to leakage. A

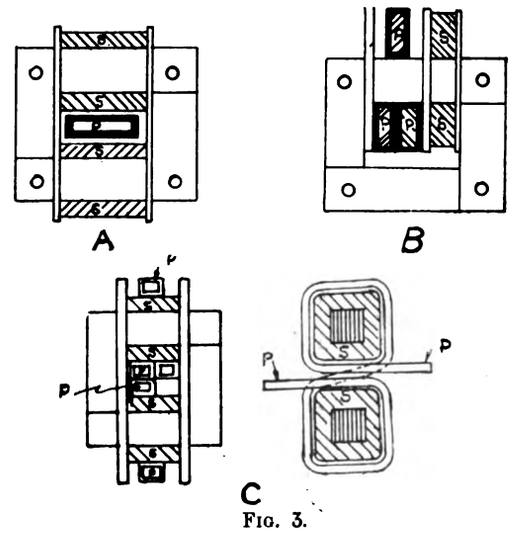

FIG. 3.

is for a transformer with one turn, half the secondary, S, being wound on each of upper and lower limbs. B is for transformers with more than one turn, the primary, P, and the secondary, S, being side by side on the upper limb. C is for transformers on which greater accuracy is desired, as the leakage is extremely small; it consists of half the secondary, S, wound on the upper and lower limbs, the primary, P, being wound over both halves of the secondary. The primary and secondary are wound on formers, insulated, and slipped in position. The primary turns are the number of times the primary lead passes through the centre of the core; thus A has one, B has two, and C has three primary turns.—S. W. P.

[Other replies to Question No. 976 will be given in our next issue.—ED. *E. E.*]

Radium.—According to the *Petit Parisien*, a student at Rochefort (M. André Lancien) has discovered a substance called "molybdott," which is said to possess the same properties as bromide of radium, and costs only 20fr. (16s.) per gramme instead of 3,000fr. (£120). According to a statement which M. Lancien is reported to have made, the discovery was made while working for a competition in scientific photography. He required phosphorescent screens, and as those he had at his disposal did not give him satisfaction he sought a radioactive substance to diminish the time of the pose. It is thus that he was led to combine molybdenum with uranium in causing the molybdate of ammoniac to act on the azotate of uranyles in the dark-room. He thus obtained a white precipitate, which, when tried in vacuum, gave a substance—the molybdate of uranyle—which produced an impression on the photographic plate, and was consequently radioactive. This is a radioactive substance, but its emissive power is very low and can replace only specimens of bromide of radium of very weak power, because if the power of radium bromide varies between 20 and 1,800,000, that of molydate does not exceed 40. No trustworthy scientific account of the discovery is yet forthcoming, though it is stated that a communication will be made to the Academy of Sciences on the subject.

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

QUESTIONS.

987. What is the best practice for electric lifts where very sudden stoppages and reversals frequently occur? Special reference to pilot and main switches and to best type of motor and brake, and also diagram of connections, desired. Low pressure. Power required, from 1 h.p. to 3 h.p.—BARBETTE.

ANSWERS.

Question No. 976.—In the design and construction of series transformers for use with relays, meters, or instruments, what are the salient points to look after to obtain the same ratio between primary and secondary currents from one-twentieth of full load to 50 per cent. overload? How much can the external resistance (in the secondary circuit) be varied without altering the ratio more than 2 per cent. on a well-designed series transformer? Give sketches showing shape of punchings, and also the best saturation of the iron to work at at full load.

Answer to No. 976 (awarded 5s.).—It is impossible to get exactly the same ratio over such a wide range as one-twentieth to 150 per cent. load. About 4 per cent. difference would be a fair figure to reckon on between 10 and 100 per cent. load. This can, of course, be improved on, and must be improved on for accurate work. To do so the following points must receive great attention: (1) The magnetising current must be kept as small as possible; this can be done by working at a low density in iron of high permeability, and by having the magnetic circuit as short and perfect as possible. (2) The phase displacement between primary and secondary currents must be very small; this can be accomplished by still further reducing the magnetising current and core loss current. This means increased size of iron circuit, or the use of an iron like "Stalloy." (3) Another very important point is to see that there can be no appreciable leakage of flux between primary and secondary. I have been able on several occasions to improve the ratio of transformation variation from about 8 per cent. to 2 per cent. from 10 to 100 per cent. load simply by a redistribution and sandwiching of the primary and secondary windings. I may here remark that the practice of winding the primary on one limb and the secondary on the other is absurd, and cannot help but produce "leaky" transformers. The best way to prevent leakage is to wind the secondary winding on the core, then put the primary over it, introducing suitable insulation between the windings. By rendering the leakage negligible, condition (2) above is made much easier of accomplishment. (4) The ratio of the C R volt drops in the primary and secondary windings must be equal to the ratio of transformation, or, in other words, the copper watts in both windings must be equal. In practice this condition is usually fulfilled if both windings are worked at the same current density per square inch—800 amperes is about the density. So much for the points in the design. Unfortunately for the instrument makers, the accuracy of ratio of a transformer depends largely on its load. Users make a point of ignoring this, and then grumble and ask for ·5 per cent. accuracy on their instruments under all conditions. As a consequence of keeping the flux density very low (a necessity for a small magnetising current) and the quantity of iron small (to keep down resistance loss), the secondary volts will be low. This means that the resistance of the secondary load must be as small as possible in order that the secondary volts produced by the transformer as designed may be sufficient to give the correct secondary current. If the resistance be too high, it is obvious that the transformer will produce more voltage per secondary turn in its attempt to get its secondary current right. This means higher flux density and correspondingly larger magnetising current. It also means that the hysteresis loss goes up, not as at ordinary densities at the rate of $B^{1.6}$, but at about B^2 or $B^{2.5}$. It has been proved by experiment that, as a rule, the self-induction volts on the secondary should not be more than 5 or 10 per cent. of the volts necessary to send the secondary current through the resistance of the secondary circuit. Seeing what a bearing the nature of the load has on the ratio, it is somewhat difficult to say by how much the secondary resistance may be varied and keep within 2 per cent. of the ratio (presumably at some particular load). If the secondary load is essentially non-inductive, "E." can calculate on his own case, from the resistance of the circuit and the current, what the change in secondary volts must be, and from this the new value of B. From B can be found the new magnetising current and hysteresis loss. The effect on the ratio can be then found in the usual way.

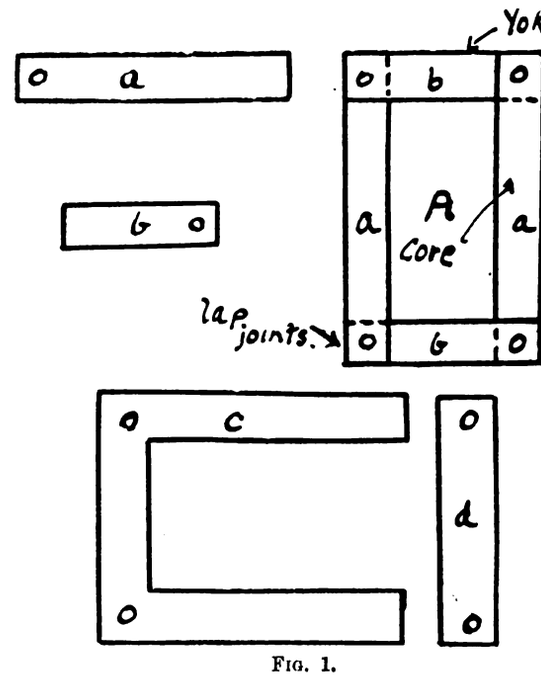

FIG. 1.

Series transformers are usually of the core type. The stampings may be either two straight pieces, as at *a* and *b*, or of two shapes as at *c* and *d* (Fig. 1). Stampings *a* and *b* are built up as at A to form the core, one of the yokes being left off until the windings are put on. Pieces *c* and *d* are placed alternatively over one another so as to form a core with lap joints, as in A. It is quite unnecessary to chamfer the corners to try and get a circular section. In a small transformer the saving of mean turn length does not compensate for the extra sizes of stampings required. The "best density" depends on the hysteresis loss, because the density which gives least variation of ratio at a constant power factor is a low one, but this means a large mass of iron and a large hysteresis loss. On the other hand, a small mass of iron means high densities. The usual densities are from 250 to 500 or 600 lines per square centimetre, and the average number of ampere-turns on primary and secondary about 800 to 1,000 each, with an iron section of about one to two square inches.—ARAMIS.

Answer to No. 976 (awarded 5s.).—This question can be answered best by the aid of a vector diagram. This diagram shows the magnitude and phase of the several currents in the series transformer, and the effect of changes in design are clearly indicated.

In Fig. 1 let O A represent the primary ampere-turns,
and „ O B „ „ secondary „ „

then the magnetising force driving the flux round the magnetic circuit is the resultant of the primary and secondary ampere-turns, and is represented by O C_0, which is also termed the no-load current. O C_0 can be split up into its two components in quadrature, O C_H, the current supplying the iron losses, and O C_M, the true magnetising current.

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Now let us consider the effect of increasing O C_H, the current supplying the iron loss, keeping O C_M constant. In Fig. 2 O C_H is doubled, producing a two-fold effect. First, the phase position of the secondary current is shifted; and, secondly, the value of the secondary ampere turns is reduced by one-tenth. As the turns clearly have not altered, the current, and, therefore, the ratio, has been

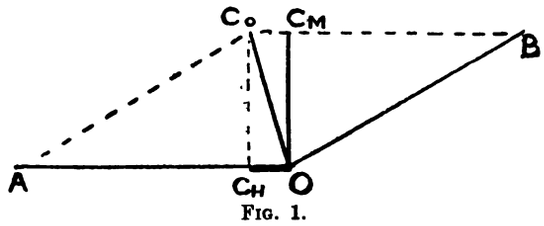

FIG. 1.

changed. Now see the effect of increasing O C_M, the magnetising current, keeping O C_H constant. In Fig. 3 O C_M is doubled, and, of course, the diagram represents a very extreme case. It will be seen that the phase of the secondary current is shifted to a large extent, and that the secondary current is actually increased. Thus increasing the iron loss tends to reduce the secondary current, and

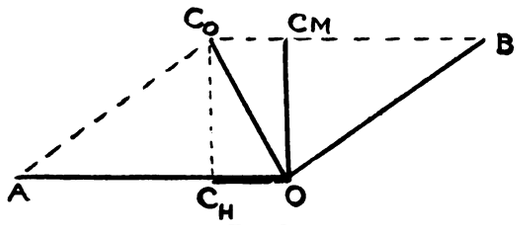

FIG. 2.

increasing the magnetising current tends to increase it, and hence the one to a large extent nullifies the other. For satisfactory operation, however, both factors must be reduced to a minimum. The first consideration in design, then, is a well-laminated circuit of iron with small hysteresis loss, necessitating good material and a low value for the flux density. The iron circuit should be as short and compact as possible, and consist of laminations of Swedish iron 16 mils thick. In practice the values of the flux density used are, roughly, one-tenth of those used in shunt transformers—that is, not more than 5,000 lines per square inch—and as the iron loss is, roughly, proportional to the 1·6th power of the flux density, the loss is thus minimised. Speaking generally, series transformers for low-tension circuits are more accurate over a large range than those for high-tension circuits, on account of the lower resistance of the winding.

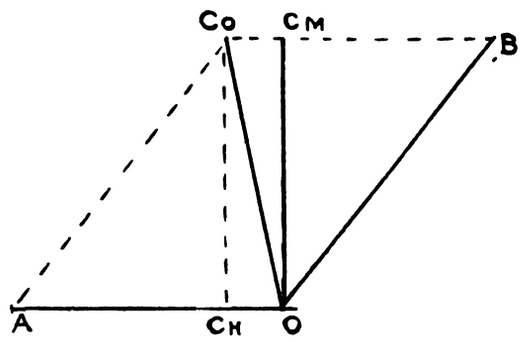

FIG. 3.

The most important point, however, is the value of the impedance of the secondary circuit. In the case of current transformers used in connection with integrating wattmeters, the coils of which have a very low impedance, it is found that the ratio is constant from one-twentieth load up to 50 per cent. overload. If, however, the secondary includes an ammeter, considerable variations of ratio will result. Few alternating-current ammeters can be read below 25 per cent. of full-load current, and hence the instrument is necessarily changed, and perhaps more than once, to get readings over the whole range. Now, the impedance of an induction ammeter is inversely proportional to the square of its capacity, and hence for the lower readings the impedance of the instrument may easily be 16 times that of the one used for the overload points. This cause alone will introduce errors of the order of 15 per cent. If by some contrivance the secondary impedance be kept constant throughout the test, it is found that at one-tenth load the ratio falls off to the extent of 5 per cent. with one induction ammeter in the circuit. It will thus be seen that unless the secondary be practically short-circuited, as in the case of operating integrating wattmeters, the series transformer cannot be relied on to within 2 per cent. at much under 40 to 50 per cent. of full-load current, and that however good the design. All instruments should, therefore, be calibrated with their own series transformers connected exactly as they will afterwards be run.

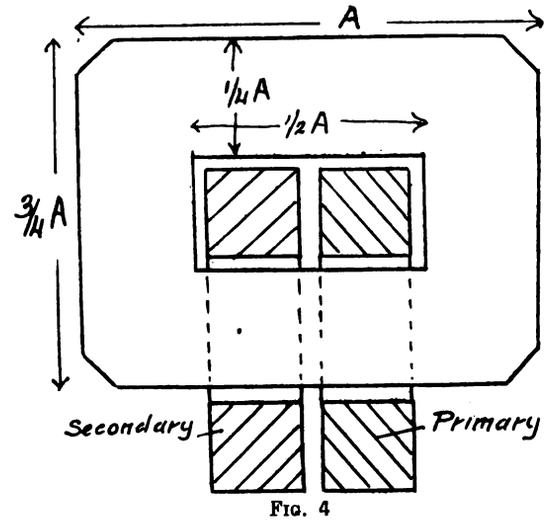

FIG. 4

The punchings are usually rectangles with one opening in the middle and the corners chamfered as shown in Fig. 4, which also gives the ratios of the other dimensions to that of the long side. A common value for A would be 5in. to 6in., and the stampings are built up to a thickness varying from 1½in. to 3in. In designing a line of series transformers it is not customary to vary the punchings even over a big range of sizes. Thus a 5–5 ampere transformer would have the same iron circuit as a 500–5-ampere transformer. Further, the same transformer can be used with accuracy over the whole range of commercial frequencies, and hence standardisation is facilitated, making for economy in manufacture.—W. M. W.

Question No. 977.—How are permanent magnets made, and with what class of steel?

Best Answer to No. 977 (awarded 10s.).—The chemical composition of two different classes of steel which give the best results for the making of permanent magnets, are as follows:

Chrome Steel.		*Tungsten Steel.*	
Iron	97·893	Iron	95·371
Carbon	·687	Carbon	·511
Manganese	·028	Manganese	·625
Sulphur	·020	Silicon	·021
Silicon	·134	Phosphorus	·028
Phosphorus	·043	Tungsten	3·444
Chromium	1·195		

Further, in the making of permanent magnets comes the all-important operation of tempering the steel. By tempering is meant the process of letting the steel down to a softer state by a partial reheating subsequent to hardening. It is further desirable to secure a fine, even, uniform grain, since any lack of homogeneity tends to reduce the quality of the magnet. The best way of hardening the steel, I consider, is to get the metal white hot, then suddenly plunge it into water, or oil, or mercury. By the above process it becomes what is known as being "glass hard."

For the purpose of comparing together various brands of steel to ascertain which is the best for the manufacture of permanent magnets, two things should be known: (1) the remanence or residual value of B after the application of a powerful magnetising force, and (2) the coercive force or amount of negative magnetising force, H, which would be needed to reduce the remanent magnetisation to zero. The force thus required to deprive any specimen of its remanent

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TABLE A.—REMANENCE AND COERCIVE FORCE.

—	Max. H applied.	Max. B attained.	Residual B.	Coercive force.	Residual I.	Specific magnetisation.
Whitworth mild steel (annealed)	250	16,120	10,740	8·3	855	109
,, ,, (oil-hardened).....	250	16,120	8,736	19·4	695	89
Chrome steel (as forged)	250	14,680	7,568	18·4	602	77
, (annealed)	250	13,233	6.489	15·4	516	67
,, (oil-hardened)	250	12,868	7,891	40·8	628	81
Tungsten (as forged).....	250	15,718	10,144	15·7	807	104
,, (annealed).....	250	16,498	11,008	15·3	876	112
,, (very hard)	250	12,133	6.818	51·2	542	69

magnetisation may be taken as a measure of the tendency of the steel of this particular quality to retain permanent magnetism. Hence it is important that the specimen should possess great coercive force. It may also be noted that, as a rule, long rods show a greater remanence than short rods, while for short magnets hardening the steel increases the retentiveness, whereas for long magnets hardening decreases it

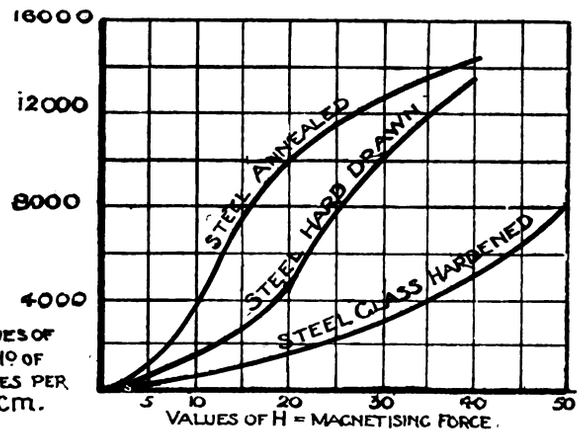
Table A gives the remanence and coercive force of a number of specimens of steel, together with some information as to the degree to which the magnetisation was temporarily pushed in order to leave the respective residua.

I also tabulate another very useful table, which gives the maximum values of permanent magnetisation :

Maximum Values of Permanent Magnetisation.

	Residual I.	Residual B.	θ
Weber common steel magnet ...	314	3,947	40
Hopkinson tungsten steel, very hard	542	6,818	70
Gray's magnet steel, glass hard	520	6,536	66
Brown's magnet steel, glass hard	477 to 556	6,000 to 7,000	61 to 72

The values in the above table are those obtained by actual steel magnets magnetised by the usual process, and of the "specific magnetisation," θ, or magnetic moment per gramme. The values in column 1, marked "Residual I.," are those of the residual magnetic moment per centimetre cube of substance in the C.G.S. measure, and obtained from residual B by dividing by 4π. If the density of a specimen is known, the specific magnetisation, or θ, can be obtained from the residual I by dividing by the density. I also give the accompanying magnetisation curves.



In magnetising the steel bars to obtain a permanent magnet, the following method will be found to be suitable: Make the steel to be magnetised "glass hard." Then place it in steam at 100deg C. for 20 or 30 hours, or longer for very massive magnets. Then magnetise it as fully as possible, and then heat it again, for five (or more) hours, in steam of the same temperature as above. Magnet magnetised by the above method will remain as constant as possible. In the Hookham meters, I think the magnets are magnetised in the following way: A number of bar magnets of tungsten steel are fitted into cast-iron pole-pieces which nearly meet, so making a nearly closed circuit. After these are fitted on, a magnetising current is sent round the bar magnets to saturate them as fully as possible. They are then mechanically hammered, and a weak demagnetising current is sent through the coils, thus reducing the magnetism by 10 per cent. Magnets made by above way will show no tendency to lose their strength for a considerable time.—W. THICKETT.

Answer to No. 977 (awarded 7s. 6d.).—The following are points which should be possessed by a good permanent magnet: (1) its coercive force should be large—that is to say, it should not be easily demagnetised; (2) it should not age—that is to say, the magnet strength should not deteriorate with time or with the vibrations, etc., to which it will be subjected when in use. The class of steel used is the highest quality cast steel, well hardened. Of course, each manufacturer of this class of steel proportions its constituents so as to obtain, in their opinion, steel which possesses best the points before mentioned. Very few manufacturers who are the final users of the magnets manufacture their own steel, the magnets, ready forged to shape and hardened, being bought from steel manufacturers. After obtaining them, they have the necessary machining done on them, such as grinding, etc., and if any additional fittings are to be put on, such as pole-pieces, etc., they are put on before magnetising the magnets.

The method of magnetising the magnet does not vary much with the use to which they are put, but the accuracy with which the density of the magnetic lines are adjusted varies with the use to which they are put. For example, with magnets used for magneto machines damping effects in instruments do not require to be adjusted so accurately with regard to the density of the magnetic lines as the magnet to be used on a moving-coil instrument, where a variation in the density of the magnetic lines would cause a variation in the torque of the instrument, and thus different control springs would have to be fitted to each instrument. The following is a good method to adopt: The magnets are put in a magnetising frame and flashed three or four times with direct current, so as to saturate as far as possible the magnet. A demagnetising alternating current is then sent round the magnetising frame, this current being gradually increased and then decreased. Whilst this alternating current is being sent round means are adopted for measuring the density of the magnetic lines. In the case of magnets for moving coil instruments, this is done by means of a moving-coil system which is put in the hole occupied by the moving-coil system. By sending a known current through the moving coil, and knowing the torque of the springs on the system, the density of the magnetic lines through the moving-coil system can be calculated. In actual practice the moving coil has a pointer attached which moves over a scale and gives a direct reading of the magnetic density when a known current is flowing through the moving coil. The density is allowed to come down until it reaches $1\frac{1}{2}$ times the final density required. At this point note is taken of the value of the alternating current required, and it is then gradually decreased. If the alternating current does not reach a definite value before the density mentioned is reached, the magnet is discarded on account of the fact that its coercive force is small. Whilst the magnet is being flashed with direct current, a keeper is put across the bottom of the magnet so as to aid the magnetisation; this is removed when the demagnetising current is sent round. When the correct density is reached the magnet is removed from the frame and well hammered until the final density required is reached, this being measured by the moving-coil system as previously explained. The magnets are then stored for a period of four to six months, each having a number and an account kept of it. Before use the density is again tested, and any that are found to have aged are discarded.

Fig. 1 shows a magnetising frame. It consists of a wood base fitted with plugs, A. B is the magnet, and over it

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goes a wood top, C, which has copper prongs, D, in it. These prongs go into plugs A, and thus complete the turns round the magnet. In the plan the top is removed; the dotted lines show the connection of the plugs, A. On putting the top on, one prong connects F to G, another J to K, and so on; it will be seen that the magnet is inside a coil.

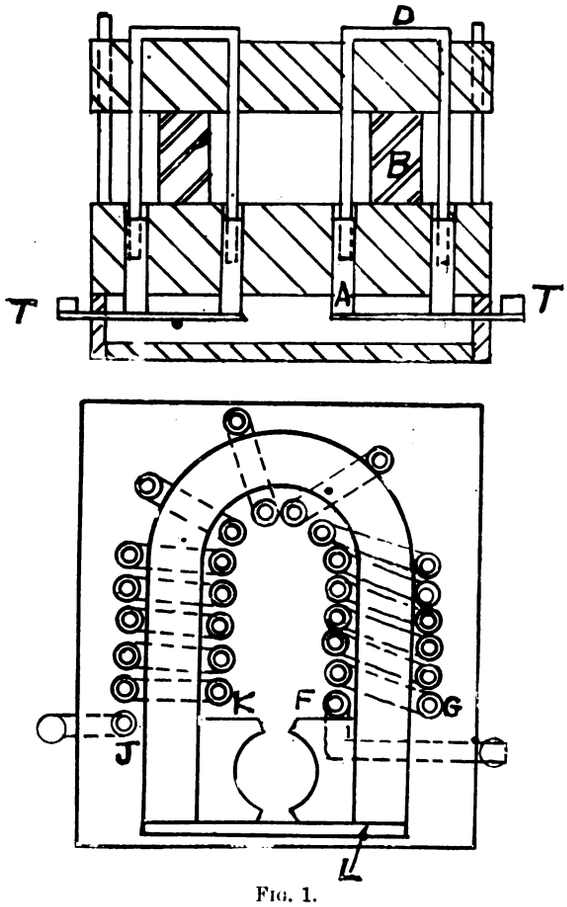

FIG. 1.

T are the terminals, L being the keeper. The flashing can be done in several ways. Fig. 2 shows two methods. A consists of two carbons, D, fixed as shown. Between these another carbon rod, E, is drawn, the two carbons, D, springing apart when the rod, E, is pulled down. B is another method, and consists of a spring switch, F. It will be seen that on pushing the knob, contact is made between the three carbon blocks, G, and on releasing the

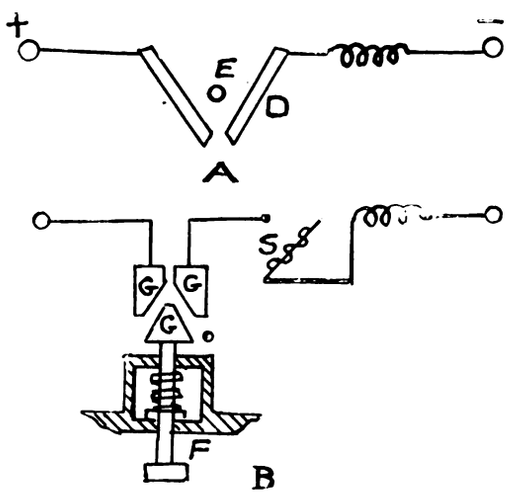

FIG. 2.

handle flies back. In series is a switch, S, which has an overload trip coil on it; this is set to operate at a low overload. This switch, S, is closed and then the knob is pushed; this allows a large current to flow round the coil, and at the same time the switch, S, breaks circuit so that no damage can be done due to excessive current. The coercive force for a good magnet should be between 60 and 70, and from this the demagnetising ampere-turns required for the magnet can be calculated, and the minimum value of the demagnetising alternating current.—MAGNET.

Answer to No. 977 (awarded 5s.).—The best permanent magnets are made of best tool steel. They are drawn and shaped to the required dimensions during the time they are in a soft state. The steel should be in a good solid state, and all joints and flaws should be avoided, or anything that is likely to cause vibration, as this helps to destroy the residual magnetism when finished. Care should be taken when shaping the steel that an excessive heat is not used. It is better to shape it at a little over bright red heat, as at high temperatures steel loses its permanent magnetic properties. It must also be remembered that the lifting power of a magnet depends a great deal on the size and shape of its polar surfaces as well as its strength. It has been shown by experiments that magnetism imparted to steel is confined principally to the surface. Nearly as strong a magnet may be made from a hollow steel tube as from a solid bar of the same diameter. If a laminated magnet made up of thin steel plates be used, the magnet will have much more tractive force than the solid steel magnet, but each lamination should be thoroughly hardened and magnetised before building up to the required size; also great care should be taken to see that they are not jarred after magnetising, as this tends to decrease their strength and lifting power. They should be thoroughly riveted together, and built up with due regard to their polarity. In magnetising a laminated core, a good way of magnetising the separate laminations is either to rub them with a strong permanent magnet, always rubbing with the same pole and in the same direction, lifting the magnet at the end of each stroke and bringing it back through the air. If each half of the bar, assuming it to be a bar magnet, be magnetised separately, better results will be obtained, the strokes being made from the centre to each end. In the case of a horseshoe magnet, the ends are first joined together by a piece of soft iron or keeper. Another way very often used is to wind a few turns of copper (insulated) wire round them and couple them to a small battery, a very small amount of current being necessary. Of course, the laminations must be done separately before fixing together; if not, it will take a greater amount of current to magnetise them when they are built up, and in the end they will have no more, if as much, strength as the solid bar or steel tube. In making up small magnets it is only necessary to thoroughly rub them with a strong magnet, as in the case of the laminations.

In making up large solid magnets, after shaping and thoroughly hardening them—the harder the steel the better the magnet—it is best to wind a coil of copper insulated wire round them and pass a fairly strong current through the coil. The magnetising current should be left on for a little time to ensure the steel getting thoroughly saturated. It is also advisable to do this on a laminated core after building up; this will then help to make up for any loss during the riveting of the laminations together. But great care must be taken to see that the coil is wound correctly and with regard to the polarity of the magnet; if not, it may destroy a great deal of the strength obtained by separately magnetising the laminations, and the result would be that the core would be no stronger than a solid core. The tractive force of a magnet may be obtained from any magnetic table, together with the flux density per square inch. This is all that will be required for working out the ampere-turns required to magnetise the steel, the formula being

$$A.T. = \cdot 313 \times B \times l,$$

where A.T. = ampere-turns;
B = flux density per square inch;
l = length in inches.

Care must be taken as to which direction the coil is wound on the magnets, so that the right polarity is obtained. A good method of finding out the north and south pole is to remember, when coupling the coil up, that the N is always to the left of the direction the current is travelling. Any good class of tool steel will do, hardened tungsten steel being the best.—A. C. R.

[Other replies to Question No. 977 will be given in our next issue.—ED. *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

QUESTIONS.

988. In a small high-tension hydro-electric power scheme it is proposed to use two 100-kilovolt-ampere three-phase generators instead of one machine. This is on account of transport difficulties in dealing with heavy weights. Which would be the better method to adopt: to couple the two generators rigidly together with the turbine connected at either end, or place the turbine between the two generators? As the generators are to be insulated from earth, insulated flexible couplings must be used in either case. Give advantages and disadvantages of each arrangement.—P. C.

989. The 500-volt circuit of a large factory is short-circuited, with a fuse in series for the purpose of magnetisation. It is found that although five-ampere fuse wire is used, the effect of the short is to pull out the breakers of many machines on the same circuit, although the current used in the short does not pass through the machine breakers. What is the reason of this?—J. H. ODAM.

ANSWERS.

Question No. 977.—How are permanent magnets made, and with what class of steel?

Answer to No. 977 (awarded 5s.).—Permanent magnets can be made in a number of ways, the method to be adopted being chosen according to the use to which the magnet is to be put. With small light magnets for experimental purposes the steel is usually magnetised by stroking with another permanent magnet. When only one permanent bar magnet is available, the steel to be magnetised should be stroked from end to end slowly and carefully. The stroking should always commence from the same end, and the permanent magnet should be lifted well clear of the steel after the stroke and it is being returned to start another. This method is called "single touch." Another method is by "divided touch." In this case two bar magnets must be used, and they are placed each with an end in the middle of the piece of steel to be treated, and their polarities should be opposite. They are then slowly drawn apart and back again, always leaving off in the middle. The bar of steel is then turned over and the process repeated. The magnetising is more effectual if the bar can be supported at each end on the poles of other permanent magnets having the polarities the same as the stroking ones. Another method sometimes used is the "divided touch," which is very similar to the previous one, only a piece of wood or cork is inserted at the middle between the two permanent magnets. There is very little to choose between the last two methods. A horseshoe magnet can be used in the above cases if bars are not available.

These methods of magnetising with other permanent magnets, however, do not make very strong magnets. The best way is by a very powerful electromagnet, either a spiral into which the steel to be magnetised is slipped, or a "horseshoe" type across the poles of which the steel can be drawn. With the coil method the steel must be put in the coil before the current is switched on, and it must not be removed until the current is off. The steel should be drawn over the poles of the "horseshoe" type of electromagnet to magnetise it. Both these methods are satisfactory, and the choice of method depends chiefly on the shape of the steel to be magnetised. With the electromagnet most intense fields have been obtained by experimenters such as Ewing and Hopkinson. The best steel to use for the magnets is cast steel or tool steel, and also some of the special steels, such as chrome and tungsten. Tempering of the steel after it has been made glass hard has a great deal to do with the retaining power of it. The correct amount of temper can only be found by experience with a particular steel. Some magnets are made up of laminæ, and are called compound magnets. This is done because the hardening is usually only skin deep with solid steel bars, and so the amount of hard steel in a magnet is increased by this method. Each of the laminæ is magnetised separately and assembled afterwards. Another point is the ratio of length to diameter or thickness. This has a great effect on the amount of temper required. Thus short bar magnets need not be tempered after being made glass hard, as they retain most magnetism if left in that state. On the other hand, magnets having a length over 20 times their thickness should be tempered down to straw or even blue tint.—M. G. TWEEDIE.

Answer to No. 977 (awarded 5s.).—In selecting a material for permanent magnets the chief factors to be considered are retentivity and permeability. By retentivity we mean the power which the material has of retaining the magnetism imparted to it, and by permeability is meant the ease with which a substance conducts magnetic lines of force. Pure soft irons have a high permeability and low retentivity, and are, therefore, advantageous for electromagnets where the effects of magnetisation should be reduced, if possible, to a minute quantity after the current has been cut off; therefore, in choosing a material for permanent magnets a hard steel is preferable on account of its high retentivity. It was found that by admixing iron with certain foreign substances, alloys were obtained that embodied all the above advantages suitable for permanent magnets. Tungsten, sulphur, phosphorus, arsenic, etc., impart beneficial effects to the iron, while other metals, such as zinc, copper, etc., destroy the effects of magnetisation. As a rule, tungsten steel is employed. The steel is gently heated to a dull red heat and hammered into the required shape. Care should be taken, however, that the steel does not get overheated, as tungsten is volatile It is then hardened by being first placed in a close fire with no access of air, as the metal may oxidise slightly. To complete the hardening process it is finally dipped slowly in water, and if of the horseshoe pattern, the ends are first dipped and slowly immersed till it is completely under water. It is then polished and passed over the poles of a large and strong permanent magnet, the steel being turned over a few times to ensure its magnetisation on both sides. Sometimes large electromagnets are used, although permanent magnets are quite as well and efficient. It is well known that vibration applied to a permanent magnet partially destroys its magnetism, due to the fact that the individual particles of the steel, which in themselves are magnets, rotate and form closed magnetic circuits in the mass of the steel. Hence permanent magnets should never be allowed to drop.

It has been noticed that magnetism penetrates only a short distance into the interior of the metal, hence it is advisable in making large magnets to build up a number of thin strips of steel cut to a certain size, and then magnetised separately. When these laminations are assembled, the complete magnet will be stronger than a solid magnet of similar dimensions. It, however, should be noticed that iron screws and bolts should be employed in fastening together the individual magnets. Brass bolts are sometimes used, but they tend to disperse the lines of force, and thus weaken the polar strength.—OSCAR DINERMAN.

Question No. 978.—What is the best method of leading in overhead wires to a power station?

Best Answer to No. 978 (awarded 10s.).—The best method to adopt depends considerably upon the situation of the

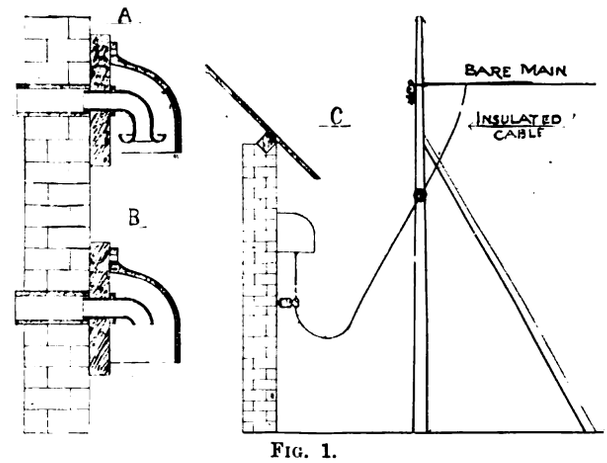

FIG. 1.

power station with regard to the line, also upon the pressure of supply. As a low-tension supply calls for no special constructional features, those for high or extra high pressure only need be considered. There are several

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methods in use, but three only will be enumerated, as one or other will probably fulfil the necessary requirements. In Fig. 1 A and B show high and low pressure leading-in tubes for use with insulated cable between the switchgear and bare overhead main, as shown in C. Preference would not usually be given to this method unless the overhead main was at a much higher level than the point of entry to the station.

Fig. 2 shows a method applicable under almost any conditions. The bare main terminates outside the building, and is jointed to an insulated cable running to the switchgear through a porcelain tube in the station wall. The joint is protected by the terminal insulator and porcelain

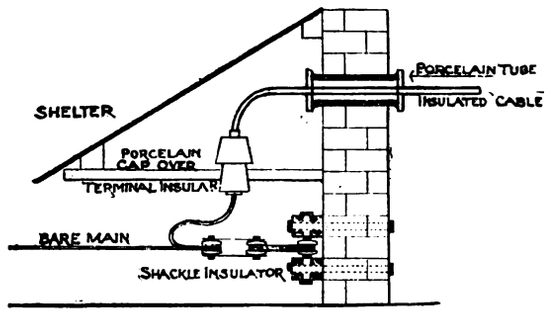

FIG. 2.

cap above it, the strain of the line being taken by the shackle insulator below the joint. Protection against the weather is afforded by a shelter above the joint.

The third method, illustrated in Fig. 3, differs from the preceding two in that the bare conductors are taken inside the station, entering the building through circular holes in heavy glass panes. The strain of the line is taken by shackle insulators placed in a convenient position inside the building. The area and position of the glass panes

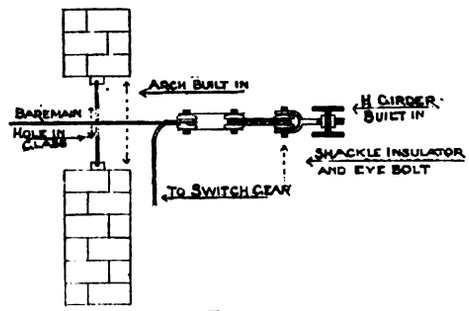

FIG 3.

must be such as to prevent any accumulation of snow in close proximity to the main. The fact that no joints are necessary is certainly in favour of this method; also the bare main can be taken direct into a lightning arrester or a switch if needed.—O. H. BRICKWELL.

Answer to No. 978 (awarded 7s. 6d.).—The above question must be understood to refer to extra high-tension lines only, as the various methods of leading in low-tension lines call for no special remarks. The method by which the above is carried out becomes more important the higher the working pressure of the line. As yet there is no standardised method of bringing overhead lines into the power-house. Each engineer when confronted with the problem carries it out after his own ideas. So that, perhaps, the most satisfactory way of answering the above question will be to illustrate one or two outlet arrangements that have been found to give satisfaction in practice. There are several conditions that have to be complied with and that are common to all: the line must be carried in in such a way that it is impossible for driving snow or rain to enter the power-house—this is, perhaps, of more importance in the States, for instance, than at home, owing to the more rigorous climatic conditions; the wall bush must be constructed in such a way and of such materials as to be immune from fire; and the whole must be designed with due regard to insulation. I think the above three examples will give "C. B. C." some idea of the lines along which a cable outlet should be designed; it is impossible to state definitely which is the "best," because that design must be chosen which is best suited to the special requirements of the case in hand.—J. A. VICE.

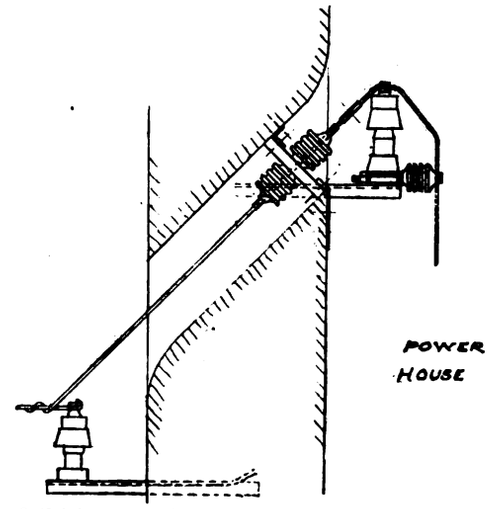

FIG 1.—Outlet Arrangement as used by the North Wales Power Co. at their Gwynant Valley Station. The line voltage is 10,000.

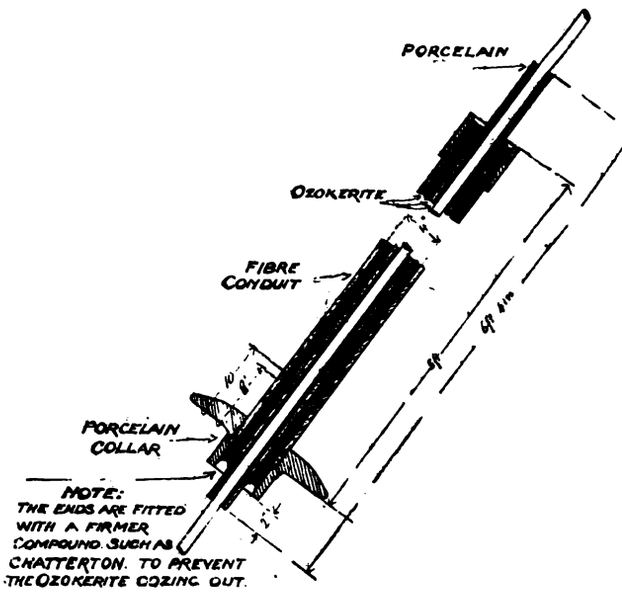
PORCELAIN
OZOKERITE
FIBRE CONDUIT
PORCELAIN COLLAR
NOTE:
THE ENDS ARE FITTED WITH A FIRMER COMPOUND SUCH AS CHATTERTON TO PREVENT THE OZOKERITE OOZING OUT.

FIG. 2.—Cable Outlet of the Telluride Power Co. of Utah. The line voltage is 44,000.

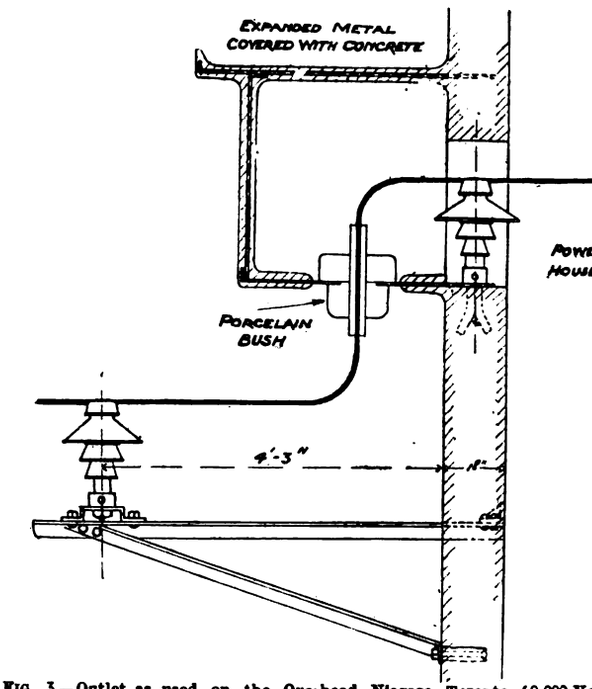

FIG 3.—Outlet as used on the Overhead Niagara Toronto 40,000-Volt Transmission Line.

Answer to No. 978 (awarded 5s.).—Figs. 1 and 2 represent the best practice of leading in overhead wires to a power station. The construction shown in Fig. 1 has been

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extensively employed in America, and proved very successful for pressures up to 50,000 volts. It consists essentially of the following: A is an insulator, an enlarged half section of which is shown in Fig. 3, it being so shaped to provide dripping points for any moisture which might be deposited on it, and thus prevent the current from "creeping" On the top knob of the insulator is a radius to suit the size of conductor, the conductor being kept in position by binding wires being bound round it, and then bound on the small shoulder of the insulator. B is a slab of insulating material, usually slate, and kept in position by the wooden blocks, D.

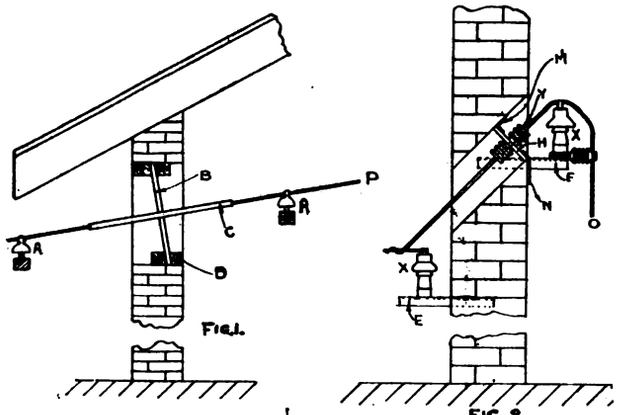
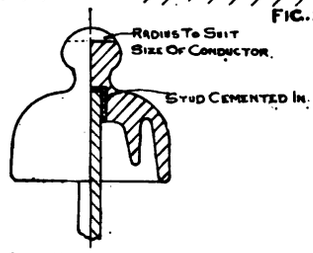


FIG. 1.

FIG. 2.



ENLARGED HALF SECTION OF INSULATOR A.
FIG. 3.

Through B is fitted a long insulating tube, C, the internal diameter of which is made to suit size of conductor, which passes through this tube. The roof is usually extended in order to keep the rain from driving in. Fig. 2 represents the method employed on the 10,000-volt transmission lines of the North Wales Power Company, and, of course, represents the latest practice. X is an insulator which is supported on an angle bar built into the wall. The conductor passes through Y, another insulator, which is fixed into the insulating slab, H, and this slab is held in position by the angle piece, M, and the bent strip, N.—ALPHONSE.

Answer to No. 978 (awarded 5s.).—Different methods are used for different cables and the voltage used on them. For such cables as small lighting, motor, and telephone leads, the overhead lines are joined up to a good insulated cable and taken through an iron pipe built into the wall. This pipe is bushed on the outside with a wooden bush, to keep it from damaging the insulation of the wires; it is also bent in such a shape as to exclude all wet and damp from the outside; on the inside of the station it is generally bent downwards, so that any water getting into the pipe, due to condensation, it runs away, and the wires are kept perfectly dry. In many cases, when this is overlooked, the wires have laid in water, causing a bad leak. The tube is fixed to a small joint-box inside the station or building, which is drained to let the water away, if any, the wires being run to wherever required through a conduit For larger sizes of wire, if insulated, they are run straight through the tubes without any jointing. In many cases the tube is of iron, but it is a general rule to employ a porcelain tube, which is built into the wall of the building through which the wires have to pass through, in the same way as the iron tube; these tubes are allowed to project about 3in. on each side of the wall. Another method used for large cables is to run them into a distributing box outside the station, either fixed to the wall or the last pole carrying the overhead wires. The cables are then joined up to sheathed cables, which are taken through straight iron pipes. After fixing the cables, the iron tubes are joined up to the cable sheaths by means of wiped soldered joints at both sides of the wall. This excludes all water excepting that caused by condensation, which is got rid of by draining the pipes; but in most cases there is very little water, unless there is a long run of piping. Sometimes a large block of wood is built into the wall and the cables run through holes bored through it, but this method is not greatly used. For all bare overhead wires an insulated wire is first joined to them near the end insulators, then run through into the station.

For overhead high-tension work an archway is built through the wall having insulators fixed into the sides by which the cables are supported, the archway being sealed up against the weather by means of an iron or steel door. Another method employed on high-tension work is to join the overhead wires to sheathed cables in a distribution box; the sheathed cables are then run down underground enclosed in porcelain pipes filled with bitumen. After entering the station they are then run through iron pipes filled with dry silver sand. In some cases, where the wires pass through an archway, they are threaded through strong glass or porcelain tubes. It is much better to use an archway than jointing up the cable, as all joints should be avoided if possible both on high-tension and low-tension work, especially on high-tension work, as sometimes a very little flaw in an high-tension joint causes a lot of trouble. If a distribution or joint box be used, care should be taken to see that it is sealed up and filled with bitumen or some good insulation.—A. C. R.

Question No. 980.—Some small portable motors used for drilling purposes are often overheated on account of workmen putting excess pressure on the drills. What inexpensive mechanical or electrical device could be used to prevent this? Fuses are not permissible, as they are blown too often; circuit breakers, also, would be held in by the men.

Best Answer to No. 980 (awarded 10s.).—The design of motors for operating small portable drills is such that only an intermittent service is permissible, as, in order to reduce the weight to a minimum, the heating characteristics of the motor would result in a dangerously high temperature being reached with continuous service. In consequence of having to rate the motor practically up to its limit of output, any overload, in the shape of excessive pressure on the drill, produces a considerable rise in the temperature of the motor, and finally results in a burnt-out armature. Even where fuses and circuit breakers are installed for protection, these are generally abused and rendered useless. It is probably due to this fact that pneumatic drills are still largely used in workshops where all the machine tools are electrically driven, special compressors being installed for supplying compressed air to the portable drills and other pneumatic tools.

In order to prevent the overheating of the drill motors and consequent burnt-out armatures, some sort of overload clutch is required which would transmit a certain power and slip above this point. We may, therefore, suggest that an overload clutch, similar in design to that used by Colonel Holden in the Royal Gun Factory, Woolwich, may with advantage be adopted. (The clutch was described in a paper read before the Institution of Electrical Engineers in November, 1905. See also the *Electrical Engineer*, Nov. 24, 1905, p. 734.) This clutch is a modification of the "claw" type, with the engaging surfaces serrated. The two halves of the clutch are pressed together by a spring, which exerts a definite pressure between the engaging surfaces. When the retarding force of the tool exceeds this pressure, the clutch, of course, slips, and emits a hideous noise, thereby drawing the attention of the workman to the fact that he has an overload on. The sketch of Fig. 1 shows how such a clutch may be applied to a portable electric drill for protecting the motor against overloads. In this case the drill is provided with change-speed gear giving two speeds for the drill, and the overload clutch may be conveniently located inside the gear box so that it cannot be tampered with. The overload clutch consists of two portions, A, B, the former rigidly fixed to the drill spindle and the latter sliding freely on the drill spindle, D. The part B of the clutch also carries a gear wheel, G, which is driven by a pinion on the change-speed shaft. The two portions of the clutch are pressed into contact by the spring, S, and under normal conditions the whole of the clutch rotates with the drill

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spindle. When, however, an overload comes on, due to excessive pressure on the drill, the retarding force produces a pressure on the engaging faces of the clutch which is greater than that due to the spring, S, and in consequence the drill stops. This causes the teeth of the clutch to slide over one another, due to the elasticity of the spring. On the excessive pressure being removed, the drill at once

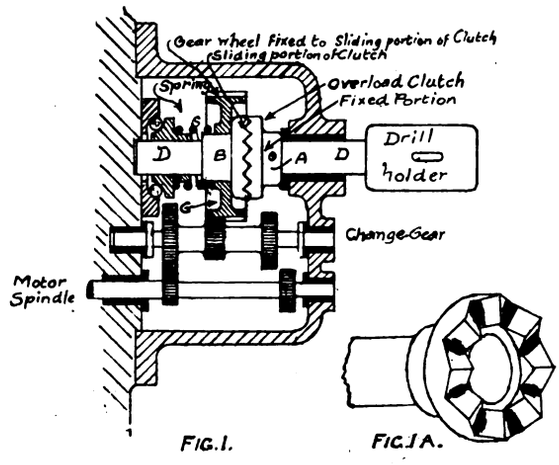

FIG. 1. FIG. 1A.

rotates at its normal speed. The spring, S, is, of course, adjusted to fulfil these conditions, and generally only a light spring would be required. The coils of the spring must be sufficiently far apart so as to allow the spring to be compressed enough for the two portions of the clutch to clear one another. One half of the clutch is shown separately in Fig. 1A, and it may be mentioned that the engaging surfaces should preferably be case-hardened.

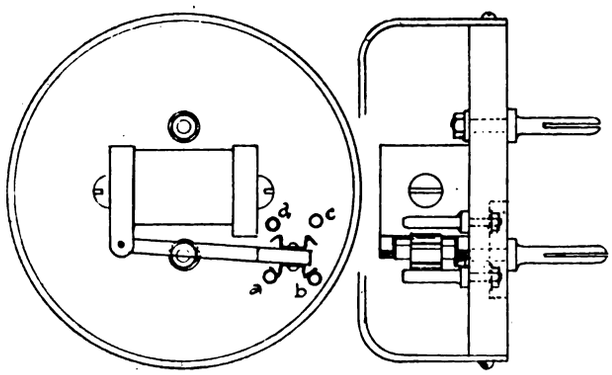

FIG. 2.

It is the practice of several Continental makers of portable electric drills to fit an automatic cut-out inside the plug connecting the drill to the supply circuit. This cut-out is different from the ordinary type of circuit breaker in that it is self-setting—*i.e.*, when the overload is removed the drill is automatically restarted. An automatic cut-out designed to meet these conditions is shown in Fig. 2, the general arrangement being similar to the overload release fitted to starting rheostats. The connections

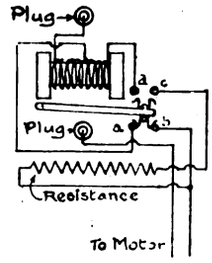

FIG. 2A.

are shown in Fig. 2A, from which it will be seen that when the movable arm of the cut-out is in its normal position, the contacts *a b* are connected, putting the overload coil in series with the motor. When the overload on the motor reaches a predetermined current, the arm is drawn up, and connects contacts *c d*, thereby inserting a resistance in series with the motor to limit the current to a safe value. The insertion of the extra resistance in the motor circuit causes the motor to stop, and it will remain at rest until the pressure is removed from the drill. The current passing through the motor when it is stopped through overload is limited by the external resistance to a safe value, and the overload coil should be provided with an additional coil, so that the arm is held up with this current. When the pressure on the drill is removed, the current in the motor armature causes the motor to restart. As the motor is running unloaded the current will be reduced as the speed increases, due to the counter E.M.F. of the armature, and will be insufficient to hold up the arm of the cut-out. The release of this arm cuts out the extra resistance, and the motor is again under working conditions. As the cut-out does not require resetting, it may, therefore, be placed in an inaccessible position, such as inside the plug connecting the flexible leads from the supply to the motor (see Fig. 2).

In the above discussion we have principally confined our attention to the small electric hand drills, where motor and drill are all combined in one casing. The devices described above may easily be adapted for larger portable tools, where the motor usually travels on a small truck, and drives the drill through a flexible shaft.—F. B.

Answer to No. 980 (awarded 5s.).—The following would be two good practical methods of preventing the overheating of the motors working the drills. Fig. 1 is a mechanical arrangement. A friction disc, A, revolving round with the drill, is pressed by a powerful spring, B, against the part C, which is driven by the motor. If too much pressure is applied to the drill, it releases itself from the driven part, C. A good form for this clutch is shown in Fig. 2, which has been used for a similar purpose, it being found to always release itself at the same pressure and twisting torque, although it probably would have to be modified somewhat to suit the constant use of a drill. A leather clutch would not be suitable, and a metal to metal clutch would be very liable to slip. An ideal clutch for this purpose would be the Hele-Shaw clutch, which works in oil, a section of which is shown in Fig. 3.

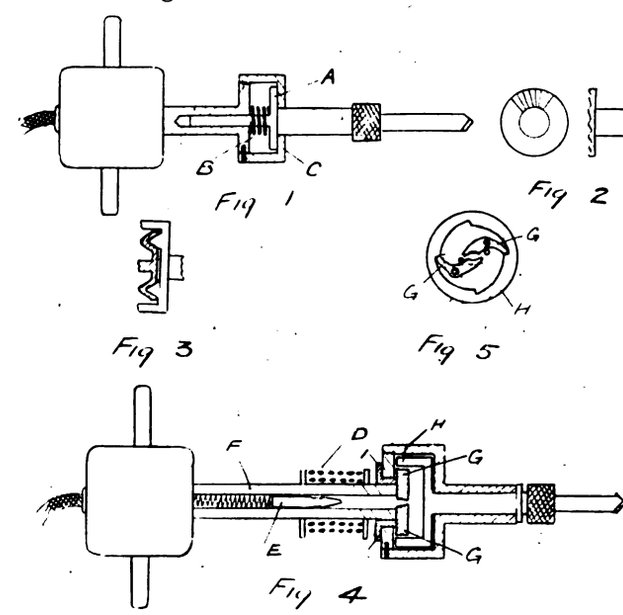

Fig. 4 is an electrical arrangement. The coil, D, energised by the excess current attracts the plunger, E, contained in the hollow brass shaft, F, shooting it between the pawls, G, releasing them from the ratchet, H, which portion revolves with the drill. The end of the plunger is arranged to catch in the pawls, thus entirely throwing out of gear the motor with the drill. The operator is then compelled to switch off the motor and free the drill, when he is then able to set the pawls, owing to that portion of the drill having stopped revolving after he has switched off the motor. It will be found with this arrangement that if the operator neglects to free the drill, the motor is instantly thrown out of gear when switching on. The pawls can be set, which liberate the plunger by the little levers. Fig. 5 is a view of the pawls.—JNO. ARNOLD.

[Other replies to Question No. 980 will be given in our next issue.—ED. *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

990. Give the connections of the relay gear, etc., when four-core pilot cables are used, required to protect E.H.T. three-phase cables of five and six miles in length, the cables being looped in and out of static sub-stations in the various districts. If the pilot cable is laid solid in earthenware troughing with the trunk cable, would appreciable induction take place? What effect would capacity in the pilot cable have on the satisfactory working of the relays? How would you overcome this latter?—PHASE.

991. What is the difference between an electrician and an electrical engineer?—J. L.

ANSWERS.

Question No. 980.—Some small portable motors used for drilling purposes are often overheated on account of workmen putting excess pressure on the drills. What inexpensive mechanical or electrical device could be used to prevent this? Fuses are not permissible, as they are blown too often; circuit breakers, also, would be held in by the men.

Answer to No. 980 (awarded 7s. 6d.).—Mr. Jefferson's trouble is by no means a rare experience among users of portable electric drilling machines, and the perfect remedy does not appear to have been hit upon. The chief method prevalent is to use fuses, but as these are so often blowing the electricians get tired of renewing them, and so put in some strong fuse, or, perhaps, even a piece of copper. The result is armatures are always being burnt out. When circuit breakers are in use, they should certainly not be on the motor, but on the wall at the plug. In this case the workman has to walk from his machine to the wall to reset the switch after "fetching" it out, and the trouble tends to make him more careful.

The ideal safety arrangement which is required is one

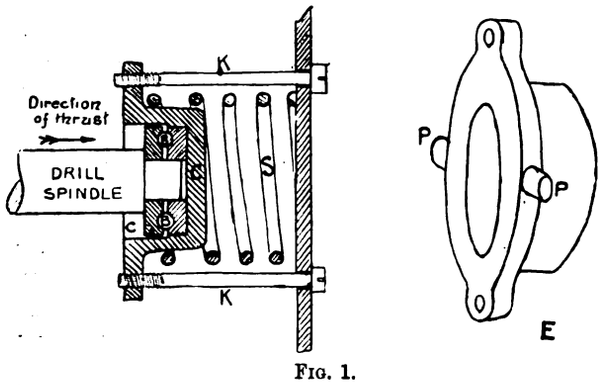

FIG. 1.

which cuts off the current when the pressure on the drill reaches a certain amount, and which, on the pressure being relieved, closes the circuit again automatically. In this case the man knows that if he puts too much pressure on the drill his motor will stop, and if it does stop he only has to release the machine a little and it starts again. The best way of effecting this seems to lie in the use of a mechanical arrangement, but the details of construction will depend entirely on the type of machine to which it is to be fitted. The sketches show the general outline of the mechanism for performing the above operations, as applied to a machine taking about ½in. drills. The back end of the drill spindle is fitted with the usual thrust ball bearing, B B, the stationary half of which presses against the casting, C, shown separate at E. A spiral spring, S, takes the thrust of the drill, and itself presses against the partition between the gear box and motor proper. So far the only alteration to an existing machine would be the moving forward of the spindle, and, perhaps, turning down the back end. Of course, the cup, C, and spring, S, are new. The spring is constantly held in compression by two screws, K K. The two round pins, P P, engage with mechanism shown in Fig. 2. A pair of light levers, M,

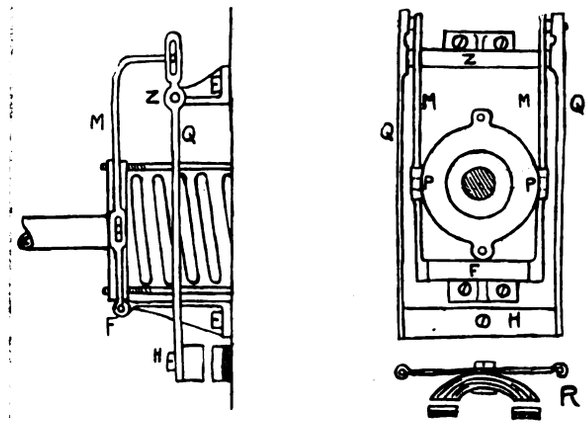

FIG. 2.

are pivoted at F and the other ends work in levers, Q, which are pivoted at Z. A light contact, H (end view, R), is used for making and breaking the motor circuit. The action of the arrangement is as follows: The drill spindle is pressed in to almost its maximum allowable pressure, and while held in this position K K are tightened. The levers, Q and M, are then adjusted by springing so that the contacts, H, are almost "breaking." This sets the apparatus. If, now, while the machine is running with H closed, the pressure on the drill be increased above the safe limit, S becomes compressed a little further and K K are pushed back. This motion is multiplied by levers, Q and M, and thus H is lifted off the contacts, stopping the motor.

The arrangement described above may seem a little complicated, yet when once it is regulated it works satisfactorily for long periods together. If there are a number of motors to convert, the cost for each one works out very reasonable, and the saving in armature winding and prevention of loss due to motor standing soon pays for the change.—PERCY DUNSHEATH.

Answer to No. 980 (awarded 5s.).—A reliable and satisfactory method of preventing excessive and undue over-

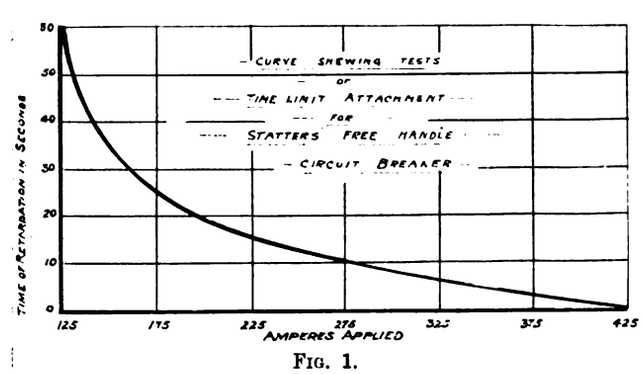

FIG. 1.

loading of an electric motor used for drilling operations may be executed by connecting in the motor circuit a free-handle circuit breaker, which, besides being the most economical protective device, has the advantage that its operation is entirely independent of the operating handle, and by providing the breaker with a time limit attachment the motor may be allowed to withstand an overload for a short predetermined period, at the end of which time the breaker would automatically cut the motor out of circuit. Such a device is manufactured by Messrs. J. G. Statter and Co.,

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of Birmingham, the time effect of the breaker being obtained by means of a metal disc immersed in glycerine (after the dash-pot principle), the disc being fixed to the plunger in the operating solenoid. The operation of this attachment is shown by the curve Fig. 1. When used, the time required to release the trigger of the breaker varies

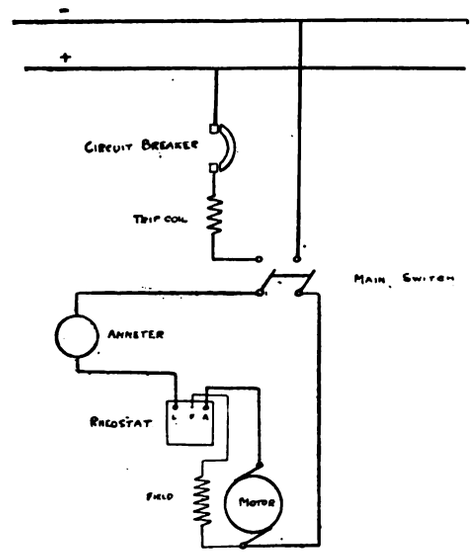

FIG. 2.

inversely as a power of the current, and if the short passes off before the breaker comes out, the time element automatically resets itself. Fig. 2 shows diagram of connections for the circuit breaker.—N.

Answer to No. 980 (awarded 5s.).—The difficulty experienced by the querist is a common one, but by inserting the electrical device described below any overheating may be obviated. Fig. 1 shows an automatic cut-out, which when once adjusted can be fixed in a box and locked up, so as to avoid being tampered with. Mounted on a suitable base is a solenoid wound on an insulated brass bobbin, and having two distinct windings, W_1 and W_2, shown in

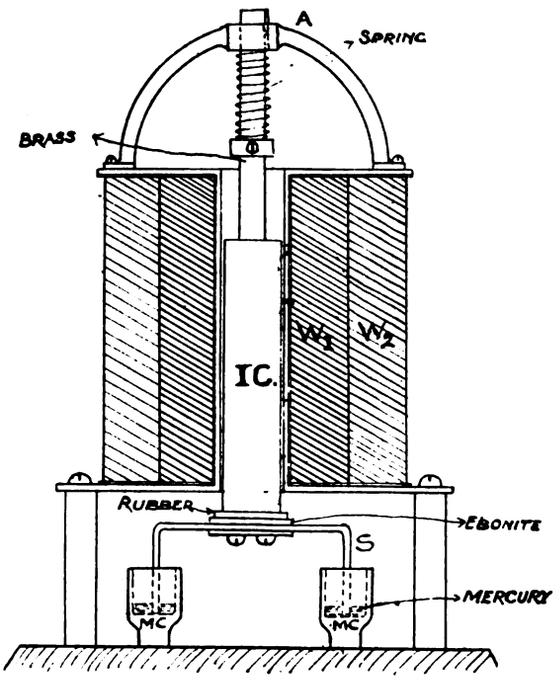

FIG. 1.

section. I C is an iron core, made an easy fit into the brass bobbin and entering three-fourths into it. Attached to the lower end, and insulated from it, is a strip of brass, S, forming a conducting link between the mercury-cups, M C. Screwed into the upper end of I C is a brass rod, which passes through the bearing, A. A spring and an adjustable collar are fixed on the lower side of A, and a small keyway is sunk in the bearing to prevent twisting of I C. In designing the mercury-cups they should be made deep to prevent loss of mercury by splashing; the bottom need only be well covered as the circuit is never entirely broken by this apparatus. Fig. 2 is a diagram of the connections. W_1 takes the whole of the motor current at all loads, and should be wound with a double cotton-covered copper wire of a suitable size to prevent overheating. The ampere-turns required will depend on the iron core and attachments. If this be made of $\frac{5}{8}$in. round iron 4$\frac{1}{2}$in. long, the total weight with attachments will be a little over $\frac{1}{2}$lb. W_1 should then have at least 1,300 ampere-turns when the motor is working at its rated output. W_2 is coupled in series with a variable resistance, R—a very convenient form for this purpose is a

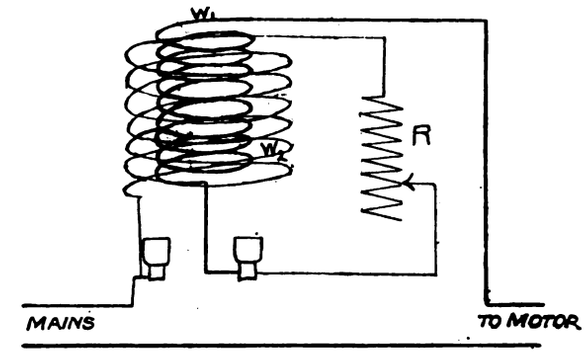

FIG. 2.

bank of incandescent lamps in parallel—and also in series with W_1. The current passing in W_2 varies, but if it be wound to carry the no load of the motor that will suffice, as the excessive current is only of short duration. The ampere-turns required for W_2 can be calculated as follows:

Let A = the no-load current, B = the full-load current, and T_1 and T_2 = the turns required on W_1 and W_2 respectively.

$$\text{Then} \quad T_1 = \frac{1,300}{B} \quad \text{and} \quad T_2 = \frac{1,300}{A} - T_1.$$

Care should be taken when coupling W_2 not to get in opposition to W_1.

The action of the cut-out is as follows: On closing the starting switch the heavy rush of current draws the strip, S, out of the contacts, M C. The path of the current is now through W_2, R_1, and W_1, and being still excessive S is still held up, but as the motor attains speed the current falls, and S forms contact again and short-circuits W_2 and R. If load is put on the motor the spring can be adjusted to suit the maximum load, and when this is exceeded I C will be sucked up, and W_2 and R put in the circuit. The motor will now slow down and likely stop, the resistance preventing the current attaining too serious an item. When the load is removed the core obviously drops again as soon as the motor attains speed. Any regulation can be got on W_2 with the resistance R, in case of lamps in parallel by adding or taking away one or more.—H. COLLINSON.

Question No. 981.—In a compound-wound direct-current generator, with commutating poles (positive equaliser, say, and four main poles, two commutating poles) should the current be led through commutating pole windings on its way from the positive brushes to the equaliser? Consider the above machine as direct-current end of a motor converter, and arranged to run shunt wound, supplying a three-wire system. Is better running ensured by leading current from positive brush round one commutating pole, and that to negative brush round other? What would be the advantages or disadvantages in having commutating poles connected thus when running compound?

Best Answer to No. 981 (awarded 10s.).—It is essential that the commutating pole windings of a compound-wound generator should always be excited directly by the armature current. The object of commutating poles and their design has been previously described in this journal,* and it is now well known that their function is to provide a "reversing" field of such a strength as to nullify the react-

* "The Present State of Direct-Current Design as influenced by Interpoles," the *Electrical Engineer*, May 24 and 31 and June 7, 1907, pp. 721, 757, 795. See also the *Electrical Engineer*, April 14, 1905, p. 57 (supplement), Feb. 22 and March 1, 1907, pp. 254A, 289A.

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ance voltage of the armature. As the reactance voltage is directly proportional to the armature current, other conditions being constant, the excitation of the commutating poles must, therefore, be equal to or directly proportional to the armature current. If the commutating pole windings

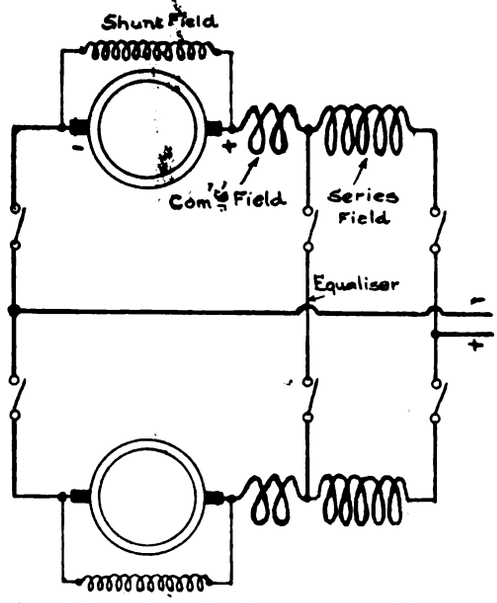
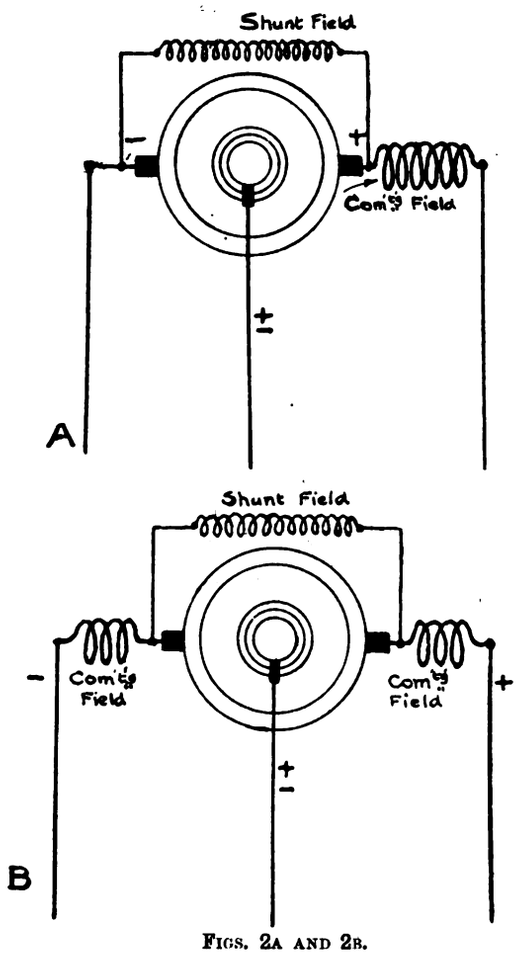


FIG. 1.—Correct Connections of Equaliser for Compound-Wound Generator with Commutating Poles.

are connected on the *line* side of the equaliser—*i.e.*, in series with the series field—then the current in their windings cannot be considered as equal to the armature current. Furthermore, this connection does not permit of satisfactory paralleling of the generators, as, if the



FIGS. 2A AND 2B.

positive and equaliser switches of the incoming generator be closed before the negative switch is thrown in, the commutating pole windings will be excited when there is no current in the armature, thereby inducing a heavy current in the coils undergoing commutation and causing serious sparking. The correct connection of the commutating pole windings of compound-wound generators, when run in parallel, is, therefore, shown in Fig. 1, the

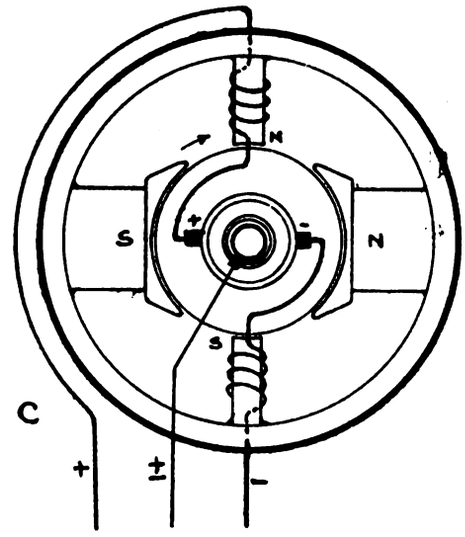
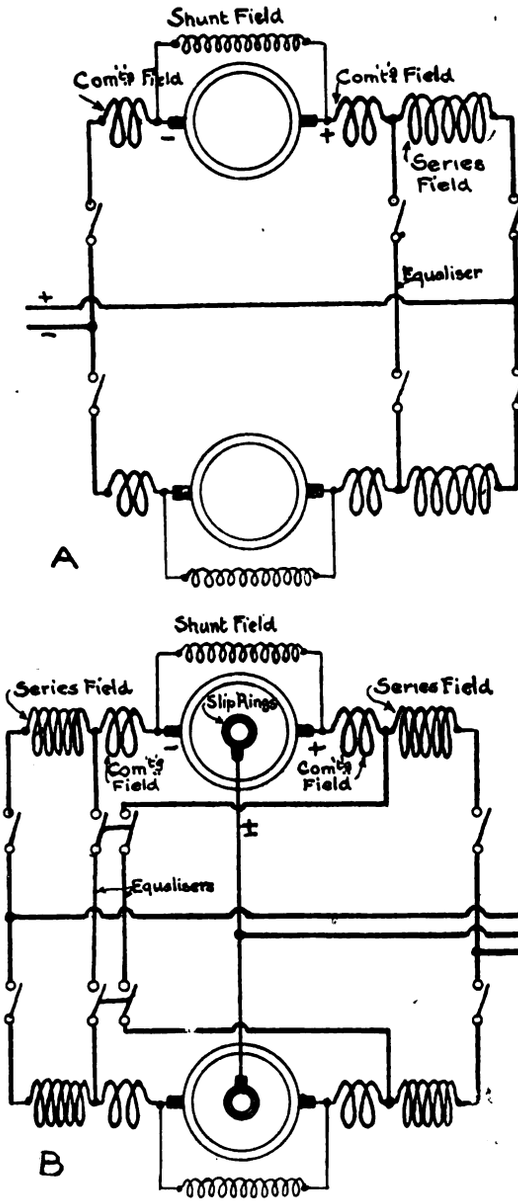


FIG. 2C.

commutating pole windings being on the *machine* side of the equaliser.



FIGS 3A AND 3B.—Equaliser Connections for Compound-Wound Generator with Commutating Poles—3A, Commutating Pole Winding in two portions; 3B, Three-Wire Generator with Series and Commutating Pole Windings in two portions.

Considering the shunt-wound motor converter mentioned in the above query supplying a three-wire system, the pro-

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posed connection is quite correct, and is, in fact, the only one possible for satisfactory running. It is for the same reason that the series fields of compound-wound three-wire generators are wound in two equal portions on each pole. The necessity for this will be readily followed from the sketch of Fig. 2A, where the neutral wire is shown connected to the short-circuited slip-rings of the motor converter. If the positive side be considered to be the more heavily-loaded side, then the excitation of the commutating poles will be due to the maximum current in the outers, and will, therefore, be satisfactory for commutation purposes. If, however, the out-of-balance current is on the negative side, then the excitation of the commutating poles will not be sufficiently strong to compensate for this out-of-balance current. With the whole of the load on the negative side, assuming such a condition possible, the commutating poles would be without excitation. The correct connection of the windings of the commutating poles will, therefore, be as shown in Fig. 2B. In this case the excitation of the commutating pole on the heavily-loaded side is stronger than that on the lightly-loaded side, and compensates for the increased current in the more heavily-loaded part of the armature. With the condition of all the load on one side, assuming this possible, one commutating pole would still be excited, and would be able to compensate for the current in the half of the armature on the loaded side. With such a connection of the commutating pole windings, it is important to see that the connections from the brushes lead to the correct commutating pole, as shown in Fig. 2C.

When the converter is run as a compound-wound generator no disadvantages will result if one-half of the commutating pole windings are connected in series with each brush, as outlined above, provided that the equaliser connection is properly located, as shown in Fig. 3A. If the converter is to be run on a three-wire system as a compound-wound generator, the equaliser connections should be located as shown in Fig. 3B, the series field being divided into two equal portions, one half being connected in the + outer and the other half in the − outer. This, of course, involves duplicate equaliser connections, and in order to overcome this objection a system has been proposed* where the whole of the series field winding is connected in series with one outer, and a supplementary winding, having one-half of the number of turns of the main series winding, is connected in series with the neutral wire. The supplementary winding is wound in the same direction around the poles as the main series winding, and the current in it is, of course, the algebraic sum of the currents in the outers.—THREE-WIRE.

Answer to No. 981 (awarded 7s. 6d.).—The current can be led through the commutating pole windings on its way

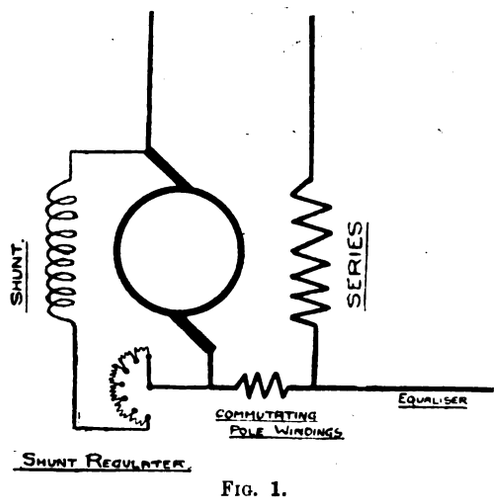

FIG. 1.

from the positive brush to the equaliser, as in Fig. 1, but it does not matter how they are connected if they pass the current that the machine is commutating only and not the equalising current. Running the machine shunt wound does not make any difference to the commutating poles, as their function is to counterbalance the E.M.F. of self-induction (reactance voltage) set up in the armature coils by the rapid reversal of the current during the time they are short-circuited by the brushes, and is proportional to the current strength. Compounding the machine only regulates the voltage, and, therefore, does not influence the commutating poles. Care must be taken that they are connected so as to be of right polarity, which depends upon the direction of rotation, and in the case of a generator they must be the same polarity as the next forward in the direction of rotation (see Fig. 2). The reactance voltage generally tends to keep the current flowing in the same direction at the time it should reverse, therefore the flux from the commutating pole must be in such a direction that when cut by the conductors it induces

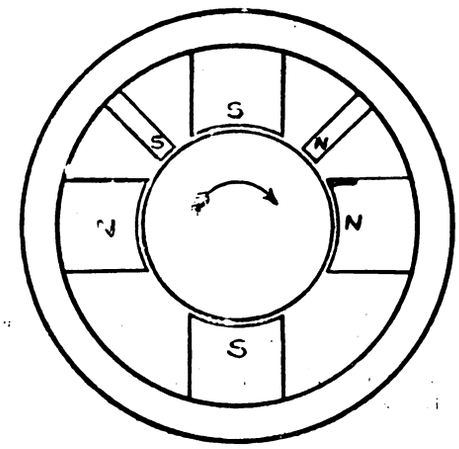

FIG. 2.

an E.M.F. opposite in direction to the reactance voltage, which is, of course, neutralised. There is no reason why the machine should run differently if the current is led from the positive brush round one commutating pole, and that to the negative brush round the other, as the current will be the same in both brushes; therefore, this is only the same as connecting them in series on one of the main brush leads—the only difference is that the external circuit is connected between them, but the same amount of current which passes from the positive brush must return by the negative brush to the armature.

A four-pole machine with two commutating poles would not run very well, as the leakage of the lines of force from the main field will be much greater in the magnetic circuits where the commutating poles are placed, as the saturation

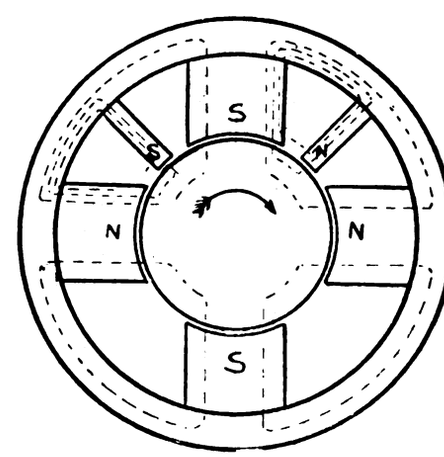

FIG. 3.

will be higher than in the other circuits, and this will cause the machine to be out of magnetic balance, and the leakage will be greater in these two circuits than the other two (see Fig. 3); and for two commutating poles to be effective a two-circuit series winding must be used.—J. E. C.

[Other replies to Question No. 981 will be given in our next issue.—ED. *E. E.*]

* See a note in the *Electrical Engineer*, "A Three-Wire Generator," May 10, 1907, p. 638.

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QUESTIONS.

992. Four 3,000-kw. turbo-alternators, generating at 11,000 volts three-phase, are running in parallel on a railway load. On the load easing up, one unit is shut down. The switchboard attendant goes to break the field circuit of this machine, but by mistake he opens the field switch of one of the other machines still on load. Discuss what would happen if (1) the three machines were left running thus for a few minutes; (2) if the field switch opened by mistake was closed again after a few seconds. The generators are star-wound with earthed neutral, and run splendidly as synchronous motors when the turbine stop-valve is shut. They are separately excited.—EBOR.

ANSWERS.

Question No. 981.—In a compound-wound direct-current generator, with commutating poles (positive equaliser, say, and four main poles, two commutating poles) should the current be led through commutating pole windings on its way from the positive brushes to the equaliser? Consider the above machine as direct-current end of a motor converter, and arranged to run shunt wound, supplying a three-wire system. Is better running ensured by leading current from positive brush round one commutating pole, and that to negative brush round other? What would be the advantages or disadvantages in having commutating poles connected thus when running compound?

Answer to No. 981 (awarded 5s.).—Compound-wound generators, fitted with interpoles, are generally connected up so that the compounding coils and the interpole coils form two separate windings, which are coupled in series, one end of the combination being connected to one of the armature leads, and the other end forming one pole

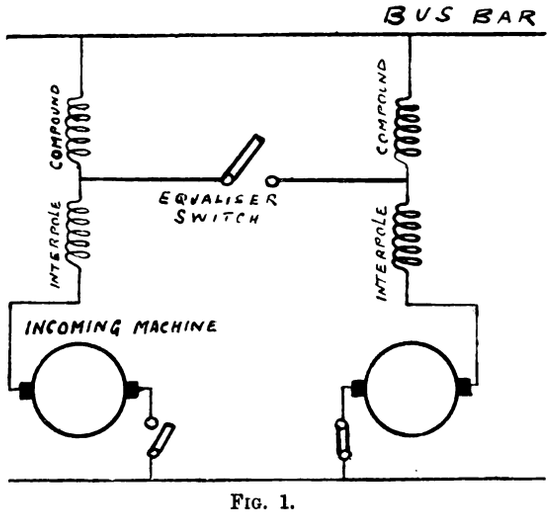


FIG. 1.

of the external circuit. Fig. 1 shows the connections which would be used when the generator was arranged to run in parallel with another machine, the connection to the equalising switch being taken from the junction between the two windings. This is important, as had the equalising connection been taken from the brush, then immediately on closing the equalising switch a current would flow through the interpole coils, magnetising them and causing a distortion of the main field, and the machine would spark although on open circuit. Since the function of the interpoles is to counteract the demagnetisation produced by the armature ampere-turns, no advantage would result by connecting them as suggested by "N. R. G."; for as long as the main current passes through each interpole coil, so as to give the correct polarity, it does not matter in what order the current goes through the coils. If the coils are connected as suggested, care should be taken not to split up the compound coils, for as the machine has to run as a shunt

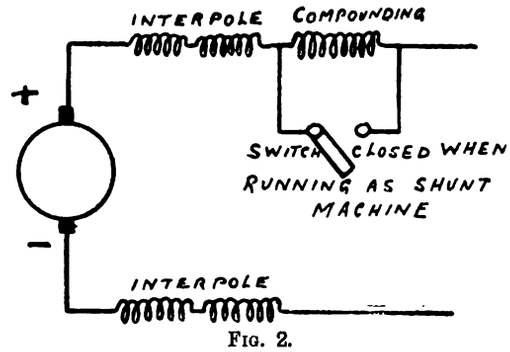
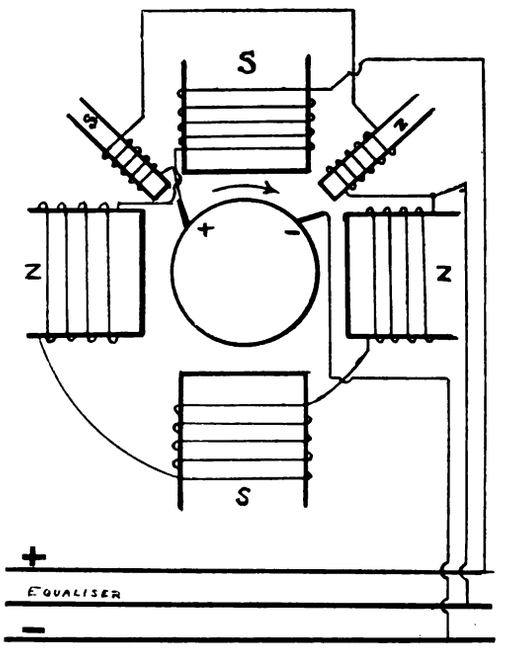


FIG. 2.

generator, a short-circuiting switch has to be placed across the *whole* of the compounding as shown in Fig. 2, whereas if the compound coils were split up into pairs, two switches would be required.—H. P. H.

Answer to No. 981 (awarded 5s.).—It will at once be seen that the question of the position of the interpole windings with respect to the other parts of the circuit is settled by the consideration, that the duties for which the various parts are designed must be fulfilled under any method of connection adopted. Thus, any position where the interpole winding is not doing its proper duty, or interferes in any way with any other part doing its duty, is inadmissible. Now, when two compound machines are paralleled together, the series field windings are usually paralleled first. For this purpose the ends of the two windings which are immediately joined to a brush are sometimes brought to a separate 'bus bar, called the equaliser, and when machines are paralleled the connections to this 'bus bar are made first. The reason of this is to



obtain a full field on the incoming machine before it is put on the line, and also to prevent this machine taking current from line, when the series field would back the shunt field and make matters worse. Now, if the interpole windings are in this paralleled circuit, there will be a compensating field on the incoming machine before it is taking any load—*i.e.*, before there is any armature current. As the object of the interpole windings is to provide a field which shall

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induce an E.M.F. in the armature winding to neutralise the E.M.F. of self-induction of the armature coils undergoing commutation, it is evident that the only current which should flow in the interpole windings should be the same as flows in the armature. Therefore, the interpoles should be connected between the positive brush and the equaliser in the case mentioned (see diagram).

Next, considering the case where the machine acts as a shunt generator for three-wire circuits. It is immaterial whether the interpole windings are both between one brush and one line, or one each side of armature. The same current flows through them in either case, and as long as they are connected up properly so that one is a N and the other a S pole, their position does not interfere with their doing their proper duty. The only case where the use of interpoles might be difficult would be where the system is balanced by a neutral compensator or choking coil. This is because the value of the current in the armature varies periodically if load is unbalanced, even though this load may be constant itself. In the same way, the arrangement of having one pole each side of the armature seems to possess neither advantage nor disadvantage over arrangement of having both poles on same side. The only case which might be made out for latter mode of connection would be that in case of one pole winding earthing to pole, the other pole winding would not be put to such a stress as it would if it were on the other side of armature.—F. H. CLARK.

Question No. 982.—Continuous current is required for tramway purposes. Motor-generators to be employed transforming from alternating current three-phase to direct current. Motor to be induction type, but capable of operation at same speed either at 25 or 50 periods by means of suitable pole-changing switches, with auto-transformer in circuit on lower frequency; the incoming alternating-current pressure being the same at each frequency. Presuming two sets are running, and it is required to start a third, state fully method of starting this set, giving full details of each successive operation. If the set be unable to start up from the alternating-current side, reasons should be clearly stated, with diagrams. Secondly, presume two sets operating from one frequency, say 50 periods, would it be practicable to operate one or more sets from the lower frequency to work in parallel on the continuous-current side with those operating from the higher-frequency supply?

Best Answer to No. 982 (awarded 10s.).—As the induction motor of the motor-generator sets has to operate at the same speed when working from both the 25 ~ and 50 ~ circuits, it will be evident that in the latter case the number of poles must be twice that in the former case, since synchronous speed $= 120 \cdot \frac{\sim}{p}$, $\sim$ being the frequency of supply in cycles per second and p the number of poles. It is very probable that the induction motors are equipped with squirrel-cage rotors, as this type is eminently suitable for changeable-pole motors. The fundamental equation connecting the E.M.F., speed, turns, flux in the three-phase induction motor is given by $E = 4{\cdot}44\, k\, t\, M \sim \times 10^{-8}$, where E is the "internal" E.M.F. per phase in the stator windings; t the number of turns in series per phase; M the flux per pole linked with these turns, and k the "breadth coefficient" for the winding. Hence if the E.M.F., E, and the turns per phase, t, are the same in each case, the flux per pole, M, when the motor is operating on 25 ~ will be twice that when the motor is operating on 50 ~. We are told in the above question, however, that an auto-transformer is in circuit when running on 25 ~ to reduce the value of the applied E.M.F., and, consequently, the flux. If the induction motors were designed for a normal operation on 50 ~, this reduction of the flux is a necessity when operating on 25 ~, as otherwise, with the full voltage applied to the stator, there will be considerable heating of the iron due to the high flux density. The amount of reduction in the voltage when operating on 25 ~ is not stated, but for the purpose of this discussion we will assume that the stator flux can be increased by 25 per cent. above normal, so that the applied voltage will be reduced to such an amount to give this flux when operating on 25 ~. We will, therefore, investigate what will be the effect of this reduction in the applied E.M.F. on the performance of the motor.

It may be shown that the total torque, T, developed by an induction motor is given by

$$T \text{ (pound-feet)} = {\cdot}0582 \frac{p}{\sim} \cdot S\, (3\, C_s^2\, R),$$

where S is the slip, C_s the secondary or rotor current per phase, R the rotor resistance per phase, and p ~ have the same meaning as in the previous equations. The term $3\, C_s^2\, R$ is the total rotor $C^2\, R$ loss. The determination of this is, of course, quite simple for a wound rotor, but presents difficulties in the case of a squirrel-cage rotor. Mr. H. M. Hobart has, however, investigated the problem, and deduced the expression: Total rotor C^2R loss for squirrel-cage rotors $= Z\, C_s^2\, (R_c + 0{\cdot}2\, Z_1^2\, R_r)$, where Z = the total number of conductors on the rotor, R_c the resistance of one rotor conductor, Z_1 the number of rotor conductors per pole, R_r the resistance of that part of one end-ring connecting two adjacent conductors, and C_s the rotor current given by: Secondary current obtained from "circle" diagram

$$\times \frac{\text{number of effective conductors on stator}}{\text{number of conductors on rotor}}.$$

The rotor current per phase C_s may, however, be deduced by analytical methods, the expression for three-phase motors reducing to

$$C_s = \frac{E}{\sqrt{R^2 + 4\, \pi^2\, \sim_2^2\, L_2^2}} \times \frac{Z}{6\, t} \times \frac{\sim_2}{\sim},$$

where L^2 is the coefficient of self-induction for one phase of the rotor, $\sim_2$ the frequency in the rotor, and the other symbols have the same meaning as in previous cases. Since $\sim_2 = \sim \times S$, the expression reduces to

$$C_s = \frac{E}{\sqrt{R^2 + 4\, \pi^2\, \sim^2 S^2\, L_2^2}} \times \frac{Z}{6\, t} \times S.$$

Inserting this expression in the above equation for the torque, we obtain for a three-phase motor with squirrel-cage rotor

$$T \text{ (pound-feet)} = {\cdot}001616 \frac{p \cdot S}{\sim} \times \frac{E^2}{R^2 + 4\, \pi^2\, \sim^2 S^2\, L_2^2} \times \left(\frac{Z}{t}\right)^2 \times Z\, (R_c + 0{\cdot}2\, Z_1^2\, R_r.$$

It will be observed that the term $\frac{p}{\sim}$ is the same whether the motor under consideration is operated on 25 ~ or 50 ~, while Z_1 will have twice the value on 25 ~ that it has on 50 ~. The most important point for consideration in this equation is the term involving $\frac{E^2}{R^2 + 4\, \pi^2\, \sim^2 S^2\, L_2^2}$, and as, under normal running conditions, the reactance term $(4\, \pi^2\, \sim^2 S^2\, L_2^2)$ is relatively small and not materially different for the 25 ~ and 50 ~ cases, we observe, therefore, that the torque is practically dependent on the square of the applied E.M.F. The output of the motor will, therefore, be reduced when running on the 25 ~ circuit. If the flux be increased 25 per cent. above normal when running on 25 ~, as previously mentioned, and if E is the E.M.F. per phase corresponding to 50 ~, then at 25 ~ the value of the E.M.F. will be 62·5 per cent. of E, and the resulting torque at 25 ~ will only be 39 per cent. of the torque available at 50 ~. If, however, a higher flux is permissible when operating on 25 ~, a much greater torque than this would be obtained, as, with a 50 per cent. increase in flux at 25 ~, the corresponding torque would be 56·2 per cent. of that available at 50 ~. An examination of the equation for torque will show that the starting torque may be approximately written as $T = K \frac{E^2}{4\, \pi^2\, \sim^2 L_2^2} (R_c + 0{\cdot}2\, Z_1^2\, R_r)$, where K includes all the "constant" terms. This shows that for the same value of applied E.M.F. the starting torque will be greater on the lower frequency. As the motors would probably be started by a compensator or auto-transformer in any case, a suitable tap will probably be found on the compensator on which the motor will start equally well on both circuits. If, however, the sets are started from the direct-current end, as is the practice in some large installations, some sort of a slip indicator should be attached to the shaft, in order to indicate when the slip is zero—*i.e.*, the correct instant for closing the switch on the induction motor side This slip indicator would indicate quite correctly on either circuit. The starting gear would, therefore, be practically the same

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in either case, and calls for no special comments, as the third set would be started up and paralleled in exactly the same way as the second set.

The parallel operation of the generators when part of the motors are operated on 25 ~ and part on 50 ~, will largely depend upon the slip characteristics of the motors under these conditions. It may be shown that the slip of an induction motor is the ratio $\frac{\text{total secondary or rotor } C_s^2 R}{\text{total input to rotor}}$, which may be written :

$$\text{Slip (S)} = \frac{\text{rotor } C_s^2 R}{\text{rotor } C_s^2 R + \text{watts output from motor}}.$$

In the case of a three-phase motor with squirrel-cage rotor this reduces to :

$$\text{Slip (S)} = \frac{Z C_s^2 (R_c + 0{\cdot}2 Z_1^2 R_r)}{Z C_s^2 (R_c + 0{\cdot}2 Z_1^2 R_r) + \text{watts output from motor}}$$

But output from motor in watts $= \frac{746 \times 2 \pi n T}{33{,}000}$, where n is the number of revolutions per minute. This may be written as :

Watts output from motor

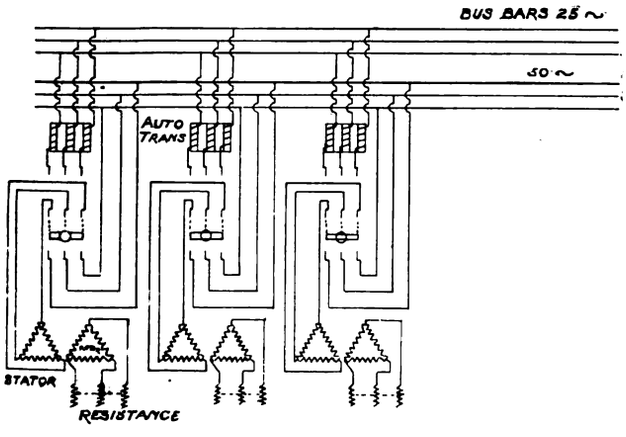
$$= \frac{2 \pi (1 - S) \sim}{p} \times \frac{T}{550} \times 746 = 8{\cdot}52 T (1 - S) \frac{\sim}{p}.$$

As the slip of an induction motor is usually very small up to its rated load, $(1 - S)$ may be considered as unity. Hence

$$\text{Slip (S)} = \frac{Z C_s^2 (R_c + 0{\cdot}2 Z_1^2 R_r)}{Z C_s^2 (R_c + 0{\cdot}2 Z_1^2 R_r) + 8{\cdot}52 T . \frac{\sim}{p}}.$$

An inspection of the torque equation will show that for the production of the same torque when operating on 25 ~ and 50 ~, a larger rotor $C_s^2 R$ is required in the former case than in the latter. This at once involves a larger slip, and, consequently, a larger drop in speed from no load to full load when operating on 25 ~ than when operating on 50 ~. With the direct-current ends of the sets in parallel, we should, therefore, find that the set running on 50 ~ would take the greater load. Of course, an adjustment of the shunt field rheostat could be made in order to make each set take the load equally, but even then this condition would only be obtained at one load. Should a sudden overload come on, it is very probable that the whole of this would be taken by the 50 ~ set.—E. T. L.

Answer to No. 982 (awarded 7s. 6d.).—The starting of any of the sets from the alternating-current side presents no difficulty. The accompanying sketch shows connections for starting and running on either frequency.



The top contacts of the change-over switches are connected to the low-frequency 'bus bars through the auto-transformers, the middle ones to the stator winding of the motor, and the bottom ones to the high-frequency bars. If the motors be of any considerable size, their rotors would probably have a starting resistance in circuit to keep the stator current at a low value at starting The operation of starting can now be followed, and is as shown in the diagram The main switch is closed on the contacts of whichever frequency is desired, having all the resistance in the rotor circuit The rotor is brought up to speed by gradually cutting out all the resistance, when, at full speed, the rotor may be short-circuited by a special switch of varying design, according to the maker. The fact that two or more sets may already be running has no influence on the starting of another set on either frequency, since the switchgear is similar in every set, as can be seen from the sketch. The pole-changing switches are not illustrated, as they have no direct bearing on the method of starting the machines.

Dealing with the second part of the query as it is stated—*i.e.*, having two machines running on the high-frequency and in parallel on the direct-current side—it is evident that the fact of the third set being run on the lower frequency supply cannot influence its operation in parallel with the other two on the direct-current side, since the direct-current machine has only a mechanical connection to the induction motor and not an electrical one. The only necessary conditions for parallel running of the direct-current machines are that their characteristic curves shall be similar if shunt wound, and, further, if compound wound (as they would probably be in the instance cited by the querist) that the resistances of the series windings be inversely proportional to the full-load outputs of the machines, if of different sizes; also that the speed regulation of each unit of motive power shall be similar, independently of the nature of the power, whether it be electricity, steam, or water. The sketch is, of course, only illustrative, and the design would have to be modified to suit the requirements of voltage, etc.—O. H. BRICKWELL.

Question No. 983.—Define the correct policy for the city electrical engineer when engaged by a corporation owning gas and electricity works. Electricity department has shown a loss for five years, a profit for one, zero for the next. Given good day-load prospects; low gas price, but bad gas; a committee containing mixed gas and electric interests who disallow canvassing expenses to the electrical department, and expect a paying concern without taking from the gas.

Best Answer to No. 983 (awarded 10s.).—A question of policy must always be governed by the circumstances of any particular case; in two cases with apparently the same conditions a similar policy might have very dissimilar results. It will, therefore, be evident at the outset that we cannot hope to define a policy which can be followed except on the merest outlines, and then with discretion and application to the particular case. The result to be aimed at should be to put the undertaking on a sound financial basis, with a credit balance and making healthy progress. The difficulties in the way are stated to be : a mixed committee, the possibility of a loss on the year's working, and that no canvassing expenses are allowed.

Perhaps we cannot do better than briefly consider each of these items separately. In the first place, we have a committee whose interest *should* be in the welfare of the city's undertakings as a whole, and we might assume that those gentlemen who are members of the gas as well as of the electricity committee wish equally for success in both cases, and quite naturally are not prepared to advocate the advance of the one to the detriment of the other. It is, then, clearly the engineer's policy to show that the success of the electrical undertaking need not be at the expense of the gas undertaking, and there is nothing like hard facts for doing this. He should procure reliable statistics to prove that in the majority of towns the rapid growth of the electrical department has been accompanied by an increased demand on, and not by taking away from, the gas department. If necessary, he can explain this by the great advance in artificial lighting generally, in some cases by the extension of the towns, and in most cases by the great demand for gas for use in domestic gas stoves. The engineer should avoid giving the committee the impression that he is prejudiced against gas, or in considering his recommendation and reports they will allow a certain margin to counteract this prejudice. It is wise to remember that the undertaking is a permanent one; it is bad to adopt a policy which will be detrimental to its future success, and the past, present, and future should be fully considered in making recommendations — the past because it will serve as a guide, it can be used to support the arguments, and that by it the committee will

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be largely governed; the present, because not only of its immediate results, but also because of its binding effect on the future; and the future, because no policy is good which does not aim for future security and success.

The engineer's chief and generally most difficult work is to deal with his committee, and on his success the welfare of the department largely depends. A close study of human nature and of the characteristics of individual members of his committee will be well repaid. For instance, if wise he will so make his proposals that the committee feels that they are its own; also he will studiously avoid letting the committee think he is trying to run them—rather he should be their expert adviser, assisting them to run *their* undertaking, not *his*. Conversations with individual members, and particularly the chairman, will materially assist in educating the committee to the necessarily more advanced ideas of the engineer, and in this way proposals, when they come before the committee, will easily go through, whereas otherwise they might have been rejected without reasonable consideration. He must avoid any attitude which might convey that he is working for his own or his department's aggrandisement, and he should take advantage of the business experience and knowledge of the city and people possessed by members of the committee. He should be persistent, and if any recommendation is rejected two or three times he should not give up the idea, but aim at its attainment in some other way, for nothing is so telling as persistency; yet it may become irritating and defeat its object if the same method is always used. The engineer should cultivate and always use tact in his dealings; at the same time he should endeavour to get the confidence of his committee for straight dealing and reliability, and that he is working for the corporation's welfare. A policy based on the foregoing should in time remove most of the difficulties in the way of attaining the desired result.

The second point is the possibility of a loss on the year's working. Engineers of experience know well that a loss, however small, at once places the department at great disadvantage, which a profit, though small, will generally remove. To take an illustration from "David Copperfield": "Income, £1; expenditure, 19s. 11¾d.; result, happiness. Income, £1; expenditure, 20s. 0¼d.; result, misery." Now, from a purely financial point of view, and with a board of directors who are far-seeing and looking to the future for success rather than the present, it may be a matter of small moment whether the present result is a small net loss or gain, and the soundest policy might be to incur a present loss for the sake of larger future profits. With a city corporation the matter is different: each year is taken by itself; and the prejudice against an undertaking showing a loss might be sufficient to prevent the adoption of proposals which, if carried, would turn the loss into a profit. On the other hand, if there is a small profit and the department is not a charge on the rates, the position of the committee on the council and with the ratepayers is an easier one, and better to combat criticism or opposition. It would, therefore, appear to be the best policy for the engineer to work for a credit balance before branching out into new departures which might defer the date of a profit, though it would be a larger one. Capital expenditure ought to be reduced to an absolute minimum, expensive alterations postponed, leakages of whatever description detected and stopped, and, generally, a degree of economy not necessary or desirable under ordinary circumstances should be practiced. One mistake the engineer should not make or allow his committee to make—viz., that of reducing the status or salary of the staff. An engineer should support his staff and encourage them, and so he will the more rapidly bring about the desired result.

The third point is that no canvassing expenses are allowed. Desirable as canvassing may be under most circumstances, it is, perhaps, as well for the present that expenses for this purpose are not allowed, for it often shows no immediate results, and in this case is not desirable. The disallowance of canvassing expenses is one of the difficulties which will probably disappear when the department is showing better results and the engineer has educated the committee to the advantages of promoting healthy growth by sound and reasonable methods. The engineer should not neglect the opportunities already at hand. When consumers or contractors call, he should not be above seeing them personally and letting them feel he is interested. When inquiries or complaints come through, either by post or telephone, the deputy engineer might call and see personally the larger consumers or prospective consumers, and a suitable qualified assistant the smaller ones. If new property is to be erected in the city, which can generally be ascertained from the city surveyor's department, communication with the architect and suggestions for electric light as being most up to date, etc., might not be without result; these and similar opportunities might be taken advantage of without incurring extra expense.

The question, though stating that there are good day load prospects, does not say if the department lets out motors on hire. Though ordinary capital expenditure for the immediate present should be avoided, if the station and mains would take more load without considerable extension it would probably be advisable to have a hiring-out department for motors. The rates for hire should fully cover the interest and sinking fund on the expenditure for motors, also the full cost of the motor department, which would thus be in no way a charge on the rest of the undertaking. The correct price of current for power can be well gauged by comparison with the prices charged in other towns having similar conditions, but the mistake should not be made of fixing it too low. Better have a small paying load than a heavy one at a loss; also the price can always be lowered more easily than raised. The hiring out of motors is an excellent advertisement, and is often an introduction to the electric lighting of buildings which are motor driven.

In conclusion, the question opens up a subject more suitably dealt with in a number of separate articles than in a short answer, and, as stated previously, the policy to be adopted must always be governed by the circumstances of any particular case. The foregoing, however, would appear to be the policy suited to this case at present, and, if adopted, could be developed and extended as results and time might suggest.—ERNEST T. WILLIAMS.

Answer to No. 983 (awarded 5s.).—In such a case as this it is somewhat difficult to advise without knowing the local conditions and more details of the undertaking As there is a good chance of a day load, it would appear to be the best policy of the engineer to do all that is possible to develop it. A great deal can be done if a scheme of hire or hire-purchase is developed. By this means a large number of consumers can be induced to take power, as they run no risk of a large capital outlay on a motor or motors. We have at these works developed the power load by this means, assisted by a power rate of 1½d., with reductions at certain consumptions. In the charges made for power, large consumers can often be offered a low rate if their load factor is taken into account. The maximum demand system has also much to commend it when long-hour loads have to be considered. A certain amount of good can be done if advertising matter is printed on the backs or at the foot of the quarterly accounts, drawing attention to any scheme the department may have on hand. Also assistance will often be gladly given by manufacturers, who will circularise the district, setting before the consumers and prospective consumers the advantages of the particular apparatus you wish to push.

In some towns electric lighting is often handicapped by the contractors charging a high price for lamps. In such a case the corporation are justified in selling lamps a little above cost price, in order to induce consumers to scrap the worn-out lamp at the proper time. Also, in connection with this work, advice can be given free to consumers as to the advisability of renewing lamps, and the most economical method of distributing their lights. The mains staff should be instructed to cultivate cordial relations with the contractors, and also to look out for new business. A great deal of good can be done by the methods indicated without incurring any expense in canvassing, and I would point out that all these methods have worked out very successfully at these works.—E P. A.

[Other replies to Question No. 983 will be given in our next issue.—ED. *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared.

QUESTIONS.

993. Discuss the pros and cons of having the rotor circuit open or closed when switching in 6,000-volt induction motors of over 200 kw. capacity.—E. F. R.

994. A double-current generator is run on short-circuit, and the reactance voltage is measured on the direct-current side. A Century testing set and a Siemens and Halske precision voltmeter are used. Both were previously checked, and are suitable for alternating-current and direct-current work. Is there any reason why the Siemens and Halske voltmeter should read 40 per cent. higher than the Century testing set?—W. W.

ANSWERS.

Question No. 983.—Define the correct policy for the city electrical engineer when engaged by a corporation owning gas and electricity works. Electricity department has shown a loss for five years, a profit for one, zero for the next. Given good day-load prospects; low gas price, but bad gas; a committee containing mixed gas and electric interests who disallow canvassing expenses to the electrical department, and expect a paying concern without taking from the gas.

Answer to No. 983 (awarded 7s. 6d.).—If the electricity supply undertaking is to show a profit, and at the same time not enter into competition with the gas estate, it is obvious that the electrical engineer must popularise his commodity and create a demand for the same. It is generally acknowledged that an exhibition is the best method of stimulating an interest in electricity, because it demonstrates in a popular manner the various uses for which electrical energy can be utilised. Another method of popularising electricity is to sell at a moderate price, otherwise people will use gas, even if the quality be bad. The engineer should do all he can to foster a day load. Although electrical energy for motive power is in some cases more expensive than gas, yet the advantages it possesses far outweigh the additional cost. A number of towns have found a deferred payment system for the supply of motors, spreading the payments over three to five years, has been the means of securing customers who would otherwise used gas. Where there is a great demand for motors, the same could be hired out to consumers. A low tariff for heating and cooking is another means of improving the day load and increasing the revenue.

With regard to electricity for lighting purposes, the engineer should endeavour to get all new property wired during erection. It is the custom in some towns for builders of houses and shops over £30 rental to wire the same, but where this is not done a deferred payment system, spreading the payments over, say, five years, will often induce people to install the electric light As an alternative scheme the electricity department could fix, say, six to twelve lights in a house or shop, the work being carried out by local wiring contractors, the electricity department recouping themselves by charging a moderate rental per quarter. This system has been the means of introducing electric light into hundreds of houses and shops, the occupants of which would otherwise be using gas. A splendid form of advertisement for electric lighting is the flame arc lamp. By hiring out lamps of this type for business premises, hotels, etc., the engineer could add to his revenue considerably. Another ally of the engineer is to be found in the metallic-filament lamp. Given a reasonable tariff, it is possible to illuminate premises with these lamps, and obtain a superior illumination at as cheap a rate as gas. The engineer should demonstrate the merits possessed by these lamps wherever there is an opportunity.

Finally, the engineer should do all he can to retain his present consumers by treating their complaints with courtesy (this is not always the case), advising them as to the most suitable methods of lighting their premises, where it is seen that improvement is needed, and by bringing before their notice improved and more efficient types of lamps and apparatus. No undertaking which is hampered by the restrictions named in the question can expect to advance by leaps and bounds, but by carrying out the details enumerated above the electrical engineer should before long be able to place his department on a satisfactory footing.—T. F.

Answer to No. 983 (awarded 5s.).—The correct policy to follow is not easy to see at the first glance. From the fact that for the last two years there has been an improvement in the financial position of the electricity department, I should deduce that the engineer was following very near the correct policy already. The committee's idea for not allowing canvassing expenses is apparently due to the fact that as they have control of both gas and electricity, they are sure to get whatever business there is going. Although in this they are apparently correct, they have lost sight of the fact that a canvasser's duty is not so much to gather in the business that is sure to come as to create fresh business; and they could very safely have a canvasser out without being in any way detrimental to the gas supply—in fact, it would be to the benefit of both undertakings. I doubt if the engineer would be able to get the committee to see eye to eye with him in this matter, but I believe that a man of some diplomacy might be able to come to some arrangement with the gas department whereby they practically assisted each other. It could be based upon some such arrangement as the following: the electricity department to have the power consumers and most of the lighting, and the gas department taking the heating and cooking and any of the lighting consumers that distinctly preferred gas. By coming to such an amicable working agreement with the gas department, I am sure both concerns would very soon be reaping a very substantial benefit. Finally, remember it is a very true Biblical truth that "an house divided against itself cannot stand." So that, whether you are an electric man or a gas man, remember you are servants of the same corporation, and don't steal each others consumers, but rather create fresh business for each other.—E. A. P.

Question No. 984.—What are the connections necessary to take (1) an E.M.F. wave, (2) a current wave-form from an alternating-current circuit by means of an oscillograph? On taking an E.M.F. wave-form from an alternator by means of the oscillograph, instead of a smooth curve it has ripples all along it. What are these due to? If due to machine, what precautions during design can be taken to prevent these?

Best Answer to No. 984 (awarded 10s.).—The oscillograph is a galvanometer, and as such requires a certain current, depending upon the strength of the magnetic field and the design of the instrument, to give a maximum deflection. This value is supplied by the makers in their instructions, but if unknown it is found out by bitter experience. Assuming that this safe value of current in strip, to give a maximum deflection for full field strength, is unknown, then, whether the instrument is being used to obtain (1) an E.M.F. curve or (2) a current curve, for the maximum deflection the circuit has to be arranged so that this current will flow through the strip. Let this current value be represented by c, then in case (1) the strip of the instrument is made to act as a voltmeter by being placed in series with a suitable non-inductive resistance across the voltage to be measured, and this resistance has to be of such a value that the current, c, will flow through the strip at the maximum voltage of the E.M.F. wave. Let V be the virtual voltage as read off from a voltmeter. Then, assuming for purposes of calculation that the wave approximates to a sine wave, the maximum voltage of wave will be 1·4 V. Then, neglecting the resistance of the instrument, the value of the non-conductive resistance, a Post Office testing box, or a wire resistance wound upon a flat thin card, R_r will be

$$R_r = \frac{1{\cdot}4\ V}{c}.$$

With this resistance, R_r, in series with the strip when put across the voltage, the current flowing through the strip will be in phase with the voltage, and will be proportional, so the deflections of the strip will follow the changes in the voltage.

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In case (2) the changes in the current have to be followed, and at the same time to have only the current, c, flowing through the strip of the oscillograph. This end is arrived at by shunting the instrument, which is non-inductive, with a non-inductive resistance. The best way to calculate this is: Take the most suitable non-inductive resistance at hand—a length of cable doubled back on itself makes a very good one—such that with the current whose curve is to be taken there will be a drop of a few volts along the resistance. Measure or calculate this: Let C be the

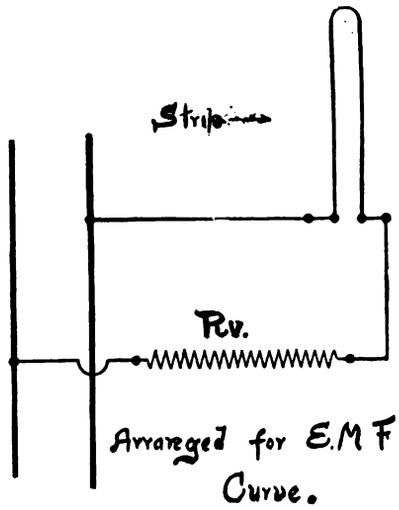

FIG. 1.

current, R_c the resistance, then the voltage at terminals of R_c will be

$$C \times R_c.$$

Then the total resistance of the oscillograph circuit will be

$$R_o = \frac{C \times R_c}{C}.$$

Then, allowing about two ohms for the resistance of the instrument itself, the resistance necessary to insert in series with the oscillograph placed across the shunt will be found. It will obviously be on the safe side to put more resistance in the series with the strip than the amount calculated, unless the resistance of the instrument is exactly known, after which the amount can be reduced until the maximum deflection of the strip is obtained with full current through the shunt.

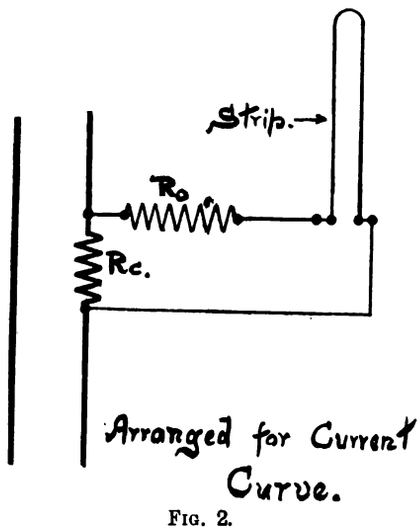

FIG. 2.

As regards the diagram of connections, this depends upon whether the instrument is fitted to take both current and E.M.F. curves at the same time or not—*i.e.*, whether it is a single-strip or a double-strip oscillograph. If it is a single-strip instrument, then the connections in each case are shown in Figs. 1 and 2. If, however, the instrument is provided with two strips, then it is necessary to arrange that the strips are at the same potential. This is done by making the terminal of the current strip shunt, which is connected directly to the strip terminal, T, in Fig. 3, a common point for both current and volt strips. The diagram of connections will then be as in Fig. 3.

With regard to the second part of the question, the ripples which you have observed on the E.M.F. curve are due to the machine, and, from the fact that you have called them ripples, their origin is in the armature teeth. The flux from the edge of the field pole, as a tooth is approaching, jumps across the slot, and similarly as the tooth recedes, at the other side, the flux suddenly drags itself across the slot, jumping from tooth to tooth. These jumps give rise to the ripples by apparently causing the speed of the cutting of the lines of force by the conductors to be first increased, giving a peak, and then decreased, giving a hollow. Thus it will be seen that the greater the number of slots per pole per phase the greater the number of ripples there will be, but the greater the number of slots the narrower they will be, and, therefore, the intensity of the flux oscillation will not be so great, and, therefore, the ripples will be somewhat smoothed out.

But the increasing the slots per pole per phase has limits from the point of view of using too much copper, and the dispersion of the winding. There is, however, another way of reducing the intensity of the flux oscillations, and that is by using partially or completely closed slots. By bridging the slots the oscillations are almost completely damped down by making the path of the flux more uniform. There remains, however, a small oscillation

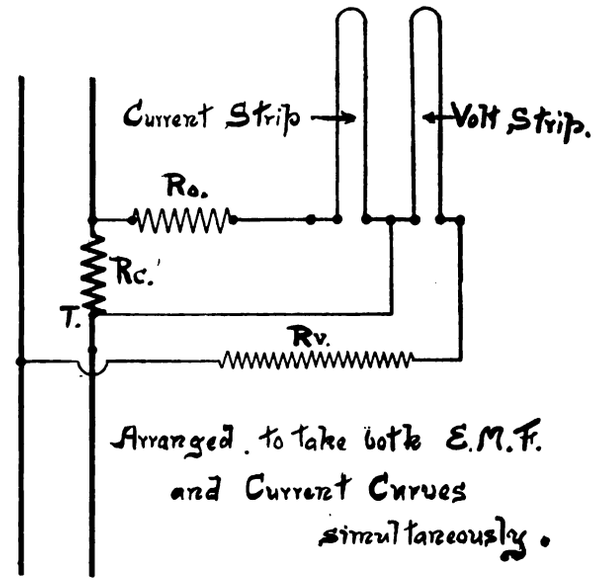

FIG. 3.

due to the slight remaining reluctance of the gap bridge, but its effect is hardly to be noticed in the E.M.F. curve. There are other oscillations in the flux which cause waves of higher frequency to be impressed upon the E.M.F. wave, but these do not seem to be present from the wording of the question. Papers on this subject have been read before the Institution of Electrical Engineers this year and last bearing on this subject by Mr. G. W. Worrall, M.Sc. Perhaps these would make the matter clearer.—W. BROWNING.

Answer to No. 984 (awarded 7s. 6d.).—The bifilar type of oscillograph is usually fitted with two pairs of strips—one for measuring or recording the potential difference or wave-form, and one for measuring or recording the wave-form of the current in a circuit, these records being taken simultaneously. The connections necessary for taking pressure and current wave-forms in an alternating-current circuit are shown in the sketch, where V S is the volt or pressure strip and C S is the current strip of the oscillograph. As these strips require only a pressure of about one volt to work them, it is necessary to use suitable standard resistances in the main alternating circuit, suitable tappings being taken off them. In order to observe the deflections of the mirrors attached to the strips, which may be vibrating hundreds of times per second, a strong source of light is provided, such as an arc lamp, which throws a beam of light on the mirrors, which reflect it back on to a rotating or vibrating mirror whose reflections are traced on a screen, photographic film, or a piece of paper.

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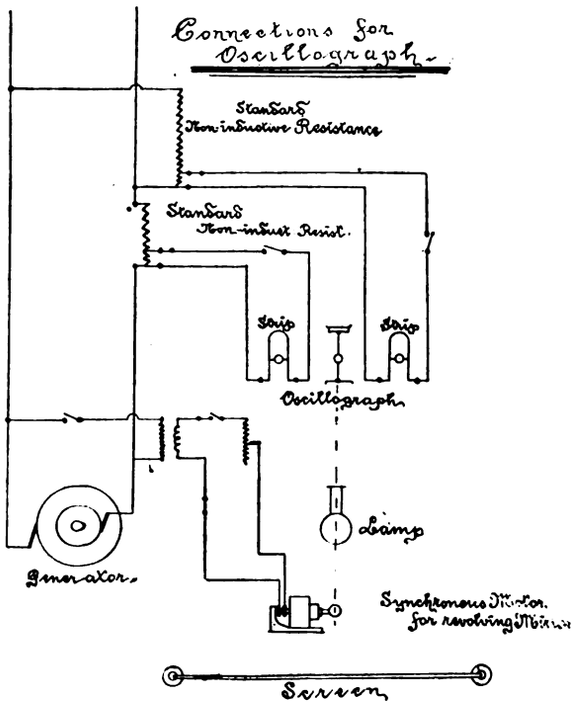
A convenient way of observing and tracing wave-forms is to use a vibrating mirror, caused to vibrate by a cam driven by a motor, these vibrations being synchronous with the waves of potential difference or current in the circuit considered. The axis of vibration should be at right angles to the axis of vibration of the oscillograph. The apparatus contains a fixed mirror in order to obtain a fixed zero line. The vibrating mirrors should be adjusted so that the base lines which they reflect when no current is passing coincide with the fixed zero line. This coincidence may alter, either owing to the heating up of the strips or owing to the wear of the cam used for vibrating the mirror which is driven by the synchronous motor. One must also be careful not to allow a high potential difference to exist between one pair and the other pair of strips or between one pair and the field magnet. For measuring pressures and currents the instrument can be first calibrated on a direct-current circuit by noting the deflection given for a known potential difference and current, and it will be found convenient to have these connections ready at hand, so that the instrument can be recalibrated at any moment.

With reference to the ripples recorded in the wave-forms, they are due to the teeth of the iron core of the generator, and in some machines are very pronounced; but in modern machines the design of the cores is such that the ripples



are just perceptible. Such ripples are not shown in the wave-forms obtained from generators with ironless armatures and revolving poles, though other variations in the smoothness of the curves may be present; and one must assume that so long as iron is used in the armatures such ripples are bound to appear in the wave-forms. It has been observed, however, that these ripples nearly disappear on circuits where two or more alternators are running in parallel, owing to the ripples due to one machine being in opposition to the ripples due to another machine; but there is also the possibility of such ripples synchronising, which may certainly increase any resonance effects.

A few years ago station engineers were much exercised in their minds as to the effects of resonance on their generator and distribution systems, but it has been shown that their fears on this account were somewhat exaggerated, there being little fear of resonance with carefully designed switches and proper handling of the plant. The loss due to the ripples is usually very small, and probably is never more than ½ per cent. of the output of the machine.—G. H. P. M.

Answer to No. 984 (awarded 5s.).—Figs. 1 and 2 show the connections for the Duddell oscillograph for taking voltage and current wave-forms with either one or two strips respectively. Also, in Fig. 2 are shown connections necessary for calibrating the wave. S_1 and S_2 are the current and voltage strips respectively. S_h is a variable shunt, whereby the current in the current strip can be varied roughly, the fine regulation being done by R_2 in series with the strip. R_1 is a high non-inductive resistance in series with the voltage strip. A C is the alternating-current generator, and D C a source of continuous current. A_1 and A_2 are alternating and direct current ammeters, and v_1 and v_2 alternating and direct current voltmeters respectively. T W S is a two-way switch for changing over from the alternating to a direct current supply. D S in Fig. 1

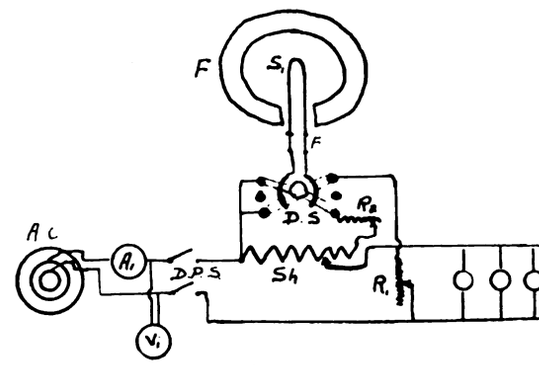


FIG. 1.

is a two-way switch to connect oscillograph for either current or voltage wave. F is the field system, which should preferably be excited from accumulators at 200 or 100 volts, according as to whether the two halves of the coils are in series or parallel. In some sets, though, a permanent magnet is used instead. M is a synchronous motor, which is used to oscillate the transverse mirror when the oscillograms are to be traced. It must be connected to the supply under investigation. F F are fuses to protect the strips. These references apply to both Figs. 1 and 2. Fig. 1 shows the simplest scheme, with one strip and a permanent magnet. Fig. 2 shows connections for a double-strip oscillograph, together with means for calibrating the curves. Care must be taken in connecting up with two strips that they are both connected at one end to a common point, so that there cannot be more than one or two volts between the strips. The normal current in the strips is half an ampere, and to obtain good-sized curves the current should be adjusted by R_1, R_2, and S_h to as near this value as possible. To calibrate the oscillograms, the two-way switch, T W S, is thrown over on to the direct-current side, the current and voltage adjusted to a convenient value, and the resulting straight line given

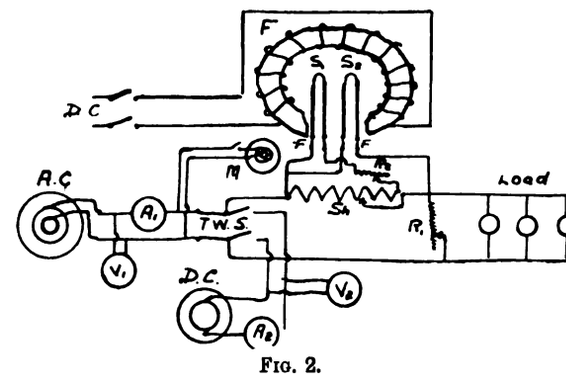


FIG. 2.

by the oscillograph superimposed on the curve. From this, knowing the values of voltage and current, a scale can be made, and then any instantaneous value of either alternating wave can be measured. If the values of the various resistances are kept constant, one scale will be sufficient for any number of curves.

The ripples or higher harmonics noticed on the wave are probably caused by the teeth of the armature. Especially if open, these cause an oscillation of the magnetic flux of a frequency equal to the number of slots per pair of poles, plus one, times the frequency of the machine. Consequently though of small value, due to their high frequency they may have a very important effect if there is capacity on the line or the load. In order to minimise the value of

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these oscillations, the teeth may be partially or totally closed. (For further particulars on magnetic oscillation see paper read at Manchester, Feb. 5, 1907, by Mr. G. W. Worrall, M.Sc., M.E., on "Magnetic Oscillations in Alternators and their Bearing upon Design.") Fig. 3 shows curves of voltage and current taken from a Witting three-phase alternator, star-connected, two slots per pole per phase, when the machine was supplying to condensers. In the current curve the thirteenth harmonic is very distinct, though in the voltage curve it is barely distinguishable. No even harmonics can occur in an electrically-balanced machine and no third harmonic in the external circuit of a three-phase star-connected system, though it may exist in the separate phases.

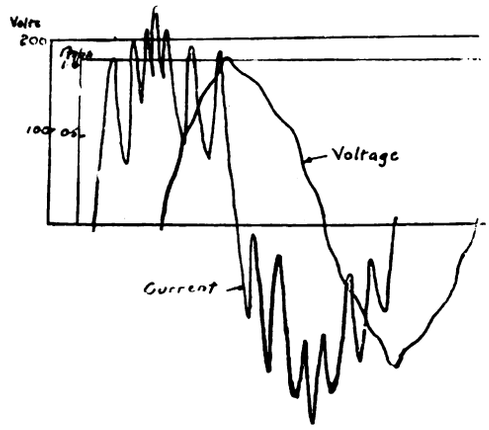

FIG. 3.

If the inertia of the synchronous motor used to vibrate the mirror was too small, ripples might occur due to periodic fluctuation in the speed of the rotating part. These fluctuations would probably only occur with low frequencies, say 25 ~ and below, and the harmonics shown thereby would be of a much lower frequency than those due to the teeth, and would be even harmonics, making the curves assymetrical. This could be overcome by increasing the inertia of the rotating part by means of a disc fixed to the shaft.—H. R. D. P.

Answer to No. 984 (awarded 5s.).—There are various forms of oscillograph in use, but as the most popular is Duddell's, we will commence by briefly referring to the construction of this instrument, and then consider the connections necessary to take E.M.F. and current curves.

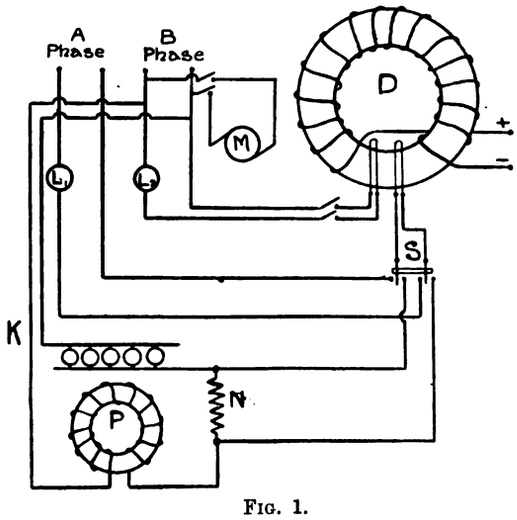

FIG. 1.

Duddell's oscillograph is essentially a modified form of D'Arsonval galvanometer. In the narrow gap between the poles of the electromagnet there are two parallel conductors, formed by bending a strip of phosphor bronze back upon itself over a small pulley which is attached to a spring balance. At the bottom the strips are clamped to a block, whilst at the top of the magnet pole-pieces a bridge piece holds them in position. Each strip of the loop passes through a separate gap in the magnetic circuit, and the clearance is only ·038mm. These gaps are filled with a viscous oil to damp the motion, and when a current traverses the strip a mirror fixed thereto turns about a vertical axis. An alternating current would produce a straight line out of the to-and-fro motion of the spot of light, and to obtain the wave-form a second mirror is interposed in the path of the beam of light, and this mirror is caused to vibrate or rotate so as to impart to the beam a uniform motion, proportional to time, in a plane at right angles to the plane of vibration of the beam due to the current. A synchronous motor is used to work this second mirror, and the wave-form due to persistence of vision appears as a bright line upon the screen. By placing tracing paper over this it is possible to trace a permanent record of the wave. There are two strips in the Duddell oscillograph, so that the E.M.F. and current wave-forms may be shown simultaneously, or, in the case

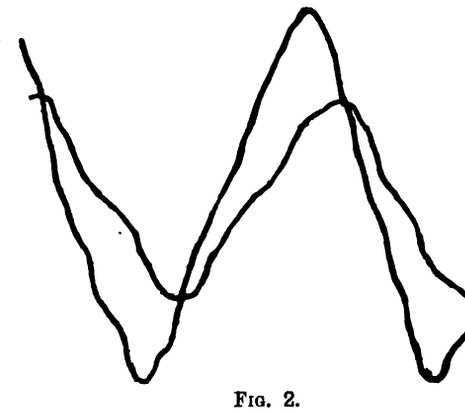

FIG. 2.

of two-phase circuits, the relation between the two E.M.F.'s can be observed.

Fig. 1 shows the connections necessary for showing the form for either E.M.F. or for the current in circuit K. As the strips only require about ·5 ampere, a lamp, L_1 L_2, is placed in series with each phase. S is a switch for connecting one strip to give either E.M.F. or current wave form. To obtain the shape of the current wave in the inductive circuit, K, a shunt from a non-inductive resistance, N, is taken to the oscillograph, D. The mirror motor, M, is connected to the mains, and the oscillograph field is connected to a battery of accumulators. By varying the self-induction of P, the lagging of the current behind the E.M.F. can very well be seen. Figs. 2 and 3 are actual wave-forms taken from the Sheffield Corporation mains.

Ripples on an oscillograph curve may be caused by the instrument or by the supplying machine. Care should be taken that the oil in the damping vessel has not by any means leaked out. If this is all right, it may be assumed that the actual wave of the alternator is the one obtained, and that some defect in the machine causes the ripples. There are several conditions in the alternator which may do so. The two most likely are, insufficiently rigid conductors and a too light rotor frame. In the first case, if

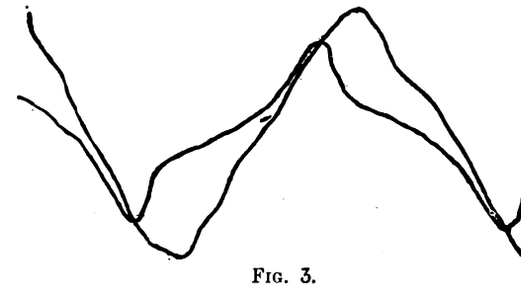

FIG. 3.

any one part of an armature conductor can vibrate and has a natural period of oscillation in sympathy with the frequency of the current, then it may possibly be set in vibration by the passing pole of the field magnet, and, acting upon the E.M.F., cause ripples. In the second case, if the spider or frame of the rotating field magnets be of light construction, the periphery may spring backwards or forwards, and thus be set into vibration, resonant or otherwise, in a circumferential direction, and this motion may cause the ripples in the wave-form of the E.M.F. generated.

PERCY DUNSHEATH.

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

QUESTIONS.

995. Give a method (graphical or analytical, preferably the latter) of determining the deflections at all points of a shaft of varying diameter, supported by two bearings and loaded with two or more loads (as, for example, a motor shaft).—C.

ANSWERS.

Question No. 985.—Discuss the advisability or necessity of providing an inverted rotary converter with separate excitation supplied by a direct-driven unsaturated exciter.

Best Answer to No. 985 (awarded 10s.).—With the ordinary type of rotary converter, converting from three-phase to continuous current, the speed of revolution of the armature is fixed, and is practically independent of the load. The machine in this case operates as a synchronous motor, the speed of which is given by $s = \frac{120 \sim}{p}$, where s is the speed in revolutions per minute, $\sim$ the frequency in cycles per second, and p the number of poles. It will be observed that this expression does not involve the flux or number of turns on the armature. When the machine is inverted—*i.e.*, used for converting continuous current into alternating current—the operation is dependent upon the characteristics of the continuous-current motor. The speed in this case is given by $s = \frac{3{,}000\,(V - C\,.\,R_a)}{T\,.\,M\,.\,p}$, where V is the terminal or line voltage on the direct-current side, $C\,.\,R_a$, the resistance drop in the armature (C being the resultant armature current), T the number of turns in series between the brushes, M the flux in megalines per pole, and s, p have the same values as in the previous expression. Since, with a given machine, T and p are constant, the expression for speed may, therefore, be written as $s = \frac{k\,(V - C\,.\,R_a)}{M}$, which shows that the speed of an inverted converter is inversely proportional to the flux, M, linked with the armature turns.

The armature reactions in an inverted converter are, in general, similar to those which occur in alternating-current generators, but in the former case the armature reaction for the same line current is lower than in the latter case on account of the superposition of the alternating and continuous currents, which result in the effective value of the armature current being less than the external or line current. This superposition or compensation of the currents in the armature of an inverted converter only occurs effectively when the load on the alternating-current side is non-inductive. As the power factor of the alternating-current load decreases below unity the resultant armature current increases, and at about 80 per cent. power factor there is practically no compensation of the alternating and continuous currents in the armature.* The armature winding of an inverted converter should, therefore, be proportioned on the same scale as for a double-current generator, in order to avoid excessive heating when the machine operates on a load having a power factor less than unity. In an inverted converter, the reaction of the armature current on the field, when the power factor of the external load is unity, results in a distortion of the field, but with a power factor of less than unity, due to a lagging current, a demagnetising effect occurs, while a magnetising effect is produced with a leading current, in the same manner as with alternating-current generators.

With a power factor of unity, assuming a non-inductive armature, the maximum value of the current occurs at the same instant as the maximum value of the induced E.M.F.—*i.e.*, under the centre line of the pole face or "mid-pole-face position"—but as the power factor decreases the maximum value of the current occurs later than that of the maximum value of the E.M.F. For an angle of lag of 90deg. the maximum value of the current will occur 90deg. after the mid-pole-face position has been passed—*i.e*, midway between the pole arc corresponding to a maximum armature demagnetisation. The demagnetising effect of the armature current is generally considered as increasing in proportion to the sine of the angle by which the maximum value of the current lags behind the mid-pole-face position. This assumption is quite warrantable for practical purposes It may be pointed out that the demagnetising effect increases at first very rapidly, as the position of the maximum current lags behind the mid-pole face position and reaches nearly its full value when the conductors of the armature coils are opposite the pole tips at the instant of maximum current, afterwards increasing more slowly. If θ be this angle of internal lag, then it may be shown that the demagnetising effect for a whole period varies as $\frac{\sin\theta}{2}$. The expression for the armature demagnetising M.M.F. for a three-phase machine may, therefore, be written as $\sqrt{2}\,C\,k_1\,\frac{T}{p} \times 3\,\frac{\sin\theta}{2} = 2{\cdot}12\,k_1\,C\,\frac{T}{p}\,\sin\theta$ ampere-turns, where C is the virtual current per phase, T the number of turns in series per phase, p the number of poles, and k_1 the breadth coefficient for the winding. The ampere-turns per pole on the field magnets to compensate for this demagnetisation will, therefore, be $2\,12\,k_1\,C\,\frac{T}{p}\,\sin\theta\,.\,v$ ampere-turns, where v is the dispersion or leakage coefficient. Hence, in an inverted converter the excitation should increase in this proportion in order that the flux linked with the armature turns may be constant. It may be mentioned that the angle of internal lag, θ, is slightly greater than the angle of external lag, ϕ, by an amount depending upon the inductance of the armature. It is, therefore, very necessary to provide an inverted converter with separate excitation from a direct-connected exciter, and it is important that the magnetic circuit of the exciter be worked below saturation—*i.e.*, on the steep part of the magnetisation curve—in order that automatic regulation may be obtained. Under these conditions a very slight increase in the speed of the converter, due to armature reaction, is sufficient to cause the exciter to build up, and, therefore, increase the excitation of the converter, thereby decreasing the speed again to normal. With careful design it is possible to so arrange the characteristics of the converter and exciter that the speed will be practically constant between 80 per cent. and unity power factor. Where it is essential that the alternating-current circuit should be supplied at about a uniform frequency, it is imperative that the excitation of the converter should compensate for the armature demagnetisation in the manner indicated above. In addition to the direct-connected exciter, all inverted converters should be equipped with a centrifugal device to open the direct-current circuit breakers when the speed reaches a certain limit. Due to these limitations the sphere of usefulness of the inverted rotary converter is comparatively small, and it is the practice to install motor-generators in place of them. The extra cost of the motor-generators is not a very large item, as in most cases a set of transformers would probably be required with the inverted converter.—E. T. L.

Answer to No. 985 (awarded 7s. 6d.).—This question is, I think, best discussed by considering the action of an inverted rotary converter, supplied with constant excitation, under load. Such a machine is essentially a direct-current motor and alternating-current generator with one common field system. Let the machine work on a non-inductive load, and take any value of the load, letting the conditions be represented by Fig. 1 so far as the alternating-current generator is concerned. It is seen from this diagram that, due to the armature reactance, there is a certain angle of lag, D A C, of the current behind the

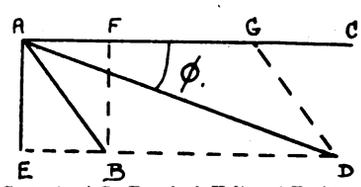

FIG. 1.—A C, Current; A G, Terminal Volts; A F, Armature Resistance Volts; A E, Armature Reactance Volts; A B, Armature Impedance Volts; A D, Generated Volts.

* A similar result would occur in the ordinary rotary converter if the power factor were decreased to 80 per cent. In this case, however, we have a means of maintaining a unity power factor by field regulation, which cannot be applied to the inverted converter.

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generated volts. In the case drawn in Fig. 1 this is small, since the load is taken as being very small. Now assume that by some means the load is suddenly increased to the value A C in Fig. 2. The generated volts will be the same as in the previous case, but the armature impedance drop is increased proportionately to the rise in current, thus greatly increasing the angle of lag, D A C. If the load is inductive, there will be an additional angle of lag, C A C'. The effect of these lagging currents in the armature of an alternator is shown is Fig. 3, which is given for the simplest case—viz., two-pole unicoil machine. When the current is in phase with the generated volts the position of maximum current is C D—that is, it is coincident with the position for maximum voltage. Consequently the

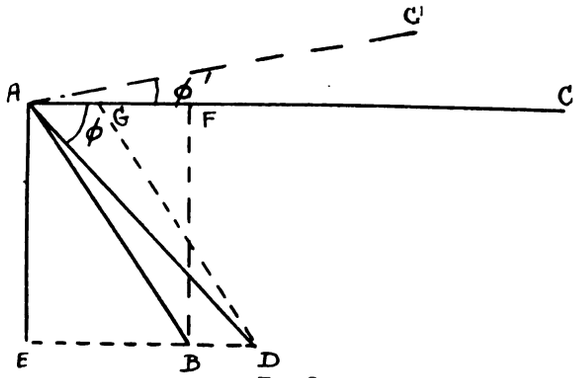

FIG. 2.

armature reaction field is at right angles to the main field, and will, therefore, not weaken or strengthen the main field. In the case of a lagging current the position of maximum current is, say, C' D'—that is, the armature reaction field is along A' B'—and by Fleming's rule the polarities are as shown by *n* and *o*, consequently the lagging currents will weaken the main field.

Now since in an inverted rotary there is only one main field system, an increase of load on the alternating-current generator side will weaken the direct-current motor field, thus causing the speed to rise practically proportionally to the amount of field weakening. It is to prevent this rise of speed that special devices are used on inverted rotaries.

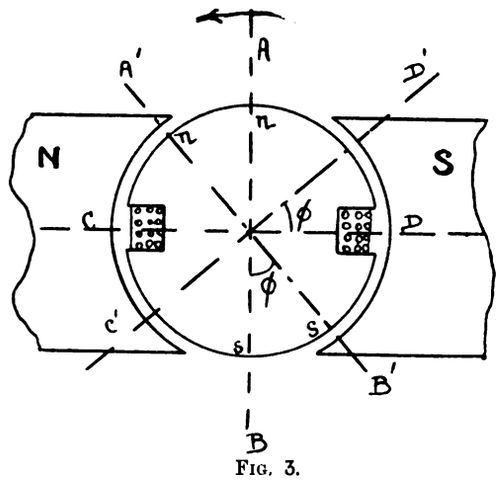

FIG. 3.

One method of preventing excessive rise is to automatically shut off the power supply to the converter motor armature by some centrifugal device on the rotary shaft. This method is, however, not very satisfactory, since the power is shut off suddenly, thus causing a very unstable state of affairs in the supply circuits to the rotary. A far better method is to mount an unsaturated shunt exciter on the rotary shaft. In this case a rise of speed will cause the voltage of the exciter to rise, firstly, on account of the increased speed, and also increased exciter field, due also to the rise in speed, since the magnetic circuit of the exciter is unsaturated. This increase in the exciter voltage will increase the field current of the rotary, thus strengthening the rotary field, and causing the speed to drop again to its original value. This method is perfectly automatic, and on account of its simplicity and reliability is much preferable to the method of cutting off the power from the rotary armature. It is, therefore, not merely advisable, but almost a necessity, from a practical point of view, to employ this device.—E. S.

Answer to No. 985 (awarded 5s.).—The advisability depends on the work required to be done by the alternating side when the rotary is motored by direct current. Suppose the rotary is running in parallel with several other alternating-current machines, there may easily be trouble through lagging or through leading currents. Such out-of-phase currents drawn from the machines will not only react on the fields, but may react on them unequally. A heavy lagging current weakens the field of a rotary, therefore in the case of the rotary being driven from the direct-current side its speed is at once increased. This follows at once from the property of the direct-current motor. It is generally considered that for alternators to run well in parallel, speed of rotation must be kept within an alteration of 2½ electrical degrees. This leads to another factor in making a choice as to excitation, and that is the periodicity. The higher the periodicity, the greater the tendency to unequal running. Westinghouse machines are sometimes fitted with motor-generators to supply the necessary excitation. The motor of the motor-generator is of the induction type, and is driven from the alternating side of the rotary, while the generator armature runs in a field well under saturation. Any increase in speed of the rotary, therefore, immediately causes a corresponding increase in speed of the induction motor and the voltage of the existing current is raised and the fields of rotary strengthened. The fact of the generator armature of the motor-generator running in an under-excited field makes the voltage at its terminals more susceptible to alteration in speed of rotation. If, therefore, the rotary is intended to run in parallel with others both on the alternating as well as on the direct current side, the complication of separate excitation may be worth consideration, but for ordinary purposes there does not seem any reason why self-excitation should not be employed.—M. M.

Answer to No. 985 (awarded 5s.).—An inverted rotary converter should always be provided with a separate exciter mounted on an extension of the main shaft, and working with an unsaturated field. The reasons for so working this type of machine are, that the converter being run from the direct-current side as a direct-current motor, its speed will not be kept constant, but will follow the law of a direct-current motor—viz., that the speed will depend on the strength of the field, and also on the effect of the armature reaction in further weakening the field. Now, a rotary converter owes much of its high efficiency to the fact that as long as it is kept up to or about its proper speed, it offers a very easy path for the flow of current from one side to the other, so that a demand from one side is very promptly met. Now, consider an inverted rotary running on a widely fluctuating load, or on a steady lighting load, on to which a heavy load is suddenly thrown on and off, due to, say, a temporary short in a service box, which short is at once burnt out. The demand for a heavy current on the alternating-current side is at once met from the direct-current 'bus bars, and the current is quickly passed through the converter. Now, the call for this heavy current would tend to slow up the ordinary shunt-wound direct-current motor, which, if well designed, would promptly adjust its speed to normal again, owing to the weakening effect on the field, and if this motor was driving an alternator the motor would deal with the extra work demanded by the alternator normally—*i.e.*, its speed would be kept up owing to the field being weakened—and the work would be done by extra current supplied to the armature, as the motor would be designed to be self-regulating, or nearly so, under these conditions.

The speed would be kept fairly constant, but in the case of an inverted converter the field has also to stand the effect of the armature reaction due to the demand for current from the alternating-current side—*i.e.*, it not only has to stand the effect of the armature reaction of the motor armature as in a motor-generator, but also the effect of the armature reaction of the alternator of the motor-generator set. Thus the armature reaction in an *inverted* rotary may be very great, due to varying loads, speeds,

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and very greatly weakens the field, so that the armature of the rotary would tend to speed up to dangerous limits. The best means of preventing this state of things, and of keeping an inverted converter running at or about constant speed, is to separately excite its field from an exciter mounted on an extension of the rotary shaft. This exciter is worked with an unsaturated field, so that a very slight increase of its speed sends up its voltage, and consequently the amount of current passing round its own and the rotary field, and as the exciter revolves at the same speed as the rotary, being on the same shaft, it follows that on a slight increase in speed the field of the rotary is at once strengthened and its speed kept within safe limits.—W. T. W.

Question No. 986.—Give a description of condensers for static ground detectors for alternating-current high-tension circuits, with sketches showing details of construction (of condensers) and connections to the circuit.

Answer to No. 986 (awarded 10s.).—The instrument about which information is required is evidently the static ground detector put on the market by the Westinghouse Company.

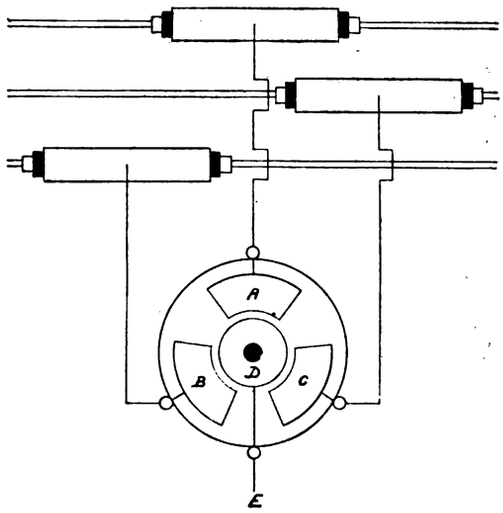

FIG. 1.

Fig. 1 is a diagrammatic sketch of the condensers, instrument, and connections. Each of the three condensers consists of an insulated brass tube covered with a copper sheathing, the brass tube being connected to line. The brass tube forms the inner, the copper envelope the outer plate of the condenser. These copper sheaths are connected to three fixed and insulated metallic vanes in the instrument, marked on sketch A, B, and C. A movable vane, D, is connected to earth; this vane is so fitted that it can move in any direction. Suppose, now, a "ground" developed on leg connected to vane A, A would

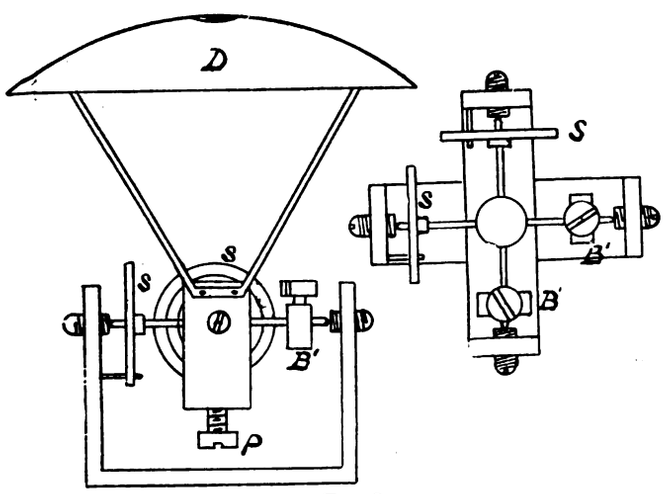

FIG. 2.

then be at earth potential, and the electrostatic conditions of the system of vanes would be thrown out of balance. Under normal conditions, the movable vane, D, is acted upon equally by A, B, and C, therefore it keeps a central position. But with A at earth potential, D moves over and takes up a position between B and C; the spot on D then affords a means of knowing not only that a ground has developed, but which is the faulty main. A, B, and C are spherical shaped, while D forms a part of a concentric sphere. D is made of aluminium, and the ingenious arrangement by which the necessary motion is secured is shown in Fig. 2. The movable vane is practically placed in "gimbals." The outer U-shaped carriage is screwed to base of instrument, while the inner carriage carries the movable vane. The two spindles are at right angles, pivoted in adjusting screws. S, S are springs to bring the spot to a central position; P is a screw to balance the movable vane; B', B' are counterpoises, one on each shaft. This is a purely static combination, and remarkable for its simplicity.

Fig. 3 shows a method of utilising condensers in connection with choking coils as a protective device. This is due to Percy H. Thomas (American Institute of Electrical Engineers' *Journal*, 1902). A much smaller choking coil can be employed with this arrangement, thus bringing down the constant losses to a minimum. The sketch shows

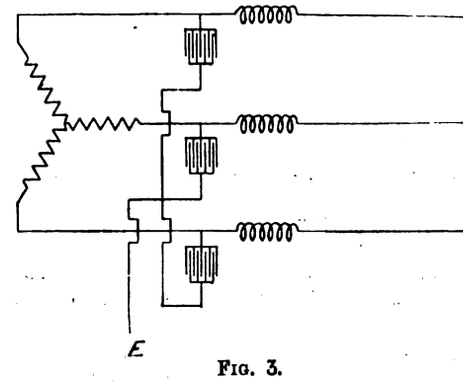

FIG. 3.

connections for a three-phase star circuit, but, of course, the method can with facility be applied to any other system of conductors and machinery.—M. M.

Answer to No. 986 (awarded 5s.).—The most convenient form of condenser for use with static ground detectors is of the tube type, as made by the Westinghouse Company,

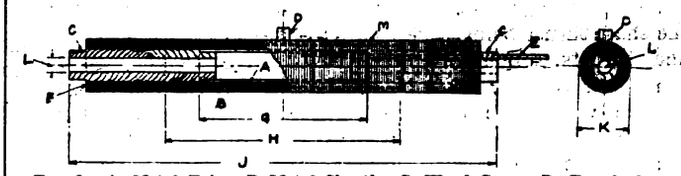

FIG. 1.—A, Metal Tube; B, Metal Sheath; C, Wood Cores; D, Terminal (soldered to B); E, Connection Wire to A; F, Insulation; G, 8in. and 1ft. 2in.; H, 8in. and 1ft. 2in.; J, 1ft. 6in. and 2ft. 6in.; K, 3½in.; L, 1in; M, Fine Cord.

and consists of, as shown in sketch No. 1, a couple of metal tubes, A and B, insulated from each other, and rigidly supported by wooden cores, A. The condenser is arranged (with an inch bore) to slip over a cable and the wire, E, directly connected to the cable.

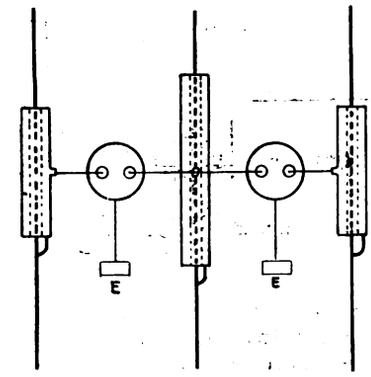

FIG. 2.—Connections for Three-Phase Circuits.

Details of Construction.—A is a brass tube about ⅛in. thick and a diameter of 2in. The ends of this tube are drilled to receive screws, which fasten it to C, hard wooden cores (vacuum treated, impregnated with insulating varnish). To the inside of A a wire, E, is fastened, and brought out

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through the wooden core as shown. Over A and C is wound an insulating paper, F, until a diameter of 2½in. is reached, when a sheet copper tube, B, is pushed on with a terminal, D, soldered to it; more insulating paper is then wound on, and then a band of fine cord is tightly wound on, which serves to protect the insulation from mechanical damage. The whole condenser is then put into a vacuum chamber and impregnated with insulating varnish, and finally dried.

The dimensions shown in Fig. 1 are for condensers suitable for voltages from about 3,000 to 7,000, and where two dimensions are shown for G, H, and I, it shows the length of long condenser it is necessary to use on three-phase

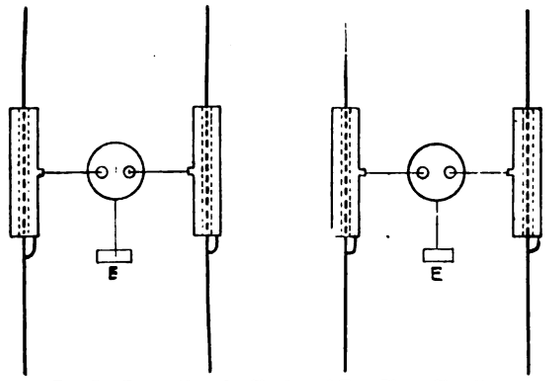

FIG 3.—Connections for Single and Two Phase Circuits.

circuits (Fig. 2). The capacity of such condensers would be about ·00010 to ·00015 microfarad. This type of condenser can be used on voltages from 1,000 to 18,000, and has the great advantage of being easy to construct and install.—E.

Question No. 987.—What is the best practice for electric lifts where very sudden stoppages and reversals frequently occur? Special reference to pilot and main switches and to best type of motor and brake, and also diagram of connections, desired. Low pressure. Power required, from 1 h.p. to 3 h.p.

Best Answer to No. 987 (awarded 10s.).—The best type of machine to use for this purpose is an over-compounded motor, giving a maximum starting torque with quick acceleration and a constant speed, driving a winding drum or wheel through a steel worm and gunmetal wormwheel, the shaft thrust being taken on hard steel balls, the worm and thrusts running in oil. Castor oil gives very good results. The drum should be grooved, so that as the cage rope winds the balance-weight rope unwinds, the cage being at the top of the lift well when the balance weight is at the bottom, and *vice versâ*. If the machine is arranged directly overhead, the drum will need to be grooved right and left handed, and the ropes anchored to the drum; unless this be the case, automatic stops cannot be relied on. For, say, ½in. or ⅝in. iron rope, guiding sheaves of not less than 24in. diameter should be used, owing to excessive wear.

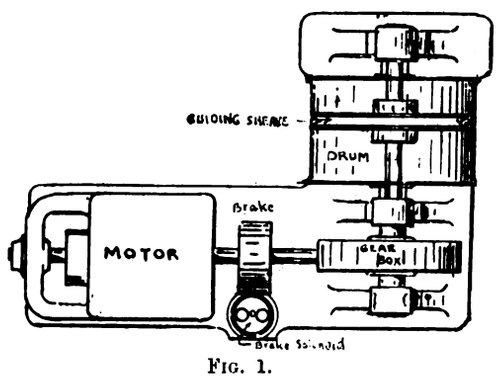

FIG. 1.

"Barbette" evidently requires a machine to withstand more severe conditions than are usually met with in practice. In a cage of dead-balanced weight from 60lb. to 600lb. plus a load of, say, 200lb. to 400lb. travelling 200ft. per minute (quick service is inferred), a goodly amount of energy is stored up, and a sudden reversal, being generally the attendant's error, whether for passenger or dumb-waiter service, is such a strain on the gearing and motor that the main fuse becomes a natural necessity.

Control.—The "pilot switch" leads us to magnetic control. This control opens up possibilities of an almost unlimited supply of safeguards—viz.: (1) against the slacking of rope if the cage or balance weight sticks; (2) stops the machine in the event of the rope breaking; or (3) overlapping of the rope on the drum; or (4) the over-running of the cage at up and down limits; or (5) the using of the lift when any doors are left open. All these

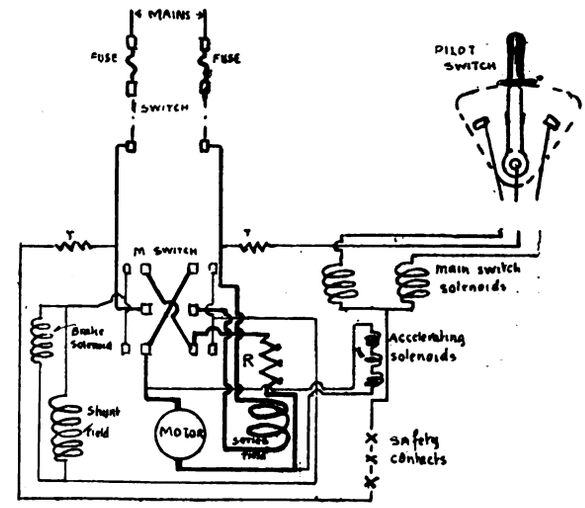

FIG. 2.

are effected by means of various push devices in series with the magnetic circuit operated by the pilot switch, which draws in and holds the main switches of the motor. The pilot switch can be arranged by means of a spring to come to the off position in case of an accident to the attendant. Acceleration can be obtained by means of gravity switch contacts and solenoids, of which there are several types in operation. Main switches, up and down, and accelerating switches can be of the "throw-to" type, carbon contacts with springs to make a quick break when released by the solenoid.

Brake.—The most successful is the band-brake type around, say, the motor-shaft coupling, a strong spring tending to keep it tight, and terminating with a plunger in a solenoid which is a shunt circuit across the mains as shown in the diagram, so that when the main switch is closed current flows, causing the solenoid to overcome the spring, and the brake comes off. If the main circuit becomes

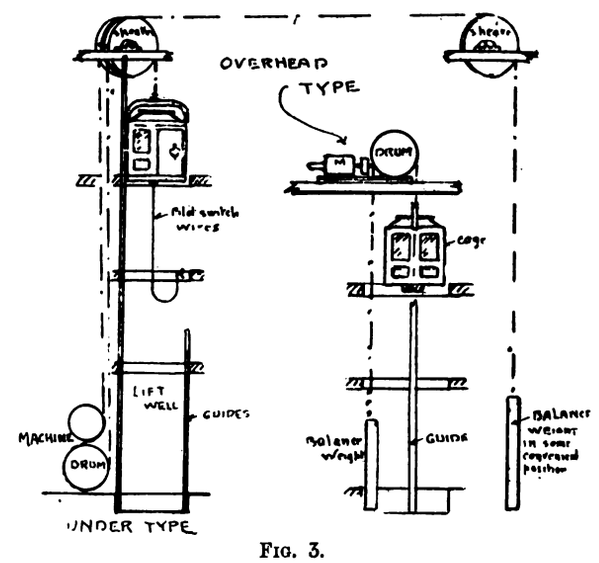

FIG. 3.

in any way broken, the brake is applied and the machine pulled up. The brake spring requires adjusting when erecting to bring the lift to a decisive but easy stop. The best results will be obtained if the total weight of cage, plus half full load, be the weight of the balance weight. The maximum that can be got from a 3-h.p. motor with a service of, say, 150ft. to 200ft. per minute is a load of 400lb.—R. V. M.

[Other replies to Question No. 987 will be given in our next issue.—ED. *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

996. We supply about 80,000 gallons of hot water from our station to the adjacent premises per month. We purchase this water, together with our boiler supply, by meter. Our neighbour's consumption of water is below the quantity available under his minimum payment to the water authority, and so he could obtain the water free of cost. Under the Waterworks Act we cannot bring water from our neighbours' water-pipes into our premises. We wish, therefore, to heat the water on their premises. (The price of the water is 1s. per 1,000 gallons.) What is the best method of doing this, using exhaust steam at atmospheric pressure?—C. B.

ANSWERS.

Question No. 987.—What is the best practice for electric lifts where very sudden stoppages and reversals frequently occur? Special reference to pilot and main switches and to best type of motor and brake, and also diagram of connections, desired. Low pressure. Power required, from 1 h.p. to 3 h.p.

Answer to No. 987 (awarded 5s.).—Where cheapness is to be looked at as an essential point in electrically-driven

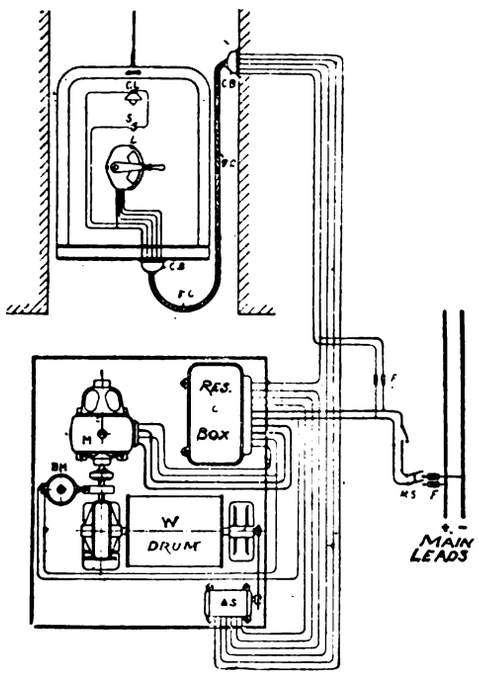

FIG 1.—CL, Cage Light; S, Switch for same; CB, Connection Box; FC, Flexible Cable; M, Motor; BM, Brake Magnet; F, Fuses; MS, Main Switch; S, Solenoid.

lifts, the hand-rope gear is at present the commonest method of operating the reversing and circuit-breaking switches. It usually consists of a direct mechanical connection between what is virtually the handle of the switch and rope, which passes through the cage, and is, therefore, available for a man in the cage to set the switch or switches in any position he may desire. In this method of operation serious destruction of switch contacts goes on very rapidly owing to an unskilful attendant "inching" the cage to bring it exactly to a floor. In consequence, when speeds of more than 150ft. per minute are required, it is now becoming usual to supersede the mechanical hand-rope transmission by an electrical method, in which the attendant merely moves a switch in the cage. Where the cage switch method is used the general practice is to avoid taking the actual power circuit to the cage, owing to the probabilities of trouble developing where heavy flexible cable is required. An independent circuit carrying a comparatively small current is led into the cage, this current being used to energise the operating solenoids of the power switches. For diagram of connections see Fig. 1.

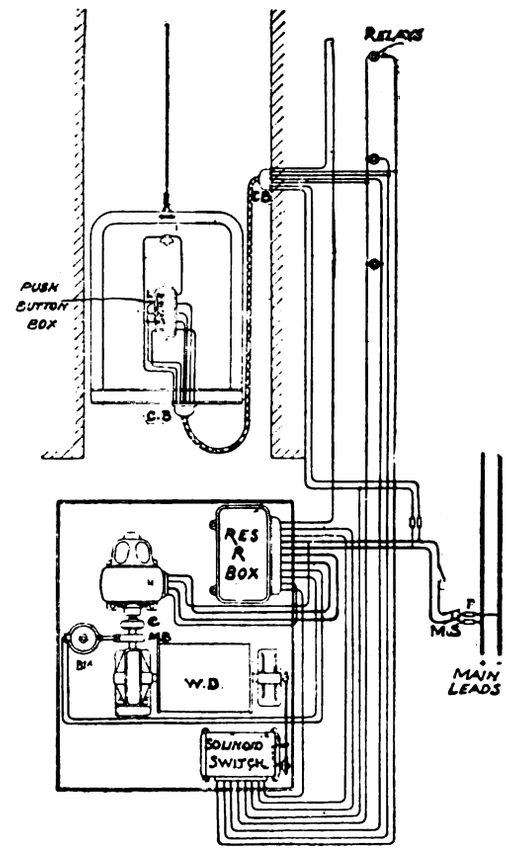

FIG. 2.—F, Fuse; M S, Main Switch; C B, Cable Box; R, Resistance and Connection Box; M, Motor; W D, Winding Drum; M B, Magnetic Brake.

Where it is desired to dispense with the services of a lift attendant, and, consequently, no skill on the part of the user can be assumed, the cage switch method is supplanted by a further developed form of electrical transmission known as the "push-button" system. In this system it is generally found necessary to still further reduce the current in the circuits leading to the cage or car, owing to the difficulty of dealing with the door contacts, which are practically indispensable on this class of work. In such cases the majority of makers insert a relay between the push button and the circuit of the solenoid switch. The relays are all grouped together and under cover in the solenoid switch. Fig. 2 indicates the arrangement of connections for push-button control. The combination of the winding gear and motor is merely a matter of direct coupling, and presents no problems essentially different from the direct driving of any other class of machinery. Owing to the essential difference in economical speed of the electrical and mechanical parts, worm gear is almost universally employed as the means of combination, occasionally, where conditions of price will allow, two worms with balanced thrust being adapted.

The question of the most suitable type of motor is a matter upon which considerable difference of opinion still exists. The choice lies between shunt and compound winding. The reasons given by advocates of shunt winding are mainly greater simplicity of only one magnet winding, less space taken by insulation, and greater simplicity of the controller. Where, however, shunt winding is used it is usually designed as if for a lower voltage than that on which the machine is to be used, and a resistance is placed

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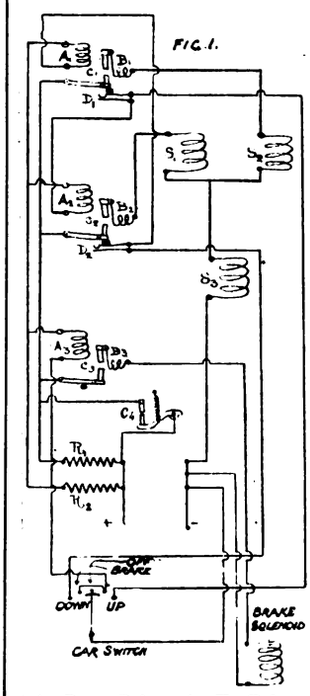
in series with it. During the process of starting this resistance is short-circuited, thus making the machine take an abnormally large shunt current, and producing the required extra torque to accelerate the load. Seeing, however, that the greatest trouble with lifts supplied from public lighting mains is their tendency to cause fluctuation of voltage by their demands on the mains at the instant of starting, it is difficult to see how the shunt winding can be really as satisfactory as a properly designed compound-wound motor arranged to have its compound coils cut out after the process of accelerating is accomplished. The compounding merely takes the place of the last section of the starting resistance, so the complication of the controller is more imaginary than real. Silent running is also frequently a highly important matter, owing to the fact that the running machinery is located close to offices or dwelling apartments. It is, therefore, essential that the motor shall be capable of retaining a first-class surface on its commutator, and that the class of brush-holder should be of good design, such as to avoid singing. The size of motor required for a lift to carry six moderate weight passengers is approximately 7 h.p.—E. L. P. L.

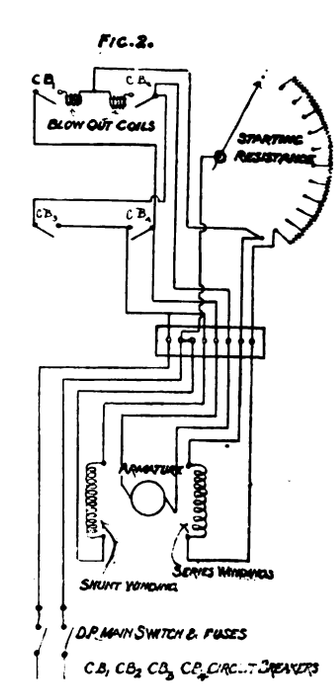
Answer to No. 987 (awarded 5s.).—The character of the switchgear for an electric lift depends to a certain extent on the method of control—whether hand-rope, car-switch, or push-button. With modern electric lifts, general practice tends to abandon hand-rope operation, except in cases where low initial cost is an essential. With high speeds, accurate stoppage at floor-levels is difficult if a hand-rope is used, and also if the cage over-runs a short distance at a floor it is no easy matter to "inch" it forward or backward until level. This disadvantage is often of less importance in passenger lifts than it is in goods lifts, where heavy trucks are wheeled into and out of the cage, and necessitating it being level with the floor. Another reason for doing away with the hand-rope is that in many cases it calls for undue exertion in weak persons who may require to use the lift. Push-button control is automatic in action, and is mostly used where a lift attendant is not kept, as no skill is necessary on the part of the user in order to operate the lift. As a description of this method of control does not appear to be what is required in the question I will not discuss it any further.

Car-switch operation is the most suitable method for the case in question, as sudden stops or reversals may be made with ease. With this method a small four-contact switch is fixed in the cage. Moving the switch in either direction on to the first contact releases the brake. Further movement causes the lift to ascend or descend, according to which way the switch is moved. The current carried by this switch is small in value, being used to energise a relay, all the other switching operations being automatically performed. A diagram of the connections to the controlling circuit is shown in Fig. 1. The relays, A_1, A_2, A_3, are actuated from the car switch. The passage of a current through A_1 closes the contact C_1. This excites (1) the solenoid S_3, the function of which is to close the circuit breakers CB_2, CB_4 (Fig. 2) and (2) the solenoid S_3, which cuts out the starting resistance. When the whole of the starting resistance is cut out, a rod attached to the core of the solenoid S_3 separates the carbon contacts C_4, inserting the resistance, R_1, in series with the solenoids and brake coil. The object of this is to economise current, as very little is necessary to hold the cores in position after their work is done. It will be noticed that blow-out coils, B_1, B_2, B_3, are fitted to the contacts, C_1, C_2, C_3. This is rendered necessary, as the circuits which they control possess considerable self-induction, causing an arc on breaking circuit. The spring contacts, D_1, D_2, are held together by the weight of the levers carrying C_1, C_2, separating only when the relay to which they are attached operates. Their object is to prevent both the relays A_1, A_2 being in action at the same time if by any chance one of them should stick, as this would short-circuit the armature of the motor, and possibly burn out the starting resistance if the fuse was too large. When A_2 is excited S_1 come into action, closing CB_1, CB_3 (Fig. 2), otherwise the cycle of operations is as before.

The connections to the power circuit are shown in their simplest form in Fig. 2. The circuit breakers, CB_1, CB_2, CB_3, CB_4, are fitted with carbon contacts, and CB_1, CB_2 also have magnetic blow-out coils. The method of connection varies considerably with different makers. It is a common practice to have the shunt circuit of the motor permanently excited if the lift is used frequently, as the starting torque and rate of acceleration is greater than in the case where the shunt is not excited until current is switched on to the armature. Sometimes the blow-out coils are connected in series with the shunt circuit of the motor, being short-circuited while the motor is running.

The type of motor generally used is compound or shunt. Series motors are unsuitable for lift work generally, as when running on light loads the speed is excessive, and difficulty is experienced in stopping at the right place. Where a compound machine is installed, the series winding is cut out or short-circuited when the motor has run up to speed. Where a shunt motor is used, the field is designed for a lower voltage supply than that on which it will be used, thus giving a strong field for starting. Resistance is inserted in the field circuit after the armature resistance has been cut out, giving increased speed to the motor. The brake is usually of the electro-mechanical type, consisting of wooden brake blocks acting on the coupling between the motor and the gear box. A solenoid acting





A1, Down Relay; A2, Up Relay; A3, Brake Relay; B1, B2, B3, Magnetic Blow-Out Coils; C1, C2, C3, C4, Carbon Contacts: F1, F2, Solenoids operating Main Switches; S3 Solenoid operating Starting Resistance; R1, R2, Resistances; D1, D2, Spring Contacts.

on an arrangement of levers serves to release the brake when starting the lift. Owing to the variable coefficient of friction between the brake blocks and the coupling, this brake is sometimes difficult to adjust. If screwed up too tight the lift is stopped with a sudden jerk, the brake giving vent to an ear-piercing shriek, and if not tight enough the lift runs a considerable distance after the brake has been applied. To overcome this difficulty a resistance is sometimes connected across the armature of the motor after the supply has been cut off. When the field is excited the motor then acts as a generator, coming to rest quickly, but without jerk. The effect of the field in a permanently excited motor is considerable, bringing the armature to rest quickly after the armature current is cut off, due to eddy currents in the core. Of course, this braking action is less than would be the case if a resistance was connected across the armature.—S. JAMES.

Question No. 988.—In a small high-tension hydro-electric power scheme it is proposed to use two 100-kilovolt-ampere three-phase generators instead of one machine. This is on account of transport difficulties in dealing with heavy weights. Which would be the better method to adopt: to couple the two generators rigidly together with the turbine connected at either end, or place the turbine between the two generators? As the generators are to be insulated from earth, insulated flexible couplings must be used

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in either case. Give advantages and disadvantages of each arrangement.

Best Answer to No. 988 (awarded 10s.).—The arrangement to be adopted in mechanically coupling the alternators to the waterwheels will depend entirely upon the nature of the electrical connection between the two machines. If the machines are to be connected electrically in series, then they must be rigidly coupled together mechanically, whereas if they are to be operated in parallel, then there must not be anything in the nature of a rigid mechanical coupling between them. A little consideration will clearly show that these conditions are necessary in order to fulfil those which govern the electrical operation of the machines.

Consider the first case of two alternators connected electrically in series but not mechanically coupled together. If the synchronous speed of one machine differs from that of the other during a part of a revolution, then we shall get an unstable condition as regards phase equality, and, further, there will be no tendency to correct this phase displacement, but a tendency to increase it and put the machines out of phase. This, of course, will cause very considerable fluctuations in the terminal or line voltage. If, however, the two machines be rigidly coupled together mechanically, then this unstable condition is removed, as any alteration in the speed of the prime mover produces a simultaneous speed variation in each machine, and, therefore, each machine is equally affected by any variable condition.

Considering the second case—viz., the parallel operation of two alternators which are rigidly coupled together mechanically—it is obvious that a serious difficulty is confronted when an attempt is made to synchronise the machines, as in this case an alteration in the speed of one machine produces a simultaneous alteration in the speed of the other machine. We have, therefore, no means of bringing the machines in phase, and the only case possible where they may be synchronised is when the lining up has been done with extreme accuracy—*i.e.*, the centre line of the pole of each machine corresponding to the centre line of the pole-pitch on each stator. Even supposing these conditions to be accurately fulfilled, then it is probable that the parallel operation will not be very good, as this scheme lacks the flexibility of the present-day practice of providing each alternator with its own prime mover. In this latter case each separate machine tends to keep the rest in phase with it, and the steam (or other) engine forms a very serviceable flexible mechanical coupling between them.

From the above discussion we observe that, under the conditions of the query, the alternators may only be connected in series. Now, it is purely a matter of floor space and accessibility as to whether the machines are coupled together at one end or whether they are located at each end of the turbine. In the latter case we should require the turbine shaft extended at each end and a half-coupling fitted. This arrangement would result in the shaft and bearings of the alternators being exactly alike, and, further, would allow of the greatest accessibility for cleaning and repairs, etc., to the alternators. It is probable, however, that this scheme would interfere with the mechanical details of the turbine, as it is the practice to put the governing gear at the end remote from the driving end. This is a matter which cannot be decided without consultation with the turbine builders.

When the alternators are coupled together at one end of the turbine, the "inboard" machine will have to be equipped with two half-couplings, one for connecting to the turbine and the other for coupling to the "outboard" machine. The shaft of the "inboard" mabnine will be subjected to double the twisting force of that of the "outboard" machine, and will, therefore, require to be of larger diameter. Furthermore, this arrangement does not facilitate the execution of repairs to the "inboard" machine, as, if the stator of this machine is not split (which is very improbable with a small machine) and the rotor is required to be withdrawn, then this will entail the removal of all of the coupling bolts and the lifting the whole of the inboard machine vertically out—*i.e.*, rotor and stator together. In this condition the machine may be blocked up on the engine-room floor and the rotor withdrawn in the ordinary way. It is very probable that the outboard machine will have to be shifted a little in order that the other machine may be lifted out. With the first arrangement—*i.e.*, the turbine placed between the alternators—the removal of the rotor of either machine does not present any special features. It would, therefore, appear that the scheme of having the turbine situated between the alternators has advantages over the alternative scheme of placing the alternators at one end of the turbine, provided that the governing gear of the turbine is not affected thereby. The former scheme will also result in a more uniform distribution of weight on the foundations.

We have assumed that the arrangement of the inlet and outlet pipes of the turbine permits the location of an alternator at each end. In a station of this sort the mechanical details of the turbine, such as governing and controlling gear, inlet and outlet pipes, sluices, etc, must be very fully considered before a final opinion can be formed as to the best location of the generators, as it would be unwise to so place these machines that the repairs and inspection of the turbine could only be performed with difficulty. The first point in the lay-out of a station should always be accessibility, and next to this as many machines as possible should be identical or interchangeable, thereby reducing the number of separate spare parts to a minimum.—E T. I.

Answer to No. 988 (awarded 5s.).—The best arrangement would be to place the turbine between the two generators, each generator being driven by a flexible coupling on the turbine spindle. One great advantage in this manner of driving is, that should one machine break down, such machine can be readily disconnected for repairs, leaving the other generator available for supply. With generators both on one side of the turbine and the machine nearer the turbine becoming unworkable, considerable inconvenience would be found in overhauling and carrying out necessary repairs. Another advantage in having a generator on either side of the turbine would be that both flexible couplings would be the same size; with the other arrangement the flexible coupling on turbine would have to be stronger and, therefore, larger than the one between the generators. The coupling on turbine would have to transmit the whole mechanical energy delivered to the generators. This argument also follows with regard to the generator spindles as well as the couplings. With both generators on the same side of the turbine the electrical connections could be more conveniently made and would be more compact; there would also most probably be some saving in first cost for cable. Although not a very important point, better ventilation would be obtained with a generator on either side of the turbine. Generally the symmetrical arrangement of a generator on either side of turbine appears much the better arrangement.—M. M.

Answer to No. 988 (awarded 5s.).—Of the two suggested systems, it appears to the writer that the system of coupling the two alternators together on one side of the turbine is preferable to putting one alternator on each side of the turbine. One reason for this will be seen from an inspection of the illustration of the North Wales power-house which was published in the *Electrical Engineer* some time last year. It will be seen that at the opposite end to that which the generator is coupled the governor gear is fitted, and it will be noticed that this gear stands out considerably beyond the bearing at that end, and, in consequence, if the generator were coupled to the shaft at this end, the set would occupy more space than if the two generators were at the other end. The hydraulic units in this particular instance are of the Pelton wheel type, but the writer is of opinion that the same argument applies to other types. In any case, it should be remembered that if the generators be placed on opposite sides of the turbine, it will mean that the manufacturer of the turbine will have to depart from his standard designs, and this usually means additional expense to the purchaser. If, on the other hand, it is decided to couple the two generators rigidly together on one side of the turbine, the initial outlay could possibly be reduced, for the two revolving fields might be coupled closely together without centre bearing, the complete set thus having only two generator bearings, as in the case of the La Cour converters, where

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the rotor armatures are mounted on the same shaft. This alteration in the manufacturer's standard designs should save expense owing to the absence of the third bearing, which would be necessary if the alternative method were adopted; also the space occupied by the set would be reduced to a minimum. Each field system would, of course, have to be provided with independent slip rings, but this would involve no extra expense or difficulty. It also appears desirable to the writer, whether the additional bearing is dispensed with or not, to keep the electrical part on one side of the station and the mechanical part on the other. The alternators should, if possible, be in good view of the switchboard, for it is from this quarter that the attention to the electrical part is usually derived.—C. COTTEREL.

Answer to No. 988 (awarded 5s.).—The chief consideration in the laying down of power station plant is freedom from stoppage of supply. Therefore, in considering this question, the writer has dealt with it from this point of view rather than from that of relative cost. The best method of connecting the generators to the turbine would be to put one machine at each end and the turbine in the centre. This would, of course, make it necessary to have two insulating couplings, as the generators have to be insulated from earth. In the event of one machine breaking down it will be a short job to shut down and uncouple it, the load being then taken by one machine while the other was being repaired. If the other arrangement was adopted—*i.e.*, the two generators connected together with the turbine at one end—only one insulating coupling would be needed between the turbine shaft and that of the nearest generator. The two generator shafts could be coupled together in the ordinary way, unless it is thought necessary to insulate them from each other as well as from earth, the disadvantage of this latter arrangement being obvious.

From an electrical point of view, either method might do; it seems to be purely a question of mechanical design. By placing a generator at each end of the turbine, the shafts of both machines will be the same size, but if they are arranged next to each other the middle machine will need a shaft of much larger diameter, as it has to transmit power to the outer machine. This also applies to the design of turbine, the size of the shaft being smaller at the couplings if the former arrangement is adopted. Taking all things into consideration, the writer is certainly in favour of placing one generator on each side of the turbine.—BEETLE.

Answer to No. 988 (awarded 5s.).—The decision as to whether the alternators should be coupled in tandem or at each end of the turbine must be decided chiefly by local conditions—such as space available, construction of turbine, etc. The alternators coupled at each end of the turbine, indicated by arrangement A, have the greater advantage over the alternators coupled in tandem—*i.e.*, arrangement B—assuming the turbine can be arranged to drive as A without any serious structural alteration or interference with the governor mechanism. With A the parallel running is better than with B (provided, of course, the insulated couplings are sufficiently rigid to prevent slipping), owing to the smaller torsional and twisting strains that are set up in the alternator shafts. There is also the advantage that standard alternators could be used, which would probably not be the case with B if the shaft diameters have to be increased, due to the total power of the turbine being transmitted through the turbine coupling and one of the alternator shafts.

The question of driving the exciters should also be considered; if these are to be direct coupled to the alternators the arrangement A has the great advantage, for with B, should one of the alternators break down, the whole set would be shut down. It might, of course, be possible to disconnect the faulty machine and couple the exciter to the remaining machine if the two alternators were designed to be mechanically interchangeable. It is the usual practice in water-turbine-driven stations to drive the exciters by separate turbines, but the above argument against B still holds good, unless the alternators are interchangeable, and even then there will be some considerable delay in changing over the machines should the outer one remote from the turbine break down, whereas with A it will only be necessary to disconnect the coupling of the faulty machine. The only possible disadvantage of A is that the turbine may have to be of special construction as regards the governor gear and the piping leading to the penstock and tailrace, but this is, no doubt, more apparent than real. It might also be said that with A two sets of insulating couplings would be required, but with B two sets of couplings would be necessary if the machines were interchangeable, and also these would have to be of larger size, as the turbine coupling has to transmit the power to drive the two alternators, whereas with A each coupling transmits half the total power of the turbine.—JUNO.

Question No. 989.—The 500-volt circuit of a large factory is short-circuited, with a fuse in series for the purpose of magnetisation. It is found that although five-ampere fuse wire is used, the effect of the short is to pull out the breakers of many machines on the same circuit, although the current used in the short does not pass through the machine breakers. What is the reason of this?

Answer to No. 989 (awarded 5s.).—The phenomenon experienced by "J. H. Odam" is by no means uncommon in large works. In any testing department where, owing to the large number of temporary connections used, shorts are almost inevitable, it will often be noticed that a short on one circuit not only blows the breaker on that circuit, but will also blow the breakers on the other circuits which are fed from the same main.

The explanation is very simple, and is given herewith. When the short occurs a large current is immediately taken from the line. The current taken under such conditions from a 500-volt power circuit may rise to an excessive amount, and as the line possesses self-induction a large field will be created about the line. When the breaker blows, or, as in the case mentioned in the question, the fuse blows, this excessive current is suddenly cut off, and the field it has produced collapses. The collapse of field immediately gives rise to a large E.M.F., which will, in this case, in accordance with Lenz's well-known law, tend to keep the current flowing—*i.e*, the E.M.F produced will be added to the line volts—so that the total voltage of the line during the collapse of the field will be greatly in excess of the ordinary working value. It is this voltage which, being applied to the other machines on the same feeder, causes large currents to be sent through them, and, consequently, to cause their breakers to be blown. The remedy, if one is really needed, is to have inverse time element breakers fitted to the machines, so that a fairly large current lasting for a short time will not cause the breakers to be blown —F. H. CLARK.

Answer to No. 989 (awarded 5s.).—The cause is due to the large increase of current following the short-circuiting. Take the usual fusing current for a five-ampere fuse—that is, that such a fuse will "go" at 7½ amperes—although this current gradually reached from zero value would just rupture the fuse, under a short-circuit the current might rise to 200 or even more amperes. Such a current would cause a considerable drop in voltage on the circuit, and this drop would result in an increased current flowing through the machines. The circuit breakers on machine circuits are therefore opened, although not directly connected with the five-ampere fuse. That increased current is taken by machines when voltage is lowered will be at once apparent when it is remembered that a shunt motor, which runs at an approximately constant speed, takes also an approximately constant quantity of electrical energy from the supply mains. Therefore, if there is a reduction in the voltage of the supply, for the motor to perform the same amount of work there must be a corresponding increase in the current supplied to the motor. It is this increase of current that opens the circuit breakers mentioned in the query. The more sudden the short-circuit the greater will be the increase of current, and, consequently, more trouble with regard to the circuit breakers opening. To improve matters, lengthen the distance between fuse contacts—that is, employ a longer fuse. Copper will be a better material for the fuses than lead, or an alloy of tin and lead.—M. M.

[Other replies to Question No. 989 will be given in our next issue.—ED. *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

997. A single-phase motor, 5 h.p., 400 volts, 50 ~, four-pole, starts on a loose pulley and attains a speed of 550 r.p.m., beyond which point it refuses to gain speed. There are 48 stator slots—32 for the running winding, 16 for the starting winding—and 43 bars in the squirrel rotor. The current measured is 13 amperes in main and five amperes in the auxiliary. Why does the motor refuse to pick up?—A. L.

998. What is the best form of apparatus to use for electric soldering metallic-filament lamps, and the particular kind of current required for same?—J. E. C.

ANSWERS.

Question No. 989.—The 500-volt circuit of a large factory is short-circuited, with a fuse in series for the purpose of magnetisation. It is found that although five-ampere fuse wire is used, the effect of the short is to pull out the breakers of many machines on the same circuit, although the current used in the short does not pass through the machine breakers. What is the reason of this?

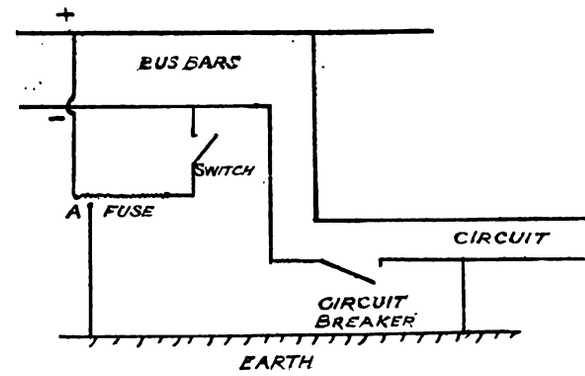
Answer to No. 989 (awarded 10s.).—The writer has had a number of experiences similar to the one referred to, and in most cases it has been possible to trace the cause of the trouble by carefully examining a diagram of the connections. Without a diagram of connections one cannot attempt to diagnose the complaint with any degree of accuracy, and it becomes necessary to suggest a number of causes to which the trouble may possibly be due.

1. The effect may be caused by self-induction in the circuit. When there is a dead short across the main cables of a 500-volt power circuit, a very heavy momentary current flows, even though the "short" be created by nothing more substantial than a piece of five-ampere fuse wire. If the circuit has an appreciable amount of self-induction, the rush of current through the fuse wire sets up a powerful magnetic field. The moment that the arc created by the fuse is extinguished this magnetic field collapses on itself, thereby inducing a high E.M.F. in the circuit, which tends to keep the current flowing. The exact nature of the complications which may ensue depends largely upon the nature of the circuit, and it is impossible to predict what will happen without a knowledge of the conditions. It is possible, though not very probable, that the excess pressure will create a surge of current heavy enough and of sufficient duration to pull out some of the machine breakers on the circuit. In the opinion of the writer it is more probable that the excess pressure will prove sufficiently high to break down the insulation in some part of the circuit, thus setting up temporary faults to earth which would be quite likely to operate some of the breakers.

2. A second explanation is one that might be applicable if any of the machines are working against load when the short-circuit occurs. If the "short" is near the generator and if there is a momentary current of several hundred amperes (which is quite possible, especially if the fuse arcs badly), then there will be a substantial drop in the line pressure. The result will be that the shunt fields of the machines under load will be considerably weakened, and the armatures will take a correspondingly heavier current from the mains. If the breakers are set to operate at, say, 50 per cent. overload, and if they have no time lag, it is quite possible that the excess current will be sufficient to pull them out.

3. If the testing circuit is at all complicated, there is another explanation which might be applicable. This third explanation rests on the assumption that, when the short-circuit takes place, an arc is formed which flashes over to some other metal which is either grounded or which belongs to some other part of the circuit. This has happened in one or two cases that have come under the observation of the writer, and might easily account for the phenomenon observed. It is impossible, however, to make any further suggestions in this case without a diagram of the connections.—FUSE.

Answer to No. 989 (awarded 7s. 6d.).—The most probable explanation of this phenomenon seems to be that when the fuse blows the arc formed flashes over on to something which is earthed, and so temporarily earths one side of the system; then if the other side of the system is earthed, it is obvious that a short will occur. With the aid of the accompanying sketch it will be seen how the circuit breakers may be opened on independent circuits. It will be noticed that a fuse is connected across the 'bus bars when the switch is closed, other devices used for the purpose of magnetisation having been omitted for the sake of simplicity. The sketch also shows a circuit connected



across the 'bus bars in which is connected a circuit breaker on the negative side. Further, it will be observed that the negative side of this circuit is earthed. This earth connection may purposely have been made or it may have developed through faulty insulation. Now, we will suppose that in close proximity with the fuse there is some metallic article which is earthed; this might be a bolt, an iron girder, or the fuse box itself. This article, whatever it may be, is shown in sketch at A, and it is evident from an inspection of the sketch that between A and the fuse there is a P.D. equal to the supply voltage—in this instance 500 volts—so that at the instant at which the fuse blows there is nothing surprising in the arc flashing over to A, which might obviously cause a considerable current to flow through the circuit breaker and so open it. It is, of course, evident that if a number of circuits were connected across the 'bus bars, with one pole earthed in the manner shown in the sketch, the effect of the arc would probably be to pull all the breakers out one after another in quick succession. It appears from the wording of the question that the machines referred to are motors, since the breakers of *many* machines are mentioned, consequently the sketch has been drawn on that assumption.—C. COTTEREL.

Question No. 990.—Give the connections of the relay gear, etc., when four-core pilot cables are used, required to protect extra high-tension three-phase cables of five and six miles in length, the cables being looped in and out of static sub-stations in the various districts. If the pilot cable is laid solid in earthenware troughing with the trunk cable, would appreciable induction take place? What effect would capacity in the pilot cable have on the satisfactory working of the relays? How would you overcome this latter?

Best Answer to No. 990 (awarded 10s.).—The general rules governing the installation of relays for the control of extra high-tension three-phase systems can be stated simply as follows: (1) When the circuit controlled feeds 'bus bars, a reverse power time limit relay must be

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installed. (2) When the circuit takes current away from 'bus bars, maximum current time limit relays are necessary. (3) The reverse relay on a three-phase generator having its neutral earthed must consist of three single-pole reverse relays, and the series and shunt coils of these must be connected in star. The three-phase shunt transformer feeding the shunt coils of the relays must also be connected in star on both the primary and secondary sides, also the secondaries of the three series transformers. All star points should be earthed. (4) The reverse relay on a three-phase mesh-connected generator should be connected in the same manner as in (3), the only difference being that the three-phase shunt transformer should be mesh connected on both sides, and mid-point tappings taken out to the shunt coils of the relays. (See article by Dr. Garrard, *Electrical Engineer*, Dec. 14, 1906, p. 837.)

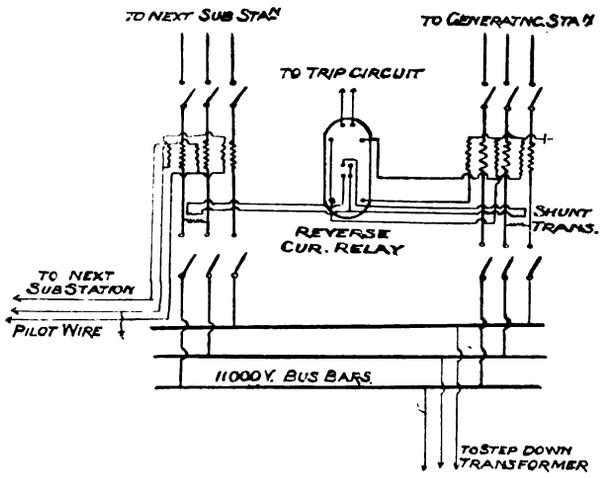

FIG. 1.

Fig. 1 shows the connections of the relay gear for a sub-station on the Clyde Valley Power Company's system, the cables being looped in and out of the various sub-stations. If the pilot cable is laid solid alongside the trunk cable, there is always an appreciable inductive effect observed in the pilot cable, depending, of course, on the distance between pilot and trunk cables and the load on the trunk cable, and the only remedy is to make the distance between cables as large as expense permits. One is apt to rely on the lead sheathing as a good safeguard for inductive effects in neighbouring cables, but experience has shown it to be otherwise. Capacity in the pilot cable will have no effect on the action of the relay, as the alternating-current reverse power relay is essentially a wattmeter, and is calibrated similarly to an ordinary wattmeter, and adjusted to operate at a definite percentage of reverse power on any power factor.—W. A. A.

Question No. 991.—What is the difference between an electrician and an electrical engineer?

Best Answer to No. 991 (awarded 10s.).—In these days, when we have with us the gentleman who titles himself "plumber, gasfitter, and electrical engineer," the problem as to what is an electrical engineer has become rather complex. If a plumber can blossom into an electrical engineer by the simple process of adding the necessary words to his signboard, then to argue any alleged difference of status as between the electrical engineer and his comrade, the electrician, would appear to be verbal quibbling of an aggravated type. However, putting our friend the plumber on one side, the question as to the difference between an electrician and an electrical engineer is one of considerable importance from a professional point of view and also from an educational point of view. In the absence of any form of registration or professional examination we cannot expect the general public to attach more importance to either title, much less distinguish between them.

Now the principal difference between an electrical engineer and an electrician is that while both have some knowledge of electricity, the former is an engineer and the latter is not. So the question therefore becomes, What is an engineer? We have altered the terms of the problem without solving it. Indeed, we are further from the solution than ever. Innumerable definitions of the word "engineer" have been advocated from time to time by various authorities. Most of these are at variance with each other, and many are quite incorrect. The fact is that an exact definition is practically an impossibility, as there are so many different branches of engineering. An engineer has been described by one eminent authority as one who utilises and controls the forces of nature for the purposes of man. This is a high-sounding definition, and in many respects fairly good. It certainly covers the ground, but suffers from being, perhaps, a little too comprehensive. Both the electrician and the plumber can certainly lay claim to directing the forces of nature for the benefit of mankind. An engineer is a man who not only directs the forces of nature, when shown how to do so, but who is capable of planning, designing, and superintending the erection of some large engineering work, whether it be a machine, a reservoir, or a suspension bridge. He must be an expert mathematician, he must be fully conversant with the laws of mechanics, hydraulics, and pneumatics and their various applications, and he must have both practical and theoretical knowledge of the machinery and prime movers which belong to the particular branch of engineering in which he specialises.

There are, of course, two sorts of electricians—practical and scientific. The scientific electrician works in a laboratory. He is a scientist and not an engineer, and he lays no claim to the latter title. It is between the practical electrician and the electrical engineer that there is a difference which needs defining. Exactly where one leaves off and the other begins it is impossible to say. Generally speaking, however, the definition given below will prove fairly serviceable. The difference between the electrical engineer and the electrician is the same as that between the sanitary engineer and the plumber, between the mechanical engineer and the fitter, between the bridge engineer and the riveter.—F. C. J.

Answer to No. 991 (awarded 5s.).—This question is not so easy to answer satisfactorily as would at first be supposed, the difference between the electrician and the electrical engineer being a very debatable point, as there is a great deal in common in both professions. However, it can be taken as a good definition of an electrician that he is a man well acquainted, among other things, with the theory of magnetism and electricity, dynamos, motors, starting and regulating apparatus, electric lighting, telephones, etc., and all the multifarious apparatus and fittings used, and who is able to erect and connect them up, test cables and wires, and make all kinds of electrical measurements and calculations. A switchboard attendant can be termed an electrician; a wireman who is only skilled in wiring is not one; an electric lamp attendant is not an electrician, but the man who repairs and tests them in the test-room is one. The majority of finished technical college students are electricians, not engineers. It will thus be seen that an electrician is simply a man skilled in the application and control of electricity, with, perhaps, a slight experience in light mechanical engineering.

The electrical engineer is a much more highly trained man. He must have had works experience, either with a purely mechanical engineering firm or one which manufactures electrical machinery, and his knowledge of electricity should be quite as deep as that of the electrician. He is the man who designs and puts down power stations and electric railways, etc, and manages them. He is a constructor and maintainer of electrical systems and schemes The man who is just out of his time from an electrical shop is not necessarily an electrical engineer. He may be merely a mechanical engineer with a superficial knowledge of electricity. The difference, therefore, between the electrician and electrical engineer is that the latter has a thorough mechanical engineering experience as well as a sound knowledge of the theory and uses of electricity.—M. G. TWEEDIE.

Answer to No. 991 (awarded 5s.).—This is a question I have often heard commented upon. For instance, if you go to a colliery you will seldom hear the word "electrical engineer"; it is always the "electrician." The reason for this I can hardly explain, but in my 12 years' experience of electrical work I have noticed that "wiremen" and

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handy men (with all due respect to them) who have a slight knowledge of electrical work always term themselves "electricians." A few years ago a branch of the Electrical Trades' Union was formed at Sunderland, and on the application form for admission there was a space to fill in marked "branch or section." Several whom I knew joined and described themselves as electrical fitters, wiremen, or armature winders. There was one exception, a man who described himself as an "electrician." This man was given a job (he was a colliery fitter) by the contractors who were lighting up a colliery, which lasted about six months. This was all the electrical knowledge the man had, and yet he was the only one that called himself an "electrician." The reason I mention this case is because there are so many people who are of the opinion that anyone can be an electrician. I know several who have picked up pit bell and telephone work and are termed "electricians."

I consider there is all the difference in the world between an "electrician" and an "electrical engineer." Electricians are men who design, calculate, standardise, calibrate, make, and repair electrical instruments, such as ammeters, voltmeters, wattmeters, testing sets—*e.g.*, the Megger, Silvertown set, current balance, Wheatstone bridge—and all electrical laboratory instruments. The term "electrician" has the same meaning as "mathematician," and, therefore, men who design generators, etc., those in the test-room, and all men who deal with the theory of electricity are electricians. The electrical engineer must first be a mechanical engineer, hence the difference. "Electrical engineers" are men who devise electrical schemes for electric light, power transmission, and traction work; also to erect and maintain the same. His duties are very extensive, and include knowledge of engines, turbines, pumps, condensers, boilers, economisers, steam-pipes, alternating-current and direct-current generators and motors, high-tension and low-tension switchgear, mains (both underground and overhead), accumulators, etc. I don't mean to say that the central-station engineers are the only electrical engineers, because there are men who do nothing else but erect lighting, power, or traction plants. Some just erect switchgear, high-tension and low-tension; others do the power work. These are all electrical engineers.—J. P. S.

Answer to No. 991 (awarded 5s.).—An electrician is one who has devoted himself to solving the more intricate problems in connection with electricity and its useful application to everyday life—*e.g.*, workers who are endeavouring to perfect telegraph (wireless and ordinary) and telephone working, the development of a better secondary battery, or the action of electricity as related to medical, surgical, or agricultural and horticultural uses. The present-day thorough understanding of the more intricate problems of alternate-current working, of long-distance transmission, of the action underlying the working of the commutator, of the behaviour of the electric arc for lighting and for welding, etc., are all the outcome of the diligent research work of the electricians of former days, whilst their successful *practical* working is due to the efforts of the electrical engineer. The electrician must be a man highly trained in electrical theory and a thorough mathematician, but he need not trouble himself about mechanical problems to any extent. His business is to elucidate the doubtful points as to the laws governing the working of any proposed electrical process, and having done this to pass the same on to the electrical engineer, who will then proceed to apply these laws to practical everyday working, pointing out to the electrician the places where practice will not let theory attain its full end, and suggesting ways and means of overcoming the difficulty in practice whilst asking the advice of the electrician as to the theoretical effect of his suggestions on the problem in question.

The electrical engineer, however, should be first and foremost a thoroughly trained mechanical engineer, and to attain any reasonable success he *must* be a man who has served a regular five years' apprenticeship in the shops. Thus not only will he thoroughly understand the workshop processes, but also have a good understanding of the different types of workmen and their capabilities, and of how much they should be easily able to accomplish of a given piece of work in a certain time. In addition to the above practical training he must possess a thorough understanding of the theoretical side of mechanical engineering, and a first-class working knowledge of the branch of electrical working in which he intends to specialise. He does not need and should not attempt to attain to the high theoretical training of the electrician, as if he does so he will have to neglect the study of the practical application of the electrician's work.

Central-station men, works managers of concerns producing electrical machinery and storage batteries, or managers of electrolytic plants, should be electrical engineers, as their work consists mostly of almost purely mechanical engineering problems. Thus the central-station man, if he wishes to get the best results out of his plant, must be a thoroughly good engine and boiler man, and completely understand the value of a pound of coal and how to extract every possible ounce of energy from the same and deliver it to the consumer. The works manager of a dynamo and motor or storage battery works must thoroughly understand how to give the necessary mechanical strength to his products without using unnecessary material. No amount of abstruse theory applied to the design of his machines or storage batteries will be of much avail if in the one the commutators tend to fly to pieces, or the segments to work up or down, or the bearings to give trouble by running hot; or if it be found that the design of the apparatus will not allow of easy overhaul or repair; or, again, however true to the best theoretical requirements the design of a plate of a storage battery may be, electrically considered it will be of no use if its mechanical design is so bad that it will not stand the strains involved in working it, and quickly collapses, due to buckling or disintegration. Also the manager of the electrolytic plant must see that his energy is produced at as low a cost as possible, and that his conveying, handling, and mixing apparatus is as nearly perfect as possible, or, in spite of the most perfect conditions in the actual electrolytic process, his profits will be largely eaten up, or else vanish altogether. To sum up, the electrician must find out and declare the laws relating to any particular process, whilst the electrical engineer must apply them to the wants of everyday life and make them a commercial success.—W. T. W.

Answer to No. 991 (awarded 5s.).—There are so many people who style themselves electrical engineers and electricians nowadays that it is sometimes difficult to form an intelligible idea of the real meaning of either of the titles. Bellhangers, gasfitters, plumbers, scrap-iron merchants, and numerous other individuals all use these titles with as much freedom as their own name, and consequently the real electrical engineers and electricians are often looked upon by the man in the street as little more than ordinary mechanics, whereas they should be grouped with such men as doctors, lawyers, and other professional members of the community.

An electrical engineer should have been through the shops, not necessarily electrical shops, but any shops where heavy engineering work is turned out. He should also have studied at a college, where he should have devoted his time to electrical and mechanical subjects, including mathematics, mechanics, steam, etc. After this, to justly term himself an electrical engineer, he should hold a responsible position in some branch of the profession. A chief engineer of a central station, provided he be a good chief, is an example of an electrical engineer, for after having received the training outlined above, he should have served in subordinate positions in a station, on the mains, and in the meter-room. Last, but not least, he should have obtained some business knowledge, which, perhaps, for a man with engineering instincts, is one of his most difficult tasks. There are, of course, other types of electrical engineers, such as the designer in a large electrical works, and so forth

An electrician, the writer considers, is a man who devotes his whole energy to purely electrical matters. A man who can localise a fault on the mains, but cannot find the cause of a hot bearing on the dynamo, is to be regarded as an electrician rather than an electrical engineer. Again, a man who holds a position in an electrical test-room or labora-

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tory and has had no shop training, or he who works on the interesting subject of wireless telegraphy and kindred subjects, come under this latter head. An electrician, in the writer's opinion, does not need the same amount of shop training as the man who aspires to the somewhat more imposing title of electrical engineer. A long period spent in a technical college is generally a greater advantage to a man who intends to become an electrician than the same time spent partly in a works and partly in a college. It is obvious, however, that if experience can be obtained in a works besides the long period spent at the works, so much the better. Many designers are clever at arriving at the electrical dimensions and technical particulars of a machine, but are hopelessly at sea when it comes to determining the size of the shaft and other mechanical dimensions. Such men are electricians.—C. COTTEREL.

Question No. 992.—Four 3,000-kw. turbo-alternators, generating at 11,000 volts three-phase, are running in parallel on a railway load. On the load easing up, one unit is shut down. The switchboard attendant goes to break the field circuit of this machine, but by mistake he opens the field switch of one of the other machines still on load. Discuss what would happen if (1) the three machines were left running thus for a few minutes; (2) if the field switch opened by mistake was closed again after a few seconds. The generators are star-wound with earthed neutral, and run splendidly as synchronous motors when the turbine stop-valve is shut. They are separately excited.

Best Answer to No. 992 (awarded 10s.).—With the type of alternator which was in common use a few years ago—viz., that in which the armature consisted of coils assembled on a disc without any iron core—the above incident would have been accompanied by a burnt-out armature on the alternator in question, and probably would have resulted in the shut down of the whole station. The conditions governing the operation of the modern alternator have, however, led to the abandonment of this type, and to the standardisation of the well-known modern type, having a considerable amount of iron in the armature core. Hence, whereas the reactance voltage of the old-type alternator was practically a negligible amount, in the modern alternator this reactance voltage is a considerable percentage of the generated voltage of the machine, and, in consequence, enables the machine to be safely short-circuited on normal excitation, as under these conditions the short-circuit current is limited to about two to three times full-load current on account of the inductance of the armature.

Considering the three alternators running in parallel under normal conditions and the field circuit of one machine to be broken, we shall have the stator of this machine still connected across the 'bus bars and being supplied with current by the remaining two alternators. The current taken by the machine running without field excitation will be given by: current per phase = applied E.M.F. per phase ÷ impedance per phase. Under ordinary conditions we may expect this current to be about from two to three times the full-load current, when supplied at the full 'bus-bar voltage. It may be mentioned that the term "impedance per phase" indicates the impedance when running without excitation on the rotor, and may be materially different from the "static impedance" measured when at rest. It is also now well recognised that this static impedance varies for different relative positions of stator and rotor, and is considerably altered by wholly removing the rotor.

As it is the practice of several manufacturers of turbo-alternators to fit the rotor with "amortisseurs" or closed circuits of low resistance located in the pole face, we may consider the effect of the alternator under consideration being so equipped. In this case, when the field excitation is removed, we should have heavy currents induced in the amortisseur circuits on the poles, which would react on the current in the stator, and produce a torque in a similar way to that occurring in an induction motor. If steam were shut off from the turbine we should observe this alternator running as an induction motor, but the current taken would probably be equal to about the normal full-load current of the alternator, although running practically unloaded. With the turbine running under steam and at normal speed, we should find that the current flowing into this machine would be considerably reduced, and if the speed were raised above normal, it is probable that the value of the current taken from the remaining two alternators would approach unity, and may even reverse, indicating that this machine was again acting as a generator. This state of affairs would, however, be entirely dependent upon the effectiveness of the amortisseur circuits on the rotor, and would be largely affected by the radial depth of the air-gap and the coefficient of mutual induction between stator and rotor. We may remark that if the current taken by the alternator running without field excitation is at all excessive this current will be at a low power factor, and will, therefore, cause a drop in the voltage of the two generators running under normal conditions. In ordinary circumstances it is inconceivable that this drop in voltage would be sufficient to pull the synchronous machinery (rotary converters and motor-generators) out of step. We may, therefore, conclude that no trouble will be encountered by leaving the alternator running under steam without field excitation for a few minutes

Considering the second part of the query—viz, the closing of the field switch opened by mistake—we may point out that when this machine is running without field excitation, the pole-pieces will become magnetised by the stator current. Now, in switching on the field current at random, it is possible to have a condition where the relative positions of stator and rotor require a polarity exactly opposite to that produced by the field excitation. In such a case we should have a heavy circulating current as this machine pulled itself in phase with the other alternators. It is, therefore, preferable to disconnect this machine from the 'bus bars and resynchronise, since this operation will occupy but a short space of time.

In large railway plants, such as that outlined in the above query, where synchronous machinery is operated from the turbo-alternators, it is important to avoid producing any large cross current between the alternators whereby the voltage of the alternators may be reduced, as this reduction in voltage may be sufficient to pull out of step some of the synchronous machinery, which would be a serious item in railway work.—A. E. T.

Answer to No. 992 (awarded 5s.).—1. In the example where the three machines are working in parallel on load, with the field of one machine not excited, it is highly improbable that the machines would run a few minutes on the same bars without disastrous results. By breaking the field of one of the generators it causes the machine (practically speaking) to lose its voltage. The other machines being coupled on the same 'bus bars as the unexcited machine, a heavy rush of current is produced from the 'bus bars through the stator (which is of low resistance) of the faulty machine, and without the machine is protected by relays or some automatic device the stator winding will eventually be burnt out, or the two other machines will pull up. The voltage on the line will drop considerably, owing to the abnormal demand made upon them. If the alternators are supplying energy for rotary converters, and the direct-current side of the rotaries are working in parallel with battery sub-stations, as in the Lancashire and Yorkshire Railway Company's system on the electrified line between Liverpool and Southport, the rotaries will motor the alternators, and the turbine may attain a dangerous speed before the direct-current breakers at the sub-station operate.

2. By closing the field switch after a few seconds you do not tend to improve matters, as the machine will in all probability be dead out of phase, and there is the possibility of doing serious injury to the insulation of transformers, windings of alternator, etc. The best method for the switchboard attendant to adopt would have been to pull out the machine switch, and disconnect the faulty machine from the bars immediately he had discovered his mistake. The turbine would, no doubt, be very well governed, so there would be no fear of it attaining an excessive speed. He could then bring his exciting voltage lower, close exciter switch, bring up his voltage to 11,000 volts, synchronise, and parallel, and give the machine the desired load, the only effect to the supply being the drop in pressure whilst this machine was out of circuit.—A. I.

[Other replies to Question No. 992 will be given in our next issue.—ED. *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

999. It is required to connect an alternating 200-volt single-phase supply to continuous current at a voltage ranging from 100 to 140. The direct current is to be regulated within this range for storage battery charging. Direct-current output will not exceed 40 kw. Compare the advantages and disadvantages in using motor-generator and rotary converter. Also describe any alternative methods of transforming alternating current to direct current for smaller powers, such as motorcar charging, etc. What modifications have to be made if supply is changed to two-phase?—F. J. H.

1,000. Give particulars of the new iron-nickel accumulators and the reactions in the electrodes, and also compare efficiency and prime cost with that of the present-day lead cell.—C. MARSHALL.

1,001. How would you calculate the dimensions of a water-cooling tower for use in a 1,000-kw. station during the peak evening load of about 600 kw.? Allow a big margin for development.—E. C. A.

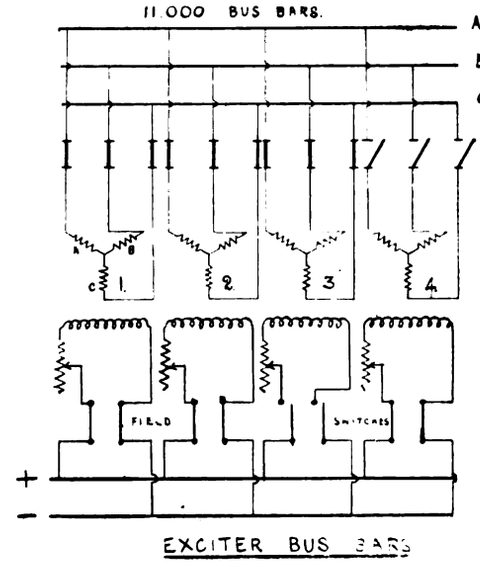
ANSWERS.

Question No. 992.—Four 3,000-kw. turbo-alternators, generating at 11,000 volts three-phase, are running in parallel on a railway load. On the load easing up, one unit is shut down. The switchboard attendant goes to break the field circuit of this machine, but by mistake he opens the field switch of one of the other machines still on load. Discuss what would happen if (1) the three machines were left running thus for a few minutes; (2) if the field switch opened by mistake was closed again after a few seconds. The generators are star-wound with earthed neutral, and run splendidly as synchronous motors when the turbine stop-valve is shut. They are separately excited.

Answer to No. 992 (awarded 7s. 6d.).—The following sketch shows the condition of affairs after the occurrence mentioned in Question 992. No. 4 has been switched out and the turbine shut down in the ordinary way, the field current not having been broken. As the machine is disconnected from the main 'bus bars, it need not be considered in any way. As shown in the sketch, No. 3 is still connected to the main 'bus bars, but the field switch has been opened by mistake.

Part 1.—Up to the moment of opening the No. 3 field switch, Nos. 1, 2, and 3 had just taken up the load of No. 4 between them, and, assuming the total load on the station to be 9,000 kw. to 9,500 kw., each machine had about 3,000 kw. to 3,200 kw., the current corresponding to this load being about 170 amperes in each phase of the three stators. As soon as the field circuit of No. 3 was broken the whole of the useful work done by this machine would be lost, thus throwing the load on Nos. 1 and 2. At the same time, a very heavy reverse current, in quadrature with the terminal E.M.F. of Nos. 1 and 2, will flow into No. 3 stator, the value of this current being determined by the ohmic resistance and self-induction of the stator coils. The effect of this current, heavy in amount, and lagging behind the E.M.F., will be to demagnetise the field of Nos. 1 and 2; thus the line volts will drop rapidly, the amount of drop in pressure depending entirely on the characteristic curves of the alternators. If there is a reverse-current relay in the No. 3 generator circuit, this should operate and trip the oil switch, thus cutting No. 3 off the line. Should there be no reverse-current relay in circuit, No. 3 oil switch should be tripped by hand at once, and although this would throw all the load on Nos. 1 and 2, the volts, which, of course, were rapidly falling, would rise to 9,000 or 10,000 volts. In any case, No. 3 should be switched out, the field circuit closed, speed adjusted, and synchronised again as soon as possible. There is no doubt that Nos. 1 and 2 would carry the 50 per cent. overload for the short time required, but if No. 3 was left on the line, the result would be a failure of the supply, as the line pressure would rapidly fall to zero.

Part 2.—The field circuit of No. 2 having been broken, the alternator may be described as a synchronous motor



operating under the worst conditions—namely, with a negligible field—the motoring current, therefore, being 90deg. out of phase with the impressed E.M.F., the resultant power factor being lagging and very low in value. When the field circuit is closed again, as the current increased round the poles, the motoring current would gradually diminish in amount, the power factor would improve, the needle of the power-factor meter changing

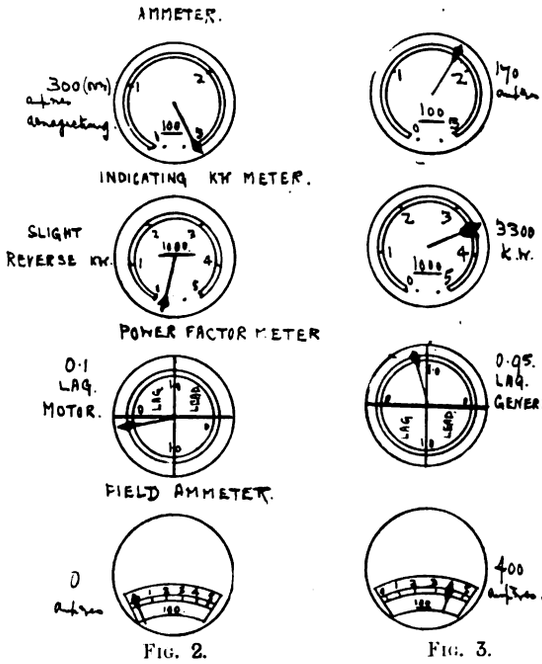


FIG. 2.

FIG. 3.

over from the motoring to the generating side of the instrument, and the machine would then begin to take up load from Nos. 1 and 2 in the ordinary way. It is doubtful, however, if Nos. 1 and 2 would carry the heavy demagnetising current for a few seconds without the line pressure failing, so that in order to maintain a continuous supply it would be advisable to adopt the course of operations outlined in Part 1.

The whole incident mentioned in the question is a good argument for an alternator to have its own direct-coupled or rope-driven exciter, the armature being connected directly

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on to the regulating resistance and the rotor field, the circuit being a permanently closed one, with no switching devices whatever. Unless due to a mechanical breakage, it then becomes impossible for an alternator to lose its field.

Figs. 2 and 3 show the effect on the generator switchboard instruments when the field circuit is open and after the switch has been closed again respectively.—J. W. A.

Answer to No. 992 (awarded 5s.).—To give a satisfactory reply to the question it is necessary to know what protective devices are fitted to the switchgear. We will consider the four most likely arrangements: (*a*) three pole switches, no automatic device; (*b*) simple overload device fitted to switches; (*c*) simple reverse-current device fitted; (*d*) combined overload and reverse device fitted.

(*a*) This method is very unlikely to be used, and in this, as in all the following, the result would depend upon the current taken by the machine whose field has been broken. This would not be equal to full load owing to the choking action of the coils, and would depend to a large extent upon the rotor. If this formed practically a short-circuited rotor, the machine would run as a squirrel-cage induction motor, but with a large slip, as it would be driven at synchronous or over synchronous speed; it would act as an asynchronous generator, and would take a magnetising current equal to from a half to two-thirds of full load. This current, being of a very low power factor, together with the overload on the other machines, would cause the voltage to drop sufficient to shut down the supply.

(*b*) The extra current required, together with the overload, would cause the sound machines to be cut out, as the breaker on the faulty machine would not act until the motoring current reached a value sufficient to slip it, probably 1½ times full load.

(*c*) This is the most to be recommended, as the reverse current would cut out the faulty machine, and there being no overload device they would probably stand up to the load until another machine could be paralleled, although the volts would be bound to drop somewhat.

(*d*) With this arrangement the effect would be similar to above, although if the overload were set too fine, they would be switched out, due to the excess current, and a total shut down would result.

It must not be thought that the machine whose field was broken would run as a synchronous motor, as it would have no field. The only possible way would be for it to run as an asynchronous motor, with a large slip, the slip depending upon the design of the rotor; if the turbine were running over synchronous speed, it would then act as an asynchronous generator. It is difficult to say what would be the effect of remaking the field, as unless it were switched in at the right moment it would only make matters worse, owing to the heavy synchronising currents, and would most likely badly damage the armature.—E. V. C.

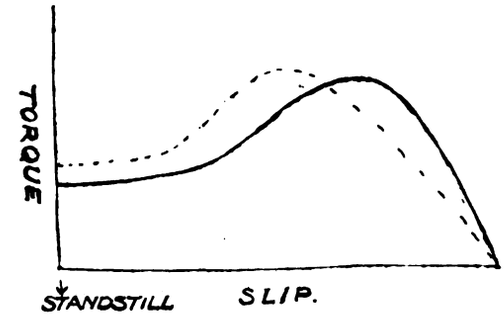
Question No. 993.—Discuss the pros and cons of having the rotor circuit open or closed when switching in 6,000-volt induction motors of over 200 kw. capacity.

Best Answer to No. 993 (awarded 10s.).—It is well known that an induction motor may be started by connecting its field directly to the line. But when this plan is adopted there is a large rush of current which is objectionable, because it disturbs other apparatus operating on the same circuit. In any case this method can only be used with very small motors starting against load and motors up to, say, 10 h.p. starting light. For motors of 200 kw. capacity a smooth start may be obtained, either by reducing the voltage applied to the primary or by inserting a resistance in the secondary. Where a rotor is provided with a squirrel-cage winding it must be started by cutting down the primary voltage. This is best accomplished by means of an auto-transformer inserted between the line and the motor field, the transformer being provided with a double-throw switch so that it can be cut out when the motor has come up to speed.

In some cases a low starting voltage may be obtained without the use of an auto-transformer or compensator. For example, if step-down transformers are used to supply the motor they can have taps brought out from the middle point of their windings and connected to a double-throw switch, so that in one position of the switch the motor gets only half the normal voltage, while for the running position of the switch it is connected across the secondaries in the usual manner, and gets the full voltage. Another scheme which has been used in connection with two-phase alternators having two armature windings inter-connected, as, for example, in Westinghouse two-phase machines, is to provide a double-throw switch, so that at starting the motor is connected across the "side phases." This method is used to some extent in shops where induction motors are supplied with current directly from the alternator. An advantage of the compensator method lies in the fact that it is simple and, moreover, that it allows the use of squirrel-cage armatures. It is also convenient when it is desired to operate the motor from a distant point. It has, however, a serious disadvantage for starting against load, inasmuch as the torque of an induction motor decreases very rapidly as the applied voltage is decreased. This is obvious when it is remembered that the torque varies as the square of the pressure applied to the stator windings.

When a strong starting torque with moderate current is desired the rotor must be of the "wound" type, with a resistance in circuit when starting. The full voltage may then be applied to the field. As the starting resistance is only in use for a short time it may be made small enough to mount on the armature spider, thus obviating the need of collector rings. This resistance is often made in the form of cast girds. It is cut out of the armature circuit by means of a sliding switch operated by a loose knob attached to a spindle running through the centre of the shaft. By adopting this construction the use of collector rings is avoided, but the construction of the armature as a whole is considerably more complicated than the squirrel-cage type. If the motor takes some time to start up, or if speed regulation is desired, slip-rings must be fitted, for the resistance becomes too large to be accommodated on the spider, and a star-connected three-phase rheostat becomes essential. If the stator is connected to a high-tension circuit, it is advisable to close the rotor circuit through the first rheostat starting contacts—*i.e.*, with all resistance in circuit—before switching on the stator, as the voltage induced in the rotor conductors, tending to break down the insulation, is thereby considerably lessened. —ROTOR.

Answer to No. 993 (awarded 5s.).—For machines of this type it would evidently be necessary to use an auto-transformer or some similar device in the stator circuit if the



rotor circuit is to be closed. To switch the full 6,000 volts across the stator terminals when the rotor is closed would lead to disastrous results, for then we should have the conditions of a "large" shorted transformer where very large currents would flow both in primary and secondary. With the auto-transformer device for reducing the initial voltage on the stator terminals we should necessarily obtain a much reduced starting torque, for, other things being equal, the torque exerted by the motor may be taken to be roughly equal to the square of the pressure impressed on the stator terminals. Under these conditions it would be necessary to start the motor up practically on no load, which condition in some cases would constitute a serious disadvantage.

Considerable advantage is to be gained at starting both in torque and in lessening the current required if the rotor circuit has a higher resistance than when in its normal running state. This condition is supplied by having the rotor circuit opened through a starting resistance, a resist-

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ance being in each phase, and the final state, when the motor has attained nearly full speed, being that of short-circuit for the rotor. Perhaps the following will make the above a little clearer.

Taking abscissæ and ordinates as representing speed and torque respectively, we arrive by elementary considerations at a curve of the general shape as shown as representing the torque of an induction motor. At standstill the curve is low, rises steeply, comes to a maximum, and finally dies away quickly. The equation to the first part of the curve may be taken as that of a hyperbola, and this will give us at starting that the torque is proportional to the resistance of the rotor. If, now, we assign a higher value to this resistance and again plot the torque curve, we arrive at one which will take up some such position as the one shown dotted where the initial torque is increased but the maximum occurring earlier. The motor gives out approximately the same power as before, but runs with a greater difference of speed between its speed at light load and full load. The efficiency at full load is also diminished. Thus, one understands the reason for constructing the rotor so that a resistance may be inserted at starting and then shorted as soon as the rotor has got up a fair speed. This open-circuit arrangement for an induction motor has no special disadvantage, and the manipulation is easy. The motor may also be started up on a fair load, which was not the case when the rotor was closed.—T. W. RUTHERFORD.

Question No. 994.—A double-current generator is run on short-circuit, and the reactance voltage is measured on the direct-current side. A Century testing set and a Siemens and Halske precision voltmeter are used. Both were previously checked, and are suitable for alternating-current and direct-current work. Is there any reason why the Siemens and Halske voltmeter should read 40 per cent. higher than the Century testing set?

Best Answer to No. 994 (awarded 10s.).—One is always prepared to meet with difficulties when using delicate electrical instruments, as these are unfortunately liable to a great many sources of serious error. It is, nevertheless, quite unusual to find two instruments, previously checked, with a 40 per cent. difference between their respective readings. In attempting to find the cause of the trouble, it is well to consider briefly the common sources of error which may affect the accuracy of voltmeters. These may be summed up as follows: (1) alteration of strength of permanent magnets; (2) short-circuits in the coils resulting from faulty or insufficient insulation; (3) external magnetic influence; (4) change of temperature; (5) faulty levelling (where instruments are used that require levelling); (6) excessive friction of moving parts; (7) same current giving different deflections depending upon whether the current is rising or falling.

It would appear that a number of these possible sources of error are not applicable in the case under consideration. On the other hand, it would be unkind to suggest that an incorrect series resistance was carelessly connected in circuit when the test was being made.

Friction errors are rendered negligible in modern instruments by careful jewelling, and in any case this could not account for a 40 per cent. difference. A position error is sometimes found in moving-iron instruments when the poles of the latter are not sufficiently definite. It shows itself by the needle not returning to the same point, when it is deflected by hand, while a certain fixed current is flowing. In modern instruments this may generally be neglected.

The seventh source of error referred to above is due to hysteresis. It may be reduced by making the iron so small that it becomes saturated by a small fraction of the maximum current, or else by making the iron so large that the density is small at all currents. All voltmeters, except electrostatics, are liable to temperature errors. The only remedy is to employ a large idle resistance of negligible temperature coefficient.

Instruments are often seriously affected by stray magnetic fields from generators or from conductors carrying heavy currents which run close to them. This is a very probable cause of the trouble in the present case. Electromagnetic instruments are very much affected, and hot-wire instruments alone are free. The only remedy is to shield the instrument magnetically. In the case of permanent-magnet instruments, a cast-iron case may be fitted, and this is a sufficient protection. It is of importance, however, that the instrument should be calibrated and checked with the cast-iron lid in position. For electromagnetic instruments a shield of thin sheet iron is the only effective protection.—VOLTMETER.

Answer to No. 994 (awarded 5s.).—As it is stated that both instruments are suitable for reading on direct-current circuits, and that both were checked before the experiment, it is evident that the instruments themselves are not at fault. The error is apparently caused by the way in which the instruments are used. Possibly when the experiment was made the instruments were so placed as to be in the stray field of the generator, in which case the stray field would be superimposed on the field produced by the current flowing in the coils of the instrument. If the instruments were wound astatically, stray fields, if uniform, would have no effect on the readings.

The difference of 40 per cent. between the readings of the two instruments is, of course, large, and may be explained thus: (*a*) If both instruments were *not* astatic, it may have so happened that one instrument was placed so that it read 20 per cent. above the correct voltage and the other instrument was placed so that it read 20 per cent. below the correct voltage; (*b*) one instrument may be astatic, and, consequently, all the error is on the other instrument.

The earth's field has an effect on the readings of some instruments, as the following experiment will show: A commercial type of watt-hour meter of 50-ampere range was set up facing east, and was tested at 10 per cent. of full load. It was then placed facing west with the same load, care being taken that it was turned in the same horizontal plane by suitable arrangements. The difference between the "east" and "west" readings was 3·6 per cent., and was entirely due to the fact that the earth's field was *quickening* the meter in one case and *retarding* it in the other.

The stray field from the generator may have been many times as strong as the earth's field. Tests with which the writer is acquainted show that the value of B in various types of instruments varies throughout a wide range of values. If the value of B in the instruments used was small compared with the stray field, then the difference of 40 per cent. may have been caused in one of the two ways (*a*) or (*b*) above.—ELECTROLYTE.

Question No. 995.—Give a method (graphical or analytical, preferably the latter) of determining the deflections at all points of a shaft of varying diameter, supported by two bearings and loaded with two or more loads (as, for example, a motor shaft).

Best Answer to No. 995 (awarded 10s.).—In answer to question No. 995, I should like to say that it is almost impossible to calculate the deflection of a beam with anything like accuracy without the aid of graphs. The following is a method which I have found from experience to be the most accurate, reliable, and, at the same time, shows the leading points clearly that are advantageous to know when designing a shaft. The shaft may be taken as a beam supported at both ends and unevenly loaded.

First set off to a convenient scale the length, l, of shaft from centre to centre of bearing (Fig. 1) and make height of load lines, W_1, W_2, and W_3, proportional to the loads at distance l_1, l_2, l_3, as the case may be, and drop perpendicular through each, as shown in Fig. 1. On a vertical line (having no relative position to Fig. 1) set off to the same scale as before the length of line W_1 represented by $f e$ (Fig. 2), then $W_2 = e d$, etc., corresponding to the number of loads on beam. Choose any convenient point O (Fig. 2) distance O h from the vertical line $f c$ (O h is termed the polar distance). Join f to O, e to O, etc., from each load point to O. From a point j (Fig. 1) at the point where R_1 cuts draw a line, $j m$, parallel to f O (Fig. 2) by means of set squares. From M (Fig. 1) draw a line, M k, parallel to e O, and so on, till the line through g at R_2 is reached, then join j and g and draw O a (Fig. 2) parallel to this last line, then the reaction on bearing $R_1 = f a$ and on R_2 = A C. Then the vertical depth of the bending moment diagram (Fig. 1) at any given section is proportional to the bending moment at that section of the shaft.

Proof—$j q$ (Fig. 1) = l_1 and $a f$ (Fig. 2) = R_1, and let $m p = D_x$—*i.e.*, the depth of bending moment diagram at the section x—or $R_1 l_1 = D_x$ O $h = M_x$ = bending moment

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at x, and so on, taking each point D on the beam where bending moment is required. Thus the bending moment at any section is equal to the depth of the diagram at that section multiplied by the polar distance, both taken to the

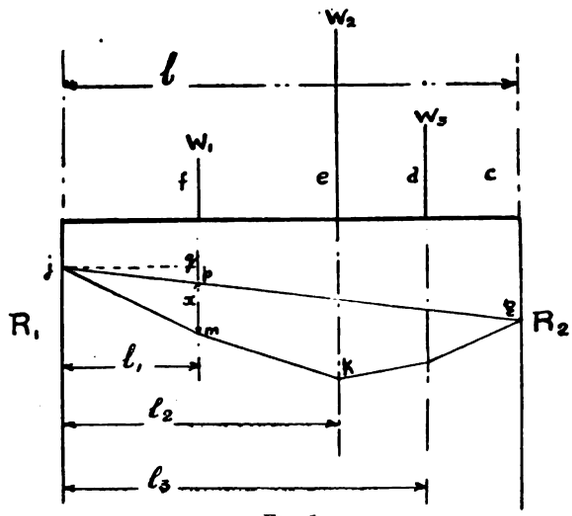

FIG. 1.

proper scales, which we will now determine. The diagram is drawn so that 1in. on the load scale = m pounds and 1in. on length scale = n inches. Hence the measurement taken from the diagram in inches must be multiplied by $m\ n$.

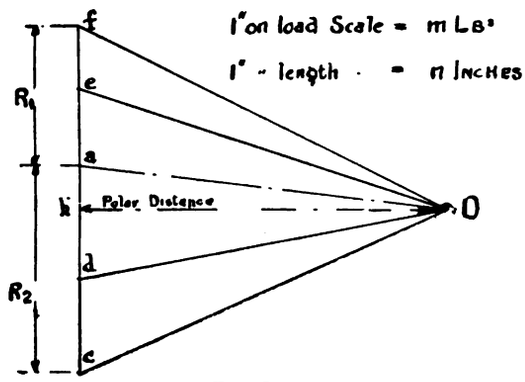

FIG. 2.

The bending moment expressed in pound-inches at any section = M = $m\ n$ (D O h).

From this diagram (Fig. 1) we can now proceed to find the deflection by means of a somewhat similar diagram obtained from Fig. 1. We know that the deflection is

FIG. 3.

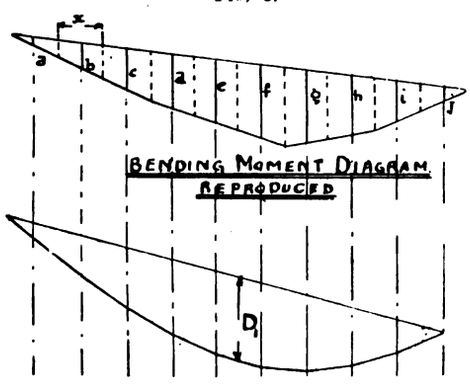

FIG. 5.—Deflection Curve.

numerically equal to the moment of each little element of area of the bending moment diagram about the free end ÷ E I (E = Young's formula, or modulus of elasticity, and I = moment of inertia). The amount of each portion of the bending moment diagram may be found by a link and vector polygon similar to the bending moment diagram itself. Fig. 3 = bending moment reproduced and split up into narrow strips of (the more strips the more accurate the result) width x as shown by dotted lines. Draw the mean ordinate of each as shown in full lines (then any given ordinate multiplied by x = area of strip). Set down these ordinates on a vertical line (similar to Fig. 2), one below the other, as shown in Fig. 4; choose a pole distance,

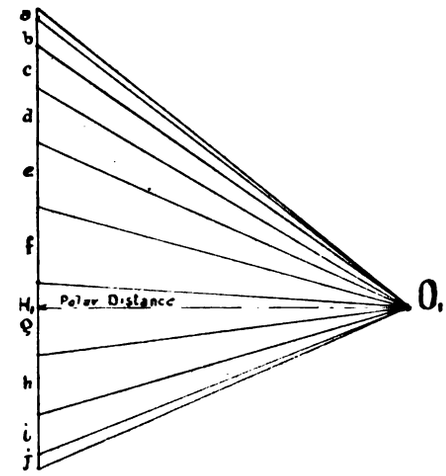

FIG. 4.

O_1, and complete both polygons (Fig. 4 and 5) as in Figs. 1 and 2. The link polygon thus formed (Fig. 5) is then the form of the bent beam or shaft. This is then reproduced to a horizontal base line as in Fig. 6, which gives the shape of shaft in full black lines. The only point to be determined now is the scale of deflection curve. We have 1in. on the load scale of the bending moment diagram = m pounds, also 1in. on the length of bending moment diagram = n inches, and bending moment at any point = M = $m\ n$ D O H, where D = depth of bending moment diagram at the point in inches and O H is the polar distance in inches. Hence 1in. depth of bending moment diagram = $\frac{M}{O} = m\ n$ O H inch-pounds and one square inch of bending moment diagram = $m\ n^2$ O H inch inch-pounds. ∴ the area

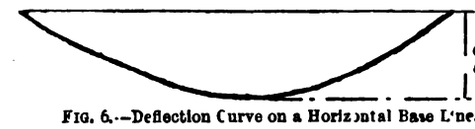

FIG. 6.—Deflection Curve on a Horizontal Base Line.

x D = x D $m\ n^2$ O H inch-pounds, but as the area represented on the second vector polygon by D its scale is $x\ m\ n^2$ O H,

$$\therefore \delta = \frac{x\ m\ n^2\ \text{O H}\ n\ \text{D}_1\ \text{O}_1\ \text{H}_1}{\text{E I}} = \frac{x\ m\ n^3\ \text{D}_1\ \text{O H O}_1\ \text{H}_1}{\text{E I}};$$

where δ = deflection at that particular depth taken. For varying diameter the moment of inertia, I, will vary as the section of shaft; hence different deflection. E = modulus of elasticity. If it be found convenient to reduce the vertical ordinates of the bending moment diagram when constructing the deflection vector polygon by, say, $\frac{1}{r}$, then the foregoing expression must be multiplied by r.—C. H., JUN.

[Other replies to Question No. 995 will be given in our next issue.—ED. *E. E.*]

Boiler Cleaning.—The Admiralty have directed that in future cylindrical boilers in warships are to be examined and cleaned when they have been in use for 21 days. If that period is exceeded owing to the exigencies of the service, the power limit is to be temporarily reduced until examination and cleaning has been carried out. The reason for this order is that it has been brought to the notice of the Admiralty that cases have occurred in which damage has been sustained by boilers not having been examined and cleaned for a longer period than 21 days. In comparing this period with that necessary for boilers in central stations, it must be remembered that on ships there is a 24-hour load on the boilers.

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

1,002. Describe a satisfactory and, as far as possible, inexpensive method of making laminated contact brushes, such as are used for various sliding and stationary contacts, the various plates of which the brush is composed having a certain initial tension, so that the brush when at rest will not tend to separate.—CONTACT.

1,003. (1) When designing the field coils of direct-current motors, what allowance, if any, is made for the demagnetising and cross-magnetising effect of the armature, as authorities seem to differ on this point? (2) In a large works there are various direct-current motors working shearing and punching machines throughout the yards. These are controlled from one central starter, which does for all motors, and is about 100 yards from most of them. Are there any Home Office or Factory Act rules concerning such a switch? The supply is at 110 volts.—W. C. C.

ANSWERS.

Question No. 995.—Give a method (graphical or analytical, preferably the latter) of determining the deflections at all points of a shaft of varying diameter, supported by two bearings and loaded with two or more loads (as, for example, a motor shaft).

Answer to No. 995 (awarded 7s. 6d.).—The deflection of a shaft depends mainly on the following factors: loading and supporting methods, also on the speed of the shaft. Let us, for example, take the motor shaft alluded to in the

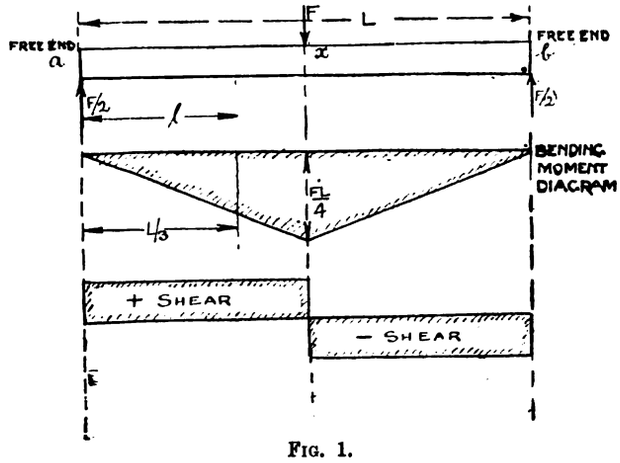

FIG. 1.

question. The slight increase of diameter occurring in the above shaft is immaterial when calculating the deflection; hence we may, to all intents and purposes, assume it of a uniform diameter, and consider it as a beam loaded in the centre (armature) and supported at both ends. Let the central load (armature) = F; distance between inner edges of bearings = L; deflection of shaft = δ; area of bending moment diagram = A; moment of inertia = $I = \frac{\pi D^4}{64}$ for circular section; modulus of elasticity, F, for mild steel = 13,000 tons per square inch.

We may here make clear the terms of bending moments and shearing forces. When two equal and opposite couples are applied at opposite ends of a shaft or beam in such a manner as to rotate it, the bar is said to be subjected to a bending moment. Thus, in Fig. 1 we have the following couples: $F_2\,a\,x$ and $F_2\,b\,x$, equal and opposite, which tend to make it rotate round a point, x—*i.e.*, bend it—hence the term bending moment. When bending takes place upwards we have a + bending moment, and down we have a − bending moment, as in our case. The depth of the diagram below any point in the beam is the bending moment under that point—*i.e.*, the algebraic sum of all moments of external forces about the point acting to right or left of the point. When couples are applied to a beam, not only bending moment takes place, but also shearing. The shear at any section (point) of a shaft is equal to the algebraic sum of all forces to right or left of that section (point).

Let us now return to the diagram shown in Fig. 1. Each support takes half the weight, F—*i.e.*, F/2.

$$\text{Bending moment at } x = \frac{F\,L}{4} = \frac{F}{2} \times \frac{L}{2}.$$

At any other section the bending moment is (proportional) varies directly as the distance from the supporting

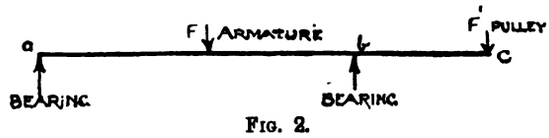

FIG. 2.

force; hence the diagram is triangular. The only force to right or left of x is F/2; hence our shearing diagram is positive on one side of x and negative on the other.

$$A = \frac{F\,L}{4} \times \frac{L}{4}.$$

Let L_c = distance of centre of gravity of bending moment diagram from free end. Let $L_c = \frac{L}{3}$.

$$\delta = \text{deflection} = \frac{F\,L}{4} \times \frac{L}{4} \times \frac{L}{3} \times \frac{1}{E\,I}. \qquad \delta = \frac{F\,L^3}{48\,E\,I}$$

Or, integrating at any point distant l from support, we have

$$\text{Bending moment} = \frac{F}{2}\,l.$$

$$\delta = \frac{F}{E\,I}\int_0^l \frac{l^2\,d\,l}{2} = \frac{F}{E\,I}\left(\frac{l^3}{6}\right).$$

When $l = \frac{L}{2}$ we have $\delta = \frac{F\,L^3}{2^3 \times 6\,E\,I} = \frac{F\,L^3}{48\,E\,I}$ = deflection, d, occurring in a motor shaft due to its central load (armature).

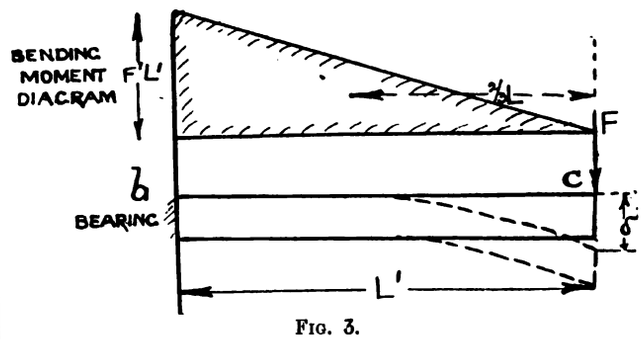

FIG. 3.

A horizontal shaft sags between the bearings due to its own weight; hence during each revolution it is bent to and fro. If the period of this disturbing approximates to the natural period of vibration of the shaft, the amplitude of vibration will continue to increase and set up a violent action known as "whirling." If the speed of rotation be increased beyond this whirling speed, the shaft will again become steady. This amount of sag is, however, not taken into consideration for all ordinary problems, but the formula given above is used. Assuming the motor shaft to be loaded—*i.e.*, by a belt on the pulley—we shall have a shaft under the conditions shown in Fig. 2. We shall also get a certain amount of deflection in the piece $b\,c\,d\,e$ to the load on it, F'. F' = loaded pulley; L' = distance between bearing and centre of pulley; δ = deflection.

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$$A = F' L' \times \frac{L'}{2} = F' \frac{L'^2}{2}. \qquad L_c = 2/3\ L.$$

$$\delta = \frac{F' L'^2}{2} \times \frac{2}{3} \times \frac{I}{E I} = \delta = \frac{F' L'^3}{3 E I}.$$

Bending moment $= F' L'$.

Hence we get deflection for part $a\ b$ (Fig. 2) $= \frac{F L^3}{48 E I}$ and deflection for $b\ c$ (Fig. 2) $= \frac{F' L'^3}{3 E I}$.—OSCAR DINERMAN.

Answer to No. 995 (awarded 5s.).—The following is a graphical method of determining the deflections of a shaft of varying diameter, say 3in. at the ends and 4in. at the centre, with loads of one ton and half a ton supported at the positions shown in Fig. 1. The first operation is to find the bending moment diagram. This is done by calculating the bending moment for each load and adding

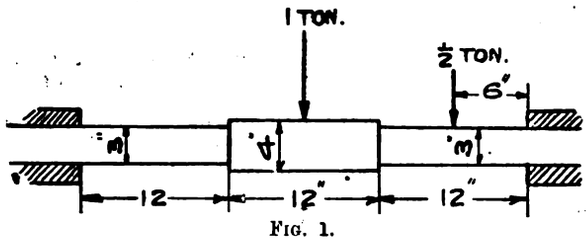

FIG. 1.

the ordinates of the resulting diagrams. The reactions at the supports due to the one ton are half-ton each end. Therefore, bending moment at centre $= \frac{1}{2} \times 18 = 9$ inch tons. Take $a\ b = 9$ to some scale and join b to P and Q. Now for the bending moment due to the half-ton load, reaction at Q $= \frac{5}{6} \times \frac{1}{2} = \frac{5}{12}$ ton Therefore, bending moment under half-ton load $= \frac{5}{12} \times 6 = 2\frac{1}{2}$ inch-tons. Set off $c\ d$ to represent $2\frac{1}{2}$ and join P d, d Q. Now, adding diagrams P d Q, P b Q, we obtain P $f\ g$ Q, which is the real bending moment diagram for the shaft when the bearings are considered as supports only. In practice, however, they will have the same effect on the bending moment diagram as building the ends of a beam in a wall, and to obtain the new

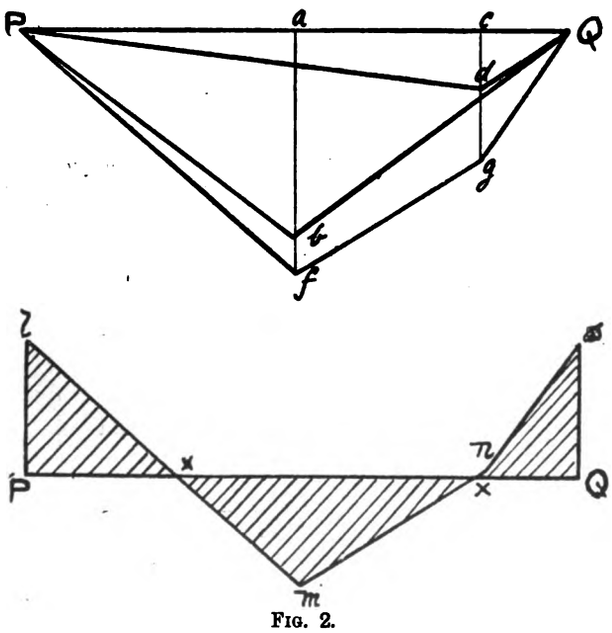

FIG. 2.

diagram, P $l\ m\ n\ s$ Q, we raise the whole diagram by an amount equal to the average height, and this allows for the fixing of the ends. Points $x\ x$ are points of contrary flexure—*i.e.*, where there is no bending.

We now require a diagram of $\frac{M}{E I}$, where M, E, and I are respectively the bending moment, Young's modulus for the material, and moment of inertia at the different sections. The best way is to first find the values of I, and then plot E I, taking E to be 13,000. I at 4in. diameter $= \frac{\pi (4)^4}{64}$ $= 12{\cdot}56$in. units, and I at 3in. diameter $= \frac{\pi (3)^4}{64}$ $= 3{\cdot}97$in. units. Then the two values of E I for the shaft are $12{\cdot}56 \times 13{,}000 = 163{,}000$, and $3{\cdot}97 \times 13{,}000 = 51{,}600$, which on being plotted give Fig. 3. The following table gives the calculated values of $\frac{M}{E I}$, and Fig. 4 is the same plotted to scale.

Distance from left end.	M.	E I.	$\frac{M}{E I}$.
3	4	51,600	+·000077
6	$2\frac{1}{4}$	,,	+·000043
9	$\frac{1}{2}$	,,	+·000009
12	$-1\frac{1}{4}$	163,000	−·000007
15	-3	,,	−·000018
18	$-4\frac{3}{4}$	,,	−·000029
21	$-3\frac{1}{2}$	,,	−·000021
24	$-2\frac{1}{4}$	,,	−·000013
27	-1	51,600	−·000019
30	$\frac{1}{4}$	,,	+·000004
33	3	,,	+·000058
36	$5\frac{3}{4}$	,,	+·000111

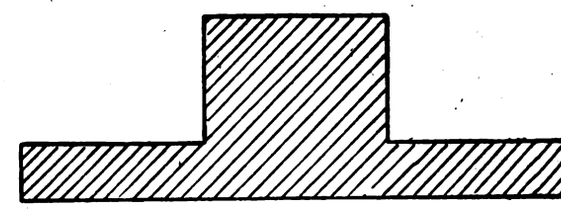

FIG. 3.

Now, to obtain the shape taken up by the shaft, the diagram of Fig. 4 is treated as if it was a load diagram, and the resulting bending moment diagram obtained by the usual link polygon method gives the inverted shape taken up by the shaft. The most difficult matter is to settle on the scale of this diagram, and it can be obtained as follows: If 1in. length of shaft is represented in Fig. 1 by S inches, and if in Fig. 4 unity is represented by m inches, and if the distance between the ordinates of Fig. 4 used to represent loads be V, and the polar distance for obtaining Fig. 5 be x, then a deflection of 1in. is represented on Fig. 5 by $\frac{m S^2}{V x}$, and by scaling this diagram when obtained accurately we get the deflection at all points. The above method is applicable in all cases, whether the shaft is taper

FIG. 4.

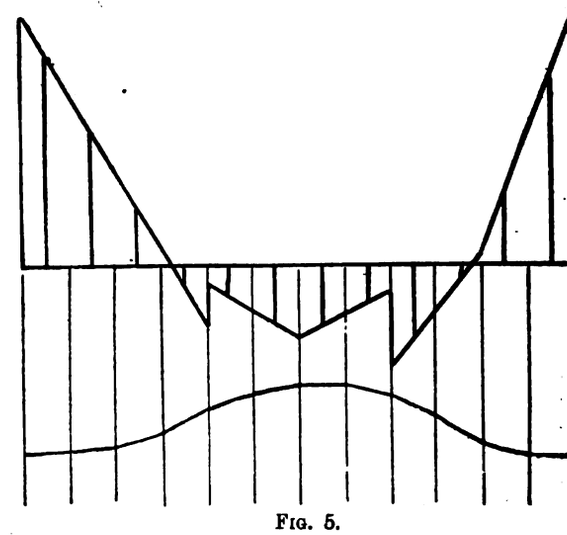

FIG. 5.

or changes diameter in steps, but the analytical method can only be applied when the shape varies regularly and lends itself to being represented by an equation, so that for practical purposes the graphical method as shown in the above example is the one generally used — PERCY DUNSHEATH.

Answer to No. 995 (awarded 5s.).—The analytical solution of the above problem is usually obtained by methods involving the use of higher mathematics, and we shall assume that we are not restricted in this respect with regard to the problem under consideration. In dealing with the above problem, we will first investigate the deflection of a loaded beam of uniform section, supported at the

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ends, and apply the results of this investigation to a shaft of varying diameter loaded at various points. Our first investigation will be confined to the general case of a supported beam loaded at *any* point along its length, and presents a number of complications which are not met with in dealing with the special case—*i.e.*, the load applied in the centre only—the proof of which is given in most text-books on applied mechanics. In these text-books it is demonstrated that $\frac{1}{\rho} = \frac{M}{E\,I}$, where ρ is the radius of curvature for the deflected beam, and M, E, I represent respectively the bending moment, modulus of elasticity, and moment of inertia, in suitable units, for the beam under consideration. Now, from analytical geometry, we have the general equation for the radius of curvature as

$$\rho = \frac{\left\{1 + \left(\frac{d\,y}{d\,x}\right)^2\right\}^{\frac{3}{2}}}{\frac{d^2\,y}{d\,x^2}}.$$

Where the curve is flat, which is the usual case when dealing with loaded beams, the expression $\left(\frac{d\,y}{d\,x}\right)^2$ becomes so small in comparison with unity that it may be neglected. Hence we have the equation $\frac{1}{\rho} = \frac{d^2\,y}{d\,x^2} = \frac{M}{E\,I}$. In interpreting this expression we must note that y represents the deflection at a distance x from some fixed point or origin

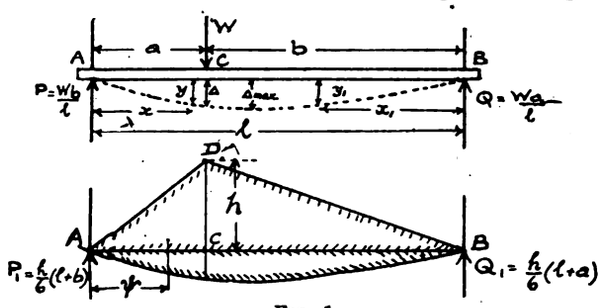

FIG. 1.

Considering a beam of uniform section loaded, as in Fig. 1, with a weight, W, the curve of bending moment due to this load may be represented by the triangle A D B. If, now, we consider this triangle, or bending moment curve, to represent a *distributed loading* of this beam, then the bending moment curve due to this loading will represent, to some scale, the curvature or deflection of the beam due to the original concentrated load. (The proof of this theorem is given in Prof. J. Perry's "Applied Mechanics," p 441.) We shall have occasion to make use of this theorem in obtaining our solution. Referring to the first case of Fig. 1—*i.e.*, a concentrated load, W, placed at distances a and b respectively from the points of support, A B—it is well known that the reactions, P Q, at these points of support are:

$$P = \frac{b}{l} \cdot W; \quad Q = \frac{a}{l} \cdot W \quad . \quad . \quad . \quad (1)$$

Considering the second case—viz, where the triangle or bending moment curve, A D B, constitutes the curve of loads—if we denote the reactions at the points of support, as P_1 Q_1, these may be evaluated as:

$$P_1 = \frac{h}{6}(l+b); \quad Q_1 = \frac{h}{6}(l+a) \quad . \quad . \quad (2)$$

where h represents the altitude of triangle A D B, or maximum bending moment in the first case. It is generally known that in the case of a beam loaded with a concentrated load at its centre, the form of the deflection curve is symmetrical on each side of the load, and, in consequence, the position of zero slope on this curve can easily be determined—being at the point of application of the load. Now, with the beam loaded unsymmetrically, as in Fig. 1, the deflection curve will not be symmetrical, and the point of zero slope cannot be determined very readily. We can, however, consider this deflection curve (A C F B, Fig. 1A) to be made up of two separate curves, A C E and B F G, intersecting in C, corresponding to the unequal distributed loads (A C D, B D C of Fig. 1). Let the points of zero slope on the curves A C E, B F G be at distances u and v respectively from the points of support, A, B (Fig. 1A). Consider a section distant ψ from A.

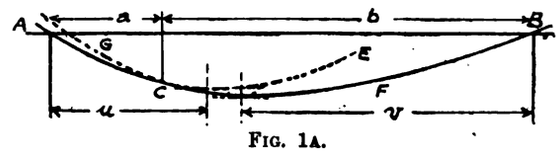

FIG. 1A.

Then, since A D B is the curve of loading, we have:

Bending moment at

$$\psi = M_1 = P_1\,\psi - \tfrac{1}{6}\frac{h}{a}\psi^3 = \frac{h}{6}(l+b)\,\psi - \tfrac{1}{6}\cdot\frac{h}{a}\cdot\psi^3.$$

Hence $$\frac{d\,M_1}{d\,\psi} = \frac{h}{6}(l+b) - \tfrac{1}{2}\cdot\frac{h}{a}\psi^2.$$

Now the point of zero slope corresponds to the condition $\frac{d\,M_1}{d\,\psi} = 0$. Therefore,

$$\frac{h}{6}(l+b) = \tfrac{1}{2}\frac{h}{a}\psi^2,$$

whence $$u = \frac{1}{\sqrt{3}}\sqrt{(l^2 - b^2)} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Similarly, it may be shown that

$$v = \frac{1}{\sqrt{3}}\sqrt{(l^2 - a^2)} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

We are now in a position to determine the deflection due to the concentrated load, as in the first case of Fig. 1. Let y be the deflection at a distance x from the support A on the part A C of the beam. Then

$$\frac{1}{\rho} = \frac{d^2\,y}{d\,x^2} = \frac{M}{E\,I} = \frac{b}{l}\cdot\frac{W}{E\,I}\,x.$$

Integrating, we have:

$$\frac{d\,y}{d\,x} = \frac{b}{l}\cdot\frac{W}{E\,I}\cdot\frac{x^2}{2} + c,$$

c being a constant. Now, when $x = u$, $\frac{d\,y}{d\,x} = 0$, and hence

$$c = -\frac{b}{l}\cdot\frac{W}{E\,I}\cdot\frac{u^2}{2}.$$

$$\therefore \frac{d\,y}{d\,x} = \frac{b}{l}\cdot\frac{W}{E\,I}\cdot\frac{x^2}{2} - \frac{b}{l}\cdot\frac{W}{E\,I}\cdot\frac{u^2}{2}.$$

Integrating a second time we obtain:

$$y = \frac{b}{2\,l}\cdot\frac{W}{E\,I}\left(\frac{x^3}{3} - u^2\,x\right) + c_1.$$

In this case c_1 is obviously zero, since y is zero at A when x is zero.

Finally, $$y = \frac{W}{6\,E\,I}\cdot\frac{b}{l}\cdot x\,\{x^2 - l^2 + b^2\} \quad . \quad . \quad . \quad (5)$$

Similarly, considering a section of the beam on the other side of the load, the deflection at a section y_1 distant x_1 from support B will be found to be

$$y_1 = \frac{W}{6\,E\,I}\cdot\frac{a}{l}\cdot x_1\,\{x_1^2 - l^2 + a^2\} \quad . \quad . \quad . \quad (6)$$

If Δ represents the deflection at the point of application of the load, then from (5)

$$\Delta = \frac{W}{3\,E\,I}\cdot\frac{a^2\,.\,b^2}{l}$$

while the maximum deflection, $\Delta_{max.}$, is given by

$$\Delta_{max.} = \frac{W}{15{\cdot}6\,E\,I}\cdot\frac{a}{l}\,\{l^2 - a^2\}^{\frac{3}{2}}$$

or $$\Delta_{max.} = \frac{W}{15{\cdot}6\,E\,I}\cdot\frac{b}{l}\,\{l^2 - b^2\}^{\frac{3}{2}}$$

according as b is greater or less than a. In interpreting these expressions, Δ will be given in inches if l, a, b are in inches, W in pounds, and E in pounds per square inch. I is, of course, the moment of inertia of the section about the neutral axis, and its value must likewise be given in inches.

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If we assume a loading as in Fig 2, and denote Δ_1, Δ_2, Δ_3 as the total deflections at the points of application of the loads, W_1, W_2, W_3, we have: $\Delta_1 = y_1' + y_1'' + y_1'''$; $\Delta_2 = y_2' + y_2'' + y_2'''$; $\Delta_3 = y_3' + y_3'' + y_3'''$; y_1', y_1'', y_1''', etc., being the deflection corresponding to the separate loads when applied singly, as in the above case.

Hence in Fig. 2:

$$\Delta_1 = \frac{1}{3\,E\,I} \cdot \frac{a}{l} \left\{ W_1\, a\, \beta^2 + \frac{W_2}{2}\, \lambda \left(a^2 - l^2 + \lambda^2 \right) + \frac{W_3}{2}\, \xi \left(a^2 - l^2 + \xi^2 \right) \right\}$$

$$\Delta_2 = \frac{1}{3\,E\,I} \cdot \frac{1}{l} \left\{ \frac{W_1}{2}\, a\, \lambda \left(\lambda^2 - l^2 + a^2 \right) + W_2\, \lambda^2\, \gamma^2 + \frac{W_3}{2}\, \xi\, \gamma \left(\gamma^2 - l^2 + \xi^2 \right) \right\}$$

$$\Delta_3 = \frac{1}{3\,E\,I} \cdot \frac{\xi}{l} \left\{ \frac{W_1}{2}\, a \left(\xi^2 - l^2 + a^2 \right) + \frac{W_2}{2}\, \gamma \left(\xi^2 - l^2 + \gamma^2 \right) + W_3\, \xi\, \zeta^2 \right\}$$

It will be observed that, even assuming I to be constant, the solution of our problem is by no means simple, and if I were variable, the above equations would become much more complicated. However, for most cases, when dealing with small machines I may be considered to be constant, at an estimated average value, for all practical purposes.

In cases where I varies considerably at different sections the deflections may be obtained by employing a graphical method, which may be similar to that made use of in

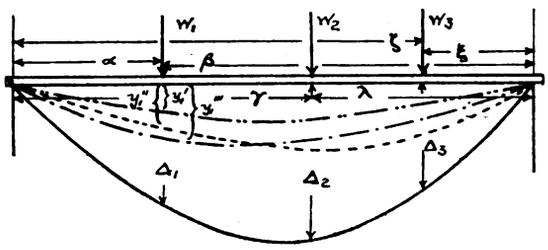


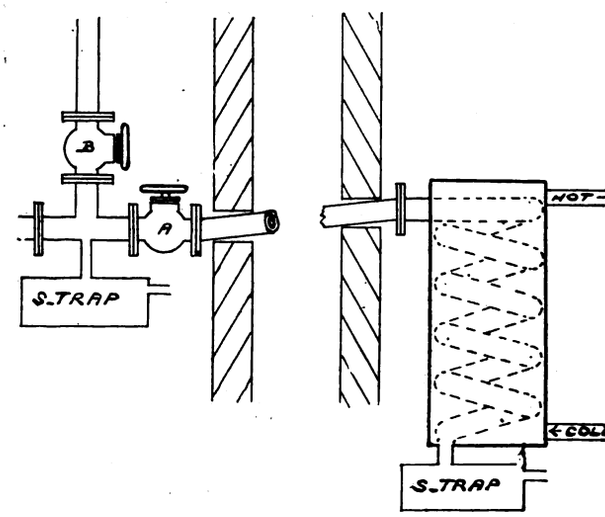
FIG. 2.

Fig. 1, or a combination of a graphical method with an arithmetic or summation method of finally obtaining the deflection. For the purely graphical case a method of procedure would be: given the particulars of the loading, the value of E, and the various diameters from which I may be calculated (for a shaft $I = \frac{\pi}{64}\, d^4$, d being the diameter), construct a diagram so that the ordinates represent the value of $\frac{M}{E\,I}$ (M being the bending moment) at every place along the length of the shaft, which is represented as the abscissa in the diagram. Now treat this diagram as if it were a distributed loading, and proceed to determine the bending moment curve *corresponding to this loading* by means of the "link polygon" or other method. The curve obtained will then represent the deflection of the shaft due to the *original* loading. Now as to the scale of the deflection curve. If the scale of the diagram is such that a length of 1in. on the beam is represented by a length of x inches (x being a fraction), and if the scale of the $\frac{M}{E\,I}$ curve is such that (1in. × 1lb) bending moment is represented by a length of y inches, and unit area (one square inch) on the $\frac{M}{E\,I}$ or secondary loading diagram is represented by a length z inches on the scale of loads in the "force polygon," then a deflection of the beam of 1in. is represented on the diagram by a length of $\frac{x^2 . y . z}{p}$ inches, where p is the perpendicular distance (in inches) from the "pole" to the line of loads in the force polygon. Hence a deflection represented by 1in. on the diagram corresponds to an actual deflection of $\frac{p}{x^2 . y . z}$ inches of the beam.

For the partly graphical and arithmetic method attention should be drawn to an example appearing on pp. 442 and 443 of Prof. J. Perry's "Applied Mechanics." This example is, however, worked out for a concentrated load of 50lb. at the end of the beam in addition to the uniformly distributed load, which is not stated in the text. By inserting the value of I corresponding to each value of x in the column $\frac{M}{E\,I}$ (p 443, *ibid*), this method fulfils the requirements of the above question.—A. E. T.

Question No. 996.—We supply about 80,000 gallons of hot water from our station to the adjacent premises per month. We purchase this water, together with our boiler supply, by meter. Our neighbour's consumption of water is below the quantity available under his minimum payment to the water authority, and so he could obtain the water free of cost. Under the Waterworks Act we cannot bring water from our neighbours' water-pipes into our premises. We wish, therefore, to heat the water on their premises. (The price of the water is 1s. per 1,000 gallons.) What is the best method of doing this, using exhaust steam at atmospheric pressure?

Answer to No. 996 (awarded 5s.).—There will be no difficulty in taking the exhaust steam to neighbouring premises and utilising it there for heating purposes, but the commercial advantage will depend on several factors. These we will consider in detail. An arrangement as per diagrammatic sketch will be found convenient for the purpose. Exhaust steam is sent on to customer's premises by means of valve A; when not required A is shut



and steam passes by way of valve B. Heater on customer's premises contains a pipe coil in which the steam is condensed, the condensed water escaping through the steam-trap. In case the hot water required should exceed the amount necessary to bring customer's meter up to the minimum it may be advantageous to have an auxiliary pipe (not shown in sketch) to supply part of the hot water direct from station. There will be less loss in conveying hot water than exhaust steam. When designing the arrangement three things must be carefully considered: pipes must be lagged to prevent loss by radiation, they must be drained, and means must be provided in order that expansion and contraction may not cause trouble. Lagging the pipes by covering with a good non-conducting composition will keep losses due to radiation down to about 10 per cent. The pipes carrying exhaust steam should be inclined, having a drop towards the station; any condensed water will then pass through the steam-trap in station. Although exhaust steam is to be used, some sort of expanding joint or joints will be necessary to prevent leakage at connections or even worse disaster owing to expansion and contraction. We may take the exhaust steam as being about 20lb. pressure (absolute), and suppose length of piping to be 100ft. Coefficient of lineal expansion of cast iron for 1deg. F. = ·0000065; temperature of steam at 20lb. pressure = 228deg. F.; temperature of air surrounding pipe 60deg. F (say). Then increase in length = (228 − 60) × ·0000065 × 100 × 12 = 1·3in. In place of telescopic expansion joints the writer would suggest copper bends as being infinitely superior.—M. M.

[Other replies to Question No. 996 will be given in our next issue.—ED. *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

1004. Discuss street-lighting photometry, giving the merits and demerits of ascertaining the "illumination on a horizontal surface" as compared with the "direct candle-power," the measurements in each case being taken at varying distances from posts, and at a height of about 1m. from the ground. Clearly describe the term "candle feet." Also describe a type of photometer (complete) with which it is possible to take either of the above, and also laboratory measurement.—J. C. L. V.

1005. Discuss the pros and cons of the three following methods of regulating the voltage of alternators: (1) Alternator derives exciting current from station direct-current main 'bus bars, regulating resistance being in series with field coils; (2) alternator derives exciting current from direct-current dynamo coupled to its shaft, the regulating resistance being in series with excitation dynamo field coils; (3) alternator derives exciting current from direct-current dynamo coupled to its shaft, the field coils of the excitation dynamo being in turn excited from the station direct-current main 'bus bars, and the regulating resistance being in series with the field coils of excitation dynamo.—O. D.

ANSWERS.

Question No. 996.—We supply about 80,000 gallons of hot water from our station to the adjacent premises per month. We purchase this water, together with our boiler supply, by meter. Our neighbour's consumption of water is below the quantity available under his minimum payment to the water authority, and so he could obtain the water free of cost. Under the Waterworks Act we cannot bring water from our neighbours' water-pipes into our premises. We wish, therefore, to heat the water on their premises. (The price of the water is 1s. per 1,000 gallons.) What is the best method of doing this, using exhaust steam at atmospheric pressure?

Answer to No. 996 (awarded 10s.).—The best method, were it not for the legal restriction, would be to bring the water on to the premises and heat it in close proximity to the engines, in order that exhaust steam would not have to traverse a long pipe. Under the conditions, however, the exhaust pipe should be kept as short as possible by placing the heater at that point of the customer's premises which is nearest to the engines. The type of heater to be used depends upon the use to which the water will be put. If the water need not be quite pure, then the steam can be turned directly into it, but if purity is essential, some kind of surface heater should be used. For most practical purposes the steam, after passing through an oil separator, would be "clean" enough to go into the water. An iron tank should be fitted as in Fig. 1, with two pipes, A and B, for the inlet and outlet of the water, and a special nozzle, N, leading the steam below the water surface. N is a large funnel-shaped opening, the bottom end being covered by a perforated disc, through which the steam emerges as a number of small jets. The advantage of this type is that it presents a large area of water to the steam, yet the back pressure of the water can be reduced to a minimum by bringing the nozzle near to the water surface, or even just above the surface. Fig. 2 shows an alternative method with the same advantages. A large shallow tank contains the water to be heated, and the exhaust steam is led into a number of horizontal straight pipes, which are perforated on the under side with a number of small holes, through which the steam escapes and heats the water.

Fig. 3 shows a type of heater to be used where purity of the water is desirable. It consists of a cast-iron vessel, A, with connections for the water, and fitted with a number of 1¼in. diameter bronze or copper tubes, through which the steam passes on its way from the top steam chamber to the bottom one. Fig. 4 shows an efficient joint for use on this class of work. Whether the steam is turned straight into the water or passes through tubes, there should be a by-pass arrangement at the power-house, as shown in Fig. 5, to regulate the flow to the heater. The two valve spindles are geared to one another, so that if the admission to the heater is closed the one to the atmosphere is opened and

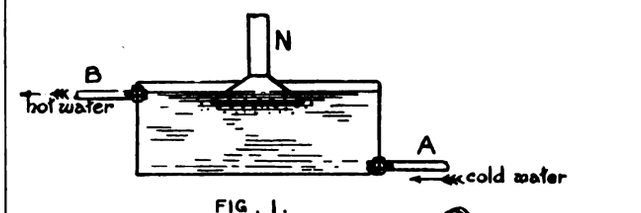

FIG. 1.

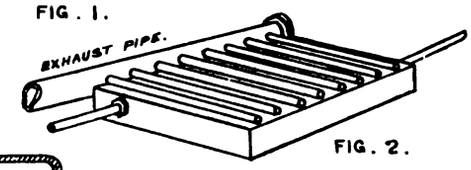

FIG. 2.

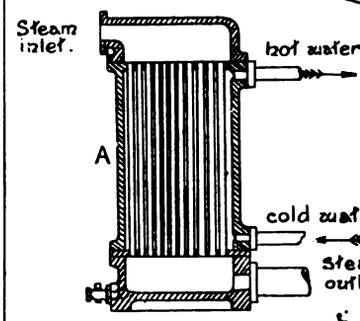

FIG. 3

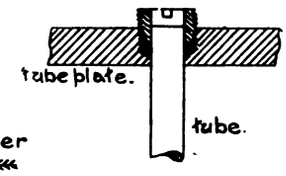

FIG. 4.

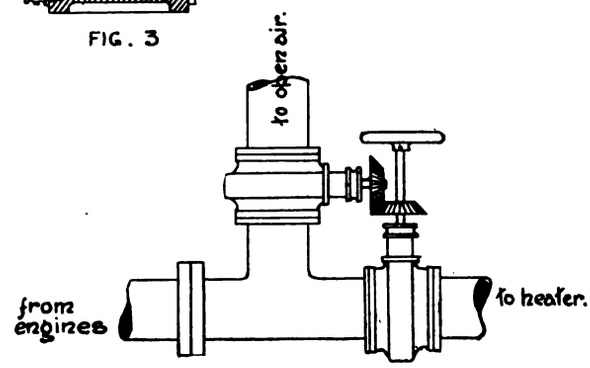

FIG. 5.

vice versâ, so that there is no risk of the engine exhaust being totally stopped.—PERCY DUNSHEATH.

Answer to No. 996 (awarded 5s.).—The simplest method would be to install one of the numerous forms of exhaust steam feed-water heaters now on the market. Fig. 1 shows one of these; it consists of a cylindrical body surrounding a nest of tubes. A cap is bolted to the top and bottom, as shown, that at the bottom being divided into two compartments. The feed water enters on one side of this, flows up one half the tubes to the top and down the other half to the exit, as shown by the arrows. The exhaust steam is let into the cylindrical body at the bottom and passes round the outside of the tubes and out at the top, as shown. As these feed heaters are made to stand the boiler pressure, the feed water being passed through them on its way direct to the boilers, it might be cheaper to make one specially, as it could be made much lighter, owing to the water not apparently being required under pressure.

Another method would be to inject the steam directly into the water, but in this case care would have to be taken to prevent the vacuum causing the water to siphon back into the exhaust, and a large storage tank for the water would be required. A variation of this method might be used in which the water is sprayed into a chamber or vessel in which the exhaust steam is allowed to accumulate, the condensed steam and water being taken away by means

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of a pump. Both of the latter methods have the disadvantage of allowing the steam to mix with the wator, with the result that any oil, etc., which is carried over by the exhaust

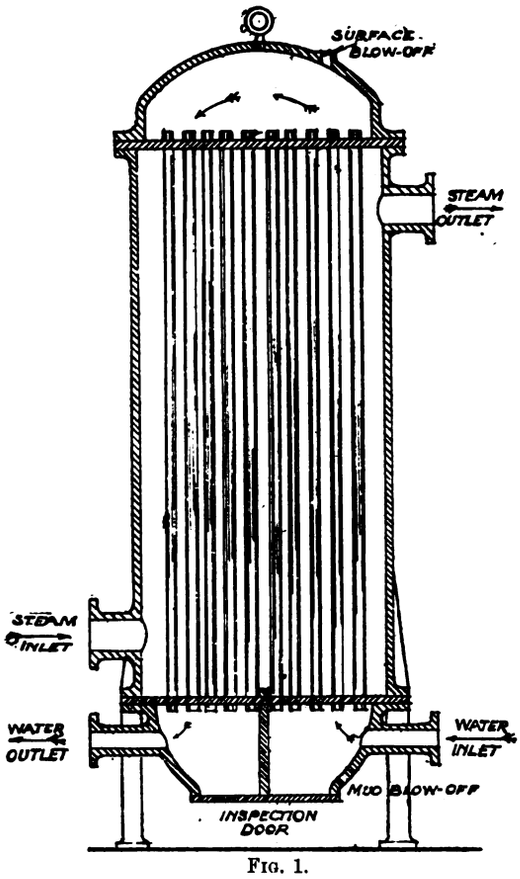

FIG. 1.

steam mixes with the water, and may cause damage later on, so that an oil filter would be required.—NOTAC.

Question No. 997.—A single-phase motor, 5 h.p., 400 volts, 50 ~, four-pole, starts on a loose pulley and attains a speed of 550 r.p.m., beyond which point it refuses to gain speed. There are 48 stator slots—32 for the running winding, 16 for the starting winding—and 43 bars in the squirrel rotor. The current measured is 13 amperes in main and five amperes in the auxiliary. Why does the motor refuse to pick up ?

Best Answer to No. 997 (awarded 10s.).—The principal factors which govern the speed of alternating-current induction motors are (1) the frequency of the supply, (2) the number of poles in the stator, (3) the resistance of the rotor. The synchronous speed of a four-pole, 50-period machine is 1,500 r.p.m., and the actual speed on light load should be only a trifle less than this, provided the rotor resistance is practically negligible. If the motor does not speed up beyond 550 r.p.m., then clearly one or more of the three speed-determining factors indicated above must be looked to for an explanation. That is to say, putting on one side the possibility of the frequency being incorrect, either the number of poles is abnormally high or the resistance of the rotor circuit is abnormally great.

It is, perhaps, not very generally known that a single-phase four-pole induction machine may, under certain conditions, behave as though it had eight or even 16 poles. This phenomenon is due to irregular flux distribution in the stator, and may be explained as follows. The field of a single-phase induction motor, if the impressed E M F. follows a sine curve, may be regarded as consisting of two equal components rotating uniformly in opposite directions. At normal speed the backward component is practically neutralised, and the motor runs as though it were a polyphase machine. At standstill the torques due to the oppositely rotating fields are equal and opposite so that the motor has no tendency to start. At intermediate speeds the forward torque is the greater, but the backward torque is far from being negligible. At these intermediate speeds the rotating field tending to speed up the motor is very complex, particularly so if the impressed E.M F. wave is irregular. The difficulty of there being no starting torque is overcome by the provision of an auxiliary winding which should be supplied with current as nearly as possible 90deg. out of phase with the current in the main winding. A phase-splitting device of some sort is employed to furnish the auxiliary starting current, and if this device is not properly adjusted the phase displacement is very slight and the rotating field produced is extremely imperfect. But however complex the field distribution may be during the period of starting up, it may be analysed by Fourier's well-known theorem. Thus, if a single-phase motor with p pairs of poles is connected on a circuit having frequency n, the field may be regarded as consisting of the following components.

A sinusoidal field of p pairs of poles moving forward at $\frac{n}{p}$ revs. per sec.

An equal sinusoidal field of p pairs of poles moving backward at $\frac{n}{p}$ revs. per sec.

A sinusoidal field of $2p$ pairs of poles moving forward at $\frac{n}{2p}$ revs. per sec.

An equal sinusoidal field of $2p$ pairs of poles moving backward at $\frac{n}{2p}$ revs. per sec.

and so on with $3p$, $4p$, etc., pairs of poles.

These harmonics always exist to some extent, and account for the fact that single-phase induction motors sometimes have a tendency to run at sub-multiples of their proper speed. In the case under consideration the motor would tend to run at $\frac{1,500}{2}$, or 750 revolutions if the second harmonic predominated. The trouble could probably be remedied by adjusting the phase-splitting device until a more perfect rotating field at starting is obtained. On no account should the auxiliary winding be disconnected until the speed has nearly reached synchronism.

Another suggestion as to a possible cause of the trouble rests on the assumption that the rotor resistance is abnormally high. With a squirrel-cage rotor this would mean that a number of the bars are loose or otherwise making imperfect contact with the short-circuiting rings. If this is the fault it can, of course, be easily tested and remedied. The motor should be allowed to run up to speed without any load at all, and it would be well to make sure that there is no excessive friction at any of the bearings.—ROTOR.

Answer to No. 997 (awarded 7s. 6d.).—The starting of single-phase induction motors of the above type is usually accomplished by one of the methods indicated by the diagrams of Fig 1, the net result being to obtain a phase displacement of approximately 90deg. between the currents in the main and starting windings, whereby some sort of a rotary magnetic field may be produced in the stator in place of the alternating magnetic field produced by the main winding alone. The main winding is usually proportioned to occupy two-thirds of the pole-pitch, the remaining third being occupied by the starting winding. This winding is usually designed with either one-half of the number of turns per phase of the main winding, or with twice the number of turns of the main winding, depending upon the arrangements to be adopted for starting. If the starting winding carries twice the number of turns as the main winding, then the self-induction of the former will be considerably greater than that of the latter winding. In order to still further increase the self-induction of the starting winding circuit, a reactive coil is inserted, which is usually adjusted to give the best starting torque for each individual motor. When the main and starting windings are connected in parallel across the supply (Fig. 1C), the current in the starting winding will be nearly in quadrature with that in the main winding, thereby creating a revolving field and causing the motor to start as a two-phase motor. The starting device, however, must be adjusted so that the motor attains a speed above half synchronous speed *before* the starting switch is thrown over to the running position, otherwise we shall have a recurrence of the phenomenon recorded above—viz, that the motor will continue to run at a speed considerably below that corresponding to

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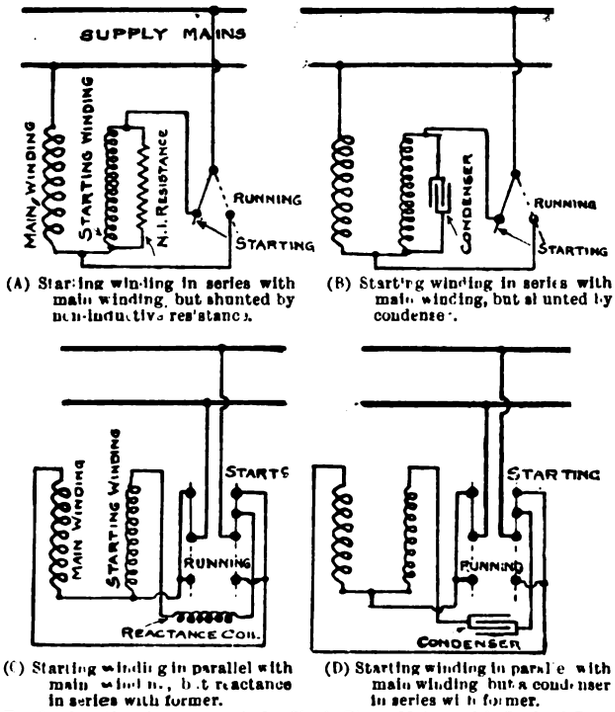
synchronism, and this speed will generally be a sub-multiple of the synchronous speed.

It has been shown by Ferraris that the effect of the impressed alternating current in producing a magnetic field in the single-phase induction motor, is equivalent to two equal rotating fields which rotate in opposite directions, each having a frequency equal to that of the supply. Now, at standstill it is evident that the torque due to these revolving fields is zero, since each produces an equal but opposite torque. When the rotor starts revolving, however, the backward torque becomes gradually weaker, and at full speed the only operative torque of any magnitude is that due to the forward rotating field.

It has already been shown that the starting is accomplished by creating some sort of a revolving field by means of an auxiliary winding combined with a phase-splitting device.



(A) Starting winding in series with main winding, but shunted by non-inductive resistance.
(B) Starting winding in series with main winding, but shunted by condenser.
(C) Starting winding in parallel with main winding, but reactance in series with former.
(D) Starting winding in parallel with main winding but a condenser in series with former.

FIG. 1.—Starting Arrangements for Single-Phase Motors with Squirrel-Cage Rotors.

The flux distribution in the stator under these conditions will be irregular and not sinusoidal, the irregularity approaching a minimum value as the magnetic field becomes a perfect rotary one. Hence we cannot make the assumption that $B = B_0 \sin \theta$, as we could in the case of a polyphase motor (B_0 represents the maximum value of the magnetic induction and B the maximum instantaneous value corresponding to an interval represented by θ, measured from the zero point). We can, however, apply Fourier's theorem to the case of the single-phase motor, since the flux distribution is a single-valued function of time. This theorem states "that any single-valued periodic curve may be built up by combining a suitable number of single sine curves." Hence, if $y = f(x)$, then

$$y = A \sin \alpha x + B \sin \beta x + C \sin \gamma x + \ldots$$

where $f(x)$ is a single-valued function of x, and A, B, C, etc., are constants.

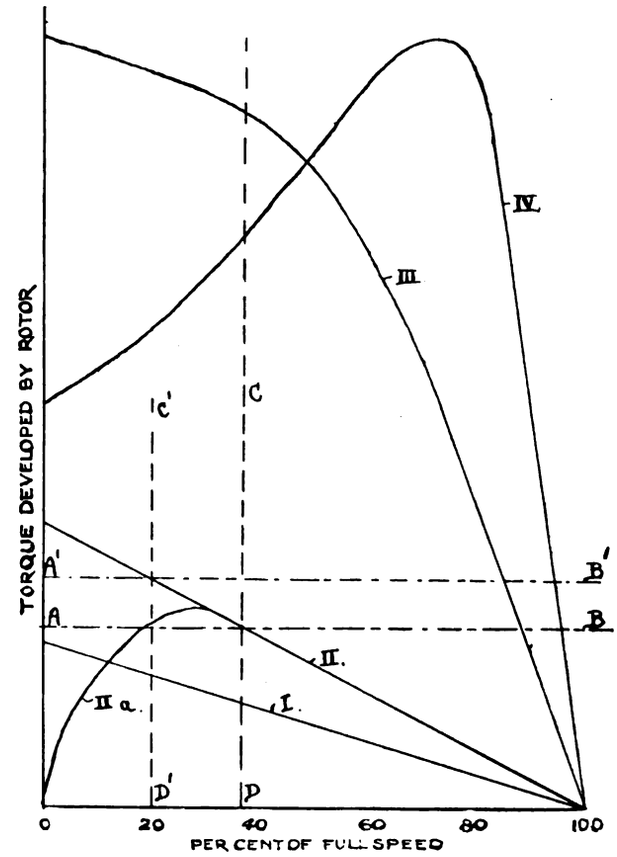
If y is a single-valued function of θ—*i.e.*, $y = f(\theta)$—then $y = A \sin(\theta + \phi_1) + B \sin(2\theta + \phi_2) + C \sin(3\theta + \phi_3) + \ldots$ Hence, in our case, B, the magnetic induction, is a single-valued function of the time (or abscissa), θ, and, therefore, $B = f(\theta)$, whence

$B = B_1 \sin(\theta + \phi_1) + B_2 \sin(2\theta + \phi_2) + B_3 \sin(3\theta + \phi_3) + \ldots$

The interpretation of this expression is that the total flux distribution may be split up into successive components, such as: (1) a sinusoidal distribution corresponding to the number of poles on the stator; (2) a sinusoidal distribution corresponding to *twice* the number of poles on the stator; (3) a sinusoidal distribution corresponding to *three times* the number of poles on the stator, and so on.

For the motor under consideration, which has four poles, the synchronous speeds corresponding to these components are: (1) 1,500 r.p.m.; (2) 750 r.p.m.; (3) 500 r.p.m. It is, therefore, evident that as the motor continues to run at a speed of about 500 r.p.m. instead of 1,500 r p m, the trouble is due to the preponderance of the flux corresponding to the third harmonic. In order to get the motor up to full speed we must diminish the effect of this third harmonic and increase that due to the fundamental frequency. As the trouble is due to the phase displacement of the currents in the main and starting windings being insufficient—*i.e.*, less than 90deg.—we would suggest that the reactance of the starting circuit be increased, or a non-inductive resistance be placed in series with the main winding. This latter procedure will diminish the starting current, and probably the torque, but will increase the phase displacement of the currents in the main and starting windings. A series of trials with various combinations of reactance and resistance, will readily show which combination gives the best results in the shape of high torque and minimum time to run up to speed. It may be mentioned that the combination giving the lowest starting current generally corresponds to a long starting interval—*i.e.*, the motor takes a long time to run up to speed when the switch is in the starting position. Generally the best starting results on single-phase induction motors of the squirrel-cage type are obtained by allowing a starting current of from 25 to 50 per cent. above the full-load current, as in this case the time taken for the motor to run up to speed is a minimum. When starting induction motors of the squirrel-cage type, the switch should be left in the starting position until the speed has got well up to its final value, otherwise, if the starting switch is thrown over to the running position too soon, then the motor will not run up to full speed, but will remain running at a lower speed. We have assumed, in the above discussion, that this fact is known to the querist.—A. E. T.

Answer to No. 997 (awarded 5s.).—Although the question says "single-phase" motor, under the conditions stated the



machine is a two-phase motor, and must, therefore, be dealt with as such. In all polyphase induction motors the effect of varying the rotor resistance is to alter the speed at which we get maximum torque, but does not alter the actual value of the maximum torque. This is shown very well by Fig. 1, the curves marked 1, 2, 3, and 4 showing the relation between torque developed by the rotor and the speed of the rotor, the rotor resistance having the highest value in Curve 1 and the lowest value in Curve 4. In the machine in question the synchronous speed is 1,500 r.p.m., consequently it is only running at 36·7 per cent. of its full

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speed — that is, synchronous speed when running at 550 r.p.m. This speed (550 r.p.m.) is shown by the vertical line, C D. It is obvious that a certain torque will be required to overcome the no-load losses of the machine. Such torque has for simplicity's sake been assumed constant, though naturally it varies slightly with the speed. When this resisting torque and the developed torque exactly balance each other the speed will be constant, and this constant speed in the case in question is 36·7 per cent for the rotor resistance in Curve 2. As will be seen from the figure, below the speed of 550 r p.m. the torque developed is greater than the resisting torque, and consequently the speed will rise until a balance is obtained. Also the speed for this value of the rotor resistance cannot rise above 550 r.p.m., because above this point the resisting exceeds the developed torque. If the motor be loaded as a two phase machine the resisting torque will be, say, C' D', and the speed must fall to A' B'. It is, perhaps, worthy of note that above a certain value of the rotor resistance the developed torque is never as great as the resisting torque, and thus the motor will not start. This is so in the case shown by Curve 1. If the auxiliary phase is cut out when a speed of 550 r.p m. is attained, the machine becomes a single-phase motor, and as the value as well as the point of occurrence (of maximum torque) is altered by the change in rotor resistance, the curve of torque and speed will perhaps follow II.A, which is even worse than in a polyphase machine.

In a squirrel-cage rotor the chief resistance is that of the end rings or connections The defect in the case in question may be due to a bad connection of one or more bars on to the ring, or to the section of the end rings being too small for the current they have to carry. As the type of end connection employed is not stated, I cannot suggest how to overcome the defect save that in some way the resistance of the rotor must be reduced.—J. P. G.

Answer to No. 997 (awarded 5s.).—The question does not give any particulars relative to the starting apparatus of the motor, as it is there where the cause of the trouble is most likely to be found. It is assumed that the voltage of the circuit is correct. This point is mentioned as the motor would not run much beyond 550 r.p.m. if supplied at 200 volts instead of 400 volts, the synchronous speed being 1,500 r.p.m. The normal starting current of the motor on a loose pulley should be about 18 amperes, assuming a graduated starting arrangement is in use. Should the starting current exceed the above value the rotor had better be examined to see if it is free in the bearings, also whether there is any undue friction with the loose pulley and belt when running up to speed. The starting apparatus is, no doubt, adjusted to reduce the starting current to a minimum with the motor starting on light load. If, therefore, a greater torque is required, the motor must take more current and the starter adjusted accordingly.

There are many types of single-phase starters on the market for motors with squirrel-cage rotors, a few examples of which are given below: (1) a plain starter with non-inductive resistance and throw-over switch, the latter opening the starting coil circuit and short-circuiting the resistance when the motor is up to about 60 to 70 per cent. of the full speed; (2) a similar arrangement as above, except that a graduated resistance connected to a multiple-contact switch is used; (3) a throw-over switch as in (1) used in connection with a choking coil, and a condenser in the starting and running coil circuits respectively; (4) a multiple-contact switch with resistance and a choking coil, the former being in the running coil circuit and the latter in the starting coil circuit. It is assumed that an arrangement with a throw-over switch is used as in (1) or (4), in which case the resistance or the impedance of the choker must be reduced, thereby permitting a larger current to flow to obtain the increased torque. The limit, however, of an increase of current consumption and increased torque is very soon reached with the ordinary single-phase induction motor.

The writer has frequently experienced the difficulty in question. The starters used were as described under (1), and after some time the motors failed to run up beyond a certain speed with the switch in the starting position, this speed was not sufficiently high to pull the motor into step when the switch was changed to the running position, as the motor fell out each time this was attempted. The trouble was due to the resistance wire having scaled, due to the constant overheating when starting, with the result that the total resistance had increased beyond the original value, after the resistance was adjusted no further trouble was experienced. If a choking coil is used, the impedance can be varied either by altering the number of turns (if suitable tappings are available), by altering the air-gap between the yoke and core if a closed circuit choker is used, or by adjusting the core in the coil if open circuit choker is used. It is a difficult matter to say definitely without particulars of the windings whether the starting or running windings require more current to obtain the increased torque, or both, the usual practice being to arrange the ampere turns in both windings to be the same. The starting and running windings should also be tested to see that the insulation resistance between the coils is satisfactory. If the above suggestions are carried out the location of the trouble should not be a difficult matter.—JUNO.

Question No. 998.—What is the best form of apparatus to use for electric soldering metallic-filament lamps, and the particular kind of current required for same?

Best Answer to No. 998 (awarded 10s.).—At the present time, when so many of the metallic-filament lamps that have recently been invented are still more or less in the experimental stage, there is a great lack of uniformity in the method of attaching the filament in different kinds of lamps. The simplest method, and one that is probably

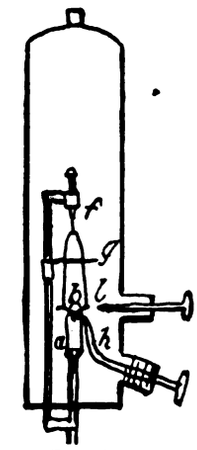

FIG. 1.

most widely used, is to insert the end of the filament in a cavity prepared at the extremity of the leading-in wire. The two are then fused together in the electric arc. As these filaments are usually extremely refractory, it is practically impossible to obtain a sufficiently high temperature by any other method.

A special apparatus for uniting filaments to leading-in wires was patented in 1904. In this the filament is suspended from a hook, *f* (see Fig. 1), and is pressed by a support, *g*, against the leading-in wires, *b*, which are prepared to receive it. One wire is connected by a metal electrode, *h*, to one terminal of a source of current, the other terminal of which is connected to a metal or carbon electrode, *l*. This electrode is placed in contact with the end of the leading-in wire and withdrawn, so as to form a quickly broken arc, thereby fusing the leading-in wire over the filament. The operation may be repeated if necessary. After the fusion the filament is released by depressing the hook, *f*, which is under spring tension. The fusion may be effected by introducing the wires into an arc deflected by a magnet, but the above method is preferable. Several filaments and stems may be mounted side by side. If the material of the filament is attacked by air the apparatus is immersed in an inert gas contained in a closed vessel, stuffing-boxes being provided for the electrodes.

It is noteworthy that leading-in wires of copper and iron wire coated with aluminium are now being used instead of platinum. Another method used for joints between tungsten alloys and leading-in wires employs a cement containing carbon. The joint is heated either by passing current through it or with an electric arc.—FILAMENT,

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

1,006. If the neutral point of a generator in a three-phase extra high-tension system is earthed, what objections are there to earthing the neutral point of the motor-generators also?—J. R. M. S.

1,007. I have three 200-kw. induction motor-generators, high-tension current at 5,500 volts carried direct to motors, which are coupled direct to direct-current generators delivering current to a three-wire network at 460 volts across outers. On paralleling two machines, the machines take the load equally on direct-current side, but the alternating-current ammeters show on No. 1 set 27 amperes on each phase, and No. 2 set 15 amperes per phase. How is this? By inserting resistance in shunt field of No. 1 I can get the machines to take an equal amount of current from the high-tension mains, but not an equal load, of course, on the direct-current side. Phases tested and found correct.—L. V. F.

ANSWERS.

Question No. 999.—It is required to connect an alternating 200-volt single-phase supply to continuous current at a voltage ranging from 100 to 140. The direct current is to be regulated within this range for storage-battery charging. Direct-current output will not exceed 40 kw. Compare the advantages and disadvantages in using motor-generator and rotary converter. Also describe any alternative methods of transforming alternating current to direct current for smaller powers, such as motorcar charging, etc. What modifications have to be made if supply is changed to two-phase?

Best Answer to No. 999 (awarded 10s.).—In order to meet the requirements of the above specification as to voltage regulation, it would be preferable to install a motor-generator set. This would consist of a single-phase induction motor direct-coupled to a 40-kw. continuous-current generator on a common bedplate. We will, however, compare the operation of such a set with that of a corresponding single-phase rotary converter.

Rotary Converter.—A single-phase rotary converter is not an ideal machine for converting alternating current into continuous current, and cannot compare with multiphase converters with respect to regulation, heating, operation, etc. It is well known that in a multiphase rotary converter, when working at unity power factor, the motor and generator currents in the armature neutralise one another to a large extent, and, therefore, the heating of the armature for a given output is much lower than in a corresponding continuous-current generator. In the case of a single-phase rotary, however, the resultant armature current has an average effective value considerably greater than that of the continuous-current component, thus making the armature $C^2 R$ loss *greater* for a given output than when the machine is used as a continuous-current generator. An investigation into the armature $C^2 R$ loss of rotary converters leads to the results of Table I.,* where the converter output is given in terms of the output of a continuous-current generator for equal $C^2 R$ loss in the armature conductors. This table shows that a single-phase rotary converter must be larger for the same temperature rise than a continuous current generator of the same output. Table II. gives the voltage ratio between alternating and continuous current sides for single and multiphase converters, based on no-load conditions and a sine wave distribution of flux. The frequency of supply is not stated above, but we will assume that this is 50 ~. Hence the rotary would probably be a six-pole machine running at a synchronous speed of 1,000 r.p.m. Table I. shows that such a machine must have at least 15 per cent. more copper in the armature than a similar machine operating as a continuous-current generator. A continuous-current generator for this output (40 kw.) would, however, be designed with four poles. Hence we see that this rotary converter will be considerably more expensive than the generator part of a motor-generator set. Table II. shows that a transformer is required in order to supply the correct voltage to the collector rings for 100 to 140 volts on the commutator. The corresponding voltages between the collector rings are 70·7 to 99. In order to obtain these voltages from the 200-volt supply, we have the choice of (1) a transformer of 2 : 1 ratio and an "induction regulator," or booster transformer; (2) a transformer of 3 : 1 maximum ratio, but with variable-ratio switches, giving ratios varying from 3 : 1 to 2 : 1. It should be mentioned that the rotary would be shunt wound, the field excitation being adjusted for unity power factor, and the variable direct-current voltage being obtained by varying the collector-ring voltage by means of suitable transformers.

* See Kapp's "Dynamos, Motors, and Rotary Converters," published by Messrs. Biggs and Sons.

TABLE I.—Theoretical Output of Rotary Converters in terms of the output of a continuous-current generator for equal $C^2 R$ loss in armature conductors—*i.e.*, equal heating. These values are based on a conversion efficiency of 100 per cent.

Type of converter.	Number of collector rings.	Power factor.	Ratio: $\frac{\text{pole arc}}{\text{pole pitch}}$ = 1·0 *	·66 †	·5
Single-phase	2	1·0	0·85	0·88	0·95
		0·9		0·81	0·88
		0·8		0·73	0·8
		0·7		0·63	0·7
Three-phase	3	1·0	1·34	1·38	1·44
		0·9		1·28	1·37
		0·8		1·17	1·26
Two or four phase	4	1·0	1·64	1·67	1·7
		0·9		1·6	1·67
		0 8		1·44	1·53
Six-phase	6	1·0	1·96	1·98	1·99
		0·9		1·92	1·96
		0·8		1·77	1·88

* Of theoretical interest only.
† Corresponds to ratio adopted in most commercial machines.

TABLE II.—Theoretical Ratio of Commutator Voltage to Collector-Ring Voltage in Rotary Converters, assuming a sine wave distribution of flux and alternating E.M.F.

Type of converter.	Number of collector rings.	Commutator voltage.	Effective value of collector-ring voltage (between adjacent rings).
Single-phase	2	100	70·7
Three-phase	3	100	61·2
Two or four phase	4	100	50·0

Motor-Generator Set.—This set would consist of a 60-h.p. single-phase induction motor direct-coupled to a four-pole, 40-kw., shunt-wound continuous-current generator, and mounted on a common bedplate. With the supply at 50 ~ the induction motor could be designed with six poles, giving a synchronous speed of 1,000 r.p.m., or a full-load speed of about 950 r.p.m. If the continuous current from the batteries is always available, arrangements may be made for starting this motor-generator set from the *direct-current end*, thereby permitting the use of a squirrel-cage rotor on the induction motor and avoiding the extra cost of a rotor rheostat, slip-rings, etc. With this scheme the auxiliary winding on the stator, for starting purposes, is also unnecessary, which further dispenses with the phase-splitting device. The induction motor would, of course, be wound for the supply voltage—viz., 200 volts—and the field rheostat on the generator side will give the necessary voltage regulation for charging the batteries. It will, therefore, be evident that a motor-generator set built on these lines will be much cheaper than the single-phase rotary converter and transformers outlined above. The motor-generator set will also be free from such troubles as hunting and instability which are associated with single-phase rotaries when operating on 50 ~ circuits.

With a two-phase supply the rotary converter scheme

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becomes perfectly satisfactory as regards operation, regulation, and stability. Table I. shows that such a converter will contain considerably less armature copper than a continuous-current generator of the same output, and, considering the relatively small output required—viz., 40 kw.—there is no reason why a thoroughly satisfactory machine could not be built with four poles for working on a 50 ~ circuit giving a synchronous speed of 1,500 r.p.m., thereby making this machine considerably smaller than the generator end of a motor-generator set. Table II. shows that the voltage between adjacent collector rings for 100/140 volts on the commutator will have to be 50/70. A variable-ratio transformer will, therefore, be required having the ratio-changing switches on the 200-volt or primary side. On account of the low voltage the cables between transformers and rotary will be considerably heavier than those required between switchboard and induction motor in a corresponding size of motor-generator set. It is, therefore, probable that the cost of the rotary converter plant in this case will be about equal to that of a motor-generator set.

Referring to an alternative method of conversion for small powers, such as motorcar charging, etc., there is nothing better than the mercury-vapour type of converter, which has been very successfully applied to this service in America. The action of the mercury-vapour converter or rectifier depends upon the fact that when an electrical discharge takes place in mercury vapour the ionised vapour becomes a good conductor in one direction, but an exceedingly bad conductor in the other direction. Thus, when in operation, only about 12 to 14 volts—*i.e.*, the back E.M.F. of the arc—are necessary to maintain the discharge or arc in one direction (from the anode to the cathode), but several thousand volts would be necessary to maintain a discharge in the other direction—*i e*, from the cathode to the anode. When in its vapour state mercury vapour offers an exceedingly high resistance to an electrical discharge, regardless of polarity. Hence, if we have an exhausted tube containing mercury vapour, with mercury

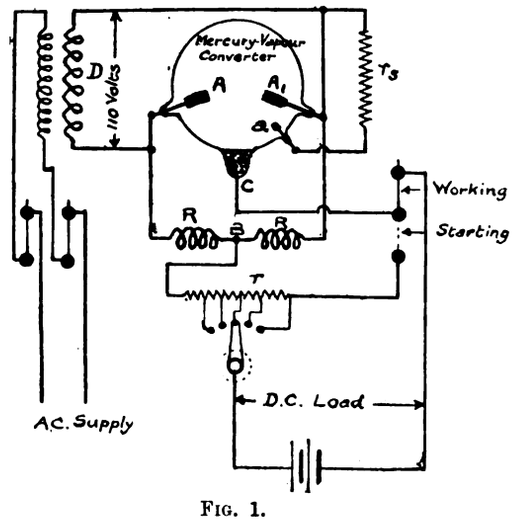

FIG. 1.

as the cathode, and start an electrical discharge by suitable means, we shall find that this discharge will be continuous when the anode and cathode are connected across a continuous-current supply, but when connected across an alternating supply the arc will be maintained for one alternation only, and will cease as soon as the wave of the impressed E.M.F. passes through the zero point. This difficulty is overcome, in the commercial form of the rectifier, by the use of suitable reactance, as indicated by the diagram of Fig. 1, which shows an application of the rectifier to the charging of motorcar cells for ignition purposes, etc. The single-phase supply is transformed down to 110 volts pressure by means of the main transformer, D, the two anodes, A, A_1, being connected directly across the secondary, as well as a reactance coil, R, the middle point, B, of which forms one of the terminals of the continuous-current load, while the cathode, C, form the other. The discharge or arc is started by means of an auxiliary anode, *a*, which is temporarily connected to the cathode by a bridge of mercury, formed by slightly tilting the tube. On the tube resuming its normal position an arc is formed, and the discharge is continued by the main anodes, A, A_1. The function of the reactance, R, is to create a phase displacement between the back E.M.F. of the arc and the E.M.F. across the secondary of the transformer, D, whereby the arc is maintained between one anode and cathode until a sufficient E.M.F. is applied to the other anode (from the main transformer) to cause the arc to form between it and the cathode. This results in a unidirectional current being produced between C and B, the pulsations of which are of relatively small magnitude. The amount of charging current is regulated by the resistance r, while the resistance r_s serves to limit the starting current. With a two-phase supply the reactance coil, R, is dispensed with, but in this case the neutral point, B, must be obtained by means of a suitable transformer. The tube is furnished with three or four anodes, depending upon the design of the transformer used for obtaining the neutral point. The pulsations in the E.M.F. of the continuous-current load are much less with this type of rectifier than with the single-phase type described above.

The mercury-vapour converter (or rectifier) should, therefore, find a field of usefulness in those garages where the electricity supply is alternating, as it has considerable advantages over a small motor-generator set, and skilled attendance is unnecessary.—A. T. L

Answer to No. 999 (awarded 7s. 6d.).—Since in the converter the alternating and direct current pass through the same armature conductors their E.M.F.'s stand at a definite relation to one another, which is such that in this case, and in nearly all cases, step-down or auto-transformers are necessary to generate the required alternating voltage. Comparing thus the rotary converter with the combination of synchronous or induction motor and direct-current generator, the converter requires a step-down transformer, whilst the synchronous motor can be wound directly for the line voltage, and so dispenses with the transformer. Thus we have the choice of two types of machines without transformer, or the single machine requiring a transformer. With regard to prime cost and reliability, obviously a single machine is preferable. Mechanically the rotary converter has the advantage that no transfer of mechanical energy takes place, since the torque consumed by the generation of the direct current and the torque produced by the alternating current are applied to the same armature conductors, while in the case of a direct-current generator driven by either a synchronous or induction motor the power has to be transmitted mechanically through the shaft. As regards efficiency, the induction motor is certainly less efficient than the synchronous motor. So it will be sufficient to compare the converter and transformer with the synchronous motor and direct-current generator. The efficiency of the transformer may be taken as about 96 per cent., the converter 93 per cent., and synchronous motor 90 per cent. The direct-current generator will probably have an efficiency of 90 per cent. Thus the converter and transformer will have a combined efficiency of 90 per cent., and compared with the 84 per cent. of synchronous motor with direct-current generator will be the most efficient.

Another feature in the comparison of these machines is the method of starting. The converter starts under the same conditions as the synchronous motor, and the two most usual methods are: (1) starting up from direct-current end and synchronising; (2) starting by means of a small induction motor coupled either direct or by means of a clutch to the shaft. Very little additional power is required, and the motor can be taken out of gear when the set has been synchronised. It will be seen in both cases that direct current is required to start both converter and synchronous motor. Here the single-phase induction motor wound with starting coils has the advantage if direct current is not available, and, moreover, it dispenses with all synchronising apparatus.

Where a fairly large range in voltage regulation is required, a shunt-wound generator with rheostat is better than a rotary converter with a regulable transformer. If the supply is likely to be changed to two-phase, sufficient space should be left for two additional slip-rings and brushes

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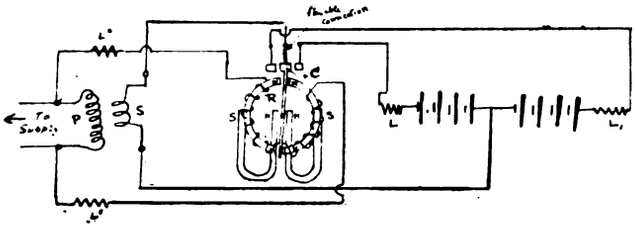
when the machine is built. Two more tappings per pair of poles would then have to be taken off the armature windings 45deg. in advance of those for the single-phase. With a synchronous or an induction motor the stator coils could be divided into two separate windings, all the odd coils being connected to form phase A and the even forming phase B. An alternative method of converting alternating current to direct current for charging accumulators is to use some sort of rectifier. The Batten rectifier is a good type for dealing with small powers. The accompanying diagram of connections illustrates the method of working.



The step-down transformer reduces the supply volts to about 50. By means of the polarised relay, R, and pivoted contact, C, the secondary current induced in S is made to flow in one direction in the external circuit The accumulators to be charged are arranged in series, additional resistance in the form of lamps, L L_1, being inserted to give the required voltage. One end of S is connected to the middle of the battery, so that the vibrating contact, C, causes the current to flow in either direction through the two halves. No alterations are necessary for a two-phase supply, as one phase only need be connected to the step-down transformer and resistance altered by means of the lamps if necessary.—J. B. F. B.

Answer to No. 999 (awarded 5s.).—In comparing the merits of the various rotating plants for converting single-phase alternating current into continuous current, we will consider the use of (*a*) asynchronous motor-generators; (*b*) synchronous motor-generators; (*c*) rotary converters. The question does not state the frequency of the circuit, as this point will considerably influence the advantages and disadvantages of the different machines. We will, however, assume a periodicity of 50.

(*a*) The asynchronous or induction motor-generator possesses the great advantage of simplicity of control and reliability of operation; the motor can be started with a very simple resistance and run up to speed without any synchronising apparatus being required; the set can run without attention, and is capable of withstanding large variations of load without danger of falling out of step or hunting. The disadvantage of the induction motor is the power factor and resultant lagging currents. The power factor in a properly designed motor at about 950 r.p.m. should not be less than ·87, which is not very serious when comparing the many advantages.

(*b*) The only advantage of the synchronous motor-generator over (*a*) is that the excitation can be adjusted so that the power factor is unity, and it can be arranged that the current absorbed is a leading one, thereby tending to assist the regulation of the supply. The disadvantages are that complicated switchgear is required for starting up, and the motor has to be synchronised before switching into circuit if it is started from the continuous-current side or by an auxiliary induction motor This type of machine is always liable to hunt and fall out of step when subjected to a large variable load, or if there is any disturbance in the line or circuit supplying the motor. There is also the necessity of continuous current for excitation, although this is not a serious item in the present instance after the first battery charge. The question states that a voltage of 100 to 140 volts is required from the continuous-current side; this is a very simple matter in the case of both (*a*) and (*b*), the voltage variation being carried out by shunt regulation.

(*c*) The use of a rotary converter possesses all the disadvantages of (*b*) as compared with (*a*), and, further, the continuous current voltage cannot be regulated without complication. This type of machine could hardly be considered in the present instance, as in order to obtain 100 volts at the continuous-current side about 70 volts will have to be supplied to the alternating-current side, which means that transformers have to be used to reduce the pressure from 200 to 70. Now, as the voltage ratio between the alternating-current and continuous-current output is practically a fixed quantity, it follows that the alternating-current voltage will have to be varied if the continuous-current side is to give 100 to 140 volts, or, failing this, a separate continuous-current booster will have to be used to obtain the desired pressure.

The above arguments will still hold good if the alternating-current supply is charged to two-phase. The rotary converter will, however, operate more satisfactorily than on a single-phase circuit. If the periodicity is higher than 50, then the disadvantages of both (*b*) and (*c*) are more pronounced. With regard to small converters for battery charging for motorcars, mention may be made of the Noden valve or electrolytic rectifier and the mercury arc rectifier. The former is specially adopted for working at any pressure between 50 and 120 volts on the alternating-current side. The continuous-current side can be designed to give any output between 5 and 100 amperes and up to 115 volts. The necessary voltage regulation is carried out on the alternating-current side by means of a variable-ratio transformer, which also reduces the pressure of the supply mains to suit the converter. The efficiency of this type of converter with an output of 5 kw. is about 65 per cent. at full load and 60 per cent. at half load. The converter does not appear to be affected by any change in frequency.

The mercury rectifier can now be supplied in standard sizes complete with the switch panel, mercury arc tube, compensating reactance coil, and starting resistance; the converter can be arranged to give a continuous-current pressure of 15 to 50 volts and 55 to 110 volts when supplied with current on the alternating-current side at about 110 and 220 volts respectively. The efficiency of the converter increases with the continuous-current pressure—for instance, with a current of 25 amperes the efficiency at 30 volts is about 60 per cent., and with 110 volts about 80 per cent. The mercury arc is started in the glass tube by short-circuiting the continuous-current terminals through a resistance, after which the resistance is cut out of circuit. The compensating reactance is connected direct across the alternating-current supply, the voltage variation being carried out by means of tappings on the reactance coil which are connected to a suitable switch. There is a large field for these small rectifiers, which are simple to operate, low in first cost, and high in efficiency, and they are specially suitable for small battery-charging garages or other similar work —JUNO.

Answer to No. 999 (awarded 5s.).—Presumably the question should read "it is required to *convert* an alternating," etc. Consider first the case in which a rotary converter is used As the supply is single-phase it would be necessary to start up the rotary on the direct-current side, and the questioner must consider whether direct current is always available from his storage battery for starting purposes. With both single and two phase rotaries the alternating current voltage expressed as a percentage of the direct-current voltage will be either 75 per cent. or 82 per cent., according as the ratio pole-arc ÷ pole-pitch is either $\frac{2}{3}$ or $\frac{1}{2}$. These ratios are those usually found in practice. We see thus that with 200 volts alternating-current supply we get on the direct-current side of the rotary a voltage which may be between 266 and 244 volts. Thus: $200 \times \frac{100}{75} = 266$, also $200 \times \frac{100}{82} = 244$. As, however, only 100 to 140 volts is required, it would be necessary to use a transformer in order to step down the supply voltage to that suitable for the rotary. Assuming that the ratio pole-arc ÷ pole-pitch = $\frac{2}{3}$, we should require 105 volts alternating current to give 140 volts direct current, since 75 per cent. of 140 volts direct current = 105 volts alternating current. The ratio of the step-down transformer must, therefore, be 200 to 105 volts. To reduce the 140 volts direct current to 100 volts, it would be necessary to have a regulating switch in the secondary of the transformer so as to reduce the secondary turns and consequently the voltage. A regulating resistance in the shunt of the rotary would not

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alter the direct-current voltage given, but would merely alter the amount of wattless current taken from the lines—*i.e.*, the power factor of the rotary could be altered, but not the voltage. If a choking coil be placed in circuit between the transformer and rotary, then regulation of the shunt field would vary the direct current voltage. Usually this alteration of voltage does not exceed 20 per cent., whereas 40 per cent.—*i.e.*, 100 to 140 volts—is required.

Consider, now, the case of a single-phase motor-generator. The alternate-current motor would, of course, be connected to the supply without the interposition of a transformer. A starter would be connected to the rotor circuit, and could be of a short time rating, say half a minute, as the only load at starting would be friction and windage of the motor and dynamo The alternate-current motor would be direct coupled to the dynamo, and the combination would take more floor space than the rotary. The direct-current voltage would be regulated by a rheostat in the shunt circuit. An unskilled attendant could easily regulate the current by this rheostat, and it would not matter if he left the contact arm joining together two studs. On the contrary, if the contact arm was left on two studs of the regulating switch of the transformer used with the rotary, the "bridging" resistance on the two halves of the contact arm would probably be burnt out. Further, the regulation by means of the shunt rheostat is more economical than regulating by cutting out coils of the transformer used with the rotary. The polarity of the dynamo would remain constant, so that an unskilled attendant would only have to connect the red poles of his cells to the positive of the dynamo, which could also be painted red. With the rotary, however, the polarity of the direct-current end may be different at different times, according to the instant at which the field circuit is closed. The attendant would, therefore, have to find out the polarity of the rotary every time it was started up. With regard to the modifications necessary in case the supply is changed to two-phase, I assume that the existing supply is single-phase, and that at some future date it may be changed to two-phase supply. In this case it will be well to foresee the two-phase requirements, and to provide for them at first.

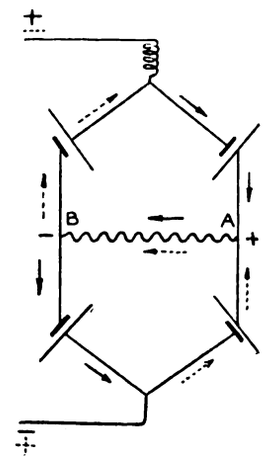
Consider the rotary converter first. (*a*) The main switch should be four-pole, so that it will be suitable for the two-phase supply. (*b*) The transformer should have three limbs, with the windings on the two outer limbs. With single-phase supply these windings should be in parallel; each half would thus carry half the total current. The number of turns on each limb should be suitable for 200 volts, assuming that the two-phase supply will also be at 200 volts. The section of the middle limb should be suited to twice the single-phase flux, and to 1·4 times the two-phase flux. When supply is changed to two-phase, A phase would be connected to one coil on one limb, and B phase connected to the other coil. (*c*) On the rotary four slip-rings should be provided, two of which should be used for single-phase and four for two-phase. (*d*) The regulating switches in the secondary of the transformer would be used in parallel on single-phase, and although used in separate phases on two-phase supply, they would require to be moved in unison. They would, therefore, remain unaltered. (*f*) At a power factor = 1·0 a rotary will deliver about twice as much power as a two-phaser as it will when a single-phaser for equal armature heating. With $\cos \phi = 0{\cdot}8$ the output is reduced, but the ratio between single and two phase outputs is practically the same.

Consider now changing the motor-generator from single to two phase. (*a*) Same as for rotary. (*b*) The winding of the stator of the induction motor should be of the same section all through. It should be arranged with two-thirds of the winding for the running phase and one-third for the starting phase. By special tappings one-half of the total winding could be used on each phase of a two-phase supply. These special tappings could be cheaply added when the motor was ordered to be made. (*c*) The starter in the rotor circuit would be unaltered. (*d*) The dynamo would be the same. It should be noted that the two-phase induction motor would give a greater output than when used as a single-phase in the ratio 70 : 100, and the direct-current dynamo should be built to allow for this.—B. R. S. L.

Answer to No. 999 (awarded 5s.).—Rotary converters are distinctly unsuitable for such work as requires a variable voltage, and, as the following remarks will show, the only feasible method is to use a motor-generator. An ordinary rotary converter consists of an armature fitted with slip-rings for leading in the alternating current and a commutator for the collection of the direct current, and is capable of rotation between the poles of a field magnet. The machine is driven as a single-phase synchronous motor with the field excitation taken from the direct-current side. Now, from fundamental considerations of the same conductors in the same field, it is evident that the maximum value of the E.M.F for the alternating current side is equal to the E.M.F. of the direct-current side. The virtual voltage is 200, so that the maximum value is $1{\cdot}414 \times 200 = 282\,8$; therefore the direct-current output will be at a pressure of 282·8 volts, and not 100 to 140, as required. To bring the direct-current volts to 140 the alternating current would have to be stepped down in a static transformer to a pressure of $\frac{140}{1{\cdot}41} = 100$ practically. Even then it would still be unalterable by changing the excitation, as this does not make any material difference to the ratio of the two E.M.F.'s. The change could be brought about by inserting a choking coil in the alternating-current side, and the complications that would ensue are obvious.

The motor-generator consists of a synchronous motor driving an ordinary direct-current dynamo, and the starting is effected by "motoring" from the battery. In this case varying the field of the dynamo gives the required regulation and does not affect the motor field. The efficiency of the motor-generator is not as high as that of the rotary converter for the following reason. A single machine (the rotary converter, say) has an efficiency of 90 per cent., then the efficiency of the motor-generator (two machines) is $\frac{90}{100} \times 90 = 81$ per cent., and this, along with the increased cost of two separate machines—field magnets, bearings, etc.—is the chief advantage of the rotary converter over the motor-generator.

An alternative method of transforming alternating current into direct current for small powers is by means of electrolytic valves. A typical example is manufactured by Messrs. Mors and Co., and consists of a prismatic vase of lead surrounded by sheet iron as cathode and an aluminium



anode immersed in a saturated solution of neutral ammonium phosphate. The principle of the action is that the combination only allows current to flow through it in one direction. The combination of four valves, as shown, causes the current to flow along A B always in the same direction, and to be continuous, and a battery of accumulators can be charged with this rectified current. The efficiency of these valves is about 70 per cent. If the supply is changed to two-phase, a more complicated connection of valves is applied, and the resulting rectified current will fluctuate less than with single-phase supply.—PERCY DUNSHEATH.

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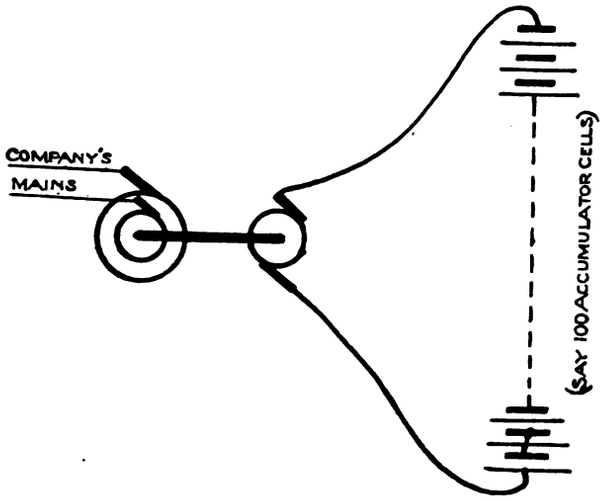
TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared.

QUESTIONS.

1,008. *Re* attached diagram of a rotary transformer or motor-generator to transform from 2,000-volt, 100 ~, single-phase to 250-volt direct



current, I believe it is the general practice to start up on continuous-current side. This would entail special interlocking arrangements of switches. Give diagrams of switchgear necessary. The supply company supply at 500-volt direct current.—W. J. R.

1,009. An induction motor may be loaded until the slip reaches a certain value depending on the design—say, 20 per cent.—after which further load causes the machine to stop dead. How is it that if this motor is connected in cascade with a similar motor, it will run satisfactorily with a slip of over 50 per cent.?—SAXON.

ANSWERS.

Question No. 1,000.—Give particulars of the new iron-nickel accumulators and the reactions in the electrodes, and also compare efficiency and prime cost with that of the present-day lead cell.

Best Answer to No. 1,000 (awarded 10s.).—Numerous attempts have been made to establish an accumulator with an alkaline electrolyte—some have succeeded and some not. Mr. Edison has, however, after much labour brought out a cell to embody the following advantages: (1) absence of deterioration by work; (2) large storage capacity per unit mass; (3) capability of being rapidly charged and discharged; (4) withstanding careless treatment; (5) inexpensiveness.

The standard cell as used in America especially for automobiles, consists of 14 positive and 14 negative plates, made of ·024in. thick sheet steel, nickel-plated and punched with 24 rectangular-shaped holes. In each of these holes (pockets) the active material is inserted, which is nickel peroxide for the positive plate and finely-divided iron in the negative plate. The positive and negative frame is exactly the same. Finely-powdered graphite is mixed with each active material. The plates are assembled very near each other, in a steel case measuring 13in. high and 5in. by 3·5in. horizontally and separated by vulcanised rubber plates, the weight complete being 17·8lb. On the top of the case a spring stopper with a rubber flange covering the hole, by which the electrolyte and distilled water are introduced, is fixed. A vent hole guarded by a gravity valve is also fixed on top of the case to provide for the escape of gas during charge. The hole and valve are covered by a gauze nipple which prevents escape of spray. The electrolyte is a 20 per cent. solution of potash. Having explained the construction of this cell, we may now proceed to the

Electrical Data.—The cell under test is one of 60 ampere-hours, 1·33 volts, and ·0013 ohm internal resistance. The output at 60 amperes was 210 watt-hours—*i.e.*, 11·8 watt-hours per pound. The above voltage is not quite correct, as the persistent gaseous polarisation tends to alter the E.M.F. The curves in Fig. 1 will show some results obtained from one of these cells. The difference in discharge is very uniform; indeed, between 30 and 60 ampere-hours it was very small. At 120 amperes discharge the capacity is 93 per cent. of maximum, and at 200 amperes discharge the capacity was 82 per cent. of maximum, which

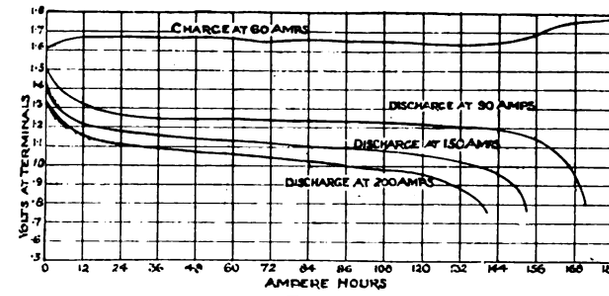


FIG. 1.

compares favourably with lead cells. The output in relation to weight of cell to work done is higher than ordinary cells. Taking the output at 210 watt-hours, the output amounted to 11·8 watt-hours per pound of cell, which is very high. The effect of temperature on lead cells is to reduce the efficiency; with the Edison cell it is beneficial—in fact, a temperature rise of 20deg. C. showed a 5½ per cent. increase in output. This cell does not suffer when allowed to stand discharged for fair lengths of time, to verify which the following test was applied. After being

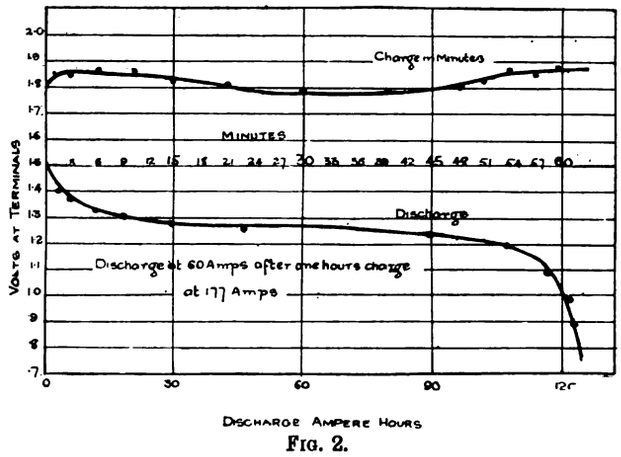


FIG. 2.

charged fully and allowed to stand for 48 hours before discharge began, it then yielded 91 per cent. of full charge. Fig. 2 shows a cell charged for one hour only at 177 amperes. On discharging, 124 ampere-hours—*i.e.*, 70 per cent. of total charge—was obtained, which is a remarkably good figure for so short a charge. Fig. 3 tells its own story, showing how the action of gaseous polarisation decreases the voltage of the cell immediately after charge.

Efficiency.—On a bench test it showed 50 to 66 per cent. Charged and discharged at 60 amperes, the efficiency was

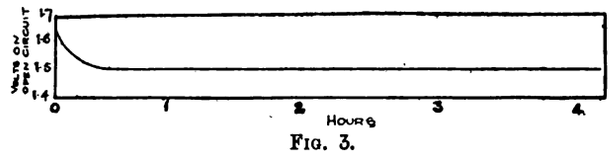


FIG. 3.

60 per cent.; charged at 100 amperes and discharged at 60 amperes, the efficiency was 56 per cent.; charged one hour at 177 amperes and discharged at 60 amperes, the efficiency was 50 per cent. While the highest figure was 66 per cent., obtained when discharging at 30 amperes. The above figures do not compare favourably with the lead cells, their efficiency being 60 to 72 per cent., but the high rate of discharge and capability of retaining the charge are the two great features about this cell.

Chemical Action.—In charging, the current is sent into the positive pole and its attached negative nickel plate,

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through the electrolyte, and into the positive plate of the iron compound which carries the negative pole. This current deoxidises or reduces the compound (active material) to spongy metallic iron, and carries the oxygen through the film of electrolyte to the nickel compound, oxidising it to the hyperoxide of nickel (NiO^2), a higher stage than the peroxide. On discharge the current passes from the positive pole, through the external circuit, to the negative pole and its attached positive plate, and then through the solution to the negative or superoxide plate. In so doing the oxygen moves back against the current, and partially reduces the nickel superoxide (NiO_2), while oxidising spongy iron. The energy of burning of the iron and oxygen, which would be developed as heat in the ordinary chemical process, is now liberated as electrical energy. This cell is really a gas cell. Charging pulls the oxygen away from the iron and delivers it temporarily to the nickel; discharging allows the oxygen to fall back to the iron with the affinity this gas has for iron, the equation being:

$$\{N_1O_2 \mid KHO \mid Fe\} = \{N_1O \mid KHO \mid FeO\}.$$
After charging. After discharging.

As to the "life" of these cells, it may be pointed out that after several months' use (I think four months) the following result was obtained: amount of solid matter in bottom of cell = 1·4 grm., the composition of which was: carbon, 22 per cent.; iron (ferrous oxide), 27 per cent.; nickel (difference), 51 per cent. The price of nickel-steel cells is a quarter more than the ordinary lead cell.—OSCAR DINERMAN.

Answer to No. 1,000 (awarded 7s. 6d.).—The new nickel-iron accumulator, more commonly known as the Edison accumulator, is the invention of Mr. T. A. Edison, and is intended for automobile work. The chief particulars of the cell are as follows. The plates, both positive and negative, are made of sheet steel provided with rectangular holes, forming a light grid, which is nickel plated. Some small steel pockets containing the active material are fitted into the rectangular perforations in the plate, the walls of the pockets being perforated in order that the electrolyte may be in contact with the active material. In the case of the positive plate the pockets are filled with nickel oxide, NiO_2, and iron in a very finely divided condition (known as pyrophoric iron) forms the active material in the negative plate. The electrolyte is a 20 per cent. solution of caustic potash. Both the iron and nickel oxide are mixed with a small quantity of flake graphite in course of manufacture. Vulcanised rubber separators are placed between the plates, and the whole cell is contained in a steel box, which is sealed up. The reactions which take place are, very roughly, as follows: on discharging the metallic iron is oxidised to FeO, and the nickel oxide reduced probably to the lower oxide, NiO, whilst on charging the reverse process takes place. Apparently the electrolyte, KOH, acts simply as an oxygen carrier, and itself remains unchanged. This may account for the fact that the density of the liquid remains almost constant, and does not increase on charging, as does the acid in a lead cell.

According to Mr. W. Hibbert, to whom we are indebted for a good deal of information respecting the Edison accumulator, the efficiency of the cells when new is from 50 to 60 per cent., according to the rate of charge and discharge, the lower figure being obtained, of course, with a high rate. The capacity of the cells is about 12 watt-hours per pound, or 1,500 watt-hours per cubic foot, which figures compare favourably with the corresponding figures for lead traction cells. The E.M.F. is from 1·2 to 1·3 volts per cell. One of the important advantages claimed for the alkaline cell is that, on being left standing, it retains its charge for a much longer period than does a lead cell on account of the almost complete absence of local action. Experiments tried by Prof. Fleming and others show that no corrosion takes place with steel plates placed in caustic potash.

The great difficulty which has been experienced with lead cells when used for automobile work has been caused by the rapid deterioration of the plates, and, as a necessary consequence, the heavy repairs bill. When running constantly on the road the cells have usually to be renewed about every 12 months. This is due to the fact that lead is a metal which stands shaking very badly, and under this treatment quickly loses its tenacity. For this reason it is hoped that the Edison battery may prove superior to present-day cells when tried on the road. It is nearly seven years, however, since Edison filed his patent specification having reference to the iron and nickel oxide combination. During this period, with the exception of the informing paper by Mr. Hibbert before the Institution of Electrical Engineers and the paper read before the Electrical Congress at St. Louis by Messrs. Kenneth and Whiting, practically nothing has been heard of this new battery, which was going to revolutionise the industry, from technical men. In September, 1903, we were told that the Edison Automobile Company was turning out 150 cells per week, and was making addition to its plant in order that 100 cells a day might be manufactured. In June, 1904, we learned from the *Electrician* that a syndicate was being formed in this country to manufacture Edison cells, and was even at that moment on the look-out for a building site. Probably the high prime cost of the Edison cell has put an end to these hopes, for certain it is that in this country, at any rate, the principal source of information on the subject is to be found in the advertisement of the makers of a well-known type of lead cell, who inform the public that they can supply accumulators for automobiles at one-fifth the cost of the Edison accumulator.—F. S.

Answer to No. 1,000 (awarded 5s.).—The Edison cell differs from the lead cell in having as its electrodes oxides of nickel and iron and an electrolyte of caustic potash. The cell is made up in plates of sheet steel nickel plated about ·024in. thick, and having a number of holes of rectangular shape punched in them. In each of these holes is inserted a small pocket containing the active material. These pockets are made of thin nickel-plated steel, and are perforated with very fine slots through which the liquid can penetrate. Both positive and negative plates are alike, except for the active material contained in the pockets. The positive pockets are filled with a mixture of finely-divided compound of iron and flake graphite, equal parts of each being taken, the mixture being pressed into moulds at a pressure of about two tons per square inch. The negative pockets are filled with a mixture of a compound of nickel and flake graphite prepared in a similar manner. After the pockets have been filled and fitted into the plates the whole is subjected to an hydraulic pressure of 100 tons, thus producing a rigid steel plate full of the active material. The electrolyte consists of a 20 per cent. solution of caustic potash. The chemical action which takes place in the cell during the charge and discharge is given below:

$$\underset{\text{After charge.}}{NiO_2 \mid KHO \mid Fe} \text{ becomes } \underset{\text{After discharge.}}{NiO \mid KHO \mid FeO},$$

the E.M.F. being an average of 1·3 volts per cell. The following table gives a rough comparison of the working properties of the Edison and lead cell:

	Edison.	Lead.
Efficiency on the basis of $\frac{\text{watt-hour output}}{\text{watt-hour input}}$	50 to 66 per cent.	70 to 80 per cent.
Discharge rates	8·6 amps. per square foot of + plate.	6 amps. per square foot of + plate.
Capacity	14 watt-hours per pound of + plate.	32 watt-hours per pound of + plate.
Mean working voltage ...	1·3 volts.	2·0 volts.

In comparing the capacity, it must be remembered that the rate of discharge will greatly affect this, and while with the lead cell the capacity falls off rapidly as the rate of discharge increases, the Edison cell is affected to a much smaller extent, and also when standing retains its charge to a much greater extent than does the lead cell. It also has the advantage that it rapidly recovers itself after being discharged above the normal rate, and will, unlike the lead cell, quickly regain its former capacity. It is difficult to compare the costs, as up to the present the Edison cell has not been made in similar sized units to the lead cells, but a leading firm of makers were advertising their lead cells as being about one-half the cost of the Edison. Further particulars as to the working and behaviour of the Edison cells can be obtained in the paper read before the Institution by Mr. Hibbert, entitled "The Edison Accumulator for Auto-

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mobiles," published in the *Journal*, vol. 33, where full particulars of tests which he made are given.—E. V. C.

Answer to No. 1,000 (awarded 5s.).—The iron-nickel accumulator owes its commercial development, and any measure of success which it has attained, to Edison, although the use of nickel cannot be claimed to be original, since Dun used nickel as an element in his experiments with storage batteries in 1885. This type of cell is claimed to be more durable and lighter than the lead type, and it has been developed and standardised with particular reference to the requirements of electric vehicle service, but it has not been used to a sufficient extent commercially to indicate whether it possesses such distinctive advantages as to displace the lead type of cell. Edison is responsible for four British patents for his iron-nickel battery, although all the cells appear to be of the same general character, and differ chiefly in the nature of the materials used. The construction of the latest type, which embodies the best points specified in the other three patents, is described below. The positive plate is iron, the negative plate is a superoxide of nickel, and the electrolyte is a 20 per cent. solution of caustic potash. Each plate is formed of thin sheet steel, ·024in. in thickness, in which 24 rectangular holes are stamped, approximately 3in. by 1½in. in size, so as to leave a grid, each recess of which is filled with a shallow pocket of the active material; these pockets are perforated to admit the electrolyte, but conceal the active material from view. The active material is made in the form of rectangular cakes of size to fit the pockets, each plate thus containing 24 cakes of active material. The cakes are placed in close-fitting nickel-plated boxes of thin crucible steel, covers of the same material are fitted over the same, and the boxes placed in the pockets in the nickel-plated steel grid. The assembled plate is then subjected to hydraulic pressure, which tightly closes the boxes, and clamps the whole mass into a rigid steel plate, with the pockets full of active material. The positive cakes are made by mixing a finely-divided compound of iron, obtained by a special chemical process, with a nearly equal volume of flaked graphite, which does not enter into any of the chemical actions, but increases the conductivity of the cakes. The negative cakes are made by similarly mixing a finely-divided compound of nickel, obtained by special chemical means, with a nearly equal bulk of flaked graphite, the cakes being pressed into the requisite shape in moulds by hydraulic pressure. As with all cells using a hydroxide for the electrolyte, the air must be excluded to prevent the formation of carbonates.

The chemical action of the cell may be simply explained without the use of intricate chemical equations. During the operation of charging, the current deoxidises the compound to spongy metallic iron, and carries the oxygen through the film of electrolyte to the nickel compound, oxidising it to superoxide of nickel. In other words, the charging current simply carries oxygen in the opposite direction, against the forces of chemical affinity, from the iron to the nickel, and stores the energy in the reduced iron, which is passive in the presence of the potash solution. On discharge, the oxygen moves back against the current, and partially reduces the nickel superoxide, whilst oxidising the soft iron.

In comparing the efficiency of this type of cell with the lead type, it must be borne in mind that the iron-nickel cell is primarily an automobile cell The E.M.F. of the cell is 1·3 volts, and the weight efficiency is about 10 ampere-hours per pound of cell. The E.M.F. of the lead-sulphuric type is normally (on discharge) 1·8 volts, and the weight efficiency is roughly seven ampere-hours per pound of cell. Thus it will be seen that the weight efficiency of the iron-nickel cell is greater than that of the lead type, and for automobile work the weight efficiency is one of the most important points. Comparing the prime costs of the two types of cells, the cost of actual manufacture is approximately the same for both types, whilst the cost of material is considerably heavier for lead cells than with the type under discussion.

To sum up, it may be concluded that for automobile work the nickel-iron cell is the cheaper and more efficient of the two types, but for central-station work the lead type holds the field, since its rival has been developed up to the present to meet the requirements of vehicular work rather than central-station storage.—E. F. RENDELL.

Question No. 1,001.—How would you calculate the dimensions of a water-cooling tower for use in a 1,000-kw. station during the peak evening load of about 600 kw.? Allow a big margin for development.

Answer to No. 1,001 (awarded 7s. 6d.).—Previous to calculating the size and capacity of a cooling tower it will be advisable to determine the type of tower to be used. For this purpose a brief description of standard towers follows. Of course, to fit any exceptional case a combination of different types could be effected, but this is not advisable, in view of the extra cost of altering makers' patterns, etc. Water-cooling towers can be divided into four classes or types. Each type or combination of types has its own sphere of usefulness according to duty, locality, etc. A certain kind of tower may be chosen, set to work, and duly condemned as useless, solely because it was erected in a wrong position, or that it cannot be extended, etc, when a tower of similar design with slight modifications would have been an efficient and useful addition to the plant. All designs of cooling towers are based on the power of air to evaporate water and absorb it as vapour. The amount of moisture air is able to absorb varies according to the dryness and temperature of the atmosphere. On a cold day the efficiency of a cooler is increased, but when misty the efficiency is decreased. As, generally, it is cold when misty, the weather factor can be neglected.

Construction.—All towers of different makes are designed on very similar lines. In all the water is delivered into a trough from 20ft. to 30ft. above the ground level; from this trough it either flows or trickles down through the cooling or water stack. This cooling stack extends from the distributing trough down to ground level, and is fitted with rough unplaned boards inclined to the horizontal, so that the water trickles from one to the other, and is broken up for greatest contact with the air. One make of tower is fitted with curved splash bars, arranged in such a manner that the water does not pour or trickle, but falls on the curved bar and rebounds. This splashing and rebounding divides the drops into many minute particles, thus more intimately mixing the air and water. In some designs the stack consists of earthenware pipes, and in some metal grills and mats.

Tower or Chimney Cooler, Natural Draught.—This pattern is the most commonly used, especially where space is not limited. There are no fans, all the power required is for pumping the water into the distributing troughs. Above the water stack is a wooden chimney. This chimney varies from 20ft. to 50ft. in height, making a total tower height of from 40ft. to 80ft. Around the lower part of tower or cooling stack are louvre boards, which serve a double purpose of keeping the water from splashing out and deflecting the air on to the falling water. The average ground space occupied is one square foot for every 60 gallons of water cooled per hour. One advantage of this type is that the vapour carried off is set free at a considerable height above ground level, and is not likely to cause a nuisance.

Underground Chimney Coolers, Natural Draught.—Of the same construction as a tower cooler, but is sunk into the ground. By this arrangement the water from jet condensers will flow to the distributing troughs by gravity, and will in time be drawn from the reservoir into the condensers by the vacuum. The foundations of these towers are very costly to construct, there being a large amount of excavation and concreting necessary. An underground cooler occupies more ground space than an above-ground cooler for equal duty, averaging 30 gallons of water coooled per hour per square foot of ground surface.

Open Coolers—These consist of a water stack only with the usual reservoirs under. All round the water stack louvre boards are fitted to prevent the water from spraying out and to deflect the air. The ground space occupied is slightly less than an underground cooler occupies, but more than that of a chimney cooler, the average duty being 38 gallons of water per hour per square foot of ground surface. A serious disadvantage of this type is the necessity of building same well in the open, as any obstruction to the wind blowing into them seriously reduces their

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capacity. The efficiency of these towers will vary by 20 per cent., according to the velocity of the wind. These towers can also create a nuisance if not screened from a public highway. This is the only type of tower that can reduce the temperature of the water below that of the surrounding air, and is very much used for ice machinery.

Fan Coolers are of exactly the same construction as the chimney type, but, in place of louvre boards for air, inlets are fitted with one or more fans. Fans, while consuming a considerable amount of power (about 2 per cent. of total engine output), are very flexible, and are useful on varying loads. Fan towers should never be erected where there is room for other types.

Size of Tower.—As previously mentioned, all cooling towers operate on the principle of air being capable of absorbing water, every pound of water evaporated and carried away absorbing 966 latent heat units. There is also a certain amount of heat absorbed by the rise in temperature of the air. The amount of vapour absorbed varies with the dryness of the air, but in England the air can generally absorb 5 per cent. of its own weight. Assuming "E. C. A.'s" station to be equipped with reciprocating sets, the over-all steam consumption on peak load being 35lb. per kilowatt, a tower to deal with 600 kw., or 21,000lb. of exhaust steam per hour, is a useful sized unit. Assuming the station will increase 200 kw per annum, in two years' time another tower of a similar size should be installed. As the output increases the kilowatts connected per annum will also increase, and the size of units installed will be of much larger size. Steam condensed per hour equals 21,000lb. Each pound of steam condensed will add 960 B.Th.U. to the circulating water. 21,000 × (say) 1,000 in place of 960-966 = 21,000,000 units to be dissipated by the tower per hour. As a pound of air can absorb 5 per cent. of its own weight of moisture, each pound of air (which equals 13 cubic feet normal) will carry off 1,000 B.Th.U. × ·05 = approximately 50 B.Th.U. per pound of air. The total cubic feet of air required can now be calculated:

$$\frac{\text{21,000,000 units per hour, total}}{\text{50 units absorbed per pound air}} = \text{420,000lb. air per hour.}$$

Assuming an efficiency of 75 per cent.,

$$420{,}000 \times \cdot 75 \times 13 = 4{,}100{,}000.$$

$$\frac{4{,}100{,}000}{60} = 685{,}000 \text{ cubic feet air per minute.}$$

If a fan tower is installed, the ground space occupied will be about 215 square feet. The fans will absorb approximately 18 b.h.p. If a natural-draught tower, above-ground type, the ground space occupied will be about 950 square feet. The lost water in each case is equal, and practically amounts to the quantity of feed water.—J. H. S.

Answer to No. 1,001 (awarded 7s. 6d.).—To calculate the dimensions of a water cooler to deal with the exhaust of 600-kw. plant. First we must know the amount of steam to be dealt with; this is taken as a standard practice by leading firms as 20lb. per indicated horse-power, which is a very good margin, as the average consumption of a fairly modern steam-engine is about 15lb. per indicated horse-power per hour. Assuming the above to be 20lb. per indicated horse-power per hour, we get

$$\frac{600{,}000}{746} \text{ watts} = 815 \text{ h.p. (nearly).}$$

Allowing a fair margin for development as requested, say 900 h.p., therefore the total weight of steam = 900 × 20 = 18,000lb. of steam per hour, and the weight of steam multiplied by a constant depending on the type of condenser equals the water to be cooled. Taking an average jet condenser the constant would be 3, therefore the total amount of water to be cooled will be 18,000 × 3 = 54,000 gallons per hour. The question to be settled now is what type of cooler is to be used. If land is cheap, and you have plenty of room, and do not mind having clouds of steam drifting near the ground, use an open-type cooler, as shown in Fig. 1, which is the cheapest type, and very efficient. If space is fairly limited and steam near the ground objectionable, use a natural-draught cooling tower (see Fig. 2). If space is very limited and electric power available, use a fan-draught cooling tower (see Fig. 3). Calling the above type 1, 2, and 3 respectively, we go further.

Type 1.—An open-type natural-draught cooler, as shown in Fig. 1, can be taken as cooling one bay 10ft. by 6ft. to

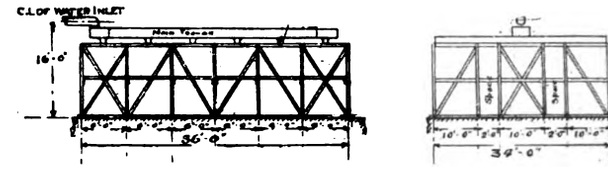

FIG. 1.

every 3,300 gallons of water per hour from 120deg. F. to 72deg. F. Fig. 1 gives actual dimensions for 900-h.p. engine.

Type 2. — A natural-draught cooling tower allows 50 gallons of water per square foot per hour, one bay never to exceed 15ft. either way on account of the weight of

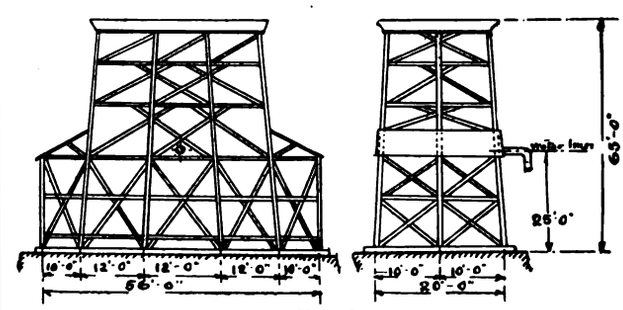

FIG. 2.

hurdles, and only being of light wood laths. Fig. 2 gives actual dimensions for a 900-h.p. engine.

Type 3.—A fan-draught cooling tower allows 100 gallons of water per square foot per hour; bay not to exceed 15ft. either way for reason as above. Fig. 3 gives actual dimensions for 900-h.p. engine. The height of water inlet

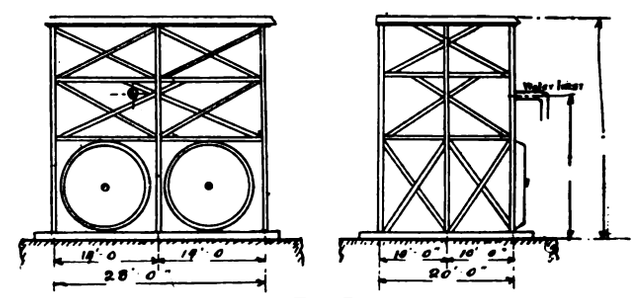

FIG. 3.

is shown in each case, and is 16ft. for open type from foundation to centre line of inlet pipe, 25ft. for natural-draught cooling tower, and 26ft. for fan-draught cooling tower. Fig. 4 shows a section of hurdles, of which there are generally two tiers of two rows per tier, one behind the other, each row consisting of 42 hurdles, making a total of 168 hurdles per bay.

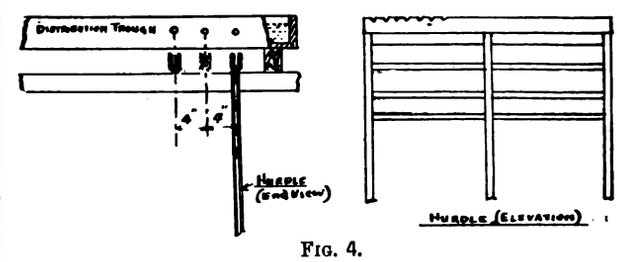

FIG. 4.

As space is limited, it is impossible to give fuller details in small sketch of arrangement of cutter, hurdles, main trough, distribution troughs, etc., and should "E. C. A." wish for more, I shall be pleased to correspond. C. H. JUN.

[Other replies to Question No. 1,001 will be given in our next issue.—ED. *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print.

QUESTIONS.

1,010. An induction motor with a three-phase rotor works on a load which varies as the cube of the speed. Show how to design a regulating resistance to give any desired reduction in speed.—PALATINE.

1,011. What is the best method of removing former-wound coils from armatures, and what tools are employed?—A. L. R.

ANSWERS.

Question No. 1,001.—How would you calculate the dimensions of a water-cooling tower for use in a 1,000-kw. station during the peak evening load of about 600 kw.? Allow a big margin for development.

Answer to No. 1,001 (awarded 5s.).—To decide what size cooling towers are required we must calculate the amount of water to be treated per hour. This will, of course, depend on the vacuum to be maintained in condenser, and also on the type of condenser used. We will consider a jet condenser maintaining a 27in. vacuum. The temperature of the exhaust steam will in this case be 126deg. F, and we will assume it is converted into water at 100deg. F. The number of B.Th.U.'s given up by every pound of this steam is found by the formula

$$H = 1{,}082 + \cdot 305\ t.$$

(H = total heat of steam in Fahrenheit units, being the heat required to generate 1lb. of steam at t degrees F. from water at 32deg. F.)

$$H = 1{,}082 + (\cdot 305 \times 126) - (100 - 32) = 1{,}052 \text{ B.Th.U.}$$

1,100 B.Th.U. will be a convenient number to adopt. With a steam consumption of 28lb. per kilowatt and a load of 600 kw., the number of heat units given up to cooling water per hour will be

$$28 \times 600 \times 1{,}100 \text{ B.Th.U.} = 18{,}480{,}000 \text{ B.Th.U. per hour.}$$

As the steam has been changed to water at 100deg. F., it follows that the cooling water has risen to this temperature, and if it entered condenser at 50deg. F., it has risen 50deg. From this rise in temperature we can calculate the amount of cooling water required per hour.

Heat given up by steam = heat gained by cooling water.

$$18{,}480{,}000 = w\,t.$$

w = weight of water, t = rise in temperature = 50.

$$w = \frac{18{,}480{,}000}{50} = 369{,}600\text{lb. per hour.}$$

This result gives us 22lb. of water per pound of steam condensed. Where a surface condenser is used the rise in temperature of the cooling water must be kept low if a good vacuum is to be maintained. We will assume a rise of 30deg. F.

$$w = \frac{18{,}480{,}000}{30} = 616{,}600\text{lb. per hour,}$$

or 62,000 gallons per hour. A tower to deal with 100,000 gallons per hour should make good allowance for plant extensions, as it could deal with the peak load for several years to come and maintain a fairly good vacuum during that load. A natural-draught tower to deal with 100,000 gallons per hour would need a ground space of approximately 60ft. by 25ft., and a height of 70ft. A fan cooler would require considerably less space, but the power required to drive the fans would be over 20 h.p. One great advantage the fan cooler has over the natural-draught tower is that it can cool the water below the atmosphere temperature.—C. R. P.

Answer to No. 1,001 (awarded 5s.).—The first point to be settled is the amount of water to be cooled per hour, and, secondly, the type of cooler which the circumstances will permit to be employed. A big margin for development is to be allowed, so that the plant had better be designed to easily deal with a load of 1,000 kw. Then, assuming that the total water consumption—including all auxiliary steam and waste—is 30lb. per kilowatt-hour, there will be 30,000lb. of steam to be condensed per hour. Now the amount of water necessary to condense this steam will vary with the type of condenser used. If ejector condensers are used, then with modern engines on a fairly steady load, and allowing 20lb. of water per indicated horse-power hour, 50 gallons per indicated horse-power hour will be required; using surface condensers it will be best to allow 30 gallons per indicated horse-power hour. Using ejector condensers we shall require 1,500 i.h.p. × 50 gallons per hour, and using surface condensers 1,500 i.h.p. × 30 gallons per hour, or 75,000 gallons and 45,000 gallons per hour. Now, cooling towers may be of three types: (1) the open type of evaporator cooler; (2) the chimney cooler; (3) the fan cooler. Whichever type is employed, the principle is the same—that of rendering the heat latent by helping the water to be cooled to evaporate to some extent, each pound of water evaporated taking away about 1,000 heat units as the latent heat of evaporation, besides some sensible heat. The medium used in cooling is air. The choice of which type to use depends on the amount of ground space available and the nearness of the plant to other property.

The open cooler, consisting merely of an open wooden framework, to the top of which the water to be cooled is pumped and then allowed to trickle in thin films over the wooden framework to the pond below, requires to be surrounded at a little distance with louvre frames, or else a great deal of the water is blown away as spray, and will, if near public roads or property, constitute a nuisance. The following are the dimensions allowed by one firm of cooling-tower makers: for 20,000 gallons per hour, 738 square feet of ground surface; for 50,000 gallons per hour, 1,500 square feet; for 75,000 gallons per hour, 1,750 square feet. The chimney cooler consisting of the above apparatus, sheeted in with wood and fitted with a chimney shaft above, is more certain, and within its capacity more efficient than the open type down to a moderate cooling point, but as its chimney effect depends upon temperature difference, the cooling point can never be as low as with the open type. The up draught is, of course, more powerful when the water delivered to the cooler is hottest, and to this extent the chimney cooler is self-regulating. Ground space required equals for 20,000 gallons per hour 19ft. by 19ft. by 57ft. high; for 100,000 gallons per hour, 58ft. by 24ft. by 65ft. This type must be on good foundations calculated to withstand wind pressures, must be kept well away from buildings, as it throws off large volumes of steam and moist air, which damage brickwork.

Fan coolers are similar to the chimney type, but have a much less stack, and the air is forced through them by fans placed at their base. They are more certain and effectual than either of the preceding types, and they will cool water lower than the air temperature; they are not, of course, at all dependent on temperature differences for their effect. Space required for fan coolers:

For 20,000 gallons per hour, 11ft. by 13ft. floor space.
For 100,000 gallons per hour, 18ft. by 24ft. floor space.

The brake horse-power of the fan motors is given as 5 b.h.p. for 20,000 gallons and 25 b.h.p. for 100,000 gallons per hour. Power being required to drive the fan cooler, it will not pay to use this type where space requisite for either of the other types is available, but in deciding the *capital value* of the ground so occupied, and its probability of being badly wanted for other uses in the future, must also be considered.—W. T. WARDALE.

Question No. 1,002.—Describe a satisfactory and, as far as possible, inexpensive method of making laminated contact brushes, such as are used for various sliding and stationary contacts, the various plates of which the brush is composed having a certain initial tension, so that the brush when at rest will not tend to separate.

Answer to No. 1,002 (awarded 7s. 6d.).—The most satisfactory and inexpensive method of making the laminated contacts referred to in the above question is by means of press tools. Sheet phosphor bronze is used to make these contacts on account of its springy nature, about ·020in.-·030in. thick, and from this the contacts are punched to

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the required dimensions, as shown in Fig. 1. This is the first operation. The next operation is to form these contacts up into the required shape (Fig. 2). For purposes of illustration I have shown contacts similar to those in use on

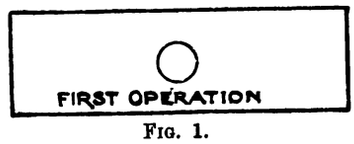

Fig. 1.

rheostats, circuit breakers, etc. This is done by means of a forming die and punch, a sketch of which is shown in Fig. 4; the curved portions of this die and punch are made equal to the required radius of the contact. Two locating pieces, *a* and *b*, are screwed on to the top of the

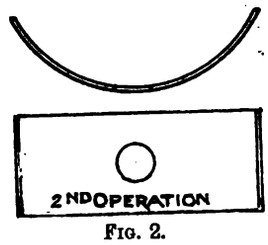

Fig. 2.

die, and so fixed that the contacts from the first operation are an easy fit between them, the object of these locating pieces being to keep the contacts in the same relative position each time. The forming die and punch is now set up in a press; the punch descends on to the contact and

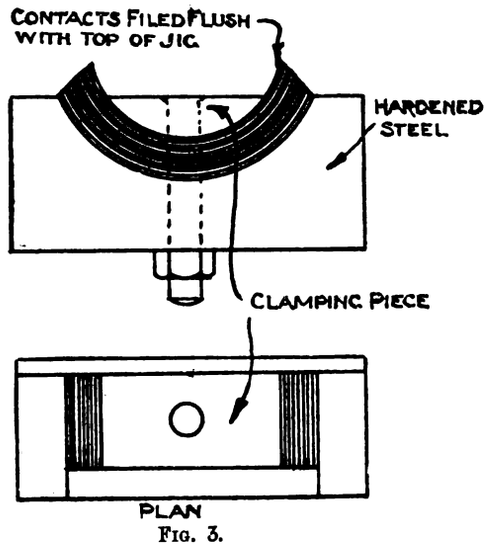

Fig. 3.

forms it up to the shape shown in Fig. 2. After this operation they are now ready to be assembled in the filing jig, as shown in Fig. 3. In assembling, the inner and outer contacts are made about twice the thickness of the others, thus tending to hold the rest more firmly together. It

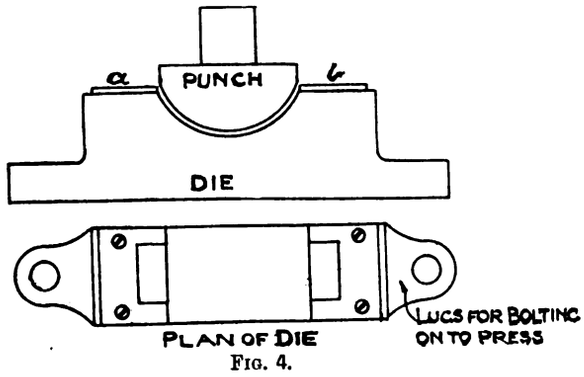

Fig. 4.

will be seen from the above that all the contacts are formed to the same radius, and from this it might seem that they would not assemble up correctly, but in practice they are found to assemble all right, the ends being filed flat in the filing jig. The cost of tools and labour for any ordinary sized contacts would be as follows.

Cost of die and punch for operation No. 1	=	£1 10 0
,, ,, ,, ,, No. 2	=	1 10 0
,, filing jig	=	0 5 0
,, labour on operation No. 1	=	1d. per 100.
,, ,, ,, No. 2	=	1d. ,,
,, assembling complete contact	=	½d. each.

ALPHONSE.

Answer to No. 1,002 (awarded 7s. 6d.).—The cheapest method for the manufacture of contact brushes depends to a large extent on the tools available for their manufacture. The following are two methods which have been adopted for the manufacture of large laminated contact brushes. The second method gives a better brush, but entails the use of a power press. In the first method, copper of the required thickness was wound under tension

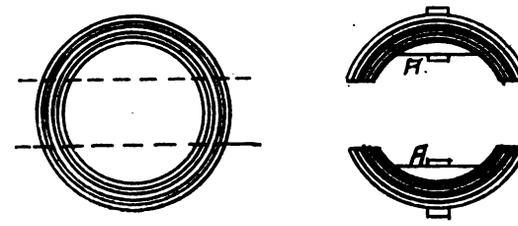

Fig. 1.

in a coil, as shown in Fig. 1. The coil was taken, and had the hole put in, and pads and bolts put through the holes as shown; it was then sawn through to the dotted lines, leaving two brushes, the contact faces of which only require grinding. The disadvantage of this method is that the copper cut out is wasted, but, on the other hand, there is no fear of the laminations spreading, as the copper is wound under tension. This spreading often occurs in brushes built up of strips which are bent by hand on formers.

In the second method, straight strips of the required length are cut off on the press, the requisite lengths being obtained by stops arranged on the press. These strips are

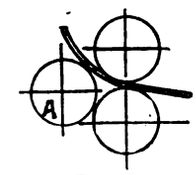

Fig. 2.

then taken and put through rollers (Fig. 2), which gives the necessary curvature to the strips; this curvature is the same for all the strips for reasons given later. These curved strips are then taken, placed one on the other, and the pad and bolt put through as in Fig. 3. The brush only now requires its contact faces grinding. The reason for giving the same curvature to all brushes is as follows: When the strips are placed one on the other it will be seen that the strips are close together at A, and will have a space between them at D (Fig. 3). On bolting the strips together there is no space between the strips at D; closing this space has the effect of forcing the outer strips, C, on the inner strips, B; this in turn tends to close the distance $B B_1$ in, and this tends to press the outer strips outward—that is, to enlarge the distance $C C_1$—thus doing away with all fear of spreading.

Fig. 3.

Fig. 4 shows a method adopted for brushes of a lighter construction. The strips are cut the requisite length, and bolt put in as described in method 2. The strips are then placed on the die plate, B, the correct position being fixed by stops on it. On descending, the punch, A, forces the brush in the shaped slot, thus accurately shaping the brush at one operation. A small hole, C, in the punch enables the punch to clear the bolt head. In conclusion, the writer obtained the best and cheapest brushes from method 2, where the brushes were of such dimensions that they could

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not be made as in Fig. 4. Only hard-drawn copper should be used, otherwise all attempts to overcome spreading at the contact face are of no use; the copper if soft drawn

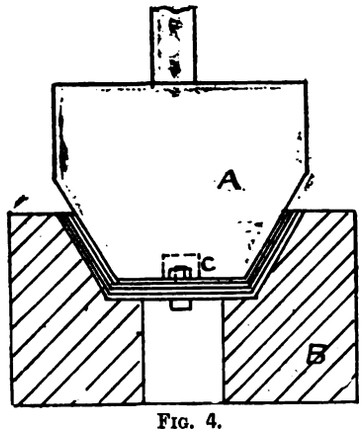

FIG. 4.

does not return to its original position when once bent slightly.—S. W. P.

Answer to No. 1,002 (awarded 5s.). — The following method is a good one for forming laminated contact

FIG. 1.

brushes. Fig. 1 shows the laminated copper cut equal to the longest length required for the brush. Fig. 2 shows the second stage; the laminations are pressed tightly

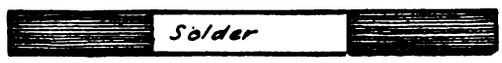

FIG. 2.

together in a vice or wooden clamp, and while in this condition soldered all along the edge in the centre, as shown. The laminations can now be tightly riveted together with

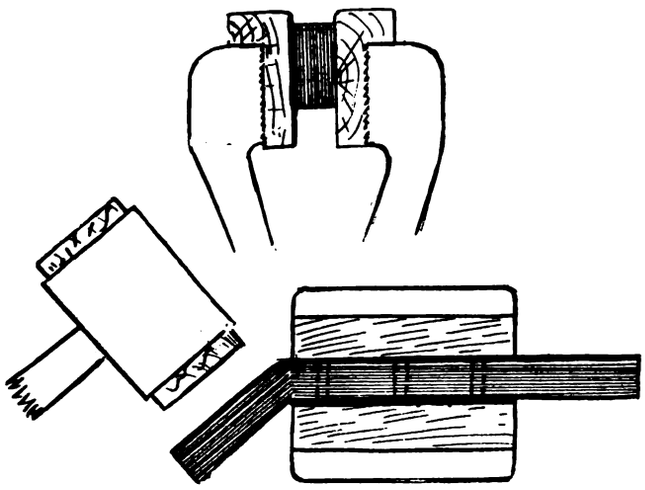

FIG. 3.

copper rivets, slightly thicker plates of copper being placed at the top and bottom of the brush. After this process the solder is filed off. By these means we have a brush

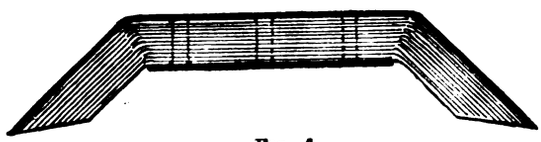

FIG. 4.

which is very tightly packed, and there is also no possibility of the laminations becoming slack. The brush must now be clamped in a vice lined with wood, as shown in Fig. 3, and the ends hammered over with a wooden mallet to the angle required (a little greater than the angle when the brush is spread on the contacts). Finally, the ends of the brush are cut and filed to the shape shown in Fig. 4. This shape allows for the spread of the brush on the contacts. If the foregoing instructions are followed, very satisfactory brushes can be obtained.—JNO. ARNOLD.

Answer to No. 1,002 (awarded 5s.). — When contact brushes are made of finely laminated copper, there is usually a difficulty in that the outer layers tend to spread. This may be overcome to a great extent by having the outside leaves much thicker, but this detracts considerably from the adjustable qualities of the brush. A method

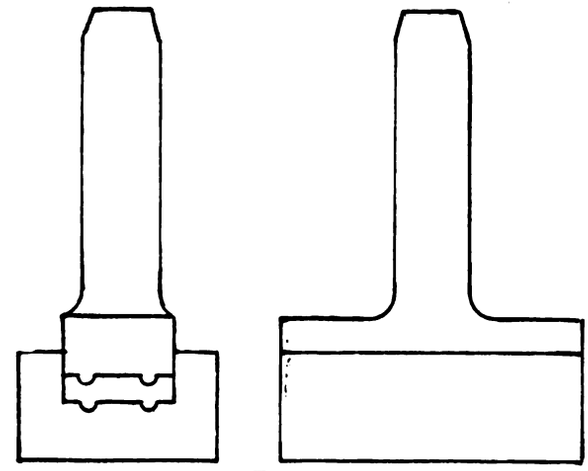

FIG. 1.

giving good results, and also fairly cheap as regards making, is to cut the thin copper sheet into slips the required size with a guillotine, rib the slips in a stamp or press, and solder at one end. If hard sheet copper is purchased, it will be found to have about enough spring for the purpose when cut into slips. The slips may then be ribbed or fluted in a tool as shown in Fig. 1. There are only two ribs, such as would be suitable for a brush from ½in. to ¾in. in width. The tool shown is intended for hand use, but, of course, for larger sizes an increased output could be arranged for power press work. Although it is suggested that two flutings would be satisfactory for a width of about ¾in, much would depend on the thickness of leaves forming the brush and the degree

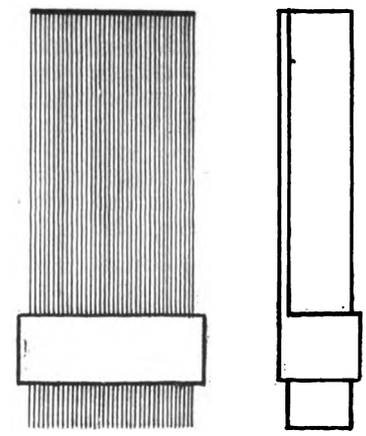

FIG. 2.

of rigidity required. The laminations can be readily soldered at one end, making a block having a certain amount of spring and adjustment at the contact face and keeping well to its proper shape. Another method would be—and in this case fluting the leaves might be dispensed with—to hold the leaves together by means of a shoe or guide, as per Fig. 2. With this latter arrangement tinned copper wire is sometimes used with advantage; such wire is easily stretched, cut off to length, brought up to shape in a die, and soldered at one end. In case of either sheet or wire being employed, there need be very little scrap by these methods—this is a point well worth consideration at the present price of copper. Where a scraping or sliding

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action takes place at the contact surface, there is little difficulty in securing good electrical connection. When there is simply a touching contact, it may be possible to tin the face, making contact with the brush; this will keep cleaner than copper. Only general suggestions have been offered, as definite sizes are not given in the question, and construction would naturally vary with dimensions of brush. There is one trouble that must be guarded against if sheet brushes are adopted—that is, the sort of riveting action that takes place with any great amount of sliding at point of contact. When sliding motion is in same plane as lamination of the brush, the edges of the leaves tend to get riveted or burred over. The result is not only considerable spreading, but the brush loses its flexibility and become little better than a solid block. The remedy is to have ample surface, and for large sizes to have several small in place of one large brush.—M. M.

Question No. 1,004.—Discuss street-lighting photometry, giving the merits and demerits of ascertaining the "illumination on a horizontal surface" as compared with the "direct candle-power," the measurements in each case being taken at varying distances from posts, and at a height of about 1m. from the ground. Clearly describe the term "candle feet." Also describe a type of photometer (complete) with which it is possible to take either of the above, and also laboratory measurement.

Best Answer to No. 1,004 (awarded 10s.).—The value of street-lighting photometry is very well emphasised in Mr. Hadyn Harrison's paper on "Street Lighting" read before the Manchester Section of the Institution of Electrical Engineers on Dec. 12, 1905, but I shall treat the various questions raised by "J. C. L. V." in the following order: definition of candle-power and candle-foot; measurement of candle-power and candle-feet; description of a photometer for street and laboratory work. The candle power (C.P.) of a source of light may be defined as its light-giving power as compared with that of a standard candle. The C.P. of a source represents the total light energy emitted from the source, and (assuming the supply of fuel constant) this is a constant quantity unaffected by position or reflectors. The intensity of illumination on any surface (usually measured in terms of the candle-foot) represents the light energy falling on a unit area of that surface, and obviously is dependent upon three things—namely: (*a*) the C.P. of the source of light; (*b*) the distance away from the source; (*c*) whether reflectors are used. Unit intensity of illumination (candle-foot) is the intensity of illumination produced on a surface held normally at 1ft. distance from a standard candle. In order to realise what this unit really means, suppose a standard candle to be placed at the centre of a sphere of 1ft. radius, then from the above definition, since each point of the interior surface of the sphere is normal to and at a distance of 1ft. from the candle flame, the intensity of illumination will be unity at all parts of the interior surface. Now, the total light energy is represented by 1 (unity), and since the whole interior surface illuminated is $4\pi r^2$ square feet, then light energy falling on unit area of surface $= \frac{1}{4\pi r^2}$, and since $r = 1$ft, light energy falling on unit area of surface $= \frac{1}{4\pi}$ of total light energy due to 1 c.p., and this is unit intensity of illumination.

Now consider a general case in which a source of light of C.P. candle-power is encircled by a sphere of radius D feet, the intensity of illumination at any point of the sphere $= \frac{\text{C.P.}}{4\pi D^2}$, and in terms of the above unit the candle-foot

$$= \frac{\frac{\text{C.P.}}{4\pi D^2}}{\frac{1}{4\pi}} = \frac{\text{C.P.}}{D^2},$$

which is our general equation for obtaining the intensity of illumination on a normal surface. From what has been stated above, it will be obvious that in Fig. 1 the intensity of illumination on a surface, S, normal to the beam of light will be $\frac{\text{C.P.}}{D^2}$ candle-feet, and it is the illumination on this surface which is measured directly by means of a photometer such as the one described hereinafter. The illumination on a horizontal surface = illumination on $S \times \sin\theta$, the value of $\sin\theta$ being read off on the photometer head on from tables.

The measurement of the illumination on a horizontal surface, therefore, simply necessitates a reading of the photometer without taking into account any distances; but, as will be understood from the previous reasoning, the determination of the value C.P. requires the distance, D, to be known, and this is an extremely cumbersome distance to ascertain. The value D^2 is usually obtained by the trigonometrical formula:

$$D^2 = H^2 + L^2 \quad \ldots\ldots\ldots \quad (1)$$

and since $\text{C.P.} = \text{Ill.} \times D^2$,

substituting (1) $\text{C.P.} = \text{Ill.} \times (H^2 + L^2)$.

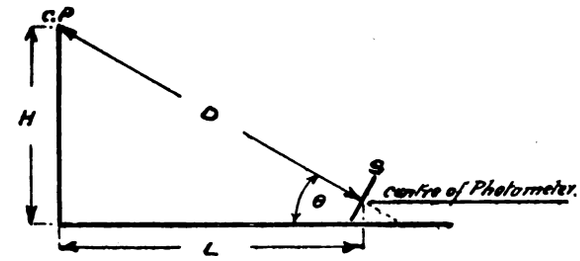

FIG. 1.

It will be understood from what has already been stated that if tests are required showing how a street is illuminated, the most satisfactory tests are those of intensity of illumination, as they actually represent the quantity of light energy falling on the street at various points. To a person with a knowledge of street-lighting photometry it would be indefinite to state that at a certain point in the street the C.P. was 6; but if it were remarked that the intensity of illumination at that point was ·3 of a candle-foot, he would signify satisfaction.

The type of photometer suited to "J. C. L. V.'s" requirements is the one patented by Messrs. Simmance and Abady, and is of the flicker type, which obviates all inaccuracies and insensitiveness due to coloured lights. The chief essential of the outfit is the "flicker head," which contains a specially made wheel of a white material, shaped in such a manner that when rotated on its axis it presents first one surface and then the other, which surfaces are independently illuminated by the sources of light under test. This wheel is rotated by a spring motor, the speed of which can be considerably varied. The "flicker head" is also fitted with sighting lenses to ensure strict alignment of the lights under test, and also a divided sector enabling all angles to be read off with ease. The standard of light employed may either be a 1-c.p. pentane burner or an eight-volt electric lamp, both of which are extremely satisfactory.

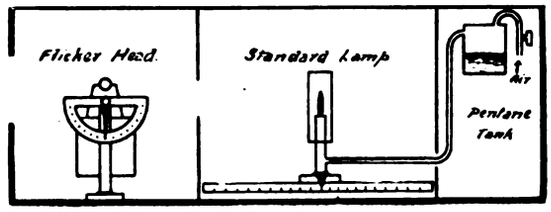

FIG. 2.

The general arrangement of the photometer is shown in Fig. 2, and the whole is transported on a light and convenient hand truck which serves as a table, about 1m. high, fitted with adjustable legs for any situation. I have found from experience that this mode of transport is by far preferable to that of the hand-camera type manufactured by some firms. The photometer briefly described above is admirably suitable for laboratory work, and, if necessary, the "flicker head" may be transferred to any existing photometer bar. I cannot trespass further on the editor's space, and would refer "J. C. L. V." to the makers (Messrs. A. Wright and Co., Westminster) for full details of this accurate and valuable photometer.—S.

[Other replies to Question No. 1,004 will be given in our next issue.—ED. *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

1.012. Describe and explain the working principles of Grove's patent three-wire network ohmmeter, and give the derivation of the working formula.—J. A. VICE.

1,013. I have heard several statements made lately to the effect that the German firms are continually cutting out the British manufacturers in electrical work in England, especially in the mining work of the North. To what extent are these statements true, and why are not the British manufacturers more successful in competing with the Germans?—E. H.

ANSWERS.

Question No. 1,004.—Discuss street-lighting photometry, giving the merits and demerits of ascertaining the "illumination on a horizontal surface" as compared with the "direct candle-power," the measurements in each case being taken at varying distances from posts, and at a height of about 1m. from the ground. Clearly describe the term "candle feet." Also describe a type of photometer (complete) with which it is possible to take either of the above, and also laboratory measurement.

Answer to No. 1,004 (awarded 7s. 6d.).—The illumination of any surface varies *directly* as the quantity of light and *inversely* as the area. The direction from which light rays

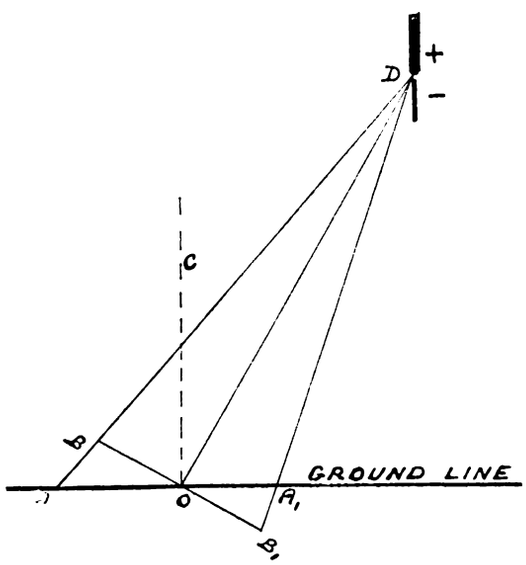

FIG. 1.

strike an object must also be taken into account, and this fact makes it difficult to gauge the actual lighting power when the rays of light fall more or less obliquely. In Fig. 1 consider the ground space, $A A_1$, illuminated by the arc lamp, D; O C being drawn normal to the ground, D O C is the angle of incidence. Suppose the illuminated surface to be turned into the position $B B_1$ at right angles to O D. The angle A O B = angle of incidence D O C. Then O B = A O cos D O C. Therefore, the greater the angle of incidence the greater is the ratio of O A : O B; the quantity of light being the same in each case, we have that the illumination falls off as the angle of incidence increases. By "candle-foot" is meant the direct illumination obtained from a standard candle when the candle is placed 1ft. from the surface to be illuminated. When estimating the amount of light to be provided, it is generally considered that when the illumination falls as low as one-tenth or even one-eighth of a candle-foot, reading ordinary print becomes impracticable. To read comfortably, the average individual requires an illumination of about one candle-foot. The question of useful illumination is a very difficult one, and opinions on the subject are much at variance. Many lamps may give high values in photometric tests, particularly when measured at certain angles, but as street illuminators worry pedestrians with their glare without commensurable advantages in lighting the roadway.

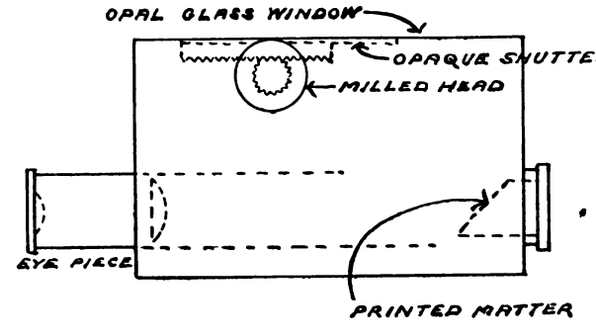

FIG. 2.

The number of photometers on the market is legion; two of portable variety are selected as illustrations for this answer. Fig 2 is the illuminometer of Messrs. Houston and Kenelly. The eye-piece can be focussed on test characters or printed matter placed on the inclined surface opposite, this surface being illuminated by an opal glass window on the top of the instrument. By means of a milled head, outside the instrument, attached to axis of pinion, an opaque shutter can be adjusted so that the area of window may be suited to the light under test. Readings are obtained by means of a scale attached to the shutter, calibration having previously been determined from a light of known power. Such an instrument as this may not give exact scientific results, but, on the other hand, it offers an excellent means of approximately finding the illumination in any position. Its simplicity is a great recommendation to the practical engineer—the instrument may be turned in any direction and is always ready for use. Fig 3 is the ingenious arrangement devised by A. P. Trotter. An amyl-acetate lamp flame, F, illuminates the adjustable reflector, R; mirror, M, gives a reflected image of the flame by which it can be adjusted to its proper height. The light under test illuminates screen at top of the instrument, and across the middle of this screen is a narrow slit. When screen and adjustable reflector, R, are equally illuminated, the slit appears to vanish; both slit and screen would appear of same brightness. If the screen were the brighter, slit would seem to be a more or less bright line.

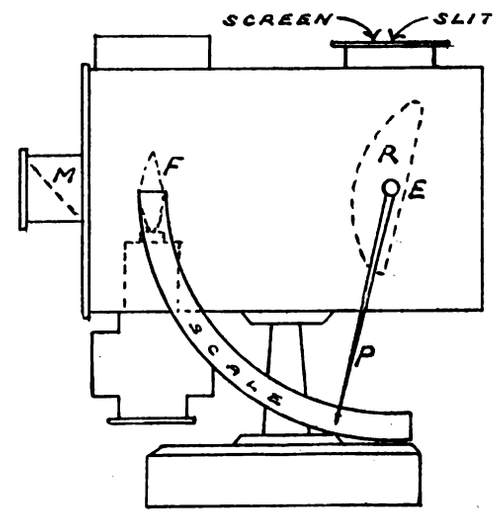

FIG. 3.

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By moving P until slit disappears, the reading on calibrated scale gives the power of the light under examination. To minimise difficulty with regard to colour, R is tinted blue and yellow screens are provided. Figure exemplifies another quality of this instrument. E, the axis of P, is extended some little distance, so that it throws a shadow from the light under test on to the scale,

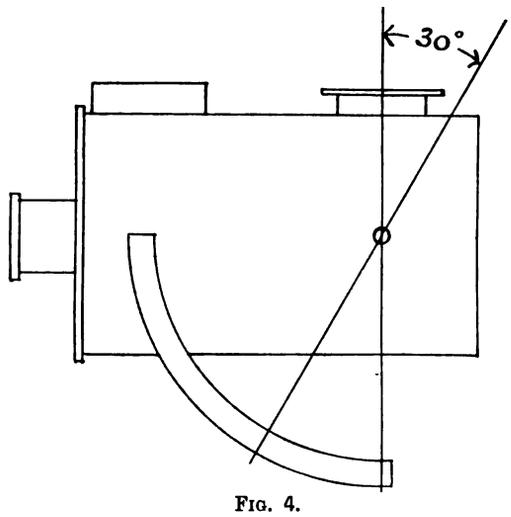


FIG. 4.

thus giving the angle of incidence; in Fig. 4 this is shown as 30deg. This gives the ability to find height of lamp above the ground. Suppose, see Fig. 5, O E is distance of instrument from base of lamp standard. The angle of incidence being 30deg., D O E is 60deg. D E = O E tan D O E = O E tan 60deg. = O E $\sqrt{3}$. Therefore, by finding O E we can calculate height of lamp. This photometer is portable, and is readily set up on an ordinary tripod.

For laboratory testing much will depend on the accuracy desired, some form of the shadow photometer being generally the easiest to manipulate. There are so many varieties that any attempt to describe them would unduly

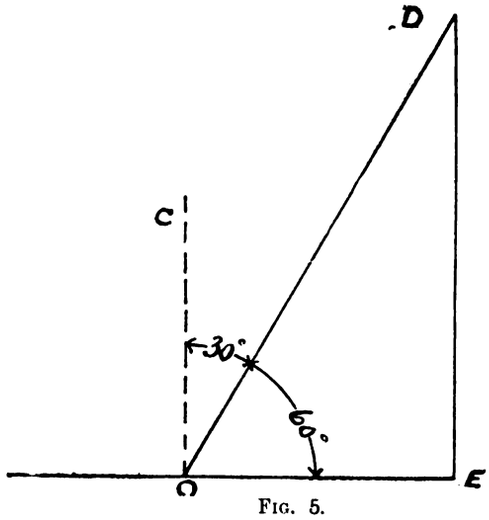


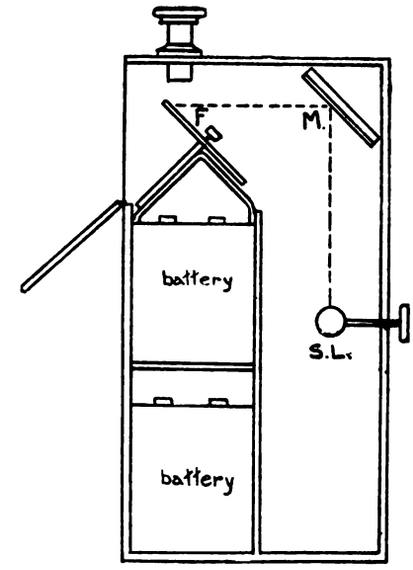
FIG. 5.

prolong this answer. The querist will find an excellent paper on the subject by Prof. Fleming in the Institution of Electrical Engineer's *Journal* for 1902.—M. M.

Answer to No. 1,004 (awarded 5s.).—Street-lighting photometry is essentially the experimental comparison of the illuminating powers of different sources of light while actually in use in the street. The main principles are the same as used in laboratory photometry, but the conditions under which outside work has to be done are very different from those which hold indoors. For instance, if it be desired to ascertain the value of the illumination given by one certain lamp, it is absolutely impossible to screen off the effect of all others or to eliminate the light reflected from walls, etc. Then, again, the nature of the work necessitates the use of portable instruments, which are never so accurate as fixed ones, and in all cases exposure to the weather (wind and moisture chiefly) inflict conditions which make street-lighting photometry a difficult operation, and one the results of which can only be considered approximate.

In comparing lighting systems, the minimum illumination should be the criterion, as, no matter how high the average illumination may be, if there be dark spaces the system is bad. The illumination on the road level is not so particular as the direct candle-power at some height above, as the latter enables persons to avoid obstructions and recognise faces, etc., whereas the surface of the road chiefly affects vehicular traffic, more particularly motorcars, and they carry their own lights. The usual illumination units are "candle-feet." By their use the particular illuminating effect at any point is expressed in terms of the equivalent number of candles placed at a distance 1ft. away from that point. Ordinary street illumination varies from ·05 to 1·5 candle-feet. The light given by the full moon in England has been found to be about ·028 candle-foot.

The sketch illustrates a portable adaptation of the flicker photometer specially arranged for street work. In this type of photometer the two surfaces illuminated by the two respective sources of light are successively brought into the field of view. If the surfaces are unequally illuminated, a flickering effect is produced, and the position for which



the flickering is a minimum is the position where the surfaces are equally bright. The advantage over the ordinary simple type is that light of different colours can be compared accurately. S L is a standard electric lamp which can be moved up and down to obtain balance. The mirror, M, reflects the light from this lamp on to the rotating screen, F, of the photometer proper. The screen which receives the illumination to be measured is inclined at 45deg., as shown, and the two illuminated surfaces are alternately presented to the observer's eye through the eye piece in the usual way. By having the screen at 45deg. it is possible to obtain a readable value close under the main source of light and also at some distance, which two conditions would be impossible with a flat or a vertical screen. The instrument is supplied supported on three folding legs, which make it very handy for street-lighting work.—PERCY DUNSHEATH.

Question No. 1005.—Discuss the pros and cons of the three following methods of regulating the voltage of alternators: (1) Alternator derives exciting current from station direct-current main 'bus bars, regulating resistance being in series with field coils; (2) alternator derives exciting current from direct-current dynamo coupled to its shaft, the regulating resistance being in series with excitation dynamo field coils; (3) alternator derives exciting current from direct-current dynamo coupled to its shaft, the field coils of the excitation dynamo being in turn excited from the station direct-current main 'bus bars, and the regulating resistance being in series with the field coils of the excitation dynamo.

Answer to No. 1,005 (awarded 7s. 6d.).—The decision as to which is the best of the three methods given will depend somewhat on the nature of the load and whether close regulation is necessary. Method 1 possesses the advantage of cheapness, since, assuming that a supply of direct current already exists, no exciting dynamos will be

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needed for the alternators. It is also simple and reliable and gives good regulation, the alternator voltage is well under control and responds immediately to any change in the field regulating resistance. The method is, however, rather uneconomical, as considerable power may be wasted in the regulating resistance when this is in circuit; also, if close adjustment of voltage is required, a large number of steps will be necessary, resulting in a somewhat costly resistance if the current to be dealt with is heavy.

Method 2 would appear at first sight to be more economical than method 1, since the only regulating resistance is in series with the exciter field coils and the power wasted is almost negligible. Against this, however, we have to put the fact that the exciting dynamos may be running for long periods at a time with very light load, and, therefore, at lowest efficiency. This method is, perhaps, the most usual employed in small power and lighting stations, although the regulating resistance is sometimes placed in series with the alternator field only, or in other cases there is a regulator in both alternator and exciter fields. It forms the cheapest and most convenient method of exciting the alternators in stations where a supply of direct current is not available. It has the advantage that each unit is independent and self-contained, and gives every satisfaction on a steady load or on any load that is not subject to sudden fluctuations, such as a lighting load. The great drawback to this method is that the alternator depends for its excitation on a self-exciting dynamo, which under certain conditions is apt to be rather unstable. For instance, suppose that the alternator is running lightly loaded and a heavy load be suddenly thrown on, causing the speed of the prime mover to drop; this will, of course, cause the alternator volts to drop, and if the machine received its excitation from an independent source it would have no further effect. But in this case, owing to the decrease in speed, the exciter volts will also drop, the net result being a serious drop in the alternator voltage, although the speed may not have fallen to any great extent. It may possibly happen also that should there be no one at hand to attend to it, the exciter, which had previously been running at a low voltage, with resistance in series with the field coils, will lose its field altogether when the speed falls, resulting in a stoppage of supply. For this reason it is very important that all direct-coupled shunt-wound exciters should be so designed that their field magnets are fully saturated at the normal voltage, and the range of working voltage to suit the excitation of the alternator between no load and full load must be well above the bend in the saturation curve. This point is usually well looked after by the designer, and trouble is not so likely to occur with well governed high-speed engines as it is with single-cylinder gas or oil engines. Another disadvantage of method 2 is that the regulation is liable to be somewhat sluggish and uncertain, owing to the fact that the exciting dynamo is a self-exciting machine, and its voltage may require time to build up.

Coming, now, to method 3, it will be seen that it differs only slightly from the second method. Its advantages are fair economy, ease of control, and fine adjustment of voltage. The regulation will be bad on fluctuating loads, although perhaps a trifle better in this respect than the second method, inasmuch as the current in the field coils of the exciter will be unaffected by any change in speed, and the voltage will not rise or fall quite so much, as the case may be. There will, of course, be no danger of the exciter losing its field providing the voltage does not fail at the direct-current 'bus bars. Should the exciter break down from any cause, it would in all probability be possible to take a temporary supply of exciting current from the direct-current 'bus bars, this constituting a stand-by.

From the above remarks it appears that the first method offers the most advantages of the three, and if a separate supply of direct current is already available there is no doubt that this method would be the best to adopt. Modern practice in large power stations all tends towards a separate supply for exciting all the alternators, and a battery is usually provided as a stand-by, making what is probably the safest system that could be devised. One other slight advantage which might be mentioned for method 1 is in connection with the starting up of large induction motors. By fully exciting an alternator while at rest, and then closing the switch connecting it to the motor, the latter may be easily and smoothly run up with the alternator, which may be afterwards paralleled on to the 'bus bars, if desired. By this means the very heavy starting currents required by this type of motor, when switched in at full voltage, are avoided.—S.

Answer to No. 1,005 (awarded 5s.).—The general standard practice with alternators to-day is to have rotating field systems with stationary armatures or stators. From the subject given to discuss, one naturally derives the impression that rotating fields are only concerned, and, therefore, I confine my remarks to this type of machine. With rotating fields it is general to run at fairly high peripheral speeds, say between 5,000ft. and 10,000ft. per minute, so that a greater degree of cooling may be obtained and accordingly a smaller machine employed for a given output. With such high peripheral speeds it is necessary for the field windings to be very strong and wound securely to withstand the strain due to centrifugal force. Thin wire cannot be used, as it would probably break or bunch up on the outer part of the bobbin. It would, moreover, cost much more to wind on the poles, both from the cost of the wire itself and the extra time and labour in winding. Therefore, in view of cheapness and greater strength in resisting mechanical forces, the field should be wound with either stout copper wire, square in section, or with strip on edge, preferably the latter, as it is the strongest way of packing the coils, and needs very little insulation. From these few characteristics necessary we can thus see that the relative number of turns per pole must be few, and to get the required excitation the field current must be fairly heavy. Also, as

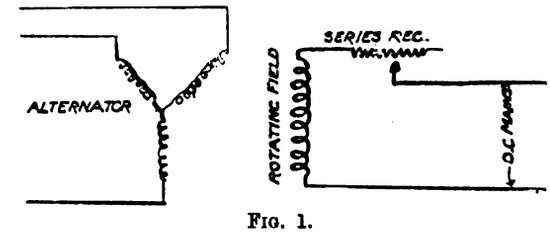

FIG. 1.

the turns are large in cross-section, the resistance of the whole field system will be low, and accordingly the voltage drop across the slip-rings will also be comparatively low. In general, these values are between 50 and 100 volts. Let us now discuss the three cases given, assuming from the above introduction that the voltage necessary for the excitation circuit is fairly low and the current of a moderately large value.

Case I.—Fig. 1 gives a diagrammatic sketch of the circuits. The stator is put in three-phase, but that does not enter the question, only making the field more distinct in the diagram. This is the worst case of the three. The direct-current main voltage is probably considerably greater than the voltage necessary for the field, and accordingly it has to be reduced in the series resistance. This has also to carry the whole exciting current, and is, therefore, exceedingly wasteful. Probably more power is used in simply heating up the regulating resistance than in the field itself. Also it necessitates using a very large regulator with large contacts and switch, which is not only costly but cumbersome upon a switchboard. Thick mains have also to be laid from the switchboard to the machine, which may or may not be some distance away. Again, the alternating set is not complete in itself, but is dependent for its running upon an outside source, and a direct-current set has to be running to supply the excitation current. This may or may not be a disadvantage, depending upon the size of the station, as to whether it is necessary to have direct-current power on supply for other purposes. The mains' voltage may not be very constant, particularly if it is on a traction circuit. This would cause fluctuations in the alternating-current voltage, which is a bad condition at any time.

Case II.—Fig. 2 gives the connections for this arrangement. I think this is the best case of the three, and is

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certainly the method one generally finds being used nowadays, particularly with large sets. One disadvantage is the extra cost of the dynamo, the special arrangements and castings for direct coupling, and the increased floor space taken up. These are of comparatively small importance if the set is a large one. Another disadvantage in this case is that the voltage variation from moment to moment is multiplied considerably if there is a very uneven angular velocity due to the engine, as, firstly, the voltage of the alternator itself is affected; secondly, the voltage of the exciter is affected; and, thirdly, the self-excited field of the exciter is affected—all of which in turn are reflected back on the fluctuation of the alternator voltage itself. However, when modern engines are designed, the necessity of having a constant angular velocity is carefully considered. The advantages in this case are considerable. The whole set is self-contained, and when it is required the

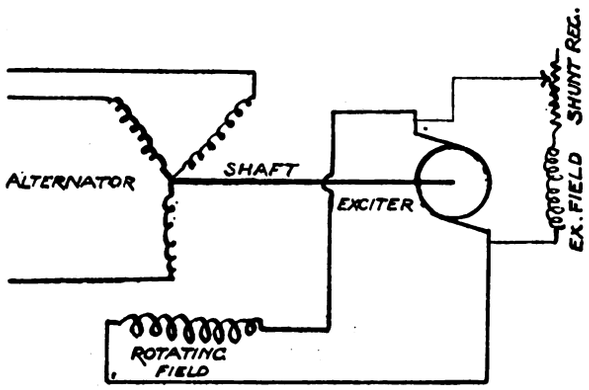

FIG. 2.

engine has simply to be run up, and it is not dependent upon outside supplies. Probably there are fewer magnetic and electrical losses with this method. A much smaller regulating resistance is required, as it has only to carry the exciter field current. Thus the initial cost is reduced, and the watts lost in the resistance itself are very low. The size and length of cable are considerably smaller than in case I. There is also less liability to breakdowns to earth, etc, as the voltage on the whole field system is very low. If a breakdown does occur, putting the exciter out of action for a short time, it is an easy matter to temporarily connect the field up to an outside supply.

Case III.—Fig. 3 gives the diagram of connections for this case. There is, perhaps, very little to choose between this case and case II. One has again the extra cost of the exciter and the increased space taken up. The magnetic

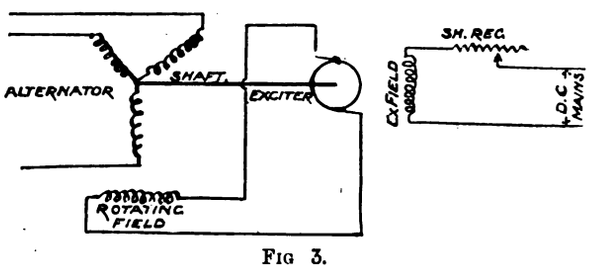

FIG 3.

and electrical losses are about the same, and the matter of cable is practically not altered. The regulating resistance in the exciter field circuit will probably have to be of a much higher resistance and rather bigger altogether, as the direct-current mains' voltage would be higher than the exciter voltage. The field of the exciter would perhaps be more liable to breakdowns, owing to working off a circuit of higher voltage. The whole set is not self-contained, but is dependent upon an outside source, and what was said in case I. about this necessarily relates in a similar manner to this case also. The voltage fluctuation due to an uneven angular velocity, which was given as a disadvantage in case II., would not be quite so bad in this case, as, of course, the exciter field would not be affected by this, being on a separate circuit.

Looking at the question from the above points of view, I think that the second case is the best for general requirements.—F. E.

Answer to No. 1,005 (awarded 5s.).—In dealing with this question it is advisable to consider first the relative advantages and disadvantages of the two general methods: (*a*) exciting from the main direct-current 'bus bars through a regulating resistance; (*b*) exciting by means of a dynamo coupled to the alternator shaft. There is little to choose as to first cost between these two methods if there is already a direct-current supply available in the station. Where the alternators are large and the first method (*a*) is employed, it should necessitate large costly field rheostats and gear for operating them, besides leads up to the main switchboard capable of dealing with full field current. There would be, therefore, very little difference on the outlay on the two methods, especially if the main switchboard was some little distance away. In some stations the voltage on the main direct-current 'bus bars is very unsteady, due to the starting and stopping of motors in the works, and if this is the case it is inadvisable to excite from them at all. If, however, the main direct-current generators are well compounded and maintain a fairly steady pressure on the 'bus bars, this method has some little advantage over (*b*) because the excitation would be quite independent of irregularities in prime mover speed, and also of any variations that might occur due to the characteristics of the small exciter. At the same time, the regulation would not be nearly so accurate, as it is difficult to obtain fine adjustments on rheostats of the size that would be required. The greater the number of steps in the resistance the better will be the adjustment, but, of course, the cost and size will increase correspondingly. When several alternators of the same type are installed, resistances are sometimes designed so that the steps are graded to suit the open-circuit characteristics of the machines, but this again adds to cost, and the result can then be only fairly accurate. Excitation from the main direct-current 'bus bars is slightly more reliable, as there are generally two or more direct-current generators available for station supply, while, should an exciter coupled to its own alternator break down, the whole set is put out of service till the fault is rectified. From the point of view of economy the direct-coupled exciter certainly has the advantage. The dynamo takes little more power than is required to excite the alternator, while with the first method the loss of power in the rheostats is often very large, and must be taken into consideration.

Comparing, now, the methods 2 and 3 of exciting by means of a direct-current generator coupled to the alternator shaft, the first—that of running a shunt-wound exciter—has little to commend it while a direct-current supply is available in the station, but if there is no supply, it is the only practical method. In power-houses where the alternators are called upon to do heavy overloads with a very variable power factor, the exciter must be designed to work satisfactorily over a wide range of voltage. The iron and flux densities must be so proportioned that the dynamo will be fairly steady at low voltages and yet be able to work at the highest voltage required without a saturation, but even with the most careful design it is practically impossible to prevent a shunt machine being somewhat unsteady when run at the lowest voltages. Another disadvantage, which is common to all direct-coupled exciters, and especially to the self-excited type, is that the exciter volts vary with irregularities in the prime mover speed, and this, together with the direct effect of the speed variation on the alternator itself, would cause very appreciable fluctuations of pressure at the alternator terminals.

The third method is certainly the most advantageous of the three. It is both steady and reliable, and it gives the closest regulation with the widest range. Provided the dynamo is of sufficiently ample design, it will be capable of working over a wide range of voltage with perfect stability and regulation, while the current required to excite its field would be so small that, even if the station had not a suitable direct-current supply, it could be obtained from a small battery or motor-generator, such as are used in many large stations to operate the remote-control switchboard gear, etc.—E. F. H.

[Other replies to Question No. 1,005 will be given in our next issue.—ED. *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it

QUESTIONS.

1,014. An electric supply company in a small country town having many small consumers purpose to use for distributors and services armoured cables. Give particulars of the relative advantages of using: (*a*) paper *v.* fibre dielectrics; (*b*) concentric *v.* twin-conductor cables; (*c*) looping in distributors from the street *v.* making T-joint services; (*d*) filling in joint-boxes *v.* leaving them empty and making red-lead joint on cover, with a view to facilitate testing.—J. A. R.

ANSWERS.

Question No. 1005.—Discuss the pros and cons of the three following methods of regulating the voltage of alternators: (1) Alternator derives exciting current from station direct-current main 'bus bars, regulating resistance being in series with field coils; (2) alternator derives exciting current from direct-current dynamo coupled to its shaft, the regulating resistance being in series with excitation dynamo field coils; (3) alternator derives exciting current from direct-current dynamo coupled to its shaft, the field coils of the excitation dynamo being in turn excited from the station direct-current main 'bus bars, and the regulating resistance being in series with the field coils of the excitation dynamo.

Answer to No. 1,005 (awarded 7s. 6d.).—Method No. 1.—Alternator is excited direct from direct-current main 'bus bars, shunt regulating resistance being in series with alternator field coils (see Fig. 1). This is a very common method of excitation in both large and small stations. It has its advantages and disadvantages, the greatest disadvantage being that in an alternating-current station with alternating-current distribution there is generally no accumulators. This at once creates a certain amount of risk, especially so as in most alternating-current stations, particularly single-phase, the works motors are all connected on the direct-current bars. A percentage of works

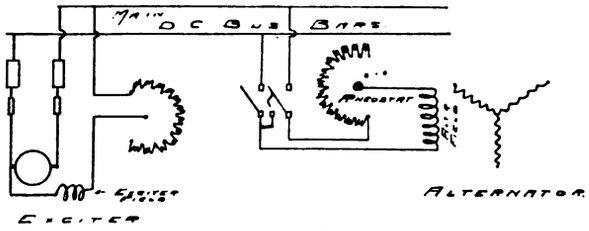

FIG. 1.

motors are usually placed in badly-lighted and inaccessible positions. These motors are more or less neglected, and the fuses, after being blown a few times, are replaced by copper links, which may on some unexpected occasion bring out the exciter brushes and shut down the supply. The cables leading to the various works motors are generally installed at odd times, and often run temporarily. These cables may develop an earth on one side of the direct-current system, which, if an earth develops on the other side in the alternator poles, will cause a short-circuit, and not only damage the alternator windings (there being no fuse in the exciting circuit), but will bring the direct current circuit breaker out, and shut down any other plant running. One advantage of this system is that if two or more machines are running in parallel excited from the station bars, and a sudden load comes on, the main supply voltage can be maintained by slightly raising the exciter voltage. A further advantage is the low capital cost compared to direct-coupled exciters, especially so in a station equipped with low-speed sets. A slow-speed exciter coupled to each main machine is an expensive item, whereas two or three small high-speed multipolar direct-current sets make a very compact and inexpensive part of an installation. A further advantage of this system is its flexibility, as any exciter can be run on any or all of the main units up to its full capacity

Method No. 2.—Alternator excited from direct-current dynamo coupled to its shaft, all regulating being done on the exciter fields, exciter being self-excited (see Fig. 2). The principal disadvantages are: Excessive capital cost of same, particularly if the alternators are of small size and of the slow-speed type, it being necessary to provide a slow-speed direct-current dynamo on each machine of 3 per cent. of each alternator's output. If the main sets are high speed this objection partially disappears, and if turbo-generators are installed, exciters direct coupled to the turbo-generator shafts form an ideal and compact installation. A rather serious objection to a direct-coupled self-excited exciter is that modern power units having large overload capacities (which in most stations is fully taken advantage of), and working on inductive loads, call for a wide range of exciting current and voltage. This large variation required causes the exciter to become rather unstable at low loads. This unstable element can be avoided by suitable means, as described in method No. 3. This system for high-speed stations is the most economical, both in capital and running cost. The shunt leads are very small, only having to carry the current required by the exciter fields. The shunt regulation will also be correspondingly small.

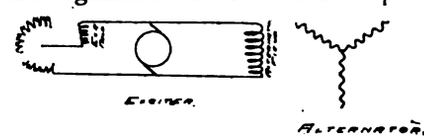

FIG. 2.

The watts lost in the shunt resistance is reduced to a minimum, due to the resistance being in the exciter shunt. The actual steam consumption, as compared with separate steam-driven exciters, is very small. A direct-coupled exciter consumes the same steam per hour per kilowatt as the main sets, and for units of, say, 2,000 kw., would be about 17·5lb. Separate steam-driven exciters, coupled to compound high-speed engines, would consume at least 35lb. per kilowatt-hour.

Method No. 3.—Alternator is excited from direct-current machine, direct coupled to main set. Direct-current machine is excited from main direct-current bars, shown by full lines in Fig. 3. For a modern station with high-speed sets or turbo-generators, this is the ideal and most reliable method of excitation. With low-speed sets it has the same objection as method No. 2—*i e*, high capital cost. This system is not open to the very serious objection that a self-excited exciter possesses, and will run satisfactorily from no load to 50 per cent. overload with perfect regulation. In its most simple form it is rather objectionable, in that any shut down of the exciter causes a large unit to be out of commission until the exciter can be repaired. This is not a great risk to take, as, perhaps, the exciter is the most reliable and easiest repaired part of the whole unit. In a modern station supplying power to large consumers at a very low price the capital costs have to be kept down to the very lowest, and there are not many large units standing as spare. In this case it is advisable to make the additions shown in dotted lines in Fig. 3. These additions consist of a connection from the main direct-current 'bus bars, through a double-pole shunt break switch, an extra rheostat, each capable of carrying the full load exciting current; also a pair of leads to a slate slab, fitted with links, on the alternator bed-plate. Under

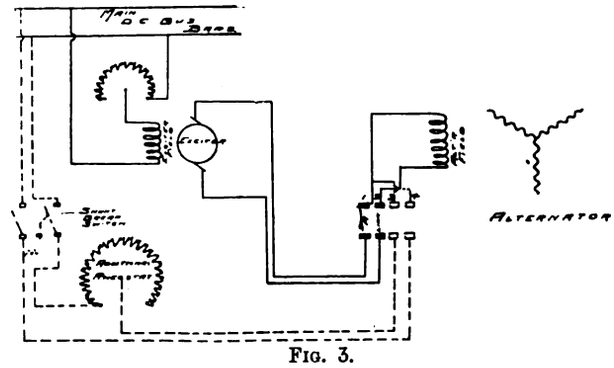

FIG. 3.

normal running conditions, shunt, A (for field ammeter), will be in position 1, with shunt break switch, B, and rheostat, C, in use. When, owing to any circumstances, it is not possible to obtain current from the exciter shunt, A, must be moved to position 3, and the copper link from 2 to 4. With these simple alterations the alternator can be run as a separately excited machine.—J. H. S.

Answer to No. 1,005 (awarded 5s.).—System 1.—The system of exciting has few good points, and bad points outweighing them. One of its chief disadvantages is that

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where there are several alternators running their excitation is dependent generally on one machine, to which, if anything happens, the whole of the alternators lose their pressure, and there is, consequently, an extinction. Then, again, if from the exciting dynamo any motors are driven, say, for instance, feed-pump motors, unless the engine driving the exciting dynamo is well governed, there are slight rises and falls in the pressure in the event of these motors coming off and on. This is also the case when the fields of the alternators are switched off and on These rises and falls are exaggerated when the exciting dynamos are not well compounded. In switching off and on the fields of alternators large currents have sometimes to be broken, hence if the non-inductive resistances across the field switches become inactive there is a liability not only of breaking down the insulation of the exciting dynamo, but also of the field coils. As large alternators have often fairly big field currents, which in this system have to pass through the regulating resistance, the latter often gets hot, and the wires sag and short-circuit. Sometimes bad contacts occur on the slide of the resistance, which, when the voltage of supply is low (frequently not above 60 to 80 volts), cause bad drops in the main voltage. The writer has known trouble to occur from the above causes. The system is good from a point of economy, as the combined efficiency is greater than in the other systems.

System 2.—The alternators are independently excited, hence doing away with the dependence on one dynamo for the excitation of several alternators, as in system 1. The pressure of excitation remains steady, which is another advantage over system 1. The regulating resistance being in series with the shunt field of the exciter has, therefore, only to carry small currents, thus doing away with the trouble mentioned in No. 1. Troubles sometimes occur in this system, due to non-excitation on starting, but with careful attention they can be eliminated. The system does not equal No. 1 for efficiency.

System 3.—The writer cannot see that any great advantage is to be gained by the method of exciting the field of the dynamo, except it be to do away with the troubles mentioned in No. 2, due to non-excitation on starting, which, as stated, ought not to occur with careful attention. On the other hand, the disadvantage of having the excitation of several alternators dependent on one arises. Granted the trouble due to the carrying of big currents through the resistance is done away with, but beyond that, if choosing between systems 1 and 3, the former would be preferable.—B. W. GOTHARD.

Question No. 1,006.—If the neutral point of a generator in a three-phase extra high-tension system is earthed, what objections are there to earthing the neutral point of the motor-generators also?

Answer to No. 1,006 (awarded 5s.).—It has been found that if two star-connected alternators, with their neutral point earthed, are running in parallel, a large earth current may frequently flow between the two neutral points of the machines. The same thing may happen when the neutral point of the star-connected generator and the neutral point of the motor-generator are earthed, and this is the reason for not earthing the neutral point of the motor-generators. The cause of these currents are the third harmonics of the wave forms of the machines. It is well known that at the neutral point of the star connections the third harmonics of the wave form (if they are present) give an alternating potential at three times the normal frequency of the alternator. These harmonics may give rise to capacity currents in the sheaths of the lead-covered cable, and the earth currents have often been attributed to this cause, but if there are capacity currents, then if we break the earth connection on the motor-generator there should be no flash, as there is an alternative circuit for the current—that is, through the alternator earth connection. It will usually be found, however, that if we have the neutral point on both alternator and motor-generator earthed, and we break the motor-generator earth connection, that we get a brilliant flash, which proves that this current is flowing between the machines and not between the machines and the cable sheaths, and are, therefore, not capacity currents, and by leaving the earth connection off the motor-generator we do away with these earth currents. As these earth currents may also flow between two generators running in parallel with both neutral points earthed, it would appear to be the correct thing to only earth the neutral point on one machine, or instead of inserting a low resistance in the earth circuit, as is usual, to insert an equivalent reactance. This would have the same effect as the resistance on all short-circuit currents of ordinary frequency, but would have a triple impedance for the third harmonic currents, and would tend to damp them down.—E. HAMER.

Question No. 1,007.—I have three 200-kw. induction motor-generators, high-tension current at 5,500 volts carried direct to motors, which are coupled direct to direct-current generators delivering current to a three-wire network at 460 volts across outers. On paralleling two machines, the machines take the load equally on direct-current side, but the alternating-current ammeters show on No. 1 set 27 amperes on each phase, and No. 2 set 15 amperes per phase. How is this? By inserting resistance in shunt field of No. 1 I can get the machines to take an equal amount of current from the high-tension mains, but not an equal load, of course, on the direct-current side. Phases tested and found correct.

Answer to No. 1,007 (awarded 7s. 6d.).—Several conditions would give the results obtained by "L. V. F.," and a little more detail in the query would facilitate the localisation of the trouble. The trouble might be due to the ammeters reading incorrectly; the meters should be changed over, using the instruments at present on No. 2 on No. 1 machine, and *vice versâ*, or, of course, the ammeters could be checked. Instantaneous readings taken on generator and motor circuits would show which instruments, if any, were incorrect. The question states that the phases have been tested and found correct; this is somewhat vague, and presumably means that the phase circuits have been tested for continuity and resistance. "L. V. F." mentions that the motor circuits take so much current *per phase*. Is there an ammeter in each phase, or is it assumed that the current is the same value in each phase? If the latter is the case, it is possible that the phase circuit containing the ammeter has one of the stator coils reversed—*i.e.*, connected up so that current flows around in the wrong direction; this would throw the phases out of balance and cause excessive current, particularly in this phase. Or, again, with a slightly unsymmetrical arrangement of windings, as, for instance, occurs with an odd number of pairs of poles, and the neutral point earthed, the ammeter, if placed in this phase, would read higher than if it were in other phases.

Failing any of the above causes, the writer would look for the trouble in the rotor circuit. If the rotor is of the squirrel-cage or short-circuited type, the joints between the rotor conductors and the short-circuiting rings should be examined to see that they are clean and making good connection, as if there is any resistance introduced in this circuit the motor circuit would take more current and run at less efficiency; the speed, also, would be slightly lower. If the rotor is of wound type with starting resistance, the starter should be examined to make sure that the resistance *is* all cut out at the last stop. The air-gaps of the motors should also be checked over.—ERG.

Answer to No. 1,007 (awarded 7s. 6d.).—Assuming the 200-kw. induction motor-generators are supplied from a 5,500-volt 25-cycle three-phase circuit, the current per phase absorbed by the motor at normal full load and when star-connected would be about 26 amperes, and for a 50-cycle circuit about 27 amperes. The question does not definitely state how the third set behaved, or whether we are to assume the same difference in the ammeter readings occurs when any two sets are running in parallel. It is stated that the phases have been tested and found to be correct. It is, therefore, of no use looking in this direction for an explanation. Now, if the generators give an output of 200 kw., the motor input must be equal to 200 kw. plus the inefficiency of the combined set. The power factor of the motor must also be taken into account when obtaining the current absorbed by the motors. The alternating-current ammeters should, therefore, give similar readings within, say, 5 per cent. with the same output. The input readings would, no doubt, vary slightly if the power factor and efficiency of the motors were not the same in each case; also one of the sets may be rather stiff in the bearings, which would, however, account for an ammeter reading on the high

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side—namely, above 26 amperes rather than below this—but as one of the motor-generator sets shows a reading of only 15 amperes, of course, assuming the full-load output, it points at once to either an error in the reading of the input ammeter or the output ammeter. The alternating-current ammeter transformers and meter should be thoroughly overhauled to see whether the correct ratio is obtained in the transformer, as it is here where the trouble is most likely to be located. Of course, the power readings could be definitely checked by means of a wattmeter on both the alternating-current and continuous-current sides if these are available. The 26-ampere input mentioned above is based on the assumption that the generator has an efficiency of 93 per cent., the motor 92 per cent., with a power factor of ·945 at full load. These figures represent the highest obtained in modern practice, which shows at once that the reading of 15 amperes must be incorrect if the set is giving an output of 200 kw.—H.

Answer to No. 1,007 (awarded 5s.).—Since the phases have been tested and found to be correct, it is obvious that the trouble is not in the induction motors, and, therefore, either (*a*) the ammeters in No. 2 circuit are wrong, (*b*) No. 2 mains are wrongly connected to supply, (*c*) No. 2 shunt regulator is wrongly connected, so that instead of inserting resistance in the generator field the latter is being strengthened. Dealing first with (*a*). The ammeters can easily be compared by connecting in series with ammeters in No. 1 motor circuit. It is quite possible for the instrument makers to have supplied current transformers having an incorrect ratio. (*b*) If the ammeters in No. 1 motor circuit are connected as shown in Fig. 1, and

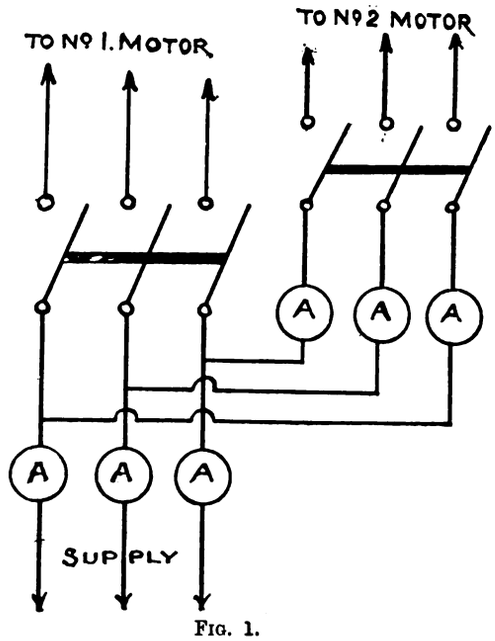


FIG. 1.

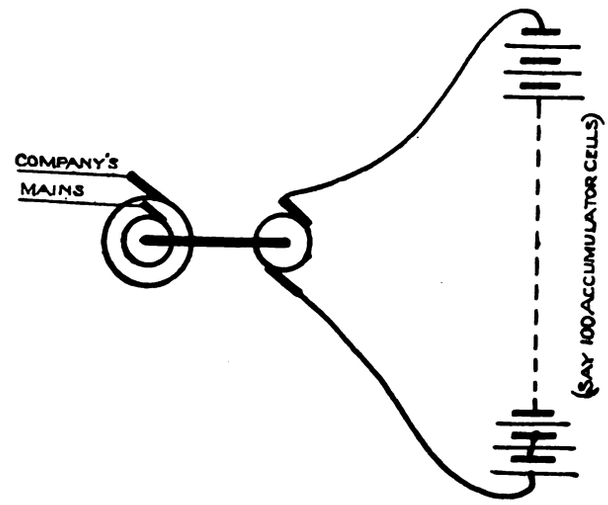
the main cables taken to No. 2 motor circuit from No. 1 switch terminals, then No. 1 ammeters will read the sum of the currents taken by No. 1 motor and No. 2 motor. The remedy is, of course, to connect No. 2 mains to the supply side of No. 1 motor's meters. (*c*) This fault, though very unlikely, is possible, and instead of No. 2 generator supplying current to the 'bus bars, it may actually be taking current, and driving No. 2 induction motor as a generator, as it is well known that if an induction motor be driven above synchronous speed whilst connected to a source of supply, current is supplied to the line through the primary winding.—P. H.

Answer to No. 1,007 (awarded 5s.).—A suggestion that might readily be put forward as a solution to this problem, is that there is a difference in the design of the high-tension induction motors as regards the length of air-gap of the two machines in question The power factor of an induction motor depends very largely on the length of air-gap, and it is important to keep the air-gap as small as mechanical consideration will allow. Considering our machines, this difference in air-gap will from the above cause one to work at a lower power factor than the other, and obviously the former will take more current from the line for a given load. The extreme shortness of the air-gap of induction motors is an important constructional feature, which forms a striking contrast to the relatively very long air-gap of the direct-current type of motor. Thus taking the case of the direct-current machines in question, the air gap in these will probably lie between 3mm. and 7mm., whereas the alternate-current machines in all probability would have a gap ranging from 1mm. to 3mm. The following table may be taken as representing the average performance of modern induction motors:

Horse-power	1	5	20	300	1,000
Efficiency at full load	80	85	88	93	95
Full-load power factor	0·80	0·84	0·87	0·91	0·94
Slip as percentage of field speed	10	6	4	2	1·2

—N.

1,008. *Re* attached diagram of a rotary transformer or motor-generator to transform from 2,000-volt, 100 ~, single-phase to 250-volt direct



current, I believe it is the general practice to start up on continuous-current side. This would entail special interlocking arrangements of switches. Give diagrams of switchgear necessary. The supply company supply at 500-volt direct current.—W. J. R

Best Answer to No. 1,008 (awarded 10s.).—Motor generator sets for converting single-phase alternating current to continuous current are usually of two varieties—viz.: (1) synchronous motor-generators and (2) induction motor generators. The former consists of a single-phase synchronous motor direct-coupled to a continuous-current generator, and an exciter, to supply the synchronous motor with field excitation, is usually mounted upon the same shaft. The second variety differs from the first in having a single-phase induction motor instead of the synchronous motor. The set in this case may be started up either from the alternating-current end or from the continuous current end. In the former case the induction motor will require to be provided with a wound rotor and an auxiliary or starting winding on the stator, together with the necessary phase-splitting device and rotor rheostat, while in the latter case the auxiliary winding on the stator is dispensed with, and the motor is usually provided with a squirrel-cage rotor. As single-phase induction motors do not admit of a good electrical design at high frequencies, we may, therefore, assume that the above motor-generator for operation on a 100 ~ circuit is of the synchronous type, and must, therefore, be started from the continuous-current end.

In the diagram accompanying the question the generator is shown charging about 100 accumulators. This at once suggests that the set be started from the accumulators. The generators in this case would probably be a shunt machine, but if a compound machine the series winding would require to be short circuited during starting up. The starting operations would be quite simple, and the only addition to the switchgear would be a starting switch and rheostat. The procedure in this case would be as follows: Assuming all of the switches controlling both machines to be open. Close the field switch of the generator and cut out all of the field rheostats. Close the main double-pole switch and cut out the starting resistance step by step. If the brushes on the generator have to be given a forward lead for normal working, it would be advisable to fix them somewhere nearer the neutral for

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starting up. When all of the starting resistance has been cut out, the set will be running at a little below its rated speed, and by cutting in the field rheostat the machine can be speeded up and the usual synchronising operations performed, when the synchronous motor may be switched in. The load or charging current may now be increased by strengthening the field of the generator in the usual way. In this case no interlocking of the switchgear is required, as will be evident from Fig. 1.

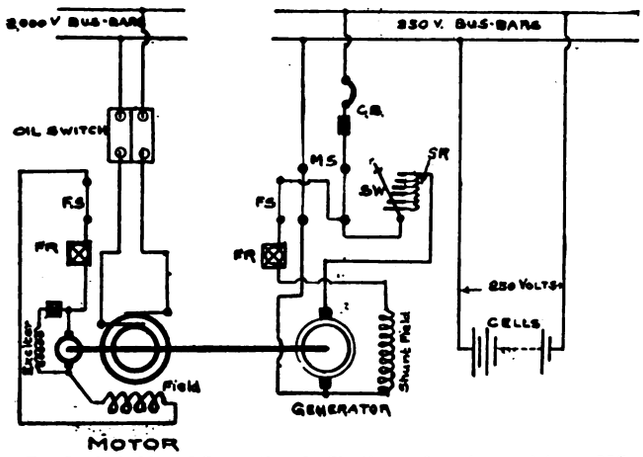


FIG. 1.—Switchboard Connections for Starting-up from Accumulators.—M S, main switch; C B, circuit breaker; S W, starting switch; S R, starting resistance; F S, field switch; F R, field rheostat.

If, however, there is only the 500-volt supply company's current available for starting purposes, the problem presents complications. In this case, the best results would be obtained by installing a motor-generator set of just sufficient size to start the larger set. This starting set may consist of a 500-volt direct-current motor, direct coupled to a 250-volt generator, or a "rotary transformer," having a common magnet system, but with independent armature coils and commutators—500 volts at one end and 250 volts at the other. The armature coils for the 500-volt end would have twice the number of turns per coil as those for the 250-volt end, while the single set of field coils would be arranged for excitation off 500 volts. Such a set would be very compact, and would be considerably cheaper than a corresponding motor-generator set consisting of two machines. As the set would only be in use for a short time the machines may be rated up to their commutation limit.

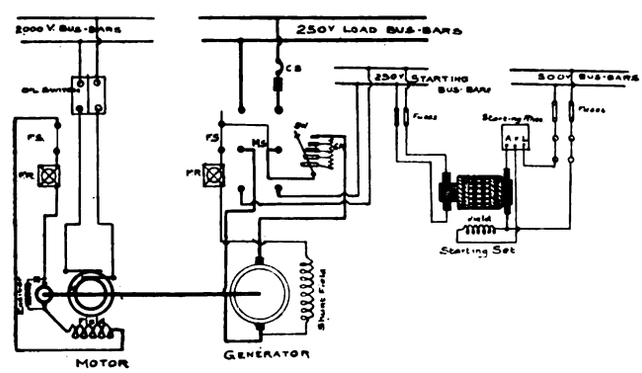
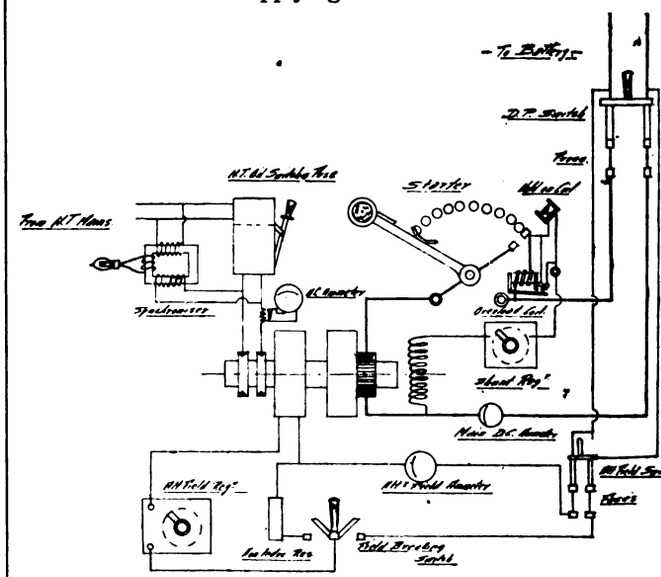


FIG 2.—Alternative Method of Starting.—M S, main switch (double-pole, double-throw); C B, circuit breaker; S W, starting switch; S R, starting resistance; F S, field switch; F R, field rheostat.

Considering this special starting set, the switchgear required is shown in Fig. 2. The starting and synchronising operations would be similar to those outlined above, with the exception, however, that the main generator would have to be disconnected from the starting 'bus bars and switched on to the load 'bus bars after synchronising has been done on the synchronous motor. Such a switching operation could be conveniently carried out by means of a double-pole double-throw switch, as shown in Fig. 2, which in itself would be interlocking, and, therefore, would not require any special interlocking attachment. In view of the simplicity attending the former method of starting—viz, from current supplied by the accumulators—we would suggest that this method be adopted, and the latter method only used when no continuous current is available for starting purposes.—A. E. T.

Answer to No. 1,008 (awarded 7s. 6d).—By suitably arranging the switchgear there is no necessity to have this interlocked, and by not doing so a good deal of expense is saved. The diagram herewith shows a suitable arrangement for the set The set is started up on the direct-current side off the battery by means of the starter shown. As "W. J. R." does not say the size of set used, I have shown a starter which would be suitable for a set up to about 60 kw., and for anything over this size it would be advisable to use some multiple switch type of starter, although in any case the starter need not be of a size equal to the full horse-power of the motor, as it will never be started up on full load. The shunt current passes through the hold on coil and shunt regulator, as shown. The main current passes through the overload coil, and if this reaches a predetermined value the armature shown is drawn up and short-circuits the hold-on coil by means of the two small studs shown, thus causing the starter to switch off the supply. For the alternating-current side an automatic high-tension oil switch is shown, also a synchroniser. For the field a field-breaking switch with non-inductive resistance shunt regulator and ammeter are supplied, also a double-pole switch and fuses. The direct-current ammeter should be of the moving coil type, and should either have a centre zero or else the zero not at the extremity of the scale, so as to be able to see when the direct-current machine is supplying current to the cells. The



method of operation is as follows: Close the double-pole switch on the battery side, cut out all resistance in the dynamo field, and start up by means of the starter. Adjust shunt regulator to give approximately correct speed and close field switches on the alternating-current machine. Adjust the alternator field to give correct alternating-current voltage and synchronise by adjusting direct-current field regulator. Then close alternating-current oil switch. By strengthening the direct-current field the generator may now be made to supply current to the cells. In the event of anything going wrong with the motor the fuses or oil switch will disconnect it from the line, and the generator will then run as a motor on light load off the battery, and the ammeter will show by deflecting to the left of the zero. A reverse-current device might be fitted, but is not necessary, as no damage would be done to the machine, and it would only take a very light load from the battery. The motor field is taken off the battery side of the double-pole switch, so that in the event of this being opened accidentally while the motor was running, the motor field would not be broken. To shut down, open the double-pole and also the high-tension oil-switch, then change over field-breaking switch and open field switch; an ammeter would be required, as shown, on the alternating-current side, and owing to the high voltage would probably be of the transformer type. It would also be advisable to provide voltmeters for both sides of the set.—E. V. C.

[Other replies to Question No. 1,008 will be given in our next issue.—ED. *E. E.*]

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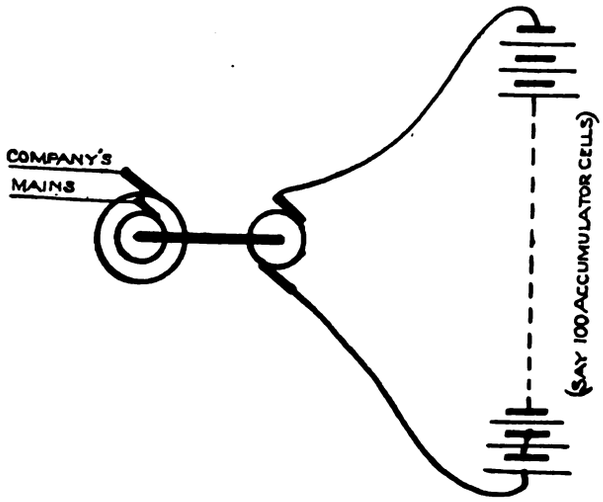
TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

ANSWERS.

1,008. *Re* attached diagram of a rotary transformer or motor-generator to transform from 2,000-volt, 100~, single-phase to 250-volt direct



current, I believe it is the general practice to start up on continuous-current side. This would entail special interlocking arrangements of switches. Give diagrams of switchgear necessary. The supply company supply at 500-volt direct current.—W. J. R

Answer to No. 1,008 (awarded 5s.).—Whether switchgear controlling rotary converters and their like requires

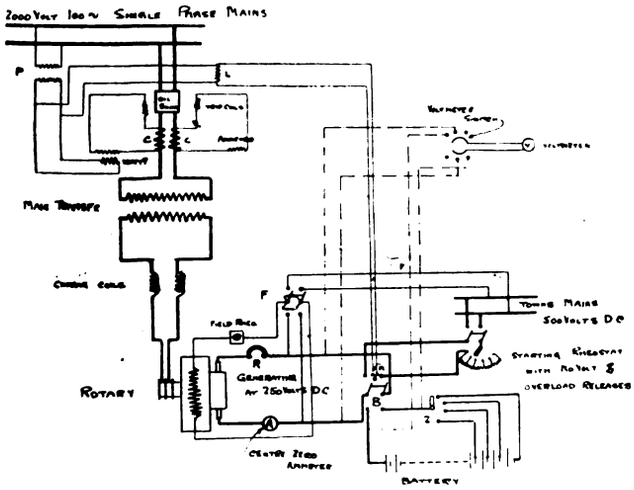


Fig. 1.—Diagram of Connections.—P, potential transformer; C, current transformer; L, low-voltage attachment for oil-switch; M, auxiliary contacts on top throw of switch (for interlocking with oil-switch); R, circuit breaker (automatic); Z, battery switch; B, D.P.D.T. lever switch for starting-up and charging battery; F, D.P.D.T. field switch interlocked with "B" and provided with discharge contacts and resistance. NOTE.—Battery gear not shown.

interlocking depends almost entirely upon the conditions of starting up the machines and the working of same. In this particular case it has been understood that it is required to start a high-tension single-phase rotary from the direct-current end, and when running the direct current generated to be used for charging battery, etc., the town's mains being available for starting. The diagram (Fig. 1) shows the complete connections for such requirements, and apparatus essential for the proper working has been included, with the exception of that for the battery.

With regard to the "interlocking" necessary, this can be summarised as follows: (1) B should be interlocked with oil switch, and (2) F should be interlocked with B. It is necessary to interlock B with the main oil switch, so that the latter cannot be closed when the machine is being started from the direct-current side, and it will be also seen that it is necessary to have the field made before starting, hence the interlocking between F and B. To deal

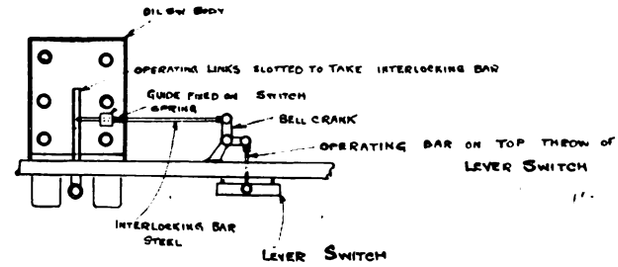


FIG. 2.—Plan showing Interlock between Oil and Lever Switches.

with the first interlock arrangement, auxiliary contacts have been shown on diagram, these shorting the low-voltage attachment on the oil switch, but as a better and more reliable form for arranging the interlock a mechanical arrangement has been shown in Fig. 2. Interlock No. 2 is taken care of by a mechanical arrangement between the two switches, and as shown in Fig. 3. This interlock not only ensures F being closed before B, but also that F must

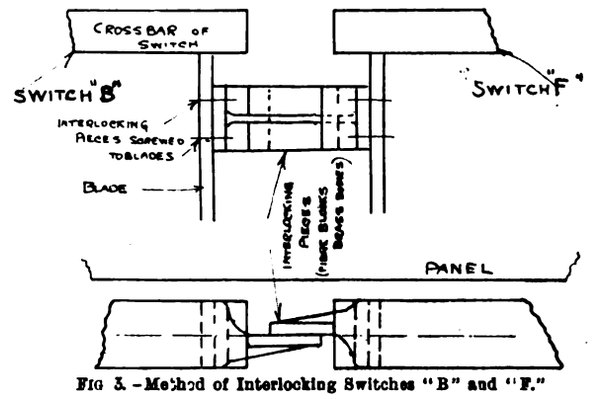


FIG 3.—Method of Interlocking Switches "B" and "F."

be closed on the top throw when starting—*i.e.*, when B is on the top throw. Reaction coils are shown in the alternating-current side, as these are generally provided as they are found to assist in providing a steadier regulation on the direct-current end. Synchronising connections are only necessary where more than one rotary has to run off the alternating-current supply.—T.

Answer to No. 1,008 (awarded 5s.).—From the wording of the above question, in conjunction with the diagram, it would appear that the supply company supply alternating current at 2,000, volts 100 periods single-phase, and direct current at 500 volts. The writer cannot understand why the latter supply is mentioned when the conversion is to 250-volt direct current, unless it is intended or necessary when starting up on the direct-current side to run up off the 500-volt circuit and change over to the 250-volt bars. It is explained below how this can be done. Taking motor-generators as the means of conversion of single-phase current at 100 periods to direct current, there should be no difficulty in running up on the direct-current side from the 250-volt circuit, providing the battery of accumulators shown in the diagram be of sufficient capacity. The alternating-current supply being single-phase, it is certainly preferable to start up on the direct-current side, not only on account of the excessive current taken by any large size self-starting single-phase motor, but on the question of initial cost of the plant.

Fig. 1 gives connections and switchgear necessary for an induction motor-generator starting up off the 250-volt 'bus bars. The alternating-current supply is taken through isolating plugs or switches, and a double-pole oil-break switch fitted with overload relay (connections not shown). The direct-current supply is taken through a circuit breaker, double-pole switch, and starting resistance. The field circuit is arranged with a switch regulating resistance

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and a non-inductive resistance for taking the discharge when the field circuit is broken. In starting up the alternating-current switch must be open and machine brought up to a speed just below synchronism, as shown by a tachometer; then the alternating-current switch is closed and the direct-current field strengthened so that direct current is generated. A shunt trip coil fitted to the direct-

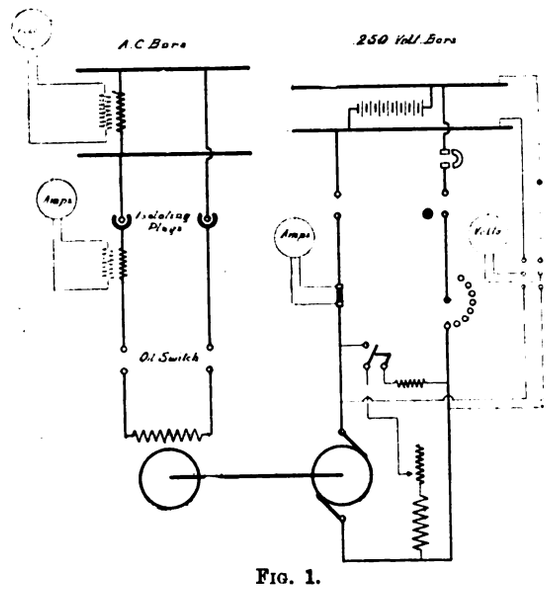


FIG. 1.

current breaker and actuated by the closing of the alternating-current oil switch could easily be arranged, and any difference between the direct-current machine pressure and that of the 'bus bars could be altered before replacing the breaker.

The second arrangement (Fig. 2) is that of a synchronous motor-generator started up off the 250-volt 'bus bars. The extra switchgear necessary would be a pressure transformer on the machine side of the oil switch, and a synchronoscope

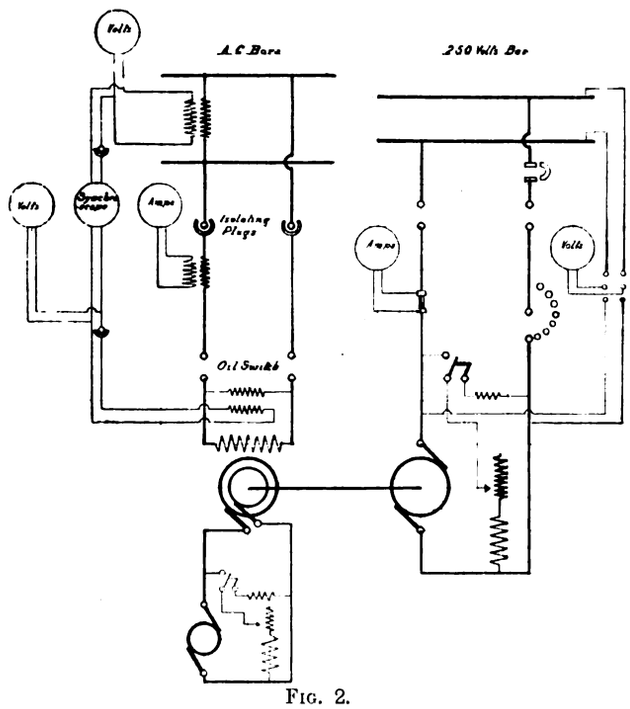


FIG. 2.

for paralleling; also similar switchgear would be required for the field circuit of the alternating-current motor as the direct-current generator.

In the third arrangement (Fig. 3) the writer has presumed that it is required to start up on the direct-current side off the 500-volt supply, the machine being suitable for generating at 250 volts. F R is a fixed resistance (either water or metallic) in the armature circuit for keeping down the pressure across the armature to 250 volts. The field circuit to be separately excited off the 250-volt bars to keep normal pressure across the fields. The amount of resistance necessary in the main circuit can easily be calculated when the no-load armature current at 230 volts is known. The connections on the alternating-current side are not shown, as this would be the same as described above. When the alternating-current switch is closed the double-throw switch is then opened, and machine pressure adjusted previous to plugging on to the 250-volt 'bus bars.

It is apparent from the switchboard gear necessary that the first arrangement is by far the cheapest, apart from the

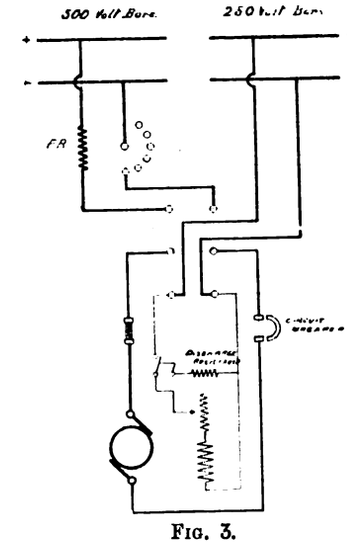
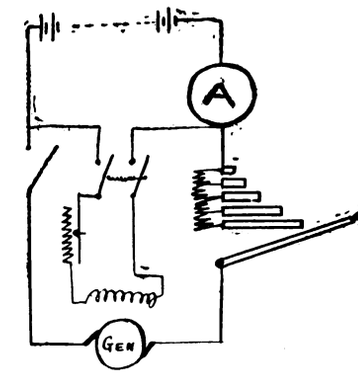


FIG. 3.

fact that an induction motor will be found to be cheaper than a synchronous one.—S. E. T.

Answer to No. 1,008 (awarded 5s.).—As a battery is available, the starting up of the motor-generator is a very simple job. The direct-current machine simply requires a field switch, an ordinary main switch on one pole, and on the other pole a four-step starting knife switch, and an ammeter. An interlocking arrangement is not really necessary. The knife starting switch is about the safest, simplest, and easiest to use, and with the ammeter fixed just above no serious mistake can be made—unless deliberately. To start up the machine, close the field switch, and see that all the rheostat is out—*i.e.*, with strongest field—then close main switch, and then bring starting switch to the first contact. Wait until the



ammeter pointer has come down to a low figure, then put it on the next stop, and so on until it is full in. If a synchronous motor, synchronise it; if not, simply close the alternating-current switch.—V.

Question No. 1,009.—An induction motor may be loaded until the slip reaches a certain value depending on the design—say, 20 per cent.—after which further load causes the machine to stop dead. How is it that if this motor is connected in cascade with a similar motor, it will run satisfactorily with a slip of over 50 per cent. ?

Best Answer to No. 1,009 (awarded 10s.).—The torque developed by an ordinary induction motor varies with the speed approximately as shown in Fig. 1. The torque reaches a maximum value at some small slip (10 to 20 per cent.), which for the particular motor represents the point at which useful flux × useful current is a maximum. Should the slip increase (speed fall), the current taken by the motor will still increase, but, owing to the increased magnetic leakage set up by this increased current, the above product

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falls, and the torque is lowered. The motor, therefore. stops dead if loaded above the torque corresponding to this critical current. At lower speeds a torque is still developed, but no use can be made of this, because, from the shape of the torque curve, the motor is obviously unstable between maximum torque and standstill.

Turning to the cascade connection, the chief difference lies in the fact that, whilst with the ordinary motor the current induced in the rotor is used only in the rotor windings, or in the regulating resistances inserted in them, with the cascade connection the current induced in the one rotor circulates round part of the second motor (either the rotor or the stator), and does useful work in this second

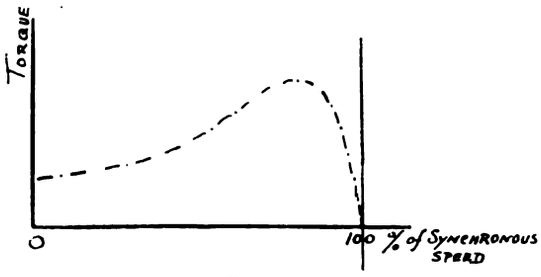

FIG. 1.

motor. This second motor drives the same shaft as the first, and, therefore, adds its torque on to that of the first; and this combined torque, instead of being a maximum at a little below full speed is a maximum at a little below half speed—*i.e*, with a little more than 50 per cent. slip.

The way in which the two torques and the combined torque vary with the speed is shown in Fig. 2. Suppose that the cascade connection adopted is that involving the electrical connection of the two rotors, and that the stator of motor I. is switched on to the supply volts whilst the stator of motor II. is short-circuited. At standstill a heavy supply current will be taken and a heavy current will be induced in rotor I. with the full supply frequency, and will pass round rotor II., and act as the primary current of motor II. Both motors will exert a small starting torque and the set will start. As the speed rises the current in

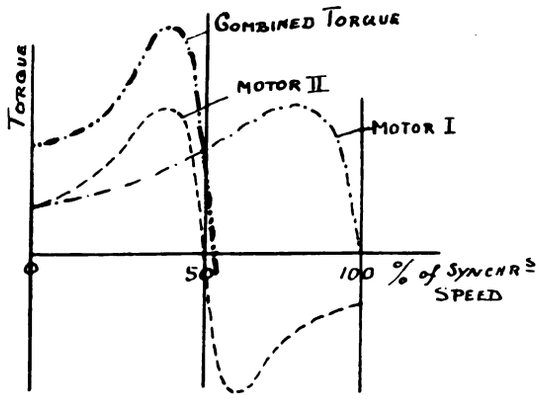

FIG. 2.

rotor I. falls in amount and also in frequency: its frequency being always = supply frequency –

$$\frac{\text{revolutions per minute of rotor} \times \text{number of poles of motor}}{120}$$

This lower frequency current passes into rotor II. and makes the rotating field produced by the rotor II. windings revolve at the speed of

$$\frac{\text{frequency of rotor current} \times 120}{\text{poles}} \text{ revolutions per minute,}$$

and the connections between the two rotors are so made that this field revolves in the *opposite* direction round rotor II. from the direction of rotation of the spindle. Under these circumstances the speed at which the working flux cuts the conductor of stator II. is

$$\frac{\text{frequency of rotor current} \times 120}{\text{poles}} - \text{revs. per min. of shaft.}$$

So that the frequency of the stator II. current as well as their amount fall rapidly with increasing speed of shaft. Owing to reduced leakage (with the reduced currents) the torques of motors I. and II. increase until at some speed just short of half speed the maximum torque of motor II. and the maximum combined torques are reached. Should the speed rise to exact half speed the torque of motor II. becomes zero, because the field poles produced in rotor II. then move just as fast forward, due to the rotation of the spindle, as they move backward, due to the interaction of the windings (now fed by a current of just half normal frequency from rotor I.). There is thus no cutting of flux by the conductors of stator II. and no current induced in the latter, so that motor II. is idle, and the only torque on the spindle is that due to motor I. with 50 per cent. slip. Any rise in speed of spindle above half speed would still further reduce the net torque, for motor II. then commences to act as an induction generator—the field pole of rotor II. moving round in space in the same direction as the spindle rotates in.

Though the set runs satisfactorily at about half speed in cascade, this result is chiefly due to motor II., and motor I. only adds the small torque, it would in any case be able to develop at a slip of 50 per cent.—Q.

Answer to No. 1,009 (awarded 7s. 6d.).—The performance of a direct or alternating current motor may be expressed by a series of curves, known as the characteristic curves of the motor. These curves generally show the relations between the various electrical quantities with the current—*i.e.*, with the load on the motor. One of the chief characteristic curves of the induction motor is that known as the slip-torque curve—that is, the curve showing the relation between the slip and the torque exerted by the motor—*i.e.*, the relation between slip and the load on the motor. (By slip will here be meant the difference between the speed of the rotating magnetic field and the speed of the rotor.) The general shape of this curve is shown in Fig 1 (Curve (*a*). From an inspection of this curve we see that an increase of torque—*i.e.*, an increase of load on the

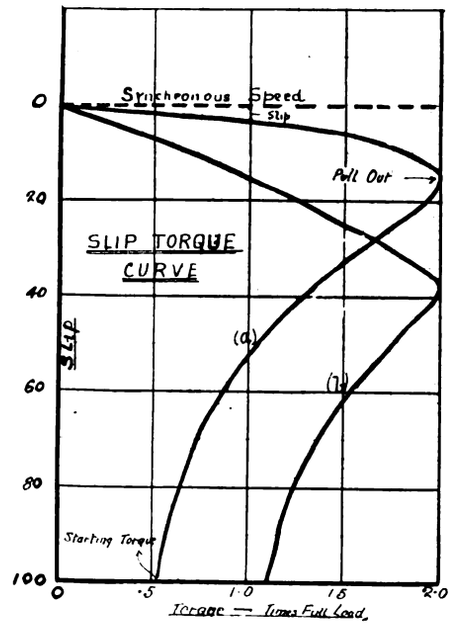

FIG. 1.

motor—produces an increase of slip. The slip gradually increases with torque until the maximum torque—occasionally called pull-out torque—is reached. A further increase in load cannot now be overcome by the torque developed by the motor. Consequently, both speed and torque diminish until the motor finally stops, as shown by the curve. The point where this curve cuts our horizontal axis gives the starting torque of the motor. The increase of slip with load may be explained as follows: The E.M.F. developed in the rotor will depend on the rate with which the rotor cuts the magnetic lines of force. That is, it will be directly proportional to the difference between the speeds of the rotating field and the speed of the rotor—*i.e*, rotor E.M.F. is proportional to the slip, and so also will be the rotor current. The rotor current will in turn be inversely proportional to the resistance in the rotor

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circuit. Now, the torque exerted by the motor will depend on the strength of the rotor current, hence the slip will be proportional to the torque—*i.e*, the slip will increase with the load on the motor.

Let us now turn our attention to the effect of resistance in the rotor circuit. If the rotor circuit of an induction motor have a resistance, R, and carry a current, C, the total power taken by motor (or rather the power exerted by motor) may be expressed as $C^2 R$. But this power may also be expressed as the product of the torque exerted by motor and the speed of the rotor (in radians per second) relative to the rotating field. That is: Power = torque exerted by motor × slip (radians per second),

$$\therefore P = 2\pi S T,$$

where S = slip in revolutions per second and T = torque exerted by motor.

Hence, $$C^2 R = 2\pi S T,$$

$$\therefore T = \frac{C^2 R}{2\pi S} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Now, we have already seen that the rotor current is directly proportional to the slip and inversely proportional to the resistance in the rotor circuit—*i.e*,

$$C = K \frac{S}{R} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where K is some constant, S = slip, and R = resistance in rotor circuit.

The actual value of the rotor current is

$$C = \frac{\pi S p Z}{\sqrt{2} R},$$

where p = number of pairs of poles of motor and Z = total number of lines forming the rotating field. (See C. F. Smith's "Practical Alternating Currents," first edition, p. 355.)

Substituting this value of C (equation 2) in equation (1), we have

$$T = K^2 \frac{S^2}{R^2} \cdot \frac{R}{2\pi S T} = K_1 \frac{S}{R} \quad . \quad . \quad . \quad (3)$$

That is, the torque varies directly with the slip and inversely with the resistance in the rotor circuit.

From equation (3) we see that for a given torque, T—*i.e*, for a given load on the motor—the value of $\frac{S}{R}$ must be constant. That is, if we increase R, S must be increased in the same proportion in order that the torque exerted by the motor may still overcome the load. Whence we get the important inference that with a given load on the motor, the slip at which the motor will overcome this load may be increased provided the resistance of the rotor circuit be simultaneously increased. Curve *b* (Fig. 1) shows the effect of increasing the resistance in rotor circuit in the shape of the slip-torque curve. In the cascade arrangement the rotor of motor No. 1 is directly connected to the stator of a second motor, the rotor of this motor being connected to a starting resistance. This means that the resistance of the rotor circuit of the first motor is increased, the increase being the resistance of the stator of No. 2 motor. Hence, as explained above, the slip at which motor No. 1 will now overcome the load will be increased.—D. JENKINS.

Answer to No. 1,009 (awarded 5s.).—In the cascade method of connecting two similar induction motors, the two rotors are rigidly connected to the same spindle. The stator of No. 1 motor is connected to the line, and its rotor is connected to the rotor of No. 2 motor, the stator winding of No. 2 motor being short-circuited either directly or through a resistance. The connections are such that the currents induced in No. 1 rotor when the combination is rotating in a given direction produces a field in No. 2 rotor rotating in the opposite direction.

The maximum theoretical speed when the motors are connected in cascade cannot exceed one-half of that of one motor connected direct across the line—that is, the slip must be at least 50 per cent. This will be quite clear if the system is examined closely. At half speed the slip of the rotor of No. 1 motor will be 50 per cent., and the frequency of the rotor field in No. 2 motor will be equal to one-half that in No. 1 stator, for, of course, the frequency in No 1 rotor must equal the slip in No. 1 motor. The speed of the rotor is proportional to the frequency, other quantities remaining the same. The action of the primary on No. 2 motor will be to induce it to rotate at synchronous speed and frequency, and since the rotors of each of the motors must run at the same speed, the second is in synchronism with its field when the slip of the first is 50 per cent. It is impossible for the motors connected in cascade to run above half speed, as then the difference between the frequency of the stator field and the cycles induced in the rotor of No. 1 motor would be less than half frequency and No. 2 motor would act as a generator, and the rotor current in No. 1 motor would become reversed, causing it to act as a generator and return current to the line.

The action of the two motors may also be explained as follows. Suppose the combination were by some means brought up to within 5 per cent. of the synchronous speed, a current will be produced in No. 1 rotor having a frequency of 5 per cent. of the line frequency. The frequency in rotor No. 2 will also be 5 per cent, so that if we call the full synchronous speed 100, the speed of rotation of the rotor relative to the speed of the rotating field in No. 2 motor is as 95 is to 5, the difference being 90, which means that No. 2 machine would act as a powerful generator, producing a large current in No. 2 stator, and requiring a large torque from No. 1 motor. This torque will produce a drop in speed, which will give more slip in No. 1 motor, and, consequently, a higher rotor voltage in both rotors, so that though the difference in the speed of rotor and the rotating field in No. 2 motor will fall to (90 − 10) = 80, yet the current induced in No. 2 stator will actually increase, for the rotor voltage being doubled the flux set up in No. 2 motor will also be doubled, and the inducing effect on No. 2 stator, instead of being proportional to 90 × 5 = 450, as with 5 per cent. slip, will now be proportional to 80 × 10 = 800. This increased current in No. 2 stator will demand more torque from No. 1 motor, and a further drop in speed will result. This will continue until a slip of 25 per cent. occurs in No. 1 motor, when the power generated in No. 2 stator will be a maximum. After that the speed would continue to fall, as the torque of No. 1 motor at 25 per cent. slip would be quite insufficient to supply the requirements of No 2 stator. The current in No. 2 stator would gradually fall off as the slip increased from 25 per cent. to 50 per cent., as shown in the following approximate table:

Slip in No. 1 motor.	N—Net speed of magnetic field in No. 2 relative to stator conductors in No. 2.	F—Flux in No. 2 motor proportional to	F × N = inducing effect on No. 2 stator.
0	100 − 0 = 100	0	0
5	95 − 5 = 90	5	450
10	90 − 10 = 80	10	800
20	80 − 20 = 60	20	1,200
25	75 − 25 = 50	25	1,250
30	70 − 30 = 40	30	1,200
40	60 − 40 = 20	40	800
50	50 − 50 = 0	50	0

When the slip is 50 per cent. there will be no current induced in No. 2 stator, for the rotating field set up by the rotor windings in No. 2 will rotate backwards just as fast as the rotor itself forward, thus producing no relative motion between the stator winding and the magnetic field in No. 2. At the same time, No. 1 motor at half speed will be capable of exerting a small torque, even rather less, however, than an ordinary induction motor at half speed, owing to the fact that in the later the rotor would be short-circuited through a non-inductive resistance, whilst in the case under consideration it is short-circuited through the highly inductive winding of No. 2 rotor. If now an external load is put on the combination when running at half speed, the speed will drop slightly, and then No. 2 motor will come into action exactly like an ordinary induction motor, producing its maximum torque with an excess of 5 or 6 per cent. of the speed of the rotating field of No. 2 motor over the speed of rotation of the rotors as usual.—E. HAMER.

[Other replies to Question No. 1,009 will be given in our next issue.—ED. *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers.

QUESTIONS.

1015. A high-tension three-phase line consists in part of bare overhead conductors and in part of underground mains. Sketch and describe the terminal pole of the overhead line, showing how you would connect to the underground mains.—J. W. F.

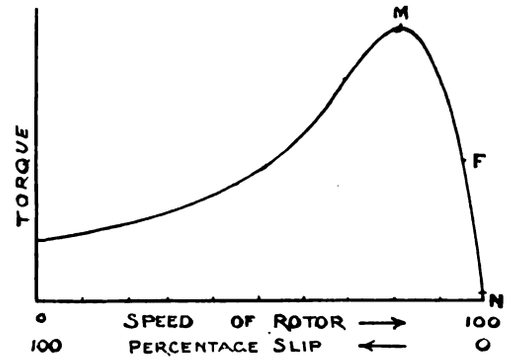
1016. Give reliable data relating to electric *versus* steam driven machinery for the soap manufacturing industry and for textile mills, also a good book on same.—READER.

1017. Discuss the design of a magnet, solenoid type, fitted with a core which will lift a weight of 4lb. through a distance of 1½in.—B. H.

ANSWERS.

Question No. 1,009.—An induction motor may be loaded until the slip reaches a certain value depending on the design—say, 20 per cent.—after which further load causes the machine to stop dead. How is it that if this motor is connected in cascade with a similar motor, it will run satisfactorily with a slip of over 50 per cent.?

Answer to No. 1,009 (awarded 5s.).—The explanation for the difference in slip for the two methods of working is given here by describing what happens when motors are started up and loaded in each case.



First, when connected as ordinary induction motors. When the current is switched on to the stator, it produces a revolving magnetic field whose speed will depend on the number of poles of the machine and the frequency of the supply. This field cutting the rotor conductors induces in them a current having at that instant the same frequency as the supply. This current and the field will together produce a torque, and the rotor will turn. The value of this torque is equal to the product of the field, the rotor current, and the cosine of the angle of phase difference between the field and the current Owing to the fact that the rotor frequency is high, the reactance of the rotor current is large, and, therefore, the cosine of the angle of lag is small, so that the starting torque is small. If a resistance is inserted in the rotor circuit, the current will be reduced, but the reduced current will be brought more in phase with the field, which will more than compensate for its reduction, so that the torque will be improved. As the rotor speeds up the frequency of its currents will decrease, so that its reactance will decrease and the current will come more in phase with the field producing a greater torque and enabling the starting resistance to be cut out. This continues till within about 20 per cent. of synchronism, and from this point onward the rotor current is practically in phase with the field, and the torque commences to decrease because the current decreases, owing to the fact that the field cuts the rotor conductors much slower than before inducing in them only a small E.M.F. Finally a speed is reached when the current is just sufficient to produce the torque required for light running; this corresponds to point N on speed torque curve. Now, suppose load is put on, the rotor will slow down a little so that sufficient current is produced in it to supply the torque required by the load. The point F will about correspond to full load. If rotor is loaded further, the speed will fall until point M is reached; this corresponds to the maximum load that the motor will take, and, as observed by "Saxon," corresponds to about 20 per cent. slip. If rotor is loaded further, it stops, for, although the rotor current will increase, its reactance will increase more in proportion owing to the increased frequency, and, therefore, torque will decrease. This is shown on curve by the decrease of the torque to the left of the point M.

Now consider, second, the action of two similar motors connected in cascade. At the instant the current is switched on to the stator of motor 1, the frequency of the current in its rotor is the same as that of the supply; and as rotor 1 supplies current to stator 2, the frequency here is also same as that of supply, and ditto rotor 2. A starting torque is, therefore, exerted by both motors. As the motors increase in speed the frequency in rotor 1 decreases, therefore frequency in stator 2 decreases; and rotor 2 being mechanically connected to rotor 1, the difference in frequency between currents in stator and rotor of motor 2 will be less than the difference of stator and rotor current in motor 1. Now suppose it were possible for rotor 1 to run at 50 per cent. slip, the currents in rotors 1 and 2 would have half the supply frequency, and as rotor 1 supplies stator 2, motor 2 will be running at synchronism. Rotor 1 cannot speed up any more, because by so doing the frequency of the currents in rotor 2 would be greater than the frequency of the currents in stator 2—*i.e.*, motor 2 would generate and send current back into rotor 1. Therefore, synchronous speed of combined set is half synchronous speed of the single motor. It might be mentioned here that the starting torque may be improved, as in the case of the ordinary induction motor, by inserting resistance in the circuits of rotor 2. On loading the combined set the speed slows down after the manner of the ordinary induction motor described above. The synchronous speed will only be half synchronous speed of single motor when the two motors have the same number of poles For instance, if a two-pole motor has its rotor connected to the stator of a four-pole machine, the maximum speed of the set will be one-third the synchronous speed of the two-pole motor; for, assuming supply frequency to be 60, if rotor 1 makes 20 revolutions per second, the frequency of its currents will be 40. Now, stator 2 having four poles, and supplied with current at 40 cycles, its synchronous speed will be 20 revolutions per second, and, therefore, this is maximum speed of set. It might be mentioned that these sets are not so efficient as the ordinary induction motor owing to the large copper losses, the high frequency in rotor 1 causing a poor power factor.—F. H. CLARK.

Question No. 1,010.—An induction motor with a three-phase rotor works on a load which varies as the cube of the speed. Show how to design a regulating resistance to give any desired reduction in speed.

Best Answer to No. 1,010 (awarded 10s.).—This problem is an interesting one to solve analytically, but being rather complicated I propose to give a graphical solution, involving only those data which can be obtained by a fundamental knowledge of the design of an induction motor. For simplicity I have assumed a motor taking 10 b.h.p. at 960 r.p.m., the synchronous speed being 1,000 revolutions, which corresponds to a 4 per cent. slip, and a rotor C^2R loss of about 300 watts. I have also assumed that at above load the amperes per phase in the rotor are 50, with a rotor voltage per phase of two volts. It will be noticed that from these figures the voltage of the rotor when standing on open circuit will be 50 per phase. The curve for this is given in Fig. 2 (No. 6). All of the above figures may be determined if one knows the number of turns on the stator and the rotor and the rotor resistance.

Now, the power of the motor varies as N^3, where N = revolutions per minute. In our case

$$B.H.P. = 1{\cdot}13 \times 10^{-8} \times N^3.$$

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This is plotted in Fig. 1 (No. 1). Also

$$\text{B.H.P.} = \frac{\text{torque (foot-pounds)} \times 2\pi \times N}{33{,}000}.$$

From which the following equation is deduced:

$$\text{Torque} = \frac{1{\cdot}13 \times 10^{-8} \times N^2}{2\pi} \times 33{,}000 \text{ foot-pounds.}$$

This is plotted in curve No. 2. In order to get the total torque to be exerted by the rotor we have to add that corresponding to the losses. These have been allowed for as follows: friction, windage, and rotor core loss have

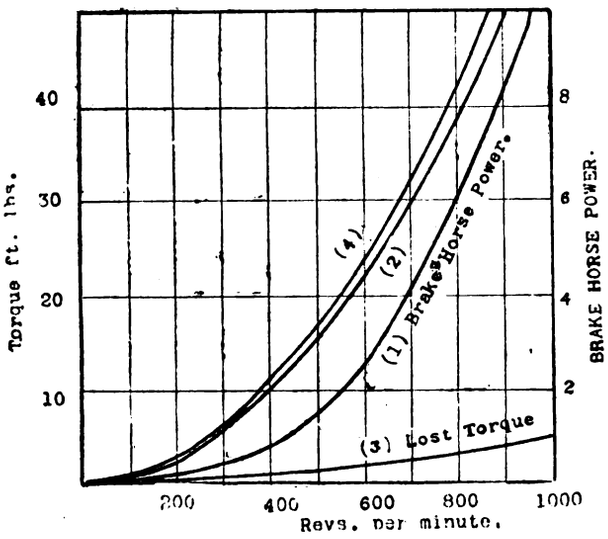

FIG. 1.

been assumed proportional to the speed, and having the value of 4 per cent. at the highest speed; while the C^2R loss has been taken as proportional to the square of the torque, being equal to 4 per cent. at the highest output. These are given as a total in No. 3, which, when added to the corresponding ordinates of No. 2, give the total torque to be exerted (see curve No. 4).

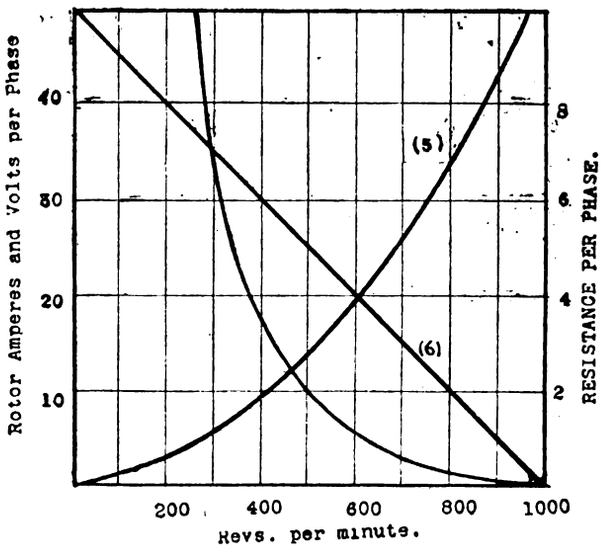

FIG. 2.

Now, since torque varies as flux × current, and the flux is practically constant, we may by altering the scale of the torque curve obtain the curve of rotor current. This has been done in No. 5 such that at 960 r.p.m. the current is 50 amperes. Now, by dividing the rotor voltage by the rotor current corresponding to the same speed, it is clear we get the impedance required in the rotor circuit, and as the self-induction of the rotor may be ignored – since when the total impedance is small the speed is high, so that the periodicity of the rotor current is small, and when the speed is low the resistance is by far the larger component—the external resistance required is given by the ordinates of curve (7) less the value of that for 960 revolutions, which may clearly be ignored. So for all practical purposes curves 7 and 5 give the resistance and its current-carrying capacity for any speed.

In the case of small motors, where the stator C R drop is considerable, the currents on lighter loads will be reduced, owing to the slightly increased stator flux on no load, but this correction is very seldom of sufficient importance to make.—J. P.

Answer to No. 1,010 (awarded 7s. 6d.).—The synchronous speed in revolutions per minute of an induction motor having a rotor of the type specified is equal to the number of complete cycles per second multiplied by 60 and divided by half the number of poles in the stator winding; but some slip must take place before any voltage is induced in the rotor, so that it is seen that maximum voltage is induced when the rotor is stationary—*i.e.*, when there is the maximum slip. The rotor voltage is for all practical purposes proportional to the slip (the slip being the difference between the actual and synchronous speeds), the torque also being proportional to the current in the rotor. Now, as the power in the case under consideration varies as the cube of the speed, it is evident that at reduced speeds the torque and, consequently, the rotor current will become very small, and a proportionately high resistance will be required. Perhaps the simplest way to make the above clear will be to take an example, leaving out of consideration the efficiency of the motor for the sake of simplicity.

Example.—100-h.p. motor; synchronous speed, 1,000 r.p.m.; slip-ring volts per phase, 350 volts per phase; slip-ring to neutral, 202; rotor amperes per phase, 123; rotor Y connected.

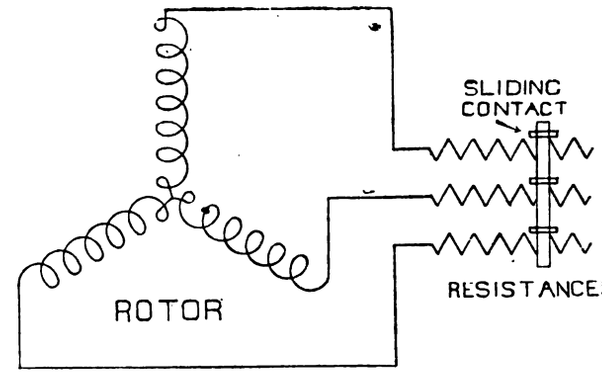

FIG. 1.

Fig. 1 shows in diagram the arrangement of resistances the various sections of which can be short-circuited as desired, either one section in each phase simultaneously or alternately, according to the design of the switch. The former method is, however, desirable, as the phases are then kept properly balanced. Now, as stated above, the power in this case varies as the cube of the speed, therefore the torque will vary as the square of the speed, and as the torque and rotor current are proportional, the rotor current will also vary as the square of the speed.

Suppose a 20 per cent. reduction in speed is required, then rotor amperes will be $\frac{800^2 \times 123}{1{,}000^2} = 79$ amperes, and rotor volts 20 per cent. of 202 = 40·4, and from this we obtain resistance required $= \frac{40{\cdot}4}{79} = {\cdot}512$ ohm per phase.

Similarly, for 40 per cent. reduction in speed, rotor amperes per phase $= \frac{600^2 \times 123}{1{,}000^2} = 44{\cdot}2$, and rotor volts 40 per cent. of 202 = 80·8; resistance required $= \frac{80{\cdot}8}{44{\cdot}2}$ = 1·83 ohms per phase.

And for 60 per cent. reduction in speed, amperes $= \frac{400^2 \times 123}{1{,}000^2} = 19{\cdot}7$; volts, 60 per cent. of 202 = 121; resistance $= \frac{121}{19{\cdot}7} = 6{\cdot}15$ ohms.

From the above it will be seen that very large resistances are required if much reduction in speed is to be obtained on a load of this nature.

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Fig. 2 shows the various curves obtained by the above working, assuming, as stated above, that no losses take place in the rotor; they will, however, serve to show the conditions brought about with a load which varies so much with the speed. The actual resistances can now be proportioned to carry the various currents, and with a resistance of a suitable value, corresponding with the above, which, of course, represents the total value of the sections in each

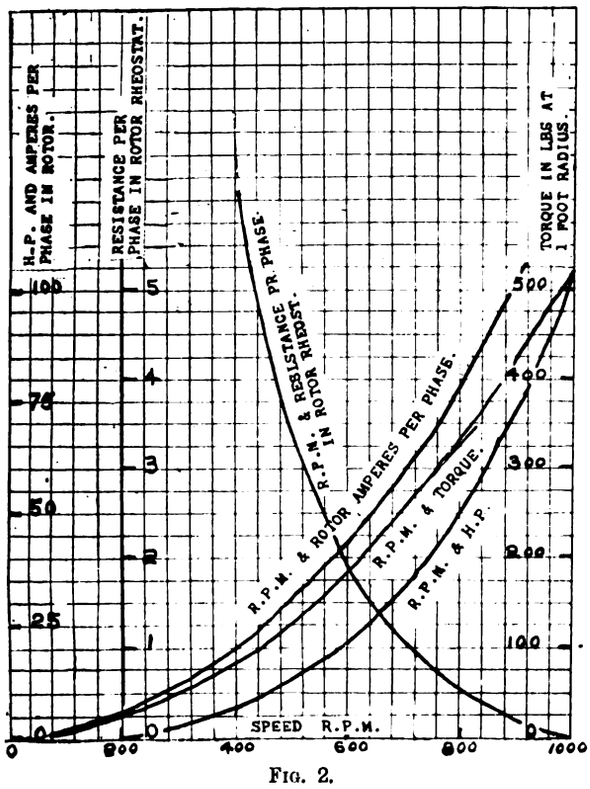

FIG. 2.

phase which are in circuit at the various positions of the switch arm.—REGULATING.

Answer to No. 1,010 (awarded 5s.).—The two best methods of speed regulation for induction motors—viz., alteration in number of poles of stator and connecting in cascade—are of no use for conditions specified in the question, as these only regulate in definite steps. The cascade arrangement is suited for two speeds—full and half—and it is not practicable to obtain more than a few speeds by means of alteration in the number of poles in the primary winding. If the motor has a squirrel-cage rotor winding, potential control can be employed, but such winding must have its resistance increased, so that full torque is given by the rotor when running at the lowest speed desired. The usual method of introducing this necessary resistance is by means of decreasing the conductivity of the end rings or connections. When a motor is provided with slip-rings, the resistance of rotor circuit can be altered as desired. When regulating the speed by varying the impressed voltage, it must be remembered the capacity of the motor falls off in proportion to square of the volts. Regulation of speed by potential control is not so satisfactory as by means of adjustable resistances in the rotor circuit, but with the latter method slip-rings are imperative. By using what is sometimes called a "boosting transformer" the supply voltage can be reduced to zero or raised above its normal value; the losses being confined to the iron and the small C^2R loss in its windings. For an adjustable resistance in rotor circuits a liquid regulating resistance, consisting of iron plates in a solution of sodium sulphate, is very convenient. There are formulæ by which the value of necessary resistance could be more or less approximately calculated, but they contain factors that are by no means easy to obtain. It would be infinitely preferable to find outside limits of resistance or of potential regulator by trial, and then arrange for as fine a grading as possible. It is on this point of fine adjustment potential regulators in the primary and liquid resistances in the secondary circuit offer such advantages.—M. M.

Question No. 1,011.—What is the best method of removing former-wound coils from armatures, and what tools are employed?

Answer to No. 1,011 (awarded 7s. 6d.).—This question is more difficult to answer than would at first appear, since the length of time the coils have been assembled on the core, and how insulated, is a factor that has to be taken into consideration. For coils that have been assembled on a core for two years or longer, that have previously been taped and dipped in standard insulating varnish, I find the best method is to dip the armature in thin varnish, or coat same a few times with benzoline, stove same to a temperature of about 200deg. F., when it will be found the coils have become plastic, thereby facilitating the easy removal of the coils without great injury by a stout short screwdriver and mallet. This must be carried out whilst the coils are hot, or any advantage will not be gained. Should only part of the coils require removing, proceed as above, lifting the necessary top halves of the coils until the burnt-out coil may be completely got at; replace with new coil, again stove, and, after examining the coils lifted, replace while armature is hot.

Small armatures wound with gauges of wire, say, up to 20's it is often more economical to totally rewind, and, therefore, the coils may be cut at the bend with an ordinary iron chisel and removed with same. With new armatures that have been on test and found faulty, the coils may be removed with a wedge of ordinary red fibre, or, say, wrought iron, after stoving a few hours, since the insulating varnish will not be so brittle.

The necessary tools required are three or four good strong screwdrivers, a leather-faced weighted mallet, pair of pliers, and a few shaped pieces of wrought iron and red fibre small enough to place between the coils.—EDW. L. CASTLE.

Answer to No. 1,011 (awarded 7s. 6d.).—After trying various methods of removing former-wound coils from armatures, I have found the following the quickest and best. Make of hardened steel, slightly tempered, a tool to fit in the slot of the armature to be stripped to be shaped as diagram. When the coils are disconnected from the

1/6 SCALE

commutator, and the bands taken off, insert a screwdriver between the ends of two coils. This loosens them from each other. Then gently prise them up by inserting the tool described underneath each coil. Do this at each end, and you will find the most obstinate coils will be speedily removed.—F. C. B.

Answer to No. 1,011 (awarded 5s.).—The best method of removing former-wound coils from armatures will generally depend upon circumstances, the method offering the cheapest repair being frequently not the best for the coils. A few of the cases in which it will generally be found cheaper to cut through the coils at the end of the core slots, remove old wire, and rewind, will be indicated.

Armatures in the design of which the question of works cost and electrical efficiency have not been skilfully equated, can rarely be rewound with the old coils. Even given good design, but badly "treated" coils—or, worse still, if the whole armature has been impregnated—the successful removal of sound coils becomes hopeless. Neither can the coils be handled if the cellulose has been destroyed by overheating. Generally with rotating armatures the small multipolar lap-wound class are the worst, especially if there be several turns per coil and one coil per slot. On the other hand, the removal of sound coils from a similarly rated wave-wound armature, or an armature lap wound with one-half or one-third the number of slots, can invariably be successfully undertaken. With armatures badly designed from a winder's point of view the method of removal will resolve itself into availability of rewinding material and facilities for coil making, therefore strip windings with special sectioned copper will invariably be carefully removed; but with armatures designed, so to speak, around standard wires, and for which it will be necessary to make a former to replace damaged coils, careful and costly removal will not be con-

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sidered, for the difference of price between old copper and cotton-covered wire remains about constant, independent of the market price of copper.

The tools generally employed are long dull-edged fox-wedges shaped similarly to joiners' firmer chisels. The feature, however, lies not in the tools, but in making the armature hot, and rendering the old varnish plastic by repeated applications of naphtha, turpentine, benzolene, etc., whichever solvent suits the particular varnish best. With large strip windings, in which the coils have become fast by complete impregnation or a too liberal application of varnish, the process is further assisted by laying blocks of red-hot iron on top of the slots; wedges are then inserted one at each end of slot and carefully set up. The coils will then, when hot, slip up without buckling. An inspection of good modern standard machines will show that this question has received attention. In addition to specially designed springy coils the class of winding is so arranged, in conjunction with number of poles, to suit the particular voltage, that the wires have a reasonable sectional area, thus making a firm coil. The grouping of three or more coils per slot also collaterally greatly assists the winder, but grouping carried too far, however, impairs the commutation.—A. E. V.

Answer to No. 1,011 (awarded 5s.).—The difficulty of removing former-wound coils is, of course, greater in the case of a series-wound than in that of a parallel-wound armature; the first operations are, however, the same in both cases. To protect the commutator from accidental injury a piece of stout paper of approximately the same width should be wrapped round it, and at the end where the connectors are soldered in a strip of ¾in. Empire or similar cloth should be wound round, sticking the end

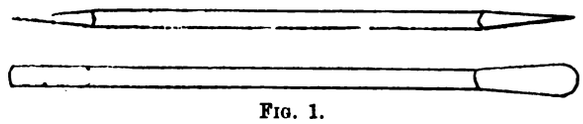

FIG. 1.

down with Chatterton's compound. To remove the binding bands (usually made of steel wire) which hold the windings in their places in the slots, an ordinary cold chisel may well be used; care should be taken to cut through the band where it passes over a tooth of the core, so as not to injure the coils. In the series or wave wound armature the connecting wires leave the coils near the iron core, and are bent back an eighth of the circumference for a four-pole machine. As it is necessary to unsolder some of the top and some of the bottom connectors half-way round the commutator, as they cover either the bottom connectors or a certain portion of the coil to be removed, it is usual to unsolder and lift half the top and bottom connectors, as when replacing it it is just as easy and makes a neater job to solder up both top and bottom connector in each slot or lug at the same time. Therefore, the next thing to do is to unsolder half the connectors—*i.e.*, an equal amount on each side of the centre of the defective coil. Now, by means of a jemmy (Fig. 1) the top half of the defective coil may be lifted, and of all the coils, until the bottom half of the coil is reached, when by the use of the jemmy and a little persuasion it may be removed and reinsulated or replaced as required.

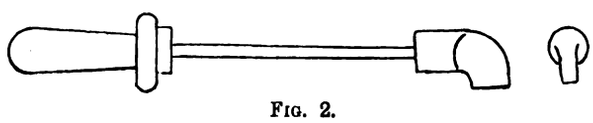

FIG. 2.

With a parallel or lap wound armature it is usually enough to unsolder the connectors of the defective coil, as, although the top halves of some of the coils overlap a certain portion of the coil, they can generally be lifted high enough to allow it to be removed. However, if the armature is wound with fine wire it is advisable to unsolder the connectors, as the heating and soldering they have already undergone is very liable to make them brittle, and the unavoidable strain they will be subjected to when the coil is being removed will probably break them. By the use of a jemmy in the same way as before the defective coil may be removed; of course, again the top halves of some of the other coils must be lifted also. Few tools are required. The soldering iron is shown in Fig. 2, when the connectors are placed straight into cuts made in the commutator bars, and in Fig. 3, when lugs are in use. The body of the iron in both cases is made as large as possible so that the heat may be retained. The jemmy consists of a ⅜in. steel bar flattened at the ends so that it may be readily inserted between and under the coils. It must have no sharp edges or the insulation will be damaged. Another useful tool at

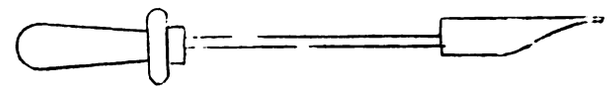

FIG. 3.

times is a long, gradual taper red or white fibre wedge, which, if carefully and gradually hammered in under the bottom half of the defective coil, will help in removing it.—H. W. C.

Answer to No. 1,011 (awarded 5s.).—In dealing with repairs to armatures which are built up of former coils, it will be found that there are two distinct kinds which need considerable difference in treatment when lifting or removing. They are (1) coils built up of strong copper strip, which will be usually found on all large arma-
(2) coils built up of many thin wires, which need careful handling, or the wires will rub against each other and the insulation worn off. When the armature is handed over to the winder for repairs, he will unsweat the leads to the commutator, and, if of No. 2 design, will bend them back carefully over the armature, and will also cut the steel wire bands round the armature with a chisel.

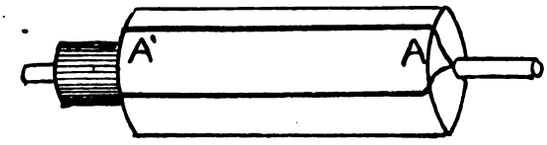

FIG. 1.

The chief difficulty is to raise the first two or three sides of the coils from the slots, and this is usually done by means of an instrument called a "bodger," which is shaped like a long screwdriver with the sharp edges ground round. This tool should be carefully inserted underneath the part of the coil to be raised which lies at the side of the armature, as a_1, a in Fig. 1. By pressing carefully, the side of the coil can be raised slightly without much difficulty. The side of the coil in the next slot should then be raised in a similar manner, and so on until the required number of sides are lifted up. After the first two or three sides have been raised, it will be found that the rest come out easily. From the foregoing it will be seen that no complicated tools are required for the job. In fact, the less use of steel tools the better, as there is less likelihood of insulation being damaged.

Sometimes in raising coils of considerable length, it is advisable to have a pair of long pliers with blunt edges to help lift the part of the coil in the centre of the core. The mica insulation is usually rather brittle and will not stand much bending, so great care must be used in handling long

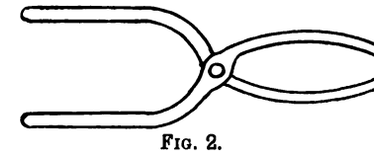

FIG. 2.

coils. In the case of No. 1 coils the stiff copper strip is a great help, as there is less chance of bending the insulation when removing the coil. No. 2 coils require more care, as they are usually smaller, less easy to handle, and cotton insulation easily rubbed off. It will be found that with a little patience and practice former coils can be easily lifted out of the slots with the use of the bodger. When replacing the coils it is advisable to rub them with paraffin wax, and they will be found to slip back more easily into the slots. A piece of fibre may be used for tapping them in again, but on no account must the coils be struck, or damage to insulation will ensue.—H. F.

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QUESTIONS.

plain the formation of cavities (blowholes) in the interior of the compound in low-tension direct-current network boxes. Explain the presence of water in these blowholes when they are first broken open. Can the formation be prevented ?—H.

1019. From an extra high-tension three-phase supply it is required to take a large amount of power—single phase and low voltage—without unbalancing the three-phase supply. What is the best way to do this, and is it possible without using rotating machinery ?—V.

ANSWERS.

Question No. 1,012.—Describe and explain the working principles of Grove's patent three-wire network ohmmeter, and give the derivation of the working formula.

Best Answer to No. 1,012 (awarded 10s.).—Grove's ohmmeter consists essentially of an ammeter, A, and voltmeter, V (Fig. 1), each fitted with a long thin needle, and so placed relatively that when the two instruments are in zero position the needles lie in one straight line, the one superimposed on the other. When they are both deflected to the same side of zero position they intersect, and it is evident that the position of the point of intersection of the needles is determined by the ratio of the deflections. For instance, if the reading of V is large compared with

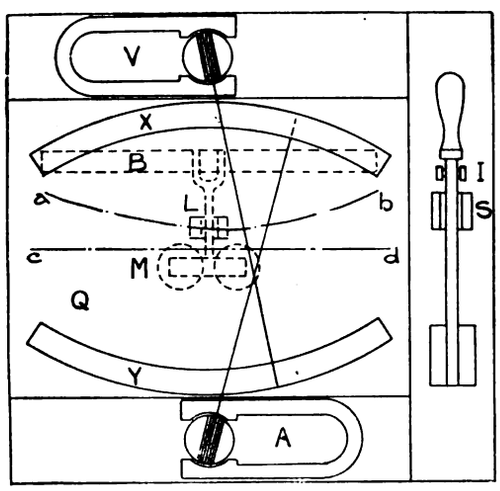

FIG. 1.

that of A, then the point of intersection approaches the scale, X, and *vice versâ*. Now the face, Q, behind the needles is calibrated in curves as shown, and any one curve is the path of the point of intersection for a given fixed ratio of the readings of V and A. But the ratio of volts to amperes in a circuit gives the resistance in ohms, so that the instrument upon calibration becomes an ohmmeter, and all points on a line such as *a b* read the same value of resistance. As will be shown later, it is necessary to be able to clamp the needle of A, and this is done as follows. The tip of the needle always moves between the face, Q, and scale, X, which is movable, and held down by springs, as shown in Fig. 2. An electromagnet, M, lever, L, and bar, B (Figs. 1 and 2), are so disposed that when the magnet is energised, the scale, X, is lifted by peg, P, and the needle freed.

Fig. 3 illustrates the instrument being used for the determination of the insulation resistance of a three-wire

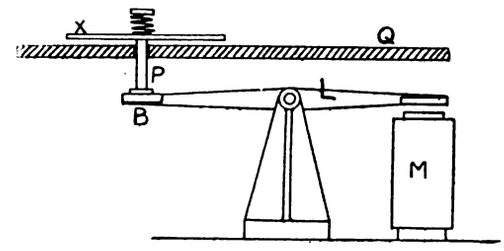

FIG. 2.

network. The ammeter of Grove's instrument is connected between the neutral and earth in series with a resistance, R, of known value and a switch, S, shown to the right in Fig. 1. V, the voltmeter, is connected directly between the neutral wire and the earth. When S is closed the reading of A gives the current which flows from the network to earth and through resistance, R, due to a pressure given by V when S is opened. It may be noticed here that the switch, S, consists of an ordinary knife switch for

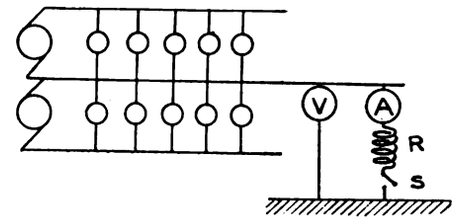

FIG. 3.

opening the circuit of A, and a smaller switch for operating the electromagnet, M. A section through I, the smaller switch, is shown in Fig. 4, and it will be observed that this circuit is only closed as the main switch is entering, and when full depression of the arm takes place this contact is broken again.

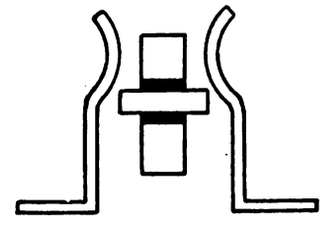

FIG. 4.

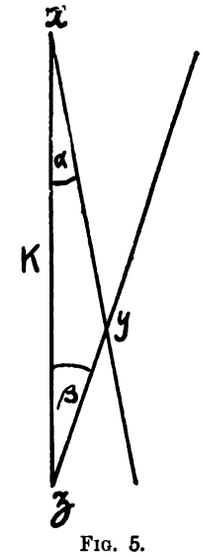

FIG. 5.

Now, in working the instrument, assuming all connections made, switch S is partially closed. This closes I and the magnet circuit, and releases the ammeter needle, which takes up some position due to the current flowing through it. When it is steady, S is pushed right in, thus breaking contact at I and clamping the needle. The volt needle now moves further over, and the position of their intersection gives the insulation resistance + R on the scale, Q. Subtracting the known value of R, we get the required insulation resistance.

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No working formula is really necessary in the use of this instrument, as, after once being calibrated, the required readings can be read straight off. If, however, it be required to calculate the scale, Q, instead of calibrating it, practically it may be done by trigonometry as follows: Assuming that we know the law of deflection of the two instruments, and, for the sake of the example, that for equal deflections the value of the voltage is 500 times the current value, then for all places where the deflections are equal the ratio of V to A is 500 to 1; therefore, $c\,d$ across the centre of the scale is a 500-ohm line. To trace out any other line, the angles α and β in Fig. 5 can be calculated from the properties of the instruments. Then, in triangle xyz the distance, K, between the centres is constant, and by the sine law

$$\frac{x\,y}{\sin\beta} = \frac{K}{\sin xyz} = \frac{K}{\sin(180-(\alpha+\beta))} = \frac{K}{\sin(\alpha+\beta)}.$$

Therefore, $$x\,y = \frac{K\sin\beta}{\sin(\alpha+\beta)}.$$

Similarly, $$y\,z = \frac{K\sin\alpha}{\sin(\alpha+\beta)}.$$

These equations fix the various loci, and by this method as many lines can be drawn as may be desired, although the work will be far more laborious than practical calibration from standards.—PERCY DUNSHEATH.

Answer to No. 1,012 (awarded 7s. 6d.).—The instrument introduced by Mr. Groves in 1904 is intended for making, in the station, the usual tests for the insulation resistance of a three-wire network without calculation. The actual test is known as Russel's test, and the usual method is as follows: (1) read volts between middle wire and earth when the middle wire is put to earth, which is the usual state of affairs—v volts; (2) open the earth circuit switch for an instant and observe the new voltage between middle wire and earth—V_2 volts; (3) while measuring v in (1), observe the current indicated on the ammeter in the earth circuit—C_1 amperes. Then insulation resistance of whole network to earth $= \frac{V_2 - v}{C_1}$ ohms.

This formula is derived thus: Let V_1, V_2, and V_3 be the potentials of the three mains, and let the fault resistances respectively to earth be r_1, r_2, r_3, and a, b, and c the respective currents to earth (see Fig. 1). V = potential difference

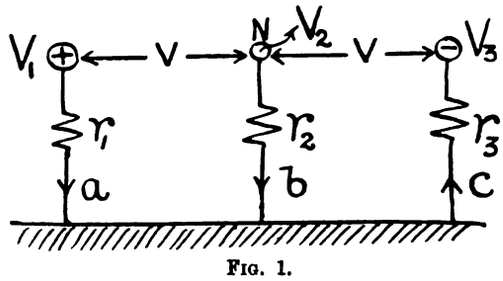

FIG. 1.

between either outer and the neutral, the equality on the two sides being maintained by the balancer. Now, net insulation resistance is defined as the parallel resistance of r_1, r_2, and r_3—*i.e.*,

$$\frac{1}{R} = \frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3}.$$

By applying Kirchoff's laws, we have

$$a + b - c = 0\text{—}i.e.,\ a + b = c.$$

or, $$\frac{V_1}{r_1} + \frac{V_2}{r_2} = \frac{V_3}{r_3} \quad \ldots\ldots \text{(I.)}$$

and $$V_1 = V_2 + V\text{; also } V_3 = V - V_2 \quad \ldots \text{(II.)}$$

from which, by substitution, we get

$$V_2 = \frac{V(r_1 r_2 - r_2 r_3)}{r_1 r_2 + r_2 r_3 + r_1 r_3} \quad \ldots \text{(III.)}$$

which shows that, since V is read on the station voltmeter, the potential of the neutral above earth (or below in some cases) is determined by the several fault resistances only.

The algebraic evolution of the rule used in Russel's test is somewhat tedious, and is considerably shortened by a mechanical analogy suggested by Mr. Alexander Russell. The analogy also serves to give clear notions as to what determines the potentials of the three mains.

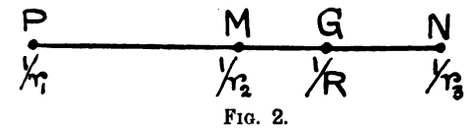

FIG. 2.

Draw P N and make P M = M N = V (see Fig. 2). Place masses of values respectively $1/r_1$, $1/r_2$, and $1/r_3$ at P M and N, and find their centre of gravity, G. Taking moments about G we have

$$\frac{P\,G}{r_1} + \frac{M\,G}{r_2} = \frac{N\,G}{r_3};$$

also $$P\,G = M\,G + V \text{ and } N\,G = V - M\,G.$$

Comparing these with equations (I.) and (II.) above, we note

P G is equivalent to V_1
M G " " V_2
and N G " " V_3

and the potential of any main is represented by the distance of the point (P, M, or N) representing it from the centre of gravity, G. The masses $1/r_1$, $1/r_2$, and $1/r_3$ (representing, of course, the currents a, b, and c) might be replaced by their resultant 1/R placed at G.

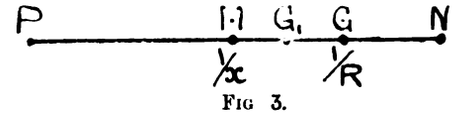

FIG 3.

Now put another mass $1/x$ at M, equivalent to earthing the neutral through a resistance x ohms. This, of course,

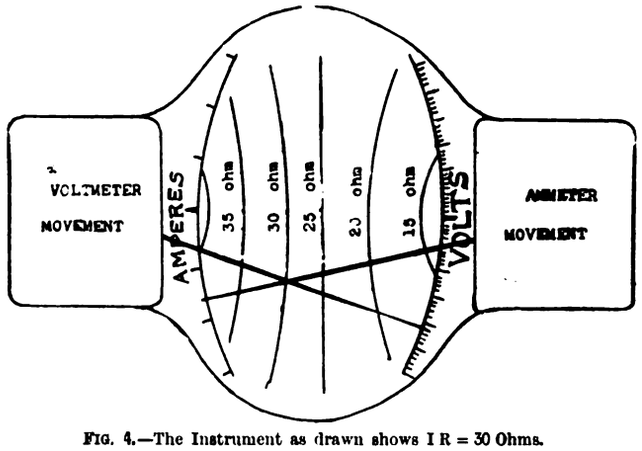

FIG. 4.—The Instrument as drawn shows I R = 30 Ohms.

alters the centre of gravity, bringing it to G_1 (see Fig. 3). Taking moments about G_1 we have

$$\frac{M\,G_1}{x} = \frac{G_1\,G}{R}.$$

But $$G_1\,G = V_2 - v,$$

$$\therefore \frac{v}{x} = \frac{V_2 - v}{R}.$$

But $$\frac{v}{x} = C_1,$$

the current indicated on the ammeter in the earthing circuit,

$$\therefore R = \frac{V_2 - v}{C_1}, \text{ or } \frac{V_2}{C_1} - x \text{ ohms,}$$

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which is the formula for Russel's test. The instrument introduced by Mr. Groves is a combined ammeter and voltmeter arranged so that the pointers overlap. The ammeter reading with earth switch closed is taken, and the act of opening the earth switch to read V_2 is arranged to lock the ammeter pointer at this reading by exciting a locking magnet. When the voltmeter pointer deflects to V_2 the point of crossing of the two pointers is made to give R direct in ohms. A scale calibrated to $\frac{V}{C_1} - x$ is placed beneath the pointers.

The instrument is shown diagrammatically in Fig. 4, while the connections are shown in Fig. 5. The scales of

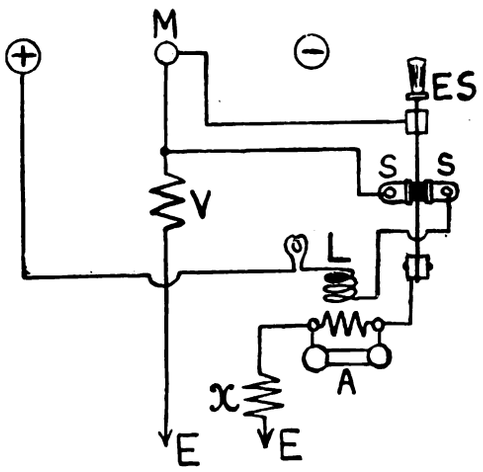

FIG. 5.—V, Voltmeter Movement; A, Ammeter Movement and Shunt.

both the ammeter and voltmeter side of the instrument are centre zero. When the earth switch, E S, is closed an insulating piece on it separates the two spring contacts, S S; but on opening the switch S S are allowed to come into contact *just before the switch is opened*, thus energising the ammeter pointer locking magnet, L, and locking the ammeter pointer at its deflection.—SPANNUNG.

Answer to No. 1,012 (awarded 5s.). — The formula employed for Grove's patent three-wire network ohmmeter is given by

$$F = \frac{V_1 - V_2}{C} = \frac{V_1}{C} - R;$$

where F = joint insulation resistance in ohms; V_1 = potential between neutral and earth when there is no artificial earth connection; V_2 = potential between neutral and earth when

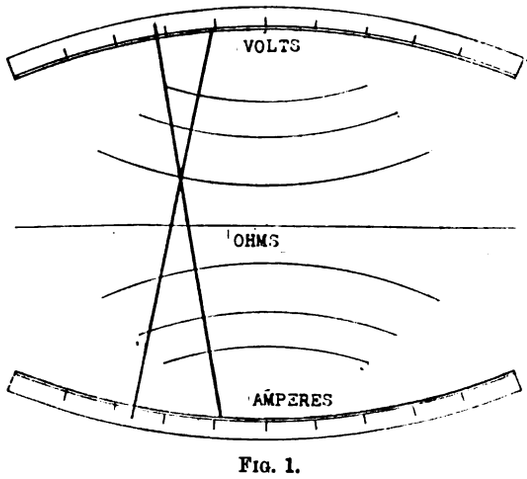

FIG. 1.

the neutral is earthed through an artificial earth or resistance; C = current passing through the earth connection; and R = resistance of artificial earth connection. Since for all ordinary working conditions R will be small, not exceeding two ohms, and, therefore, may be neglected, thus making $F = \frac{V_1}{C}$, from which value the scale of ohms is plotted.

The instrument itself consists of a combined ammeter and voltmeter, the two movements being contained in one scale, and the needles move in two parallel planes and overlap. Between the volt and ampere scale another scale of ohms is marked, and the point of intersection of the needles being noted on this scale gives the value in ohms. Fig. 1 shows a diagram of the sort of scale supplied, the lines between the volt and ampere scale being plotted to the value of $F = \frac{V_1}{C}$, and by noting where the needles intersect over this scale the ohms may be read direct Since V_1 and C_1 cannot be read simultaneously, an arrangement is provided so that the ammeter needle may be held in position while the earth connection is broken to obtain the reading V_1, the intersection of the pointers, as explained, giving the insulation resistance in ohms.

Fig. 2 shows the connection of the ohmmeter and necessary switches, etc., as supplied, mounted on a panel, by Messrs. Elliot Bros. The ammeter movement is provided with two different shunts and a two-way switch and fuse. When the earth current is seen by the recording ammeter to have a value not greater than the full load current for the ohmmeter, the short-circuiting switch is first opened, and then the earthing switch, which at the same time causes the ammeter needle to be locked. Switches and fuses are also provided for the voltmeter and locking arrangement.

When not in use the short-circuiting and earthing switch are both closed, the ammeter shunt then being short-circuited. If, when in use, the deflection be too small for

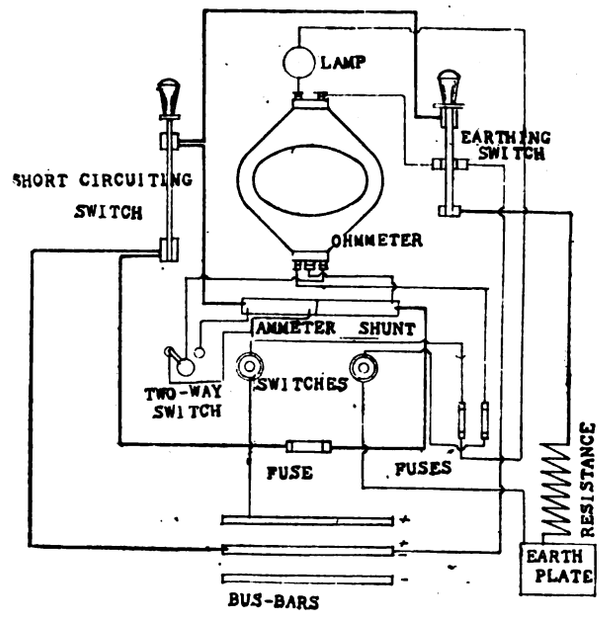

FIG. 2.

a sufficiently accurate reading of F, an artificial fault of resistance, *f*, may be switched on to one of the outer mains. Then $F = \frac{fx}{f-x}$, where x = equal the reading on the ohm scale.—E. V. C.

Question No. 1,013.—I have heard several statements made lately to the effect that the German firms are continually cutting out the British manufacturers in electrical work in England, especially in the mining work of the North. To what extent are these statements true, and why are not the British manufacturers more successful in competing with the Germans?

Best Answer to No. 1,013 (awarded 10s.).—The English manufacturers, it is true, have had to meet very severe foreign competition in every class of electrical work, but at the present time it is not nearly so severe in certain branches as it was some few years ago, when there was a period of great depression in trade throughout Germany. At the same time there was a number of large German firms which were over-capitalised, and it was, therefore, necessary for the works to maintain practically their full output to prevent serious loss. This resulted in the material not used for their home consumption being

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imported into England and sold at prices far below those which were then obtained by English firms, whose shops were busy on fairly remunerative work. Soon afterwards a similar electrical trade depression commenced in England, and the foreign competition was felt very keenly. This serious depression lasted for about two years, during which time the general trade of Germany began to improve. In the meantime, however, many of the home firms had adopted the only possible course to meet the foreign competition by reorganising not only their works, but the selling departments, etc., with a result that there was a general tendency all round to reduce the prices to more on the level of those of the foreign firms. This course affected some of the home firms very adversely, and from which they have not yet recovered. At the present time the foreign firms have quite sufficient orders to keep them fully employed, and a large number of these orders are obtained at prices which they could not obtain in England if in ordinary competition. From the above it will be concluded that a large proportion of the foreign manufactures were imported by cutting down the prices or "dumping."

When considering the question of heavy power plant, it must be acknowledged by those of experience that a large percentage of the orders for this class of material for mining work has been obtained on the technical excellence of the tenders and experience, and not on price. This especially refers to large gas-engines, alternators, alternating-current motors, controllers, etc. The writer is familiar with many instances where orders have been obtained under these conditions. At the present time there are not many orders for large electrical plant that go abroad, except in very special cases—such as large continuous-current turbo-generators, etc.—this being not only on account of the comparatively high foreign prices, but also on the quicker delivery given by the home firms.

When considering the lighter material—*i.e.*, fan motors, switches, fuses, small alternating-current and continuous-current motors, lamps, etc.—competition is still difficult to meet in view of the very low prices which at present prevail with the foreign material. The reason why the German goods can be imported at such low figures, even though there is no necessity to really cut the prices, is due to the fact that the labour is unquestionably cheaper in Germany than here, and that, as a rule, the foreign firms are better equipped with automatic tools for repetition work, thereby turning out the various items of standard apparatus in large quantities, which naturally reduces the cost of production to a minimum. With regard to the small switches and clip fuses, the majority of these are of stamped material, and of much lighter construction for the same rating that are manufactured here. The opinion of the writer is that now the English manufacturers have seriously regarded the reorganisation of their works and methods of business as an absolute necessity, they will soon be able to meet foreign competition even in the lighter electrical apparatus. This is already apparent with the small continuous-current and slow-speed ceiling fan motors, the latter being a special production with a few English firms, and with which there is little foreign competition.

Now, from what has been said above, it must not be inferred that English manufacturers have not or cannot build large power plants for mining work, as many of the largest plants installed here are of home manufacture, and there is no doubt that we shall see fewer orders for German plants in the future. But we must not lose sight of the fact that the Germans obtained a large proportion of the English orders for mining plants not only on price, but upon its merits; and it, therefore, behoves us to see that the traditional superiority of our manufactures is well maintained, in spite of the necessity for decreasing the cost of production to meet the foreign competition, which will always be regarded as a serious source of danger until the tariff relations of the foreigner and ourselves will have been placed on a more equal basis.—K.

Answer to No. 1,013 (awarded 7s. 6d.).—The root of the whole matter appears to be lack of combination among English manufacturers. There are at least 40 English firms of repute manufacturing equipment of a similar nature. As an example, let us say that this means there are 40 experts working on similar lines turning out machinery which differs only in detail both as to design and material. They have no time or opportunities to investigate and carry out research work, and the companies who employ them, nine cases out of ten, have not the necessary capital to finance such experiments. If these 40 firms were to combine, some of this number would be at liberty to carry out research and experimental work, and hence at the same expenditure new designs, and in many instances new principles, could be evolved. This is what is being done on the Continent—notably in Germany. There, as in America, the small firms have all been absorbed by one or two big concerns. These big companies can afford to allow part of their extensive capital to be spent on experimental work, and in special instances these rival combinations have joined forces in order to carry out extensive experiments upon which heavy orders depend.

The electrical industry may be likened to a generating station. In the early days it was the custom to employ a large number of small units. They did their work well, but a time came when economy was necessary, and the only way to generate current economically is by the employment of a few large units. Thus in time it will be necessary for the small companies which are now struggling on to combine and form one or two big firms.

Let us turn to the English companies. Their policy is to drag an order from their competitors (if they can), which means that the price must be cut as low as possible, and as there a large number practising these tactics, the results to the industry, as a whole, are bad.

Again, the Germans seem to understand the relation between capital and science better than we do. The English works manager looks with distrust upon the professor of engineering, and thus in nine cases out of ten the results of his labours are far too theoretical and fanciful to be of any practical service, and very often, if he does look upon such results favourably, his capital is too limited to undertake the bringing out of a new article. The consequence is the Germans can offer an intending customer machinery which is far ahead of English practice, and which is scientifically made. Take as an example the evolution of the metal-filament lamp. The experiments which brought about these far-reaching discoveries were carried out in a German technical college, and the German companies were not slow to take advantage of these inventions, and to continue to experiment on them. It is the old, old cry of conservatism, and English manufacturers who have once got into the groove of turning out a good solid article are slow, as a whole, to throw these old standard articles overboard and adopt new ideas. They are only just discovering the advantages of alternating current over direct current for mining work, whereas the Germans have been working their mines with alternating-machinery current for a considerable time. The electrical industry is one in which the formation of big trusts would be to the advantage of the majority, and if the English firms are to successfully compete with their foreign rivals, such combinations will have to be brought about in the near future. The fault does not lie with the English workman—he can hold his own any day with his foreign rival.

It is usual to point the finger of scorn at anybody who tries to point out the errors under which the English electrical industry suffers. They are called "enemies of their country," and all that kind of thing, but in a question of this description there is no doubt it is better to be a pessimist rather than an optimist, as by so doing one is prevented from resting on laurels already gained, but spurred forward to new endeavours.—T. J. PORTER.

Electric Light in Mohammed's Sanctuary.—The following telegram by Reuter from Constantinople will be read with interest: "An Imperial *irade* has been issued ordering the establishment of electric lighting in the sanctuary of the Prophet at Medina." It is instructive to witness the break-up of native prejudice against this phase of modernism. The Brahmins in India likewise permit the lighting of their temples by electricity, though it is curious that they will not permit electric punkahs.

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

1,020. Will any reader explain a method of finding the power factor (not using a power-factor meter) of a three-phase traction plant, mesh-connected, 2,500 volts, 25 ~, supplying the line at 550 volts direct by means of transformers and rotaries? There is a sub-station about three miles from main station.—H. S. I.

1,021. What are the more important considerations which should be taken into account when deciding on the ratio of commutator to armature diameters in a standard line of direct-current motors?—W. F. VERNON.

ANSWERS.

Question No. 1,014.—An electric supply company in a small country town having many small consumers purpose to use for distributors and services armoured cables. Give particulars of the relative advantages of using: (*a*) paper *v.* fibre dielectrics; (*b*) concentric *v.* twin-conductor cables; (*c*) looping in distributors from the street *v.* making T-joint services; (*d*) filling in joint-boxes *v.* leaving them empty and making red-lead joint on cover, with a view to facilitate testing.

Answer to No. 1,014 (awarded 10s.).—(*a*) *Paper v. Fibre Dielectric for Armoured Cables.*—By "paper" dielectric is meant insulation made by impregnating pure manila paper (which has previously been thoroughly dried) under vacuum with hot oils or waxes. By "fibre" dielectric is meant insulation made by wrapping thick cotton or jute yarns round the cable, the whole being afterwards dried and impregnated with oils or waxes. Pure manila paper possesses great disruptive strength, and, besides having of itself a high ohmic resistance, is capable of having this increased by about 100 per cent. by impregnation. It has also a very low specific inductive capacity value, and for this reason is much used on alternating-current systems. There is less mechanical injury to a paper cable through heating than to any other fibrous cable. A paper cable does not de-centre. The paper must be pure manila, free from all adulterants such as esparto grass, straw and other woody fibres (both cotton and jute come close to being woody fibres). The effect of using paper for insulation which is not free from the above impurities is (1) to lower the disruptive strength; (2) to increase the specific inductive capacity of the insulation, rendering it less suitable for alternating current; (3) to lower the ohmic resistance; (4) to lower the paper's natural power to remain elastic and strong under changing temperatures when working. Paper cables, therefore, are superior to fibre cables, but are dearer as a rule. They are usually of a smaller diameter than a fibre cable of the same capacity and insulation. It should be remembered when buying paper cables that pure manila—the only paper for cables—costs £45 per ton, while the adulterated stuff, which will give a bad, unserviceable cable, costs £10 to £15 per ton.

(*b*) *Concentric v. Twin-Conductor Cables.*—Concentric cables are necessary for single-phase, also in direct-current its use gives greater freedom from osmosis trouble, as the negative can be put in the centre of the cable, as far from the damp as it is possible to put it. Joints cannot easily be made without interrupting the service, and if the distributors are to be looped into houses the joints will be more difficult on concentric than on twin. On twin-conductor cable the joints can be made without interrupting the service, and are easier to make. Looping in is also easier. For the work in question twin-conductor cable is more suitable than concentric, unless, of course, it is a single-phase system.

(*c*) *Looping in Distributors v. T-Joint Services.*—As a rule, to loop in the distributors would mean a very greatly increased length of these large cables, and, consequently, would be like a copper funeral, insomuch as for most of the work smaller cable would have done. If the consumers are some distance back from the cable track, T-joints and small cable should be used. In some towns (Glasgow, for instance, amongst other places) distributors are looped into a house, and from that point several different consumers are supplied. This is a cheap way, and is very suitable for flats and office buildings. Where it is decided to use a separate service from the mains for each consumer it would be decidedly cheaper to make the T-joints and use small service cable. This would be particularly so with twin-conductor cables.

(*d*) *Filling in Joint-Boxes and leaving them Watertight.*—With cables having a fibrous insulation—such as paper or fibre—it is of the very greatest importance to have it thoroughly sealed and air and water tight all the way along. The metal or other airtight sheath put on by the makers keeps it all right lengthways, but when a joint is made it depends on the jointer whether this protection will be maintained, or whether air and dampness will be allowed to get in at the ends of the cable and travel along under the maker's cover. All joint and other connection boxes used with fibrous cables should have plenty of room where the cables enter, so that the end of the cable may be thoroughly sealed with bitumen (or other air and water proof materials) poured in hot around the end of the cable. In the case of disconnecting-box joints, the cables should in all cases be fitted with a proper cable connector—that is, a cable shoe provided with a porcelain or other insulating ferrule where the cable enters. After the cable has been soldered to the connector the ferrule should be filled as mentioned above with hot bitumen, so that the paper or fibre insulation is thoroughly and securely sealed. These cable connectors are then attached to the terminals of the link or switch which is employed for disconnecting. If the cable is finished off in watertight and gastight connectors, as advocated above, there is no objection to a watertight box unfilled with compound. A more satisfactory arrangement would be to mount the disconnecting box on the side of a wall above ground, and lead the cables up to it. The boxes would be smaller, insulation of the parts easier, and the whole thing very much more accessible than the buried boxes.—ARAMIS.

Answer to No. 1,014 (awarded 7s. 6d.).—(*a*) *Paper v. Fibre Dielectrics.*—As paper is itself a fibrous dielectric, the writer takes it that the query is intended to be one as to the relative advantages of paper and jute (or cotton) insulated cables. Fibrous insulated lead-covered cables are now almost universally used for underground work in this country, the exception being that some engineers prefer a vulcanised bitumen insulated cable on account of its non-hygroscopic nature. Both the paper and jute types of cable have common disadvantages due to their hygroscopic natures, and both on this account require to be protected by a watertight covering of lead. Jute has now, however, been entirely replaced by manila paper as a cable insulator, as paper insulation, being built up of layers of paper wrapped spirally round the conductor, will stand a much higher applied voltage without breaking down than jute. For the same reason, a paper-insulated cable is a much better cable to handle mechanically than a jute cable, and will stand much more knocking about. One other great advantage of paper insulation is that it lends itself better to the building up of concentric and multicore cables than jute insulation, and as these types of cables are cheaper to manufacture and lay than single-conductor cables, the use of paper insulation results in a saving in capital expenditure to the buyer.

(*b*) *Concentric v. Twin-Conductor Cables.*—Although the first cost of twin cables is slightly higher than that of concentric cables owing to the manufacturing process being more expensive, the writer would recommend that the twin

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conductor should be used for a small town installation. With a twin cable joints are more easily made and house services more easily connected than with a concentric cable, and thus less skilled and cheaper jointers and service hands may be employed. It is also a very easy matter to connect a service to a twin-distributor cable whilst the latter is alive, whereas with a concentric distributor cable great care would have to be exercised and more time spent on the work. This is a very important point if a motor load is expected, as in this case it is imperative that services should be connected easily and quickly to distributors whilst alive. A most important point also is that with a twin-distributor cable it is not necessary to cut through either of the conductors when making a service connection, as by using a proper connector the service cable may be connected by simply stripping off a very short length of insulation on the distributor and clamping on to the bared conductor. With a concentric cable, however, it is obviously necessary to sever the outer conductors when making a service connection to get at the inner conductor and reconnect by means of a copper bar with a clamp each end. Thus with a concentric cable the continuity of the manufactured cable has to be broken, the resistance of the outer conductor slightly increased, and the risk of a bad through connection incurred. One of the two cores of a twin cable always has a layer of coloured paper lapped on for the final layer of insulation, so that there is no difficulty in identifying the conductors when testing, etc.

(*c*) *Looping in Distributors from the Street v. Making T-Joint Services.*—As with any fibre—*i.e.*, paper or jute—insulated cable precautions must be taken to protect the insulation from moisture wherever exposed, looping in the distributor from the street to the house fuse-box would simply mean that the T-box was transferred from the street to the house. Thus any saving in the cost of the T-box due to its being made of a lighter design or being combined with the fuse-box would be more than counterbalanced by the extra cost of cable from the street, as with the loop-in system two lengths of *large* distributor cable must be brought in, and with the outside T-box system only one length of *small* service cable. It was also mentioned in answer to (*b*) that one great advantage of using a twin cable is that the conductors need not be cut when making a service. If, however, the distributors are looped in at services, it is impossible to connect to the fuse-box without cutting through the distributor cable without going to some expense. It will thus be seen that, although by looping in a distributor you do away with a buried underground box, there are many disadvantages, the extra cost being a most important one. It is, of course, also obvious that a distributor cannot be looped in after once being laid.

(*d*) *Filling in Joint-Boxes v. leaving them Empty and Making Red-Lead Joint on Cover.*—Unless a *very* wide machined joint be made between the box cover and casting and stout bolt lugs provided so that the cover may be bolted down very tightly, it is impossible to ensure that a red-lead joint will keep water out of any box buried directly in the ground. Even then, sooner or later, some man will open the box and forget to renew the joint, with disastrous results. If it is important that all boxes should not be filled right up with compound over the fittings, as in the case of street junction boxes; then the boxes should be placed in brick pits, drained, if necessary, so that they are never flooded, red-lead joints still being made on all the box covers. It is imperative, however, in any case that the fibrous insulation of the cable should be covered to a depth of at least 2in. with compound, as, without this precaution is taken, even the placing the box in a watertight brick pit and making a red-lead joint on the box cover would not prevent the insulation being injuriously affected by moisture in time.—CAROLUS.

Answer to No. 1,014 (awarded 5s.).—"J. A. R." does not say what system of supply it is proposed to adopt, but as twin cable is to be used it will be either single-phase alternating or a two-wire direct-current system, and I will assume that the supply is to be on the two-wire direct-current system, as this is the most probable, but most of the following remarks will hold even if it is an alternating single-phase system.

(*a*) With regard to the dielectric to be used for the cables, there is very little to choose between paper and fibre; they have practically the same qualities, and both are excellent, and the choice simply resolves itself into a question of costs.

(*b*) As to whether concentric or twin cables are to be used, there is much to be said for both types, but in the case under consideration the advantages of the twin-conductor cable far outweigh the advantages of concentric cable. If concentric cable is used, it is probably cheaper to manufacture, and if both poles were insulated from earth, the inner core could be made negative, as the negative is the one which gives the most trouble, a positive earth being comparatively rare. The great disadvantage of this type of cable is that the outer conductor has to be cut every time a service is taken off, and special fittings will be necessary for each service. Also, unless each street is fed from both ends it will be a very awkward job to keep up the supply beyond any new consumer whilst that consumer is being connected up. There is also greater risks of shorts being caused when working on live conductors with concentric than with twin conductor cable. If twin-conductor cable is used, extra services can be connected up at any time without interrupting the supply, and there is no fear of shorts when working on live conductors, as one can be taped up and finished before touching the other. Neither conductor has to be cut when connecting up a service. The cable will probably cost more to manufacture, but when the cost of extra fittings are added to the cost of concentric cable, the twin cable will probably come out as cheap, as no special fittings are needed for this type of cable unless the looping-in system is used. The only disadvantage would be that the negative conductor would not be as well protected as with concentric cable, but if the two-wire system is used, and both poles insulated, an earth on one side would not matter much, and could soon be cleared.

(*c*) The cost of the extra cable and the special fittings necessary to take the large cable at each consumer would be too much for any advantage gained by adopting the looping-in system. Also, the looping-in system could not be used for new consumers, and so in time T-joints would have to be adopted. If the T-joints are well made they will certainly be much better than looping in, and as the cables will not be very large there should be no difficulty in making good T-joints. If concentric cable is used, looping in would be rather difficult to make a good job.

(*d*) On no account should the joint-boxes be left empty. Moisture is certain to get in, and then the paper cables will be a continual source of trouble. The boxes should be filled in with compound, which can easily be removed to gain access to the fittings. If quick disconnecting boxes are necessary, it would be better to use boxes whose fittings were coupled with links. These links could be brought fairly near the top of the box, and if the top part of the box was filled with paraffin wax it would be quite simple to get at the fittings for testing and disconnecting. The lower part of the box could be filled in with ordinary compound in the ordinary way, which would have to be allowed to cool and set hard before the wax was poured in.

In conclusion, I should say that the best system would be to use whichever was the cheapest—paper or fibre, twin-conductor cable. Make T-joints and fill the boxes in with compound.—E. HAMER.

Answer to No. 1,014 (awarded 5s.).—The supply company under consideration have acted wisely in choosing armoured cable for their work, as in a country town with the facilities for opening up a length of ground, and the improbability of encountering networks of pipes, the system is almost the ideal one. The choice in the smaller matters, which they have left for decision, is not so obvious one way or the other, but require consideration in each case.

(*a*) *Paper v. Fibre Dielectric.*—Of these two types, which are both known as fibrous dielectrics, paper is far away the more popular. In both cases the material is simply to form a porous mass, into which is forced resinous oils to insulate the cable and keep out moisture. Fibre dielectrics

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consist of jute or cotton wound on in the form of yarn, and they are more flexible than paper cables, the outer layers of which tend to break when the cable is bent. Specially does this occur in frosty weather, due to the congealing of the permeating liquid, which does not allow the layers of paper to slide relatively. The obvious remedy is to allow the cable drum to stand in a boiler-house for a few hours before laying. One great disadvantage of paper dielectrics lies in the opportunity that cable manufacturers have of inserting inferior material, which is difficult of detection. There is little chance of adulterating the yarns in fibre cables, but the many processes by which paper is made offer every inducement to the unscrupulous manufacturer. The chief materials that can be inserted are straw, esparto, and chemical wood, which, though not discernible by the naked eye, yet can be detected by means of a microscope. These give a lower dielectric strength and insulation resistance, make the paper brittle when heated, and add a danger of rotting through residual bleaching chemicals. If, however, best manila paper be used, the result is a reliable dielectric, and the cable will stand a good overload without fear of decentralisation.

(*b*) *Concentric v. Twin-Wire Cables.*—Here, again, there are points of commendations on both sides. The chief practical advantage of twin conductors is the possibility of tapping on a service while the main is live, thus necessitating no interruption to the supply in connecting up a new consumer. Then, again, a fault in one will not necessarily affect the other, and less care and skill are required than when using a concentric cable. In the latter great care is required to avoid shorts while jointing a live cable, and it should not be attemped if avoidable. To take a tapping off the inner conductor of a concentric, it is necessary to cut some of the outer strands. An advantage of the concentric cable is that fear of electrolysis is greatly reduced. If a leak occurs from the inner conductor, a short comes on and announces itself, which is surely preferable to the insidious action of electrolysis.

(*c*) *Looping in Distributors from the Street v. Making T-Joint Services.*—Evidently the looping-in system does away with a large number of underground joints. By this means the expense of junction boxes is saved, the system is less liable to earths due to moisture getting at the joints, but in the case of a consumer's premises standing back from the road the extra expense of the double cable from the main to the house would be prohibitive. Then, again, if looping in were resorted to at first, any new consumer would have to be joined with an ordinary service, as it would never do to leave loops at every possible extension.

(*d*) *Filling in Joint-Boxes v. leaving them Empty and making Red-Lead Joint on Cover, with a view to facilitate Testing.*—There are various opinions prevalent as to which is the best method of keeping moisture out of junction boxes. The cleanest method and the one most conducive to good work on the part of the jointer is the empty box with red-lead joint on the cover. In this method, however, the moisture can get in along the side of the cable through the glands, and it is surprising what a small crevice the damp can penetrate. Of course, with the box filled with insulating compound, the moisture is kept out at every point. To ensure the mixture getting in the glands, the sheathing should be thoroughly cleaned previously, and then intimate connection will take place. Best materials only should be used here. A likely substance would have a high liquefying point, so that it will not leak away or down the cable, and certainly high insulating properties. The substance should not have a volatile constituent, as in that case it would dry up, forming a porous mass. The compound can be removed either by means of a hammer and chisel or a hot spoon. The disadvantage of boxes with red-lead joints is the necessity of nuts and bolts, which tend to rust and cause trouble in opening up. However, at all important junctions it is better to have an empty box, as probably new joints may require to be made frequently, which operation would be interfered with if the boxes were filled with compound.—PERCY DUNSHEATH.

Answer to No. 1,014 (awarded 5s.).—(*a*) Paper-insulated cables have several inherent advantages, and are now generally recognised as being most suitable for ordinary work. Paper itself, when dry, offers great resistance to puncture, and since it is applied in many layers, each overlapping, it is almost impossible for a weak place to extend for any distance radially. Also, when the cable is bent the several layers of paper slip very readily over one another, and thus there is little chance of any injury due to cracking.

(*b*) There is one very great disadvantage in employing concentric cables as distributors: when a service connection is required, it is necessary to completely sever the outer conductor before the inner conductor may be tee'd off. This requires special devices and great care if the supply is not to be interrupted every time a service is connected, which would not be tolerated; besides, there is great risk of accidental shorts during jointing. It is also obvious that the resistance of the distributor is increased for each service, and, if these be many, the additional resistance may be formidable. In the case of twin conductors there is no necessity to cut them at all, thus preserving continuity throughout the network.

(*c*) This point is best settled by considering each service separately, and is primarily a matter of first cost, as either method is reliable. If the service board is near the main, it will probably be cheaper to loop in the distributor to the service fuses than join up from a service box laid in the street, on the score of time taken, alone. On the other hand, if the service is some considerable distance away, as many are likely to be in a small country town, the cost of the double length of distribution and time taken to connect up to service fuses must be compared with the cost of a length of service cable—which may be of smaller section, and, therefore, cheaper — service box and fittings, and jointer's time. In the majority of cases it will be found cheaper to use service cables and T off the distributor.

(*d*) There is very little advantage to be gained by leaving service boxes empty. The mains may be disconnected on the service board, for testing purposes, much more easily, much quicker and cheaper, than at the service box, which would require the ground covering same to be removed, thus causing considerable inconvenience. If the cover joints be made with red lead and the boxes are left empty, it is inviting certain trouble, sooner or later, due to water gathering. Nine joints might hold tight, but the tenth would leak either at the joint or round the cables, and be the cause of endless troubles. Whereas, if the boxes are filled with a good compound, though, perhaps, of a slightly greater first cost, the job is made thoroughly watertight for years.—J. A. VICE.

Answer to No. 1,014 (awarded 5s.).—(*a*) *Paper v. Fibre Cable.*—As regards paper or fibre as the basis of insulation for lighting cables, there is not a great deal to choose between them. In America and on the Continent fibre cables are largely used, and are generally preferred to paper cables, but in this country paper seems to hold its own. Whichever is used should have been very carefully tested, both for megohmic resistance and resistance to disrupture under pressure, as these are not necessarily interdependent one on the other, but vary according to the quantity of moisture left in the fibre or paper before impregnation, and such a choice made as to best suit the particular system of distribution. Among the advantages possessed by the paper-insulated cable is that due to the fact that the specific inductive capacity of paper and air—air, of course, forming a considerable part of the effective insulation of such cable—is less than that of any other ordinary insulator, and, therefore, paper cables are specially good for alternating-current work, as they can be constructed with much lower capacity than those cables containing other dielectrics. With whichever type of this hygroscopic class of insulation is used, care should be taken that the same on completion is absolutely waterproof, as the slightest fracture would practically ruin for a time the insulation of the system.

(*b*) *Concentric Cables v. Twin Conductors.*—The question as to whether a concentric or twin conductor cable is the better to use in a network depends to a certain extent on certain of the characteristics of the system. For example, where an alternating current is used it would be found advantageous to use the concentric cable for several reasons,

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of which the most important is that by this means a cable is obtained free of deleterious inductive effects on other cables, such as telephone cables situate in its vicinity, as the effects of the inner and outer leads neutralise one another. Further, by this means loss of power in the system itself is greatly reduced, owing to the avoidance of the formation of currents by induction in the cable sheath or armouring. Another point of advantage of these cables is that they take up less space than would be taken up by twin conductors of equal capacity.

As regards the question of cost in this matter, this depends on the degree to which the relative insulation of the two conductors is carried. It will readily be seen that in a concentric cable a much greater bulk of insulation is required on the outer lead than that on the inner, owing to the fact that it is situate at a greater distance from the centre of the cable, and, therefore, must cover a bigger area, assuming equal thicknesses be used in both cases. This results in a concentric cable, which is dearer to construct than the twin conductors, but in practice the thicknesses are not made equal, and by this means concentric cables are obtained equal to or less than the cost of their equivalent insulated separate conductors, while yet retaining a sufficient depth of insulation between the outer sheath and the conductor nearest thereto. As regards safety, the concentric cable is normally better than twin conductors, provided that the insulation of all parts of the circuit is good, as the normal potential between the leads is only that due to the pressure drop of transmission; further, with proper arrangements to prevent faults, less depth of insulation, therefore, is required. A point may be noticed with advantage with reference to the use of concentric cables in direct-current systems—viz., that there need be no difficulty in ascertaining which lead is on any particular pole, as a practice can be made of having all inners of one polarity and outers of the opposite polarity, which saves the trouble of having to detect them, as in twin conductors, or of having the conductors especially made with two different colourings on the exterior of the insulation.

It must not be inferred that the concentric cable, however, has only advantages and no disadvantages with reference to the twin-conductor cable, for one serious disadvantage is that due to the fact that in a system using concentric cables the insulation resistance between both conductors cannot be taken while the network is working. A further disadvantage is that due to the question of joints, which may be to a certain extent important, especially in a system having a number of connections to be made, such as would be required by small consumers, the joints being more difficult to form adequately and with proper protection with concentric cables than with singles.

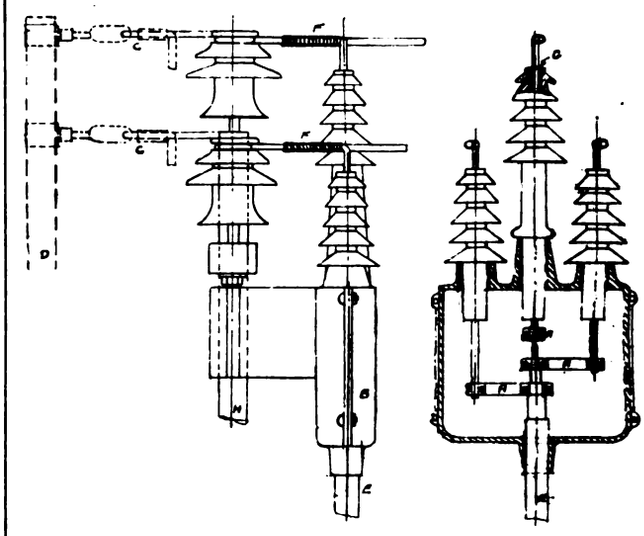
(*c*) *Looping in Distributing Boxes v. T-Joints.*—Here, again, the choice of a method for branching depends on certain conditions, such, as for example, the type of cable used. With concentric cables, as has been pointed out above, to form joints with an adequate insulation and waterproofing qualities is somewhat difficult, and more especially so as regards T-joints. In view of this, therefore, and of the fact that the joints usually constitute the weakest part of the system, and should, therefore, be inspected first on the occurrence of a fault, it is considered advisable to use a system of joint-boxes. The cables can then be laid into these, and on a fault occurring one may at once inspect the whole joints in a convenient place, which is a great advantage. It is true this system requires the use of more wire than that of ordinary jointing, but the advantages outweigh the disadvantages.

(*d*) *Filled Boxes v. Unfilled Boxes with Red-Lead Cover Joints.*—The main requirements of a joint-box are that one may readily inspect the contents of the same when desired, such as for the purposes referred to above, and also that it shall be absolutely proof against water. It is, therefore, ordinarily best to use filled boxes, and yet an unfilled box with properly secured joint has great advantages over the other in respect to testing. The best course, therefore, to be use a joint-box such that the cables are adequately protected as regards insulation, and which has a supplementary cover between the cables and the main cover adapted to fit tightly down on to a suitable ledge, the space between the two covers being filled with a suitable box compound, preferably bitumen. By this means a perfectly waterproof arrangement may be obtained, and the lower cover can readily be unsealed when desired by chipping out the bitumen, and the cables may thus be inspected in a very short time.—L. R.

Question No. 1 015.—A high-tension three-phase line consists in part of bare overhead conductors and in part of underground mains. Sketch and describe the terminal pole of the overhead line, showing how you would connect to the underground mains.

Answer to No. 1,015 (awarded 7s. 6d.).—The sketch shows the terminal pole for connection to underground cable used on a transmission line which was subject to heavy winds and rains, and it has been found to stand the weather conditions very well, and needs no attention after erection.

On the line on which it was used several underground cables were connected to the lines at various points, but the final pole is shown in sketch. It consisted in bending the line round the last insulator and binding it at F with stout wire and sweating the whole together. The lines were then bent down and passed through the porcelains in the junction box, B, one half of which was securely clamped to the pole, H, and the other half fixed to clamped half by set screws. The underground main, E, was brought up (in this case consisting of a triple-concentric cable), and connections made to the lines by gunmetal links, A, clamped and sweated to lines and cable. The whole of the connections in the junction box were well taped with insulating



tape. Where the porcelains enter the box rubber insertion was wrapped round them, so that the box would grip them firmly and hold them in position. Where the line enters the porcelain at G, a cement consisting of five parts of litharge to one part of glycerine was put in; this sets very hard and is not affected by water. After taping the inside links, etc., the cover of the box was put on and fastened in position, and the whole box was filled with insulating compound to within ½in. of top, through a plug in top of box. The junction was now complete.

If the line is of large section and long spans, an additional pole, D, should be erected about 4ft. from pole H, and instead of twisting wire round final insulators, it should be continued and connected to strain insulators, C, which are adjustable and will take up strain off final insulators. The junction box in this case can be turned through an angle of 180deg. from position shown, and leads taken into porcelain as shown dotted. The poles, D and H, should be well stayed to prevent them being pulled over due to pull in lines caused by sag and wind, and if the ground on which they are erected is wet, the terminal pole is best constructed of steel girders, resting at bottom on four large stone blocks below the ground.

The junction made is expensive, as the insulators used are costly, but if the line voltage does not exceed 8,000, this cost will be considerably reduced. The voltage of the scheme on which they were used was 20,000 on the Continent.—MAGNET

[Other replies to Question No. 1,015 will be given in our next issue.—ED. *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

QUESTIONS.

1,022. In a power-house with three-phase current, two 500-kw. three-phase transformers are run in parallel to raise the pressure from 3,000 volts to 10,000 volts. If required to add a 1,000-kw. transformer, what particulars are required by the designer so that the three transformers may run in parallel and each doing its proportion of the load. Give the tests necessary to get the above data.—E. T. B.

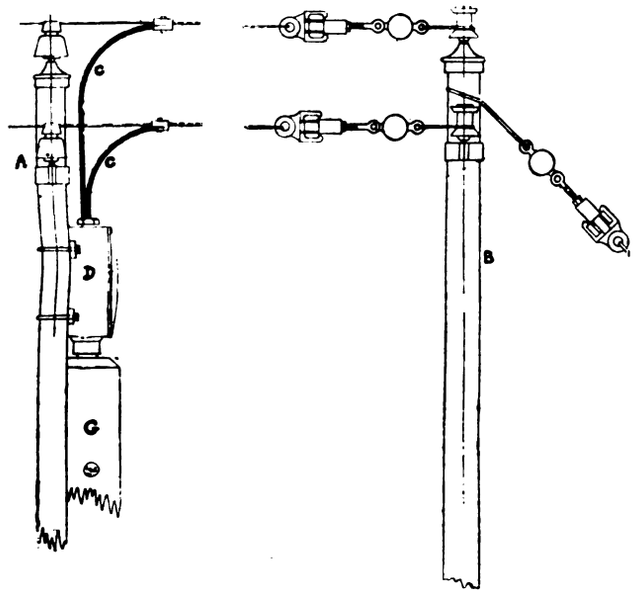
1,023. A travelling truck weighing 11 tons travels 25ft. Sketch and describe the best arrangements, size, type of motor, and starter, also automatic arrangements for cutting off the current when the truck reaches each end. It must be controlled a distance of 20 yards from the truck, and overhead mains cannot be used.—W. C.

1,024. Discuss the use of equaliser rings. Give diagrams of connections and best method of making the same.—H. F.

ANSWERS.

Question No. 1,015.—A high-tension three-phase line consists in part of bare overhead conductors and in part of underground mains. Sketch and describe the terminal pole of the overhead line, showing how you would connect to the underground mains.

Answer to No. 1,015 (awarded 7s. 6d.).—The terminal pole construction of a high-tension line is of extreme importance, and requires very careful design to prevent it becoming a constant source of trouble, due to either electrical or mechanical faults, or a combination of both.



There are a number of high-tension lines in use where the line terminates in a single pole carrying similar insulators to those used throughout the line. The factor of safety is generally much lower than it should be, owing to the stress of the line wires being taken by the two end poles of the line, the greater strain being on the end pole, which is usually guyed. The guy wires when used are in themselves a source of danger on a high-tension line working at, say, 10,000 volts or higher, as they have to be fitted to the pole near the cross-arms which carry the insulators in order to give the best results. If guy wires are used, they should be connected to strain insulators to prevent leakage, and also to reduce the potential strain to a minimum.

The sketch shows the terminal pole arrangement suitable for a line working at about 12,000 volts, with each wire of about ·25in. section. It will be seen that the line wires after connection to the insulated cables, C, continue to the end pole, B, which would be of the usual construction, except that the cross arms should be of galvanised channel steel supporting special "pull-off" insulators. The line wires are connected to these insulators through globe strain or other suitable form of insulator. The guy wire at the pole B should only be connected to the pole through a strain insulator. With this arrangement ample secondary insulation is provided. The line wires are tapped at the pole A by three rubber cables with high-grade insulation, which are soldered into special connecting sockets, arranged to clip on the line wires, and held in position by a couple of gunmetal bolts, the whole being soldered together. The three cables are brought to a three-core cable connecting box, D, bolted to the pole A, and filled with bitumen. The three-core cable is attached to the pole by cleats, and protected above ground by a wooden or other suitable guard, G.—K.

Answer to No. 1,015 (awarded 5s.).—Fig. 1 shows a terminal pole with the necessary connections to the underground main. The pole is generally known as the H type, and consists of heavy timber secured together by iron bracework as shown. Girder cross-arms are shown, from which the poles are stayed by means of galvanised stranded steel wire fitted with the usual turn buckle for tightening. The anchors usually consist of half an old railway sleeper buried at a depth of about 6ft. The bare overhead conductors are connected to straining insulators fixed to strong oak cross-arms. In some cases cross-arms of channel iron are preferable, and in this case the cross-arms and all ironwork on the pole must be well earthed. Lightning arresters should also be fitted at all points where an overhead line is connected to an underground cable.

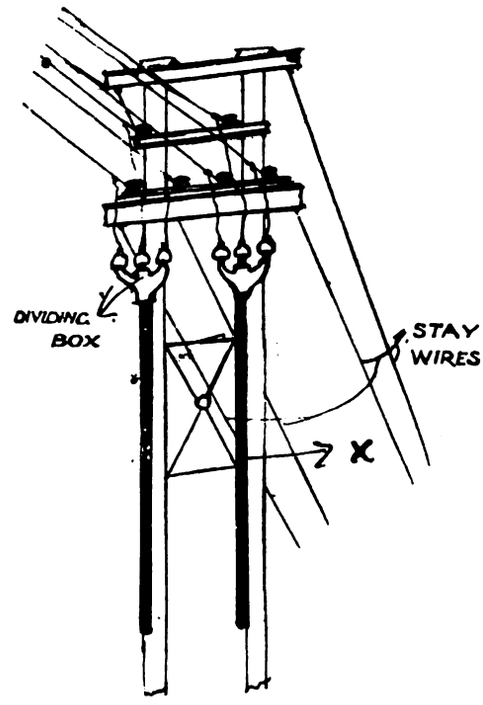


FIG. 1.

Tappings from the overhead line are taken to a special dividing box carried at the top of the pole, into which a three-core lead-covered cable is led through an iron pipe, X. The lead is connected to the gland at the bottom of the box by a wiped joint. Inside the box the three cores are divided, and each connected to a solid copper lead, which is attached direct to the line wires. The three openings at the top of the box are closed by corrugated porcelain insulators, which give a long path for leakage. These are kept dry by other insulators. The box is then filled up with compound, and the cups formed in the porcelain insulators where the conductors pass through are also sealed up with compound. A further protection against moisture is provided by the sheet copper hoods soldered to the conductor which shield the top of the insulators. The conductors leaving the dividing box are twisted into a spiral to form a choking coil, and the lightning arresters are connected to the further side of these coils. Sketch B shows the dividing box in detail (see Fig. 3 in reply by E. Hamer). The foregoing is the method employed by Messrs. Callender's on the Lancashire Power Company's mains, and is suitable for heavy transmission lines and a pressure of 11,000 volts.

In conclusion, it must not be forgotten that every care must be taken in the erection to ensure a first-class job, for on this the success of the installation depends. All terminal poles should be fenced off, and means taken to

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prevent anyone climbing up them. For this purpose a spiked collar, with the spikes pointing downward, is suitable.—H. T. G.

Answer to No. 1,015 (awarded 5s.).—Figs. 1 and 2 show a terminal pole where the overhead lines are connected with the underground. The figures show fully the arrangements of these poles and also the method of anchoring the wires, which are shown attached to the pole by means of three insulating shackles connected in series; of course, the number of these shackles will be decided by the voltage of the system. A special dividing box, details of which are shown in Fig. 3, is carried at the

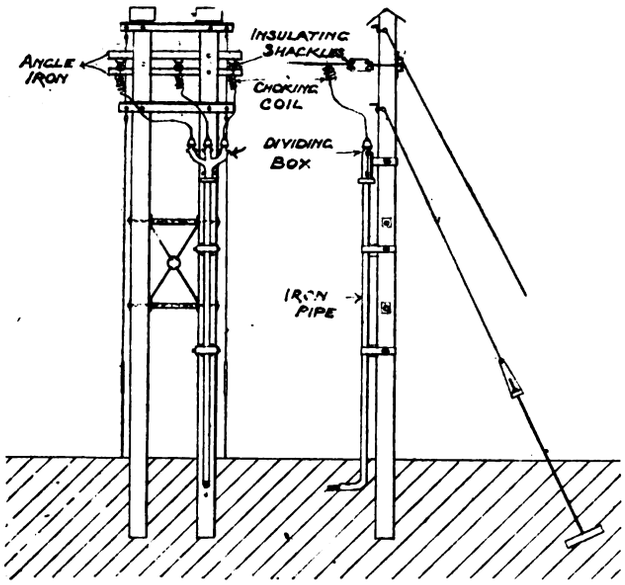

FIG. 1.

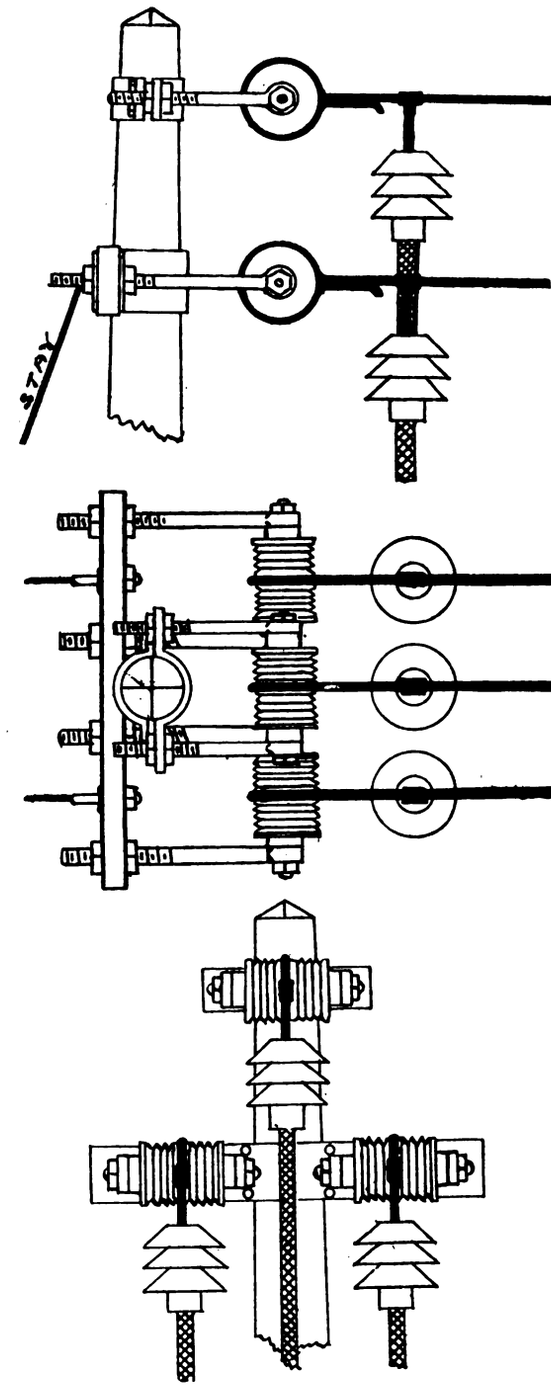

FIG. 2.

top of the poles, and the three-core lead-covered cable is led into the box through an iron pipe. The lead is connected to the gland at the bottom of the box by a wiped joint. Inside the box the three cores are divided, and each connected to a solid copper lead, which is afterwards attached to the transmission wires. The three openings

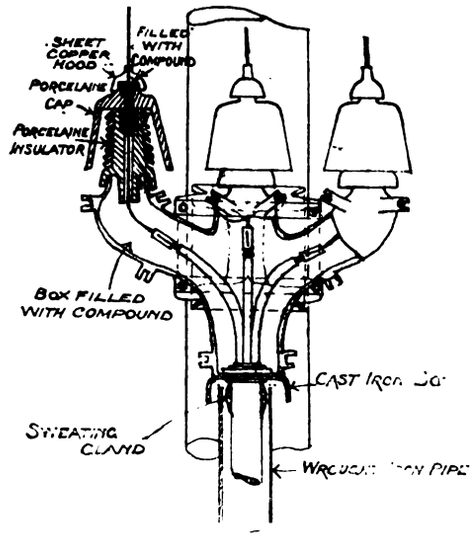

FIG. 3.

at the top of the box are closed by corrugated porcelain insulators, which give a long path for leakage. These are kept dry by other insulators. The box is then filled in with compound, and the cups formed in the porcelain insulators is also sealed up with compound. A further protection against moisture is provided by the sheet copper hoods soldered to the conductor which shield the top of the insulator. The conductors leaving the box are twisted into a spiral to form a choking coil, and the lightning arresters are connected to the further side of these coils.—E. HAMER.

Answer to No. 1,015 (awarded 5s.).—The accompanying sketch shows a method of making the connections required. Actual dimensions of parts and distances of conductors from each other will depend naturally on the voltage of the electrical energy transmitted. Suppose, for instance, the voltage was 10,000; average practice would suggest that insulators should be about 7in. in diameter and the conductors about 2ft. apart. The three conductors would be placed relatively to each other, as the angular points of an equilateral triangle. In the diagram the live uninsulated wire is shown black. The poles where conductors leave for underground position are anchored, and provision is made by which overhead conductors can be brought to the proper tension. A certain amount of sag is necessary, but it must be under control. Insulators are threaded on the vertical conductors, but below these will be the ordinary insulating media, armouring, etc., of the underground cable. In the figure these vertical conductors are shown unprotected, but it would be necessary to have them covered in, so that they would be inaccessible except to those in authority. Bolts, clips, tension screws, etc., should be well galvanised, as a protection against the weather.—M. M.

Question No. 1 016.—Give reliable data relating to electric *versus* steam driven machinery for the soap manufacturing industry and for textile mills, also a good book on same.

Best Answer to No. 1,016 (awarded 10s.).—The question as to data in the use of electric against steam driving

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applied to machinery in soap and textile industries, is one which cannot well be considered by the mere inspection of tables without their proper context explaining in full the reasons for the various figures found. It is, therefore, thought that it will be advisable to deal shortly with the points of advantage and disadvantage of electricity over steam in these applications, and then to deal at some length with the technical literature on the subject, pointing out what is to be found therein with reference to the originals which will give full details.

The advantages of the electric drive may be considered to include (*a*) a reduction of costs both as to primary costs and also to upkeep; (*b*) simplification of the internal arrangement of factories using electric drives, as the motors can exactly be placed where wanted, and may, therefore, be easily controlled without complicated means; (*c*) the mill or machine and the generating station can each be placed in the most suitable position; (*d*) great reduction of shaft and transmission friction losses; (*e*) ease with which any given section may be run or stopped without affecting the others; (*f*) reduction of maintenance and depreciation values; (*g*) steadier drive, with its attendant advantages of higher average speeds, and consequently increased output; (*h*) the important advantage that each section of room can be placed under control of a recording ammeter, whereby irregularities can easily be traced to their source quickly. It is, as has been before stated, in these factors that the relative values of the systems should be looked for, and, in addition to these, there is with steam considerable loss due to radiation, drop of steam pressure in transmission, leaky valves, and bad cut-offs.

As one specific example of the effect of converting a steam-driven factory into one driving by electricity, the following example of a textile factory may be noticed. The further data and details may be obtained from Stuart's book referred to below, and this should be consulted herewith in order to realise the proper significance of the figures:

Power used in	Steam. I.H.P.	Electric. I.H.P.	Steam. Lbs. per hour of water.	Electric. Lbs. per hour of water.
Machines.....	120·2	120·2	6,050	2,660
Shafting	87·9	57·3	4,340	1,255
Engine friction	45·4	26·0	2,260	572
Electric transmission	—	54·5	—	1,199
Total	253·5	258·0	12,650	5,686

With these remarks it is now thought that the technical literature should be dealt with and its relevant matters pointed out. In a number of publications examined relating to the above industries—electrical engineering and chemical engineering—the only one which contains any real information is "The Application of Electric Motors to Machine Driving," by Andrew Stuart, A.M.I.E.E. This publication contains a great deal of information on the matter, and has two chapters which are very relevant. One, entitled "Why Electricity Pays," gives details of prime and upkeep costs in actual practice as regards both steam and electric power, as well as details of factories of the type referred to where the one has been substituted for the other. The other is entitled "Electric Power in Textile, etc., Factories," and discusses the problem, pointing out the effect of electric *v.* steam driving, giving details, with full illustrations, of a number of factories with their equipments selected from various parts of the world. A further chapter on "Electricity Tariffs" also contains a deal of information, in particular as to the costs of power obtained in practice with certain steam and electrically driven factories.

In addition to the above publication a number of papers have been read before the Institution of Electrical Engineers on the subject, the following being the most important to date. "The Polyphase Equipment of Factories" (Wyld, vol. 30) deals with all kinds of polyphase driving, but does not discuss steam. A long table of the equipment and performance of a number of installations is given. "Electric Lighting and Driving of Textile Mills" (Osborne, vol. 31) is an important paper dealing with mills in all parts of the world. Particulars of factories are given with plans and equipment. "Electric Operation of Textile Factories" (Wilson, vol. 34) deals with the problem chiefly in respect of cotton mills, pointing out the general lines of change of efficiency. In addition there is a paper entitled "Possible Developments of Electrical Driving in Factories due to the Supply of Electricity at Cheap Rates by Large Power Companies," by Highfield, in the *Electrical Engineer*, vol. 31, p. 300. This concludes the most important publications containing practical data on this subject, but it may also be mentioned that *Science Abstracts* for the last few years also contains a number of references.—L. R.

Answer to No. 1,016 (awarded 7s. 6d.). — The soap-making trade is one of those industries which offers a very small field to the electrical power engineer, and owing to it being so limited, there is little information available regarding the power required that is at all reliable. Steam is an essential feature in a soapworks, it being chiefly used for heating and boiling purposes, also for ejector work in place of pumps. Electric motors can be applied to the rotary cutters which prepare the raw material for the boiling vats, the power consumption being about 2 b.h.p. Motors can also be arranged to drive the pumps which pump the liquid soap between the various vats or coppers. These being sometimes situated on different floors or levels in the works, the power will, of course, depend upon the amount of material to be conveyed and the height, etc. In small works, however, ejectors are employed with great success, provided the distance the soap or material has to be drawn does not exceed about 10ft. to 20ft., depending, of course, upon the vertical height to be lifted. The soap from the vats generally runs to the cooling frames by gravity. In small works the soap after cooling is generally cut into the requisite bars by hand with the aid of steel wires, but this work could be carried out by a motor-driven guillotine taking about 1 b.h.p. Power would, no doubt, also be required for elevators, hoists, etc., which could be advantageously driven by motors.

With regard to the electrical driving of machinery used in the textile industries, this offers one of the most extensive fields to the electrical engineer, and it is almost impossible to deal in the present instance with the many different classes and sizes of machines employed in this work. It would be advisable to consult some general descriptive book on the subject in order to be familiar with the various classes of machines. One of the most useful handbooks is the "Textile Year-Book," published by Marsden and Co., Carr-street, Manchester. This small book gives a great deal of descriptive information, also a list of the powers absorbed by nearly every type of standard textile machinery, but the powers given can only be used for a general guide, as they differ largely with various conditions of working. The following is a list of actual powers absorbed by some of the most common types of machines of average size: spinning mules, 120 to 140 spindles per 1 b.h.p.; flyer frames, 50 to 70 spindles per 1 b.h.p.; cotton bale breaker, 1½ b.h.p.; double beater, 5 b.h.p.; cotton-carding machine, ⅓ b.h.p. to ½ b.h.p.; hopper feeder, 1 b.h.p.; combing machine, ½ b.h.p.

The motors for driving textile machinery should not be rated too closely, as they have frequently to run at constant load night and day for a week without stoppage, except during meal hours.—K.

Question No. 1,017.—Discuss the design of a magnet, solenoid type, fitted with a core which will lift a weight of 4lb. through a distance of 1½in.

Best Answer to No. 1,017 (awarded 10s.).—The following are formulæ used for the design of electromagnets of the solenoid type: Pull on plunger in pounds per square inch = P. Then

$$P \text{ (per square inch)} = \frac{B^2}{72{,}000{,}000},$$

where B is lines per square inch. This formula is got from pull in dynes $= \frac{\text{area } B^2}{8\pi}$ by conversion from the metric to the British measurements. From this formula we can get the pull in pounds per square inch of plunger area for a given induction. Knowing the pull required, the area of the plunger can be calculated. From this total flux can be got, and the area of outer shells and ends got out. Approximate dimensions are next obtained, and the necessary ampere-turns calculated from the length of magnetic paths, and a table showing the ampere-turns per unit

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length for the materials used. For the air-gaps the well-known formula, ampere-turns = B × l × ·3133, is used, l being length in inches and B lines per square inch for air path.

We have now obtained the ampere-turns, and, knowing source of supply, a suitable wire must be taken, and the space required for the winding of the correct number of turns got out. If the approximate dimensions for the outer shell are too small, they must be enlarged and new calculations made, but after a first approximation it is easy to get fairly exactly the right size. All that now remains to be done is the calculation for heating, the outer surface being calculated and watts lost in coil. The square centimetres of radiating surface per watt can be easily found, and on reference to a table of temperature rise of enclosed coils, probable temperature rise can be obtained.

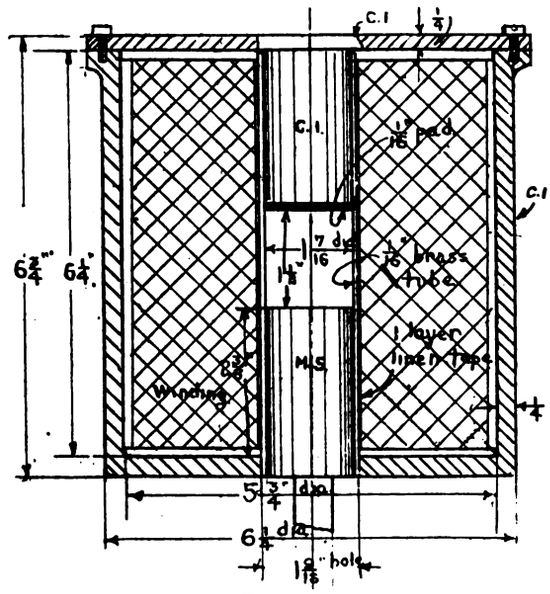

FIG. 1.

The following is a table showing ampere-turns per inch length for three materials at various densities. These give good results in practice for the commercial materials now manufactured.

Lines per square inch.	Ampere-turns per inch length. Annealed wrought iron.	Soft steel.	Grey cast iron.
2,500	1·2	2	9
5,000	1·7	2·8	13
10,000	2·2	3·7	18·5
15,000	2·8	4·3	24
20,000	3·5	5	30·5
25,000	4·4	5·8	39
30,000	5·5	6·6	50
40 000	7·5	8·8	88
50,000	9·6	11·8	160
60,000	13	16·4	295
70,000	19·6	22·7	570
80,000	31·2	34	—
90,000	50·7	57	—
100,000	91	100	—

In the magnet required the air-gap in coil is very large, and nearly the whole of the ampere-turns will be required to send the flux through the 12in. length of air gap. In order that the magnet may be of a respectable size, we shall have to take a very low induction, otherwise the air-gap ampere-turns will be very great. If possible, it would have been better to have allowed ¼in. travel, say, for the plunger and got the 4in. motion by a pivoted lever. One point that is not stated is whether it is for continual or intermittent use only, as the density in the copper can be run up high if for the latter. In the calculations the writer assumes it is for intermittent use only, and for continuous current.

Assume density of 15,000, pull in pounds per square inch area = $B^2 \div 72{,}000{,}000 = \frac{15{,}000^2}{72{,}000{,}000} = 3{\cdot}1$lb.

Allow 1lb. for weight of plunger, total pull required = 5lb.; plunger area = $\frac{5}{3{\cdot}1} = 1{\cdot}61$ square inches; $1\frac{7}{16}$in. diameter steel, area 1·62 square inches.

Allow 10 per cent. for leakage, total flux, N = 1·1 × 1·62 × 15,000 = 26,700 lines.

We can now proceed to calculate the ampere-turns for the air-gap in centre of coil.

1. Travel 1½in., and allow $\frac{1}{16}$in. for pad to prevent sticking, air-gap = $1\frac{9}{16}$in.

$$\text{A.T.} = 1\tfrac{9}{16} \times \frac{26{,}700}{1{\cdot}62} \times {\cdot}3133 = 8{,}400 \text{ A.T.}$$

If we now know the current available we can get the turns. Assume five ampere-turns = 1,680. As it is for intermittent use only we can use No. 16 S.W.G. wire, and assuming a winding length of 6in., we should get an approximate design as in Fig. 1.

We can now calculate the ampere-turns for iron and steel paths, and for hole through which plunger passes.

2. Steel plunger: Area, 1·62 square inches; induction = $\frac{26{,}700}{1{\cdot}62}$ = 16,500 lines per square inch; length of path, 2½in.

$$\text{A.T.} = 2\tfrac{1}{2} \times 4{\cdot}5 = 12.$$

3. For cast-iron fixed core, same area and induction as plunger:

$$\text{A.T.} = 2\tfrac{1}{2} \times 26 = 65.$$

4. Outer shell, cast iron: Area, 5¾in. diameter = 25·9; area, 6¼in. diameter = 30·6; area of shell = 4·7 square inches; induction = $\frac{26{,}700}{4{\cdot}7}$ = 5,700; length = 6½in.

$$\text{A.T.} = 6\tfrac{1}{2} \times 14 = 91.$$

5. Cast-iron ends: In determining these we must take the mean of the ampere-turns for induction at area of outer circumference and induction at area of hole in end, and not for the induction at average area.

Area at outer circumference = 6 × 3·14 × ¼ = 4·73 square inches; induction = $\frac{26{,}700}{4{\cdot}73}$ = 5,700 lines per square inch; length for two ends = 2 × $2\frac{7}{32}$in. = $4\frac{7}{16}$in.

$$\text{A.T.} = 4\tfrac{7}{16} \times 14 = 62.$$

Area at hole = $1\frac{9}{16}$in. × 3·14in. × ¼in. = 1·24 square inches; induction = $\frac{26{,}700}{1{\cdot}24}$ = 21,600; length = 2 × $2\frac{7}{32}$in. = $4\frac{7}{16}$in.

$$\text{A.T.} = 4\tfrac{7}{16} \times 52 = 230.$$

$$\text{A.T. required} = \frac{230 + 62}{2} = 146.$$

6. Air-gap at hole for plunger: Area = $1\frac{9}{16}$in. × 3·14in. × ¼in. = 1·24 square inches; induction as for hole in 5 = 21,600.

$$\text{A.T.} = 21{,}600 \times \tfrac{1}{16}\text{in.} \times {\cdot}3133 = 420.$$

Total ampere-turns required = 420 + 146 + 91 + 65 + 12 + 8,400 = 9,134.

$$\text{Turns} = \frac{9{,}134}{5} = 1{,}827.$$

Taking double cotton-covered wire, and working out winding space required, we should find that ample room is allowed in Fig. 1.

Proceed now to investigate the heating: Mean turn = 3½in. × 3·14 = 11in.; length of wire = $\frac{11 \times 1{,}827}{36}$ = 560 yards No. 16 S.W.G.; resistance = 4·45 ohms at 30deg. C.; watts = 5² × 4·46 = 112; outside surface = 204 square inches = 1,310 square centimetres; square centimetres per watt = $\frac{1{,}310}{112}$ = 11·7. As it is for intermittent use no damage due to heating will take place; if it was for continuous use, larger wire would have to be put in and new calculations made, the method of procedure being the same.

The electromagnet will appear to be large, but this is owing to the large lift of plunger. One recently designed by the writer to give a pull of 250lb. was the same over-all diameter and only 1½ times the length, but the travel was only $\frac{3}{16}$in., which reduced the ampere-turn for air-gap to one-eighth of those required in this question.—MAGNET.

[Other replies to Question No. 1,017 will be given in our next issue.—ED. *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared.

QUESTIONS.

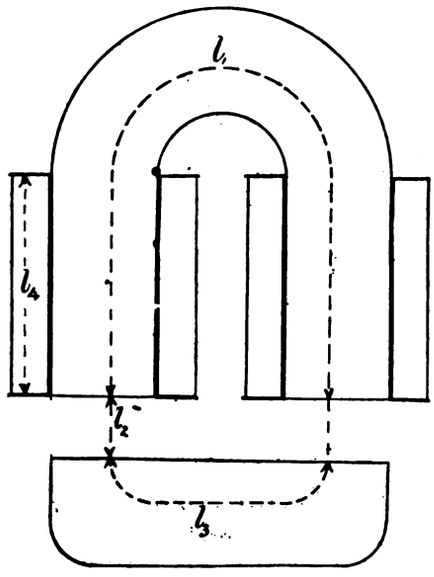
1,025. Owing to the installation of a new reversible booster, two 40-volt, 30-ampere motor-driven dynamos, formerly used for charging the regulating cells, are thrown out of use. It is proposed to use these for charging portable cells. As the cells to be charged vary from those in an electric landaulette of 100 ampere-hours to small ignition cells of 10 ampere-hours, the number of charging circuits must not be less than seven, so that large and small cells can be charged at the same time at different rates. One dynamo would be used entirely for charging the landaulette cells, and the charging rates required for the other cells are eight, five, four, three, two, one amperes. What is the most economical method of arranging the circuits? Both dynamos have field regulators giving 0-40 volts.—IGNITION.

1,026. Discuss theoretically the question of sparking in a direct-current multipolar generator when running under a varying load. Indicate the means adopted in design and construction to ensure sparkless running under these conditions. Size of generator, say, 150 kw., or larger.—P. BLACKHURST.

ANSWERS.

Question No. 1,017.—Discuss the design of a magnet, solenoid type, fitted with a core which will lift a weight of 4lb. through a distance of 1½in.

Answer to No. 1,017 (awarded 5s.).—The problem in this case bears at least two interpretations—viz.: (*a*) an electromagnet of the solenoid type having a fixed core adapted to act on an armature situate at a distance from it, and (*b*) a solenoid having a movable core attached to the piece or armature to be lifted. The former seems the most probable interpretation required, and this will be mainly dealt with.



In considering electromagnet designs the fundamental formula or law is that known as Maxwell's law of traction, and may be briefly stated as follows—viz., that the pull due to a magnetic flux when reckoned in dyne units is equal to the square of the flux density multiplied by the area through which it flows divided by eight times 3·14, all length measurements being in centimetre units—*i.e.*,

$$P = \frac{B^2 A}{8\pi}.$$

For practical purposes, however, the units are preferably changed to pounds and inch measure. This is an algebraical change, and results in the formula becoming

$$B = 8{,}494\sqrt{\frac{P}{A}},$$

where B is the flux density in lines per square inch, P the pull in pounds, and A the area in square inches.

The first point in the design is to choose some suitable value for A. In the case of a magnet having a large air-gap it is somewhat difficult, and the only guide is practice, in view of the fact that the iron will be very much under-saturated when the armature is at its full distance away, but after attraction will be enormously increased. A cross-sectional area of two square inches each may be considered an assumption to make in this case with a magnet of the horseshoe type—that is, one in which both ends of the solenoid core are used for attraction, as represented in the diagram. I now substitute this value for the area in the above formula, and substituting for P 4lb., a value for B is obtained of 8,494 lines per square inch—thus

$$B = 8{,}494\sqrt{\frac{4}{4}} = 8{,}494.$$

The next point is to determine the number of ampere-turns necessary to impose on the circuit such a flux. Seeing the enormous size of the air-gap, speaking as regards its reluctance, we may at least in the first instance calculate the windings as though there were no iron circuit. This is done from the formula

$$C\,S = N \times \frac{2\,l_2}{A_2} \times 0{\cdot}3132,$$

in which C and S represent the current and number of turns respectively, N the total flux, l_2 the length of each air-gap, and A_2 the area of the same. Substituting in this formula we get the number of ampere-turns to be required to be approximately 8,500—thus

$$C\,S = 8{,}494 \times 2 \times \frac{3}{2} \times 0{\cdot}3132.$$

Next, we must assume what current we have available, and this for our purpose may be reasonably considered as five amperes, no definite figure being given. Such a current requires a wire corresponding to No. 14 S.W.G, the diameter of which is 0·080in., and insulated with double cotton-covered magnet insulation the diameter becomes 0·09in. With such a current strength for 8,500 ampere-turns the total number of turns required is evidently 1,700—*i.e.*, 850 per pole. The arrangement on the pole is chiefly limited by the surface for carrying away the heat generated. In ordinary practice the windings must not be made more than 1in. deep on each limb, and this gives us with wire of the size above referred to a depth of 10 turns. We, therefore, have a length of 85 turns at least in each limb of the core. This will necessitate a core of about 9in. length, corresponding to l_4. The details of the iron circuit may, therefore, now be settled—viz., $l_4 = 9$in. and $l_1 = 18$in. plus the least necessary length for the top bend. These bends include a sufficient difference between the inner edges of the core in order that the leakage may be reduced to a reasonable amount. In this case 3in. may be taken as the distance between these edges which would give a value for l_1 of approximately 27in.

In this design it will be remembered that no notice was taken of any part of the circuit, except the air-gap, in calculating the ampere-turns required. It will now be seen that this was quite justified, as the total ampere-turns required

$$= 0{\cdot}3132\ N\left\{\frac{v\,l_1}{A_1\,\mu_1} + \frac{2\,l_2}{A_2} + \frac{l_3}{A_3\,\mu_3}\right\}$$

Each of the values in the bracket, it will be noticed, requires as a denominator the factor μ, and for the exceedingly low flux density which will exist in the iron at the time the armature is 1½in. away from the pole-pieces, the value for μ for any ordinary given quality of iron is practically infinite, and the terms, therefore, become indefinitely small, with the result that the ampere-turns calculated on the gap basis will be sufficient for the whole circuit.

As regards the case of a solenoid with a movable core, sufficient data are not given for carrying this into effect. Such design depends, among other things, on the distance of the armature to be attracted from the core. This is because the field on the axis of a uniform solenoid varies very considerably towards the ends of the core, although it becomes uniform at some distance away. In order to utilise, however, the field at some distance away, it would

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be very wasteful if the actual distance through which the armature would require to be moved was only 1½in. It is, therefore, thought that such is not the construction intended.—L. R.

Answer to No. 1,017 (awarded 5s.).—The chief difficulty in the design of solenoids for a given work is to find the number of ampere-turns required and the size of the plunger. There does not appear to be any really reliable and convenient formula which will give this and ensure a well-proportioned solenoid. C. R. Underhill gave a good formula in the *Electrical World and Engineer* (U.S.A.) for May 20, 1905. It works well in practice, but is rather long-winded, and is not "portable," as it contains about four different "constants," all of which vary under different circumstances. To design a solenoid by its aid, it is necessary to have a table giving its constants for all conditions. For the ordinary designer who only requires to design a solenoid once in a very long time, it is better to work from the formula for magnetic traction, although the ampere-turns are rather higher than by Underhill's method. The best form of the traction formula to use is:

$$C\,T = 2{,}700\left(\frac{l_1 + l_2}{\mu}\right)\sqrt{\frac{P}{(A+a)}},$$

where C T = ampere-turns required on coil; l_1 = length of travel in inches; l_2 = total length of gaps between core and shield and between stop and core, when core is home (usually ⅛in.); P = pounds required to be lifted plus allowance for friction and weight of plunger; A = area in square inches of plunger; a = area in square inches of gap between plunger and shield (should be made about three times A); μ = 1 for air.

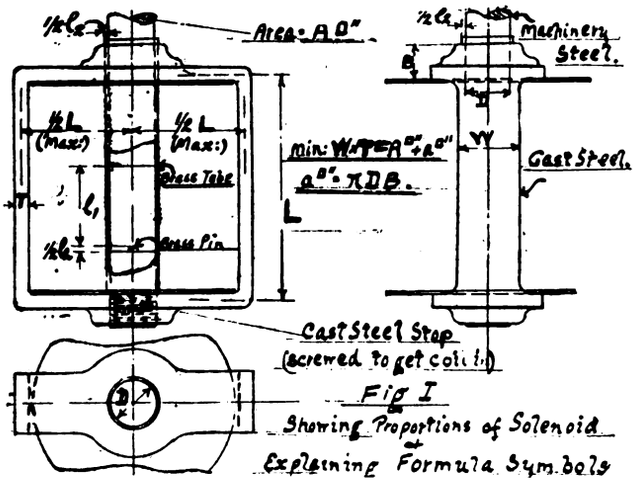

Fig I
Showing Proportions of Solenoid & Explaining Formula Symbols

It has been found that to make a solenoid as efficient as possible it should be so proportioned that: (1) The mean length of path for the flux through the yoke or shield should not exceed twice the length of the coil. It will be seen from Fig. 1 that this means that the diameter of the solenoid is about equal to its length. (2) The part of the shield through which the plunger passes should be thickened up to give as much area as possible so as to make the reluctance low. (3) The shield should be in cast steel, or, if only one solenoid is to be made, wrought iron might be cheaper to work as a forging. If cast iron is used, the weight will be much increased, as plenty of area must be allowed so as to keep the iron ampere-turns down. The plungers of cast-steel solenoids are usually made of machinery steel. (4) The "stop" should project about one-sixth to one-fourth of the way into the coil. This depends on the lift, etc. The end of the plunger when down should come at least one-third of the way up the coil, so that the lines will go through it from the start. If a steady, even pull is required, the end of the plunger can be cone shaped, and the stop similarly recessed. The initial pull is the same as for an ordinary plunger, but the pull is more even during the travel. Proceeding to the design, the magnet has to lift 4lb. + its own weight and travel 1½in. From the formula—

$$C\,T = 2{,}700\left(\frac{1{\cdot}5 + {\cdot}125}{1}\right)\sqrt{\frac{(4+2)}{({\cdot}78 + 2{\cdot}25)}}$$

(That is, adding 50 per cent. of weight to cover plunger weight and friction loss and having a plunger 1in. diameter.) This comes out to 6,000 ampere-turns approximately, and agrees fairly (though it is greater) with results on a solenoid designed by Underhill's method. It will be noticed that no allowance is made in the above formula for iron ampere-turns. If the area of the shield or yoke is not not made less than A + a square inches and the material is wrought iron or cast steel, the increase in the ampere-turns due to the iron is negligible. If the material is cast iron, then its area must be made such that the reluctance is the same as for wrought iron, having an area of A + a square inches. Having found the number of ampere-turns, the number of turns and the size of wire for the particular circuit can be found in the usual way. The winding space can then be made suitable for the coil. It is not usually advisable to have a solenoid coil less than about three times the travel in length; this would make the coil about 4½in. long and allow 1½in. depth for winding, making the space for 6,000 ampere-turns = six square inches, which is ample. If there is too much room, the depth of winding space can be reduced, and also the diameter of the solenoid.—ARAMIS.

Question No. 1,018.—Explain the formation of cavities (blowholes) in the interior of the compound in low-tension direct-current network boxes. Explain the presence of water in these blowholes when they are first broken open. Can the formation be prevented?

Best Answer to No. 1,018 (awarded 10s.).—The presence of blowholes in joint-boxes with solid compound is due either to air, water, a mixture of both, or some other gas.

1. *As to Air.*—This is formed when the compound is heated and stirred somewhat vigorously, with the result that bubbles of air are carried well down into the mass of the substance, and, owing to viscosity, cannot rise to the surface in all cases before cooling. Blowholes thus formed, however, will contain no water.

2. *As to Water and Mixtures of Water and Air.*—This is formed either by the presence of water due to the use of a damp sample of compound or due to dampness in the air bubbles carried below the surface, as explained with regard to air. Being in a state of vaporisation until cooling, the blowholes are practically of a size corresponding to the volume of water vaporised, and on setting they retain this size, but the vaporised water condenses on further cooling, so leaving a cavity with a small quantity of water therein. Further, in subjecting compound to the action of a direct current, the stresses tend to bring the water particles into line, and, therefore, if this be broken up and remelted without adequate stirring, the cooling being fairly rapid, subsequently material is obtained which is very prone to produce bubbles or blowholes containing water.

3. *As to Other Gases.*—If box compound be heated to a sufficiently high temperature locally, some of it will decompose with the evolution of various gaseous products, among which may be water. It is thus obvious how all rapid heating of the compound will, therefore, produce cavities containing water.

As to the prevention of these blowholes or cavities, this should be clear from the above remarks—viz., that compound should be well stirred while heating, but should be allowed sufficient time to permit the air bubbles to rise to the surface before setting; that the compound should be quite dry or sufficiently heated to drive off all the moisture; that the heat should be generally and not locally applied to avoid overheating any particular part of the mass.—L. R.

Answer to No. 1,018 (awarded 5s.).—These blowholes, as the blisters which at times appear in joint-box compound are called, may be due to: (1) the method of filling the box; (2) the state of the atmosphere when filling in; (3) the make of compound and its temperature; (4) osmosis.

1. This is a very important point. If the compound is thrown over the fittings carelessly a bubble of air may be imprisoned underneath the fittings, the compound will be too heavy for it to escape, and the air in it will expand, due to the heat, and a large blowhole will thus be formed.

2. If the surface of the compound is allowed to become damp after first filling, when topping up the moisture will be imprisoned by the hot compound and evaporated, a

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number of bubbles being formed which may be infinitesimally small. These make the compound more or less porous.

3. From this it can be seen that the hotter the compound the more moisture is likely to be evaporated; therefore, for this and other reasons a compound which becomes liquid at the lowest temperature should be aimed for.

4. The above only accounts for dry blowholes. Electric osmosis is the cause of water being found in some, and these near the negative pole. If a solution of sugar in water and pure water is separated by a porous septum, the water will flow through the septum to the solution, setting up a considerable pressure, which is known as the osmotic pressure. Electric osmosis is similar. It is the tendency for any moisture to travel through a porous medium in the direction of the current + to − (*i.e.*, from the point of higher to the point of lower potential). Almost all substances are porous to a certain extent. Rubber will absorb water under osmotic pressure, and, similarly, bitumen and compound will absorb moisture, but the latter to a greater extent, compound being more hygroscopic. Consequently, if there is any moisture in the compound, or any means of moisture getting into it, it will find its way to the negative pole and form a water blister, and sometimes this water is at considerable hydrostatic pressure. This latter is more noticeable when water gets into vulcanised-bitumen cable.

The formation of these blowholes can only be prevented by the careful filling of the box. The compound should be screened through a mesh of about $\frac{1}{16}$in. When the box is perfectly dry the compound should be poured in at the side of the box, so that it will rise up over the fittings, thus driving out all the air. Topping up should not be done for at least 1½ hours or more (according to size of box), and before doing so it should be ascertained that the surface is quite dry.—A. J. L.

Answer to No. 1,018 (awarded 5s.).—The following is a very interesting and simple experiment with a sample of compound, the result of which satisfactorily explains the formation of blowholes on the top surface of the compound in the end boxes of direct-current manholes. A small tin of compound was obtained, and a $\frac{3}{8}$in. hole bored in the bottom of the tin; a little of the compound was then taken out, and the cavity thus formed filled with water, the tin was then resealed, thus giving a small volume of water at the bottom of the tin of compound. The tin was then allowed to stand on a radiator for some length of time, so as to raise the temperature of the compound a few degrees above the atmosphere; it was found that a lump occurred on the top of the compound, which on being broken was found to contain water, being in every respect similar to the blowholes which occur in end boxes. This experiment proves that any accumulation of water in the end box will find its way to the surface of the compound, and cause a blowhole.

We now have to investigate the cause of an accumulation of water in an end box. At first sight it seems impossible that water should collect in the box, as it appears to be perfectly dry, as do all the cable fittings, etc., before the compound is poured in. The reason for this accumulation of water in the box is due to the fact that the cast-iron end box being cold, the pouring of hot compound into it will cause beads of moisture to collect on the inside walls of the box, and, as the above experiment proved, will cause these beads of moisture in course of time to rise to the top, and thus cause the blowholes observed. These blowholes will naturally be very small at first, but will gradually increase in size as each particle of water finds its way to the surface. Not only will moisture be formed in the box when the compound is first of all poured in, but more moisture will form if the distributor is fully loaded, as the cable would then get warm and heat the compound slightly, causing more moisture to be formed.

The usual method employed in practice of getting rid of these blowholes is to squeeze most of the water out and then heat the surface of the compound with a blow-lamp, but this will not prevent the blowholes from reappearing, for, as stated above, there is always a tendency for moisture accumulating, although this accumulation will probably be very slight after the compound has once got set. It would, therefore, seem evident that, in order to prevent moisture collecting to any extent, if it were prevented when the compound was first run into the box little trouble would be experienced due to blowholes. As the moisture is formed in the box due to its being cooler than the compound, if this difference of temperature were eliminated—*i.e.*, by heating the box before pouring in the compound—this moisture trouble would then be reduced to a minimum.—M. G.

Answer to No. 1,018 (awarded 5s.).—The compound used for filling network boxes consists chiefly of bitumen or pitch. The formation of cavities in which water is occasionally found may be explained in the following way. The compound in pieces is put in a receptacle, in which it is heated to the requisite temperature. During this process some of the air in the spaces between the pieces is entrapped by the melting stuff, from which, owing to its thick, viscous nature, it does not easily escape. Moisture may also be present, causing bubbles of vapour or steam, which also are held in a similar way. Some of these bubbles of air and vapour do not escape even when the compound is poured into the joint-box. The blowholes do not always form as separate cavities, but may take a honeycomb form. When the compound is cold any moisture present condenses, and is encountered as water on breaking up the compound.

To prevent the formation, care ought to be exercised in the handling of the compound. It should be clean and dry when placed in the heating vessel, which must be provided with a cover to prevent the access of wet—say rain—and foreign matter. A sufficient temperature must be maintained for some time to drive off any moisture, and gentle stirring to free air or gas. If, then, the compound is poured into the box slowly in a thin stream, the possibility of blowholes forming will be remote. The stuff when poured should not be in a frothy state, and the interior of the box perfectly dry. It might, in fact, be previously heated. Even greater care needs to be taken to prevent moisture in resin oil and tapes for lead-wiped joints on paper cables. Tapes should be well "cooked" in the hot oil. The presence of water in the latter can usually be detected by a crackling sound during the boiling process, which must be continued as long as is necessary to eliminate the water.

Water is sometimes found on the surface of the compound in link boxes, and may bridge across the terminals This is probably due to the cover joint not being quite airtight. Moist air finds access to the box with changes in temperature; the moisture condenses on the metal cover and drops on to the compound. The tendency to this may be reduced by painting the metal surfaces inside the box with a thick non-hardening paint, such as P. and B. In some cases it might be advisable to fill the box right up so that the cover comes down on the compound.—G. EVANS.

Question No. 1,019.—From an extra high-tension three-phase supply it is required to take a large amount of power—single phase and low voltage—without unbalancing the three-phase supply. What is the best way to do this, and is it possible without using rotating machinery?

Best Answer to No. 1,019 (awarded 10s.).—To obtain a single-phase supply from a three-phase supply without unbalancing the latter is rendered practically impossible without the use of running machinery, because of the fact that the total rate of doing work in a balanced three-ohm circuit is the same at every instant, whilst in a single-phase circuit it varies from a + maximum to a − maximum (of smaller amplitude) twice every period. The difficulty is got over with running machinery—such as a three-phase to single-phase motor-generator set—by means of the flywheel action of the rotating part, which enables the machine to store energy mechanically at those instants when the three-phase power supply exceeds the single-phase output and to give it up again to the single-phase circuit when the single-phase output exceeds the three-phase supply.

The arrangement shown in Fig. 1 (due to G. Grassot), whilst involving no running machinery, enables a nearer approach to balance of the three-phase supply to be attained than would be possible if the single-phase output were merely taken directly from one of the three phases, but it by no means offers a complete solution. The conversion in this case takes place in an ordinary three-phase

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three-limbed static transformer, of which the extra high-tension primary is connected as usual (either in star or mesh) to the three-phase supply, but of which the three secondary windings are connected in series (after one has been reversed as shown at *b*, Fig. 1) to form the single-phase supply. The three limbs carry fluxes with a phase relation of about 120deg. These set up three voltages with the same phase relation in the three secondary coils By reversing one of the secondary coils the phase relation of the three voltages is altered to 60deg., as shown in

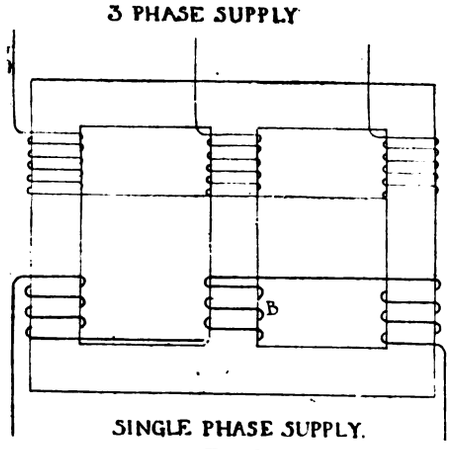

FIG. 1.

Fig. 2, and the sum of three equal voltages at 60deg. to one another being equal to 2 × 1 of the voltages, the secondary supply voltage (single-phase) will be twice that for which any one of the secondary coils is wound. It is clear that a want of balance still exists, because whilst the currents in all the three secondary windings are alike at any instant the primary currents have different values. The result is that the back volts set up in the primary coils are unsymmetrical, and a certain amount of electromagnetic storage of energy takes place in the core combined with a current distribution in the primary coils which differs from the correct three-phase balanced distribution.

If, as is preferable, the use of running machinery is decided upon, this may take the form of: (1) a synchronous extra high-tension three-phase motor direct coupled to a synchronous low-tension single-phase generator; (2) an

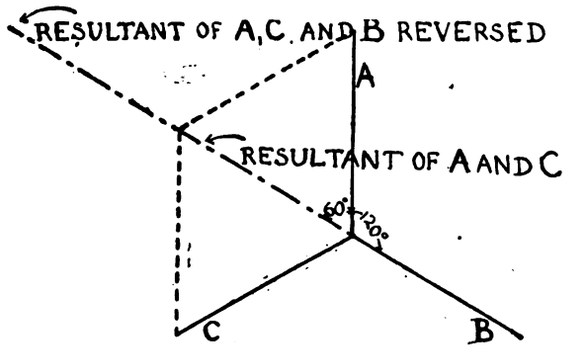

FIG. 2.

asynchronous (induction) extra high tension three-phase motor direct coupled to a synchronous low-tension single-phase generator; or (3) a synchronous three-phase low-tension to single-phase low-tension rotary converter consisting of a closed-circuit armature winding tapped off at intervals of 120 electrical degrees for the three-phase supply and at intervals of 180 electrical degrees for the single-phase supply, and having a multipolar field with direct-current excitation. In connection with this a static transformer for converting the extra high-tension three-phase supply into low-tension three-phase supply would also be necessary. Of these three arrangements probably No. 2 would be the simplest and cheapest, as both (1) and (3) require special starting arrangements.—Q.

Answer to No. 1,019 (awarded 7s. 6d.).—The simplest method of utilising a three-phase extra high-tension supply at low-tension single-phase is to transform it to the required pressure by means of three single-phase static transformers, the distribution system being divided up into three approximately equal positions, each connected to one phase of the three-phase low-tension system. By providing each feeder on the main low-tension switchboard with a double-throw quick-break switch, it is possible to balance the load sufficiently closely to satisfy the requirements of almost any supply authority, and such systems work well in practice. It may be contended, however, that this does not answer the question. It is not possible to transform three-phase to single-phase without rotary plant and without unbalancing the three-phase currents. One of the simplest rotary machines consists of two induction motors (which we will call A and B) mounted on the same shaft, and with their stators connected in parallel to the extra high-tension three-phase mains. Machine A is a two-pole machine with wound rotor, the single-phase low-tension current being drawn from one phase of its rotor. The other two phases are used in starting up and as a stand-by. Machine B is a multipolar machine, and its object is to maintain the speed of machine A at about 25 to 30 per cent. of its synchronous speed. It may, if desired, be arranged to work in parallel with the rotor instead of the stator of machine A, and if it is desired to raise the power factor of the three-phase currents to unity, a synchronous machine may be used instead of an asynchronous. The simplest arrangement, however, consists of a squirrel-cage induction motor. The principle of action is as follows: If the rotor of an induction motor be loaded on one phase only whilst the machine is at rest, we have a three-phase to single-phase static transformer, but the stator currents are unbalanced. If the rotor revolves at, say, 25 to 30 per cent. of synchronous speed, the unbalancing effect revolves with it and is transferred from phase to phase of the stator so rapidly that it ceases to be objectionable. No exciter, starting motor, synchronising gear, or transformers are required, and the efficiency, weight, and cost are very good. The inherent regulation is bad, however, and hand regulation is only possible by means of an induction regulator.

TABLE I.—For 500-kw., 10,000-volt, 50~, and Maximum Permissible Speed in each Case.

Type.	Over-all efficiency.	Power factor (primary).	Hand regulation.	Inherent regulation.	Transformers required.	Starting motor required.	Synchronising gear required.	Exciter required.	Relative best.	Secondary and primary frequencies equal.
Rotary converter.	90 %*	1 or leading	By induction regulator or booster	Good	Yes†	Yes.	Yes.	Yes.	1	Yes.
Motor converter.	87 %	1 or leading.	On field.	Fair.	No.	No.	Yes.	Yes.	1·25	No.
Induction motor driving alternator	85 %	·7 to ·8	On field.	Bad.	No.	No.	Yes.	Yes.	1·4	No.
Alternator and synchronous motor.	86 %	1 or leading.	On field	Good	No.	Yes.	Yes.	Yes.	1·6	No.

* Including transformers. † With double-wound armature no transformers are required. Parallel operation about the same for all types, with slight advantage in favour of synchronous motor-alternator. Rotary converter probably the most reliable.

Unless this type of plant be employed the problem of three-phase to single-phase conversion closely resembles that of polyphase to direct current conversion, and may best be summed up by means of Table I. Such a table was employed by Mr. Miles Walker in his paper before the Institution of Electrical Engineers on rotary converters. The only point of difference is the elimination of commutation questions, the commutator in this case being replaced by a pair of slip-rings. —J. S. MESSENT.

[Other replies to Question No. 1,019 will be given in our next issue.—ED. *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

QUESTIONS.

1027. Explain fully why it is that feed pumps will not work satisfactorily if the supply water is hot and has to be raised any height. What is the best way to overcome the difficulty?—S. E. T.

1028. In connection with a large three-phase power supply system the frequency at the generating station has lately been changed from 50 periods to 40 periods per second. The circuits consist mostly of induction motors supplied from step-down transformers (6,000 to 440 and 6,000 to 2,000). Neither motors nor transformers have been altered to suit the changed frequency, nor have the generators at the power station, and these latter have to be run very much over-excited in order to keep the voltage as high as desired at the reduced speed. What effect is this change of frequency likely to have on the power factor of the system? Give reasons.—T. W.

ANSWERS.

Question No. 1,019.—From an extra high-tension three-phase supply it is required to take a large amount of power—single phase and low voltage—without unbalancing the three-phase supply. What is the best way to do this, and is it possible without using rotating machinery?

Answer to No. 1,019 (awarded 5s.).—By employing the method of Grassi it will be possible to convert the three-phase supply into single-phase. Fig. 1 is a diagram of

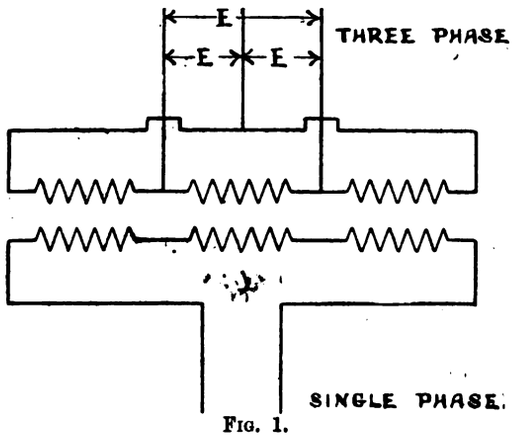

FIG. 1.

connections; primary windings of transformer are connected in delta, secondaries in series. Thus the three is converted into single-phase. Fig. 2 will explain this: *a b*, *b c*, and *c a* are the three phases, delta connected. At a particular instant, by projecting *a b* and *a c* on the ordinate, *y* y_1, it will be seen that they neutralise each other, leaving

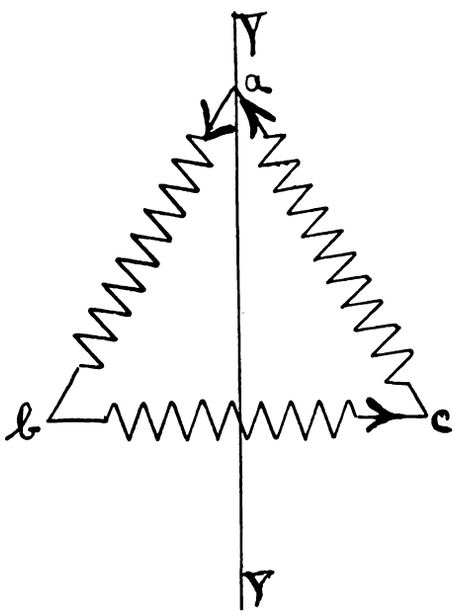

FIG. 2.

b c unaffected. But these three secondaries are joined in series with the work, therefore the result is a single-phase current supplied by each of the three primary phases in turn.

Probably the most satisfactory arrangement would be to transform from three-phase to two separate single-phase circuits—connections for this are shown in Fig. 3. This method of transformation was invented by Scott. There are two transformers, A and B; A is wound in the ratio of 10 : 1, while A is wound in ratio of $\sqrt{3}$: 2. By con-

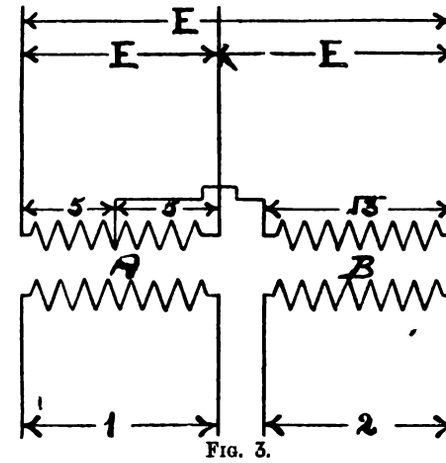

FIG. 3.

necting as in figure, either two-phase current is available or single-phase in two separate circuits. This would tend to preserve a balance, and has the great merit of simplicity—no moving machinery is required. A number of proofs of Scott's method of phase transformation will be found in the *Electrical Engineer* for March 4, 1904.—M. M.

Answer to No. 1,019 (awarded 5s.).—The best way to obtain the necessary phase transformation is by the use of a

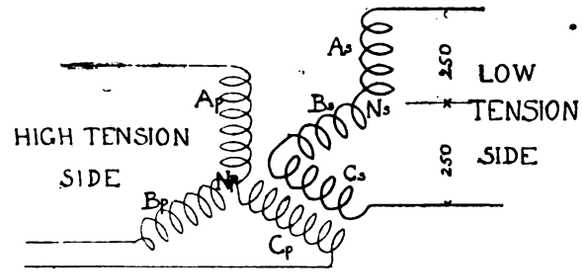

FIG. 1.—Ulbricht Method of Phase Transformation.

motor-generator, but the desired result can be obtained by the following method of connecting up a three-phase transformer (see Fig. 1). The high-tension primary phases are

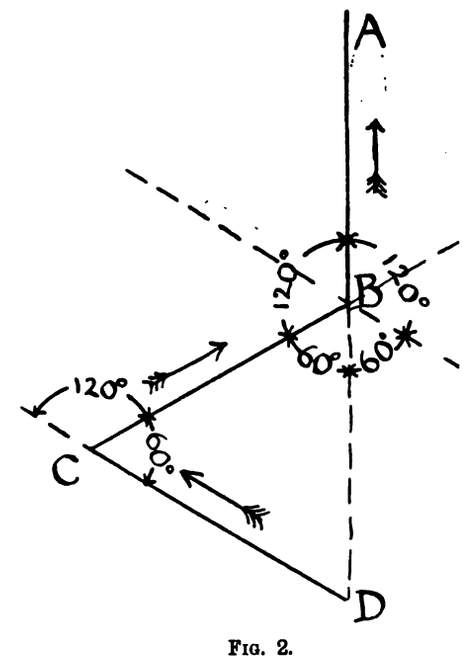

FIG. 2.

shown by A_p, B_p, C_p, and they are Y connected, the central point being N_p. The low-tension secondary windings are A_s, B_s, and C_s, but they are not connected together in Y fashion, but one of the phases—it does not matter which—is disconnected from the central point and is connected on

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to the outer end of one or other of the remaining coils, these two coils being connected at what would be their neutral point. This point is not earthed, of course. The three low-pressure phases are, therefore, in series, and the losses on each will be equal, and also the reactions.

The pressure relations are as follows: Supposing the secondary coils to be designed to give 250 volts per phase, then across any two phase when connected Y fashion, the pressure would be $\sqrt{3} \times 250 = 433$ volts. When, however, they are connected as described above, the pressure across the terminals A_s and C_s will be: phase volts × 2; 250 × 2 = 500. This is easily explained. Let vectors (Fig. 2) A B, B C, B D represent the three phases in pressure and direction. They will, therefore, be in the directions shown when connected in the manner described, and the voltage of the single-phase current is the pressure across A D. Now, pressure across A B is that of a phase—viz, 250 volts The pressure across B D is the resultant of B C and C D at 60deg. to each other, and as this makes B C D an equilateral triangle, B D is, therefore, the same as B C or C D—viz, 250. So the pressure across A D = A B + B D = 250 + 250 = 500 volts. With this method of connecting the copper losses are 2¼ times that of one phase.—M. G. TWEEDIE.

Answer to No. 1,019 (awarded 5s.).—If an absolute balance is to be maintained on the three-phase supply mains, and single-phase current is required, the use of rotating machinery is essential—*i.e.*, a three-phase motor driving a single-phase generator. This represents the simplest possible arrangement under the above conditions. The three-phase motors would be either of the synchronous, induction, or compensated induction types, either of which could be wound for working direct from the high-pressure mains, depending upon the size of the individual units, which would, no doubt, be determined by the requirements of the single-phase distribution; the limiting pressure for a 500-kw. set would be about 10,000 volts. The single-phase generator would be either of the revolving field or revolving armature type, depending on the voltage to be generated; the exciters would be direct-coupled to the alternators or separately driven by three-phase motors, if a number of motor-generator sets were installed. It should be noted that with the rotating machinery suggested above the frequency of the system can also be changed, if desired, without any complications either in the machine construction or the switchgear.

By employing static transformers for the conversion from three-phase to single-phase, many important advantages are obtained over rotating machinery—for instance, lower prime cost, lower cost of buildings (due to the smaller space occupied and to the absence of foundations), higher efficiency, maintenance and running charges practically negligible, simpler switchgear, larger overload capacity, and ease of dismantling for repairs, etc. In view of the above advantages, which are very real, the question of the plant for conversion should be seriously considered to see whether static transformers could not be adopted in the manner suggested below, and in spite of the unbalancing that would occur on the three-phase supply mains. The conversion from three phase to two phase current by static transformers is a comparatively simple matter, but there are many difficulties presented if single-phase current is required without unbalancing the three-phase supply. A method which is described in many text-books is to employ a three-phase static transformer, star-connected on both primary and secondary windings. The three phases of the secondary winding are connected in series, one of them being reversed at the neutral point. The pressure at the terminals of the three coils in series is approximately twice that of one phase. With this method the secondaries produce the same reactions, and will also heat equally, but the load on the three-phase supply will be unbalanced in the ratio of about 1 to $\sqrt{3}$. This unbalancing effect can be shown very clearly by taking an ordinary three-phase induction motor with a wound rotor and connecting the three stator phases in series, one of them being reversed at the neutral point. The rotor brushes are connected to a suitable three-phase supply. On turning the rotor slowly by hand, the unbalanced power consumption will be very apparent if current is taken from the single-phase leads on the stator.

The flow of energy in a normal symmetrical three-phase system is absolutely uniform, whereas with a single-phase it is intermittent; if, therefore, it is desired to balance the three-phase supply and obtain single-phase current, some means should be provided for storing the energy absorbed during the period of transition across the zero line of the single-phase current. This, of course, cannot be done by static transformers. It might be possible, however, to install three-phase to two-phase transformers and utilise the two single-phase currents which differ in phase from one another by 90deg., and provided the load varied equally on both phases no trouble would be experienced with the balancing of the three-phase supply. It may be of interest to mention that the cost of a 500-kw. set at 300 r.p.m., consisting of a high-tension synchronous motor and a single-phase generator, exclusive of the exciter, would be about *£1,860*, and of a 500-kw. static transformer with oil cooling, the conversion arranged from three-phase to two-phase, *£400*. These prices are exclusive of any switchgear, which would also show to the advantage of the static transformers.—K.

Question No. 1,020.—Will any reader explain a method of finding the power factor (not using a power-factor meter) of a three-phase traction plant, mesh-connected, 2,500 volts, 25 ~, supplying the line at 550 volts direct by means of transformers and rotaries? There is a sub-station about three miles from main station.

Best Answer to No. 1,020 (awarded 10s.).—After making a close investigation into the requirements of "H. S. I.," I think the following method will be found the most suitable and accurate. Referring to Fig. 1, it will be noticed that

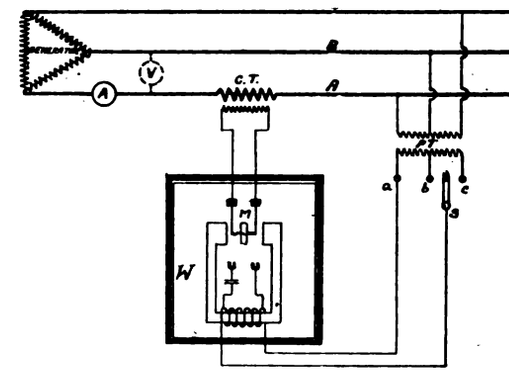

FIG. 1.

the instruments required are as follows: high-tension ammeter, A; high-tension voltmeter, V, shown dotted; wattmeter, W, with its current and potential transformers (C T) and (P T) respectively. It may be well to mention here that the type of wattmeter best suited for this test is that patented by Dr. Sumpner, and at present being manufactured by the General Electric Company, of London; I have used one of these instruments and obtained excellent results. This type of wattmeter entirely isolates all high-tension wires, and may be used also as a voltmeter by simply revolving a small change-over switch, thus dispensing with the high-tension voltmeter, V, in Fig. 1.

The test consists in making connections as shown in diagram. The switch, *s*, is placed first on *b* and then on *c*, and the corresponding wattmeter readings, together with the reading of the ammeter, A, are noted. The voltage between phases A and B is also obtained by placing switch, *s*, on *b* and reversing the wattmeter moving-coil switch, M, which places the moving coil in series with a condenser across the full-line voltage. The readings may be tabulated as follows:

Current, A.	Line voltage, V.	Watts, switch, *s*, on		Total watts $= W_1 + W_2$.	Power factor $= \frac{W_1 + W_2}{\sqrt{3} \text{ C} \times \text{V}}$
		$b = W_1$	$c = W_2$		

The proof of the above method is not very elaborate but rather lengthy, and, perhaps, it will suffice for me to remark that the reading W_1 represents the value

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C V cos (30deg. − θ), where θ = angle of lag, also W_2 = C V cos (30deg. + θ). Now, the sum of these two quantities ($W_1 + W_2$) simplifies to $\sqrt{3}$ C V cos θ, which is the total power in the circuit, cos θ being the cosine of the angle of lag, or the power factor; therefore we have:

$$\text{Power factor} = \frac{\text{total power}}{\sqrt{3}\,C\,V} = \frac{W_1 + W_2}{\sqrt{3}\,C\,V}.$$

It may be useful to note that the difference between the two readings W_1 and W_2 = V C sin θ, which, if divided by the line voltage, V, gives directly the value of the idle current in the circuit.—P. F.

Answer to No. 1,020 (awarded 7s. 6d.).—It would have been better if "H. S. I." had stated what instruments are in existence on the high-tension side of the system, as, no doubt, instruments are available by means of which the power factor can be obtained. As the load is a transformer for driving a rotary, we can look upon the system as a balanced one—that is to say, if we get the power factor for one line, it is similar for the other two lines The methods given require a wattmeter, W_1, ammeter, A, and voltmeter, V, together with the necessary instrument transformers, as the voltage (2,500) is too high for instruments to be wound for direct.

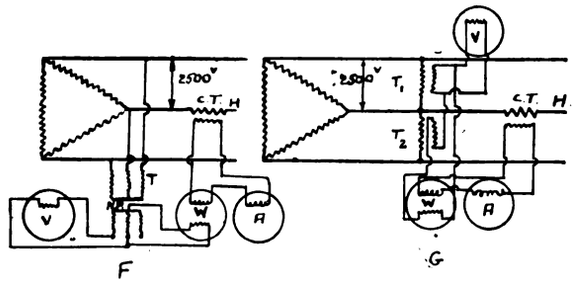

FIG. 1.

Fig. 1 shows two methods, each consisting of a single-phase wattmeter, W, ammeter, A, and voltmeter, V, C T being the current transformer. In system F a three-phase potential transformer, T, is used, and the shunt coil of the wattmeter connected to the secondary, one end to the neutral point, and the other to the winding on the leg on which the primary is connected to the line in which the current transformer is—this is a point which should be watched, as if connected to either of other two terminals, wattmeter will not read correct due to current and voltage not having correct phase relation. The voltmeter, V, is also operated by this transformer, T. The instruments in all cases should be calibrated so as to indicate the current, voltage, and watts in the high-tension lines direct, without having to multiply scale reading by a constant to get true reading.

If W = total three-phase load in watts; V = voltage between lines; and A = amperes per line; then: Power factor for line H

$$= \frac{\frac{W}{\sqrt{3}}}{\frac{A\,V}{\sqrt{3}}} = \frac{W}{\sqrt{3}\,A\,V} \quad . \quad . \quad . \quad (1)$$

As system is balanced this is the power factor for the system. If the system were unbalanced, by using a wattmeter which was calibrated to read single-phase load, and measuring the voltage between the line and neutral point to which the wattmeter is connected, we could obtain the power factor for each line by measurements on each line separately.

If W = single-phase load in watts; A = amperes in line; and V = voltage between line and neutral; then

$$\text{Power factor of line} = \frac{W}{A\,V} \quad . \quad . \quad . \quad (2)$$

As system is unbalanced, the measurement must be repeated for other two lines in order to obtain their power factor.

In system G, instead of a three-phase potential transformer, T_1 and T_2, two single-phase ones are employed, and their secondaries are connected in reverse series to the wattmeter. As in first case, wattmeter is calibrated to read total three-phase load, and formula $\frac{W}{\sqrt{3}\,A\,V}$ applies as in first case. This giving power factor of one line, and as it is on a balanced system, power factor of the system as well.

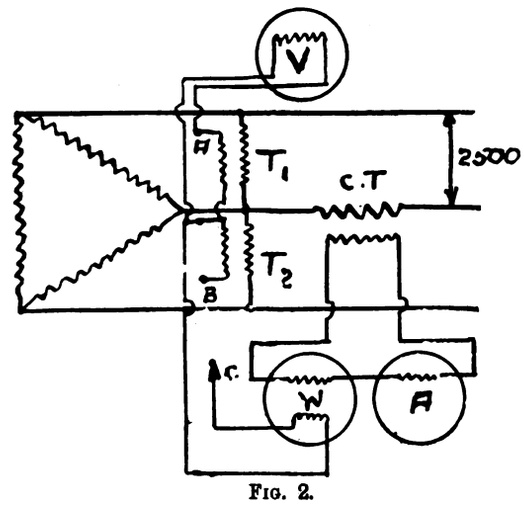

FIG. 2.

Fig. 2 shows another method by means of a single-phase wattmeter, calibrated to read single-phase load, and two potential transformers, T_1 and T_2. One end of the shunt coil is permanently connected as shown. The other end, C, is first connected to B and reading W_1 noticed; it is then connected to A and reading W_2 noticed. $W_1 + W_2$ gives total three-phase load in watts, and if V = voltage between lines and A = amperes per line,

$$\text{Power factor on balanced system} = \frac{W_1 + W_2}{\sqrt{3}\,A\,V}.$$

In order to render perfectly clear what the wattmeter should be wound for, the writer will give winding, watts through wattmeter, and scale reading for given watts through wattmeter for each case.

If V = voltage between lines; v = voltage between secondary terminals of potential transformer; A = amperes in line; and a = amperes in secondary of current transformer; then

$$\text{Ratio of potential transformer} = \frac{V}{v}$$

and

$$\text{Ratio of current transformer} = \frac{A}{a}.$$

Power-factor formulæ.	Figure.	Wattmeter for — Volts.	Amperes	Watts through wattmeter.	Scale reading in watts.
$\frac{W}{\sqrt{3}\,A\,V}$ (1)	1—F	$\frac{v}{\sqrt{3}}$	a	$\frac{v}{\sqrt{3}}a$	$\sqrt{3}\,V\,A$
$\frac{W}{A\,V}$ (2)	1—F	$\frac{v}{\sqrt{3}}$	a	$\frac{v}{\sqrt{3}}a$	$\frac{V}{\sqrt{3}}\,A$
$\frac{W}{\sqrt{3}\,A\,V}$	1—G	$\sqrt{3}\,v$	a	$\sqrt{3}\,v\,a$	$\sqrt{3}\,V\,A$
$\frac{W_1 + W_2}{\sqrt{3}\,A\,V}$	2	v	a	$v\,a$	$V\,A$

—C. T.

Answer to No. 1,020 (awarded 5s.).—Considering that the load of the plant which, "H. S. I." states, is a balanced load, the most direct way of ascertaining the power factor for a certain period is to take the number of units generated as indicated by the sum of the two readings of the two integrating wattmeters, or the reading of the one three-phase integrating wattmeter, whichever method is employed, for that period of time, and at intervals during the same period take simultaneous readings of the voltage and amperes (of one phase) of each generator on load. Then—providing all the meters are reading correctly, and that they are all connected to the same part of the circuit—as the power factor equals $\frac{\text{true watts}}{\text{apparent watts}}$, and in the mesh-connected generator the line current equals the phase

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current $C_1 \times \sqrt{3}$, the following equation will give the factor during the period taken:

$$\frac{U\ G}{a \times \sqrt{3}\left(\frac{V \times H}{R \times 1{,}000}\right)},$$

where U G = units generated; a = the sum of the ampere readings taken of one phase of each generator on load; V = average voltage, taken from the readings; H = time in hours over which the readings extended; and R = number of readings taken of volts and amperes.

If the voltage, V, is constant, then $\left(\frac{V \times H}{R \times 1{,}000}\right)$ becomes a constant, and can be used whenever the power factor is needed, which would only necessitate ammeter readings being taken. By this method the factor could be worked out at the end of each day on closing up the station log sheet. If half-hourly readings are taken, then

$$\frac{U\ G}{A \times \sqrt{3}\left(\frac{2{,}500 \times 24}{48 + 1{,}000}\right)}, \text{ which equals } \frac{U\ G}{A \times 1{\cdot}73 \times 1{\cdot}25},$$

would work out the power factor for the day, the 1·25 becoming a constant if V is always kept at 2,500 volts.

Another method, if the required wattmeters are not available, is by using three voltmeters, connected as shown in Fig. 1, where G is the generator; R, the circuit of

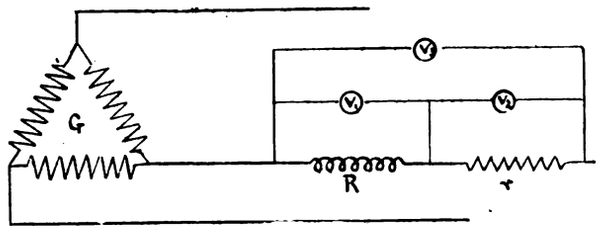

FIG. 1.

one phase, partly inductive and partly non-inductive; r, a non-inductive resistance in series with R, which must be inserted for the purpose of measurement; and V_1, V_2, V_3, voltmeters. If represented graphically, the three readings of v_1, v_2, and v_3 will form three sides of a triangle, since v_3 is the resultant of v_1 and v_2. v_2 will be the voltage

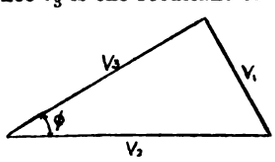

FIG. 2.

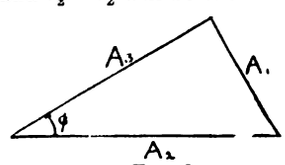

FIG. 4.

in phase with the current of the circuit due to the non-inductive resistance, r, and the angle between v_2 and v_3, as shown in Fig 2, will be ϕ, the angle of lag due to R, the circuit load.

A third method of indicating the angle ϕ is by using three ammeters connected as shown in Fig. 3, where G is

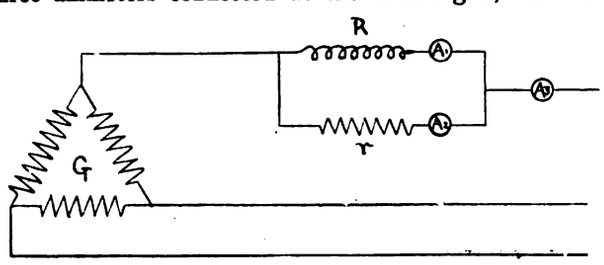

FIG. 3.

the generator; R, the circuit of one phase, partly inductive and partly non-inductive; r, a non-inductive resistance in parallel with R; and A_1, A_2, A_3, ammeters. Here again the readings of A_1, A_2, and A_3, if represented graphically, form the three sides of a triangle, since readings A_1 and A_2 are components of reading A_3, the resultant current. A_2 will be in phase with the voltage of the circuit due to the non-inductive resistance, r; therefore, the angle between A_2 and A_3, as shown in Fig. 4, will be ϕ, the angle of lag due to R, the circuit load. Then the cosines of the angles ϕ in Figs. 2 and 4 will be the power factor of that phase on which the test was taken.—W. A. B.

Answer to No. 1,020 (awarded 5s.).—There are several ways in which the power factor of the circuit described by "H. S. I." can be determined, depending upon what instruments and facilities are at his disposal. The power factor of an alternating circuit is, of course, the ratio between the *actual* and the *apparent* powers traversing the circuit, and obviously the simplest way of finding it is by measuring the actual power by a dynamometer or wattmeter, and the apparent power by taking product of voltage and current of the circuit. The power factor is then $\frac{\text{wattmeter reading}}{\text{volts} \times \text{current}}$. If a wattmeter is not available, the actual power could be measured by the three ammeter or three voltmeter methods, but these methods would hardly be practicable in the present instance.

Presumably "H. S. I." requires to know the power factor at any time on his circuits, so that it can be kept approximately at unity on score of efficiency. This can readily be done without actually knowing the value of the power factor when it is other than unity. If the load on a synchronous motor or a rotary is kept constant and the excitation of the field system varied, we get the well-known V curve, as shown in Fig. 1, by plotting values of armature

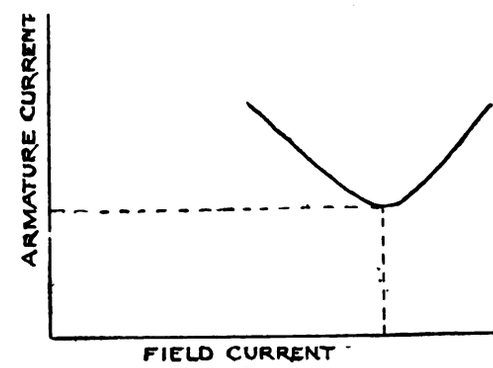

FIG. 1.

current and field current. It is seen from this curve that, with load constant, the value of the armature current is a minimum for a certain value of field current; when this point is reached the power factor of the circuit is unity. If the excitation is increased, the armature current is made to *lead*, and if it decreased, the armature current is made to *lag*. Thus at any load, by adjusting the field current until the value of armature current is a minimum, a power factor of unity is obtained in the circuit.

If "H. S. I." requires to run at any particular power factor, he can ascertain and adjust approximately the power factor by this method. At any load a reading of the main current should be taken. Call this A. The excitation should then be varied until minimum main current, a, is obtained. The voltage, V, at same time should be noted. The power factor at original value of the current is then given by $\frac{V}{V}\frac{a}{A}$. This method would, of course, give approximate value only, and, although possible, would present difficulties with two or more sets running. These readings and operations would be taken and made at the sub-station, the main current readings being taken on the feeder ammeter.

There is another method by which the power factor could be approximately obtained. Simultaneous readings should be taken of the direct-current output and alternating-current input; the alternating-current readings being taken on high-tension side of transformers. The efficiencies of the rotaries and transformers at their corresponding loads should be taken from test curves, and the power factor can then be obtained.

W = output in watts of direct-current side; E_r = efficiency of rotary with load of W watts; E_t = efficiency of transformers with load $\frac{W}{E_r}$ watts; V = volts on high-tension side; and a = amperes on high-tension side;

$$\text{Power factor} = \frac{W \times \frac{1}{E_r} \times \frac{1}{E_t}}{V\ a}.$$

—ERG.

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

QUESTIONS.

1,029. In designing compound balancers with cross-connected fields, should the series ampere-turns only balance out the armature reaction of the machines, or should they have any compounding effect greater than this? If so, how much?—A.

1,030. With reference to three-phase motors, please explain the difference between the following statements: The intensity of the resultant revolving field is equal to 1·5 times the amplitude of one of the component alternating fields; and the resultant magnetomotive force of three phases is equal to twice the magnetomotive force of one phase.—A. D.

ANSWERS.

Question No. 1,021.—What are the more important considerations which should be taken into account when deciding on the ratio of commutator to armature diameters in a standard line of direct-current motors?

Best Answer to No. 1,021 (awarded 10s.).—Practice and experience have determined that for standard continuous-current motors the most suitable ratio of diameters of commutator to armature is approximately 3 : 4. This ratio, however, is exceeded in the case of extra large machines, where considerably higher peripheral speed is allowable. It is known that the output of an armature depends directly upon the dimensions to which it is built, and in design these dimensions are arrived at by (1) the torque to be exerted, and (2) the aid of formulæ given by Esson and Steinmetz—viz.:

$$\text{Esson—} \qquad d^2 l = \frac{\text{KW.}}{\text{R.P.M.}} \times \frac{60{\cdot}8 \times 10^{10}}{B_g \times q \times \psi}.$$

$$\text{Steinmetz—} \qquad d l = \text{KW.} \times \frac{15{\cdot}9 \times 10^{10}}{B_g \times q \times \psi \times v},$$

where d = diameter of armature; l = length of armature core parallel to axis; B_g = an assumed suitable working flux density for the gap; q = specific electric loading; $\psi = \frac{\text{pole arc}}{\text{pole pitch}}$; and v = peripheral speed of armature in feet per minute.

From trial values arrived at by means of these formulæ the best dimensions for the armature are obtained, and now it is necessary to consider the most suitable size for the commutator. It is obviously an advantage to increase the diameter of the commutator up to a point at which the peripheral speed will not exceed, say, 3,000 ft./min. (above this speed the commutator losses due to contact resistance will be great). For with a larger diameter allowance is made for sufficient insulation between segments, and greater cooling surface is provided. Assuming, then, a limiting value of surface speed, v, a value of commutator diameter is obtained from the formula:

$$d_k = \frac{12\ v}{\pi \times \text{R.P.M.}}$$

From this value find the circumference of the commutator, divide by the number of commutator segments required (which will be the number of armature conductors divided by 2, 4, or 6 according to the number of coils allowed per segment), and this will give the width of each segment and the mica insulation between segments. The commutator should be of such size that the prescribed number of segments, having width at surface not less than 0·2in., and adequate insulation of the order of 0·03in. thick, can be worked into the periphery. Except in the case of large commutators, the width of segment should not exceed 0·3in., for with fewer segments of greater width the volts between consecutive segments will be great. The voltage between two segments should not exceed 10.—C. N. G.

Answer to No. 1,021 (awarded 5s.).—When settling the diameter of commutators for a standard line of machine, the following are the chief points to consider: (1) peripheral speed; (2) minimum width of segment; (3) number of segments covered by brush; (4) radiating surface of commutator.

1. The usual speeds employed vary between 2,000ft. and 3,000ft. per minute, though for large machines 3,600ft. per minute is not excessive.

2. The minimum thickness of plate at the top should not be less than ·125in., as smaller than this results in an unsatisfactory mechanical job. The thickness of mica insulation is generally about ·025in. or ·03in.

3. The number of segments covered by the brush should be between two and three. This can only be settled by the reactance voltage and the general design of the machine. For a general rule, widths of brushes can be taken as ⅜in., ½in., and ¾in. for 500, 220, and 110 volt machines respectively.

4. To dissipate the watts lost on the commutator a certain radiating surface will be required: 20deg. to 25deg F. temperature rise per watt per square inch can be assumed for this calculation. The total watts lost on the commutator are friction and $C^2 R$. They can be calculated as below.

Friction watts = ·0085 × A × P, where A = total area of brushes in square inches, and P = peripheral speed of commutator in feet per minute.

$C^2 R$ watts = ·03 × A × D^2, where D = current-density amperes per square inch.

This is assuming carbon brushes with a brush pressure of about 1½lb. per square inch. The voltage per commutator bar is not a point needing consideration when deciding on a standard line of machine, but in interpole generators this is one of the limiting factors. A good rule is to take the commutator diameter at 75 per cent. of the armature diameter. For an interpole machine this can be reduced to 60 per cent. for the same heating, owing to better commutation and reduced stray losses.

It should be remembered that, wherever possible, the wires should be sweated directly into the commutator bar, instead of employing lugs to carry the conductors. Then it may be found advisable to slightly increase the commutator diameter in order to allow of sufficient space for the wires in the plate. A minimum clearance of ·025in. should be allowed on each side of the wire at the bottom of the segment.—H. T. A.

Answer to No. 1,021 (awarded 5s.).—The following are the most important points which should be considered in deciding the ratio of commutator to armature diameters for any particular type of motor.

Type of Commutator.—It is first necessary to consider what type of commutator will be used—*i.e.*, either peripheral, a face type, or a combination of both types. In this country practically every commutator acts peripherally, though in America it is not so, and the other cases may, therefore, have to be considered.

Range of Machines.—If the same size armature core is to be used with different windings for a range of machines for purposes of economy, the maximum current which will be used in the larger size machine must be taken as that necessary for working out the design for the whole set of machines, otherwise overheating in some cases will occur. This necessitates a waste of copper, but must be done.

Material of Bars.—The material of which the bars are to be made must be tested, or data obtained as to its conductivity, in order that a sufficient size may be allowed for proper commutation.

Brushes.—The reason these enter into the design is that the conductivity of various materials of which brushes are made varies, and also of different kinds of the same material, such, for example, as different kinds of compressed carbon, and the size of the commutator bar must be such as to enable brushes of a size sufficiently low in resistance to be used.

Peripheral Speed.—The act of commutation itself takes some definite time, among other reasons, because of the induction of the coil being commutated; the peripheral speed must, therefore, be low enough to allow sufficient time for this act. Further, high peripheral speeds mean high friction losses and greater wearing of the commutator, and, therefore, the ratio of the diameter of commutator to armature must be such that at the highest motor speed the peripheral travel will not be too great. As a matter of fact, in practice it should not exceed at the most 115ft. per second.

Insulation.—The type of insulation used affects the size of the commutator in that with some materials a greater thickness must be used than in others, and, therefore, in order to allow a proper width of segment, the commutator

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must be relatively larger with respect to the armature than in other cases.

Radiation.—This must be considered, otherwise the commutator will overheat and possibly the insulation be destroyed. Further, it must be considered in relation to the acts or rules governing the place in which the motor is to be installed, as only a given temperature rise is permissible in most cases.

Design.—The design of the commutator itself also affects its relative size. With low-tension machines practically only a small number of segment is required, and the thickness of the substructure practically determines the diameter; with high-tension machines, especially those of the multipolar type, the number of segments is very great, and the diameter is practically fixed by the width at the periphery of the commutator bars, their number, and the thickness of insulation.

In conclusion, in the design of commutators the following general points should be noticed and due allowance made for them. The insulation must not only adequately protect the segments from one another, but from the sleeve, and it must be such that the centrifugal forces do not disturb it. Suitable clamping segments properly insulated must, therefore, be provided, and due space left in the design to allow this. Further, the arrangement must be such that no segment can work out of its place through the centrifugal forces or expansion by heating. The depth of the bars must be fairly considerable radially in order to allow for wear and for periodical turning down of the surface of the commutator to ensure cylindricity, otherwise sparkless commutation cannot be obtained. A usual figure for this depth is from 1in. to 2in. As to the materials referred to above, hard-drawn copper appears to be most suitable for the bars, or drop forgings may be used, suitable dimensions being chosen to allow for the use of the necessary lugs. As to the brushes, these should, of course, be of carbon, and as they may overlap more than one segment, this must, of course, be borne in mind, so that the diameter of the commutator is such that, according to its corresponding periphery and the proper width of the brush to give a suitable current density (which may be from 40 to 70 amperes per square inch, according as the carbons are hard or soft), the required number of segments only is under a brush at any particular instant.—L. R.

Answer to No. 1,021 (awarded 5s.).—The diameter of a direct-current armature being fixed from consideration of peripheral speed, the commutator diameter is fixed by the following considerations: firstly, the number of sections in the armature; secondly, the area of the surface of the commutator required to dissipate the watts lost in it. Manufacturing methods limit the size of a commutator section (commutator sections are very seldom made less than $\frac{1}{8}$in. wide on the periphery), the number of commutator sections being fixed from the design of armature winding. The minimum diameter of the commutator is, therefore, fixed in this respect. The length of the commutator being fixed by the number of brushes required to collect the current, the area of the commutator can be ascertained, thus minimum limit of diameter in this respect can be obtained. In multipolar machines the limit is generally fixed by the number of sections, and the commutators are made comparatively large in diameter and short in length. With the increased use of series armature windings the number of commutator sections is considerably reduced, and this enables the diameter of the commutator to be reduced accordingly. This is so much the case in modern large multipolar generators using series armatures and effecting commutation by interpoles, that the limit in this case is actually fixed by the size of the brush-holders, it being possible, as far as the above considerations are concerned, to make the commutator so small that the brush-holders practically touch one another. This has necessitated the redesign of the brush gear for these multipolar machines by several manufacturers. The cutting down of the size of the commutator by this method using series armatures cuts down the friction loss considerably, and also the cost of the commutator.—M. J.

Answer to No. 1,021 (awarded 5s.).—Mr. Vernon's question covers so large a field that it is impossible without fuller particulars as to the type of motor which he has in view to do more than indicate a few of the considerations involved.

The diameter and width of the commutator have to be chosen of such proportions that sufficient surface is obtained to dissipate the heat produced in the copper. According to the type of motor and the allowable peripheral speeds, each square inch of surface may be taken as being capable of dissipating a certain fraction of a watt for 1deg. C. rise. The heat produced is due partly to $C^2 R$ loss in the brush contact and partly to brush friction. A good average value for the coefficient of friction between brushes and commutator is 0·3, and brush pressure 1½lb. per square inch. Having calculated the tangential drag and converted work done against this into heat units per second, these may be converted into watts; this then represents one quantity which has to be dealt with in arriving at the surface required on commutator.

The peripheral speed of a commutator may be almost anything between 1,000ft. and 3,500ft. per minute. In any given case the actual peripheral speed is limited by the fact that the diameter of the commutator must be less than the armature, and also by considerations of economy and suitable thickness of segment. Suppose permissible peripheral speed of commutator = S feet per minute; minimum width of segment = t; number of poles = p; voltage of machine = V; and volts per segment = v; then

$$\text{Number of segments} = \frac{V}{v} \times p,$$

$$\text{and} \quad \text{Diameter of commutator} = \frac{V \times p \times t}{v \times \pi} \text{ (minimum)},$$

$$\text{or} \quad = \frac{S}{R.P.M. + \pi} \text{ (maximum)}.$$

With regard to the armature diameter, various conditions combine to decide the dimensions of an armature, the most important being the cost of material and labour as against the efficiency of operation. In a sense, these two factors are in opposition, and the design consists in effecting such a compromise that the greatest efficiency is obtained with the least cost, subject to such limitations as are imposed by the conditions under which the armature has to operate. The following points must be taken into consideration in deciding upon the diameter of an armature:

1. The peripheral speed of armature is limited by the centrifugal stresses which are permissible, and depends upon the mechanical design. It is of increasing value with the power of motor, and does not often exceed 5,000ft. per minute. Thomson gives a useful formula for the peripheral speed:

$$\text{Peripheral speed of armature} = a \times \frac{KW.}{KW. + b}$$

where a = 4,500 to 5,500 and b = 150 to 300, the upper and lower values being used with large and small machines respectively. Knowing the peripheral speed and the revolutions per minute of the motor (which latter is decided principally by the nature of service for which the motor is required) the maximum diameter can be arrived at, this being then reduced, if necessary, to suit other features of design, as

2. Another way of arriving at the diameter of armature is

$$\text{Diameter} = \frac{\text{Amperes} \times \text{volts}}{\text{Ampere bars per 1in. diameter} \times \text{volts per bar}}$$

Ampere bars per 1in. diameter not greater than 1,000, and volts per bar not greater than 10. The actual values of these factors being obtained from previous results.

3. Only a certain number of watts can be dissipated from the surface of an armature with a certain rise of temperature, depending upon the type of machine. This value also increases with the peripheral speed.

4. There is also a rule for finding the approximate diameter and length of an armature similar to the ordinary output equation:

$$(\text{Diameter in inches})^2 \times \text{length of core in inches} = \frac{c \times \text{watts output}}{R.P.M.}.$$

c has the following values: up to 5 kw., 80 to 200; 5 kw.

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to 30 kw., about 60; 30 kw. to 60 kw., about 40; 100 kw. upwards, about 30.

Having found this value of D^2 L it is usual to select such a diameter that D = number of pairs of poles × L (approximately); this ratio between D and L allowing of fairly square-shaped magnet pole-pieces and circular magnet cores.

5. A few words about the all-important feature—cost. Hobart says the cost of a motor is proportional to D × L, where D is the diameter of armature and L length, measured right across winding in barrel-wound armatures—*i.e.*, factory cost = K D L. K for continuous current = about 1s. There is, however, a good deal of difference of opinion as to whether cost is proportional to D × L, D^2 × L, or D to some intermediate power × L, and also as to whether L should represent length of core or winding.

I would suggest that the most satisfactory way for Mr. Vernon to arrive at the required ratio would be to work out the approximate dimensions for a few machines over the range of sizes required, using the constants applicable to the particular type of motor which he has in view, then plot these with, say, armature diameters as abscissæ and commutator diameters as ordinates. The curve so obtained may be used for interpolation to obtain the ratio for sizes lying between those calculated, or the equation connecting armature diameter and commutator diameter may be obtained by finding the law of the curve, which will possibly be a straight line, as the commutator generally comes out about ·66 diameter of armature.—R. P.

Question No. 1,022.—In a power-house with three-phase current, two 500-kw. three-phase transformers are run in parallel to raise the pressure from 3,000 volts to 10,000 volts. If required to add a 1,000-kw. transformer, what particulars are required by the designer so that the three transformers may run in parallel and each doing its proportion of the load. Give the tests necessary to get the above data.

Best Answer to No. 1,022 (awarded 10s.).—In order that transformers of various sizes may take their proper proportion of the load when operating in parallel, the following conditions must be satisfied: (1) the transformation ratio of each transformer must have the same value; (2) the "inherent regulation"—*i.e.*, drop in secondary voltage from no load to full load at constant primary impressed voltage and frequency—must also have the same value for each transformer. Thus, in order that the new 1,000-kw. transformer may take its proper share of the load when running in parallel with the 500-kw. transformers, the regulation curve of the former must coincide with that for the present 500-kw. transformers. If the regulation of the 1,000-kw. transformer is better than that of the present transformers, then it will take more than its share of the load, and this will be more noticeable at the higher loads, but will depend upon the characteristics of the regulation curve. Equality in the transformation ratio of transformers to be operated in parallel is, of course, obvious.

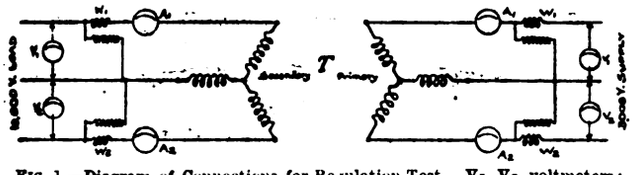

FIG. 1.—Diagram of Connections for Regulation Test. V_1, V_2, voltmeters; A_1, A_2, ammeters; W_1, W_2, wattmeters. NOTE.—The potential and current transformers for the voltmeters, ammeters, and wattmeters have not been shown.

The tests required in order that a satisfactory design may be made for the new transformer are, therefore, (1) ratio test and (2) regulation test. If, however, the new transformer is to be built by the same manufacturers as the existing ones, it will not be necessary to take these tests, as the required data would already be available.

Ratio Test.—This test consists of observations of the primary and secondary voltages at no load and normal frequency. At no load the ratio thus obtained is equal to the ratio of the number of turns in the primary and secondary windings. The voltage ratio is, however, not constant when the transformer is under load, due to the effects of magnetic leakage and inductive drop, which will be considered in the regulation test.

Regulation Test.—This test may be made under actual service conditions, indicating wattmeters being connected in the primary and secondary circuits (as shown in Fig. 1) in order to determine the power factor, or, alternatively, a power-factor indicator may be employed. In a regulation test the primary voltage and frequency should be maintained constant, while the load on the secondary is increased from no load to 50 per cent. overload, readings of volts, amperes, and watts being recorded at various loads on the primary and secondary side. The percentage regulation is given by

$$\frac{\text{No-load secondary voltage} - \text{full-load secondary voltage}}{\text{No-load secondary voltage}} \times 100.$$

If possible, regulation curves should be taken at unity power factor and at the power factor which the transmission plant usually operates at. The test on a power factor below unity is necessary in order to observe the effect of magnetic leakage, since this is considerably increased

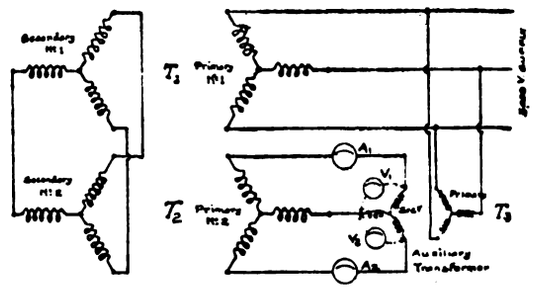

FIG. 2.—Diagram of Connections for Impedance Test under full load conditions. T_1, T_2, 500-kw transformers; A_1, A_2, ammeters; V_1, V_2, voltmeters; T_3, auxiliary transformer having a variable-voltage secondary giving voltages from about 600 to 700 volts.

when there is a phase difference between the secondary current and E M.F. The above tests give the designer all the necessary data for designing the new transformers to operate in parallel with the existing ones. If the above regulation test cannot be made, some further readings will be required in order that the regulation may be calculated. These additional tests are: (*a*) ohmic resistance of both windings, and (*b*) impedance of complete transformer under full-load conditions. The first test (*a*) is, of course, taken using continuous current, and the temperature of the windings at the time of measuring the resistance should be noted. The impedance test (*b*) is preferably carried out using the method shown in Fig. 2, where two similar transformers are required, and also a small auxiliary transformer. The secondary windings of the transformers under test are "solidly" short-circuited and connected in relation to the primary, so that the E M.F.'s induced in them oppose one another. The primary of one transformer is connected directly across the supply, while the other is connected in series with the low-tension winding of the auxiliary transformer through suitable ammeters. The

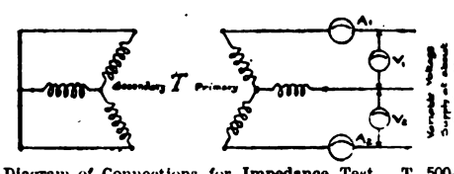

FIG. 3.—Diagram of Connections for Impedance Test. T, 500-kw. transformer; A_1, A_2, ammeters; V_1, V_2, voltmeters. The voltage of supply at the primary (3,000 v. winding) should be variable at about 300/350 volts.

auxiliary transformer is connected so as to "boost" the voltage across the primary of the larger transformer. The voltage of the auxiliary transformer is adjusted until the ammeters indicate full-load current, when the voltage supplied by this transformer is observed. One half of this voltage divided by the current gives the impedance of one transformer under full-load conditions. If, however, two similar transformers are not available, this impedance test must be taken on one transformer by "solidly" short-circuiting its secondary, and gradually applying voltage to the primary until full-load current is circulating (Fig. 3). Then the voltage across primary winding divided by the current gives the impedance, which is somewhat lower than that under full-load conditions due to the low flux density in the core.

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Having obtained the impedance and resistance of the transformer, the regulation can be calculated by applying the method originated by Prof. Kapp, the construction of the vector diagram being shown in Fig. 4. Thus the radius of arc F G represents the no-load voltage of the secondary at normal primary voltage and frequency. A vector O A is arbitrarily chosen to represent the direction of the terminal voltage of the secondary when loaded, while O I represents the secondary current, lagging by an angle ϕ (cos ϕ being the power factor). O D represents the impedance drop corresponding to the current O I, making an angle $\tan^{-1}\frac{L\,p}{R}$* with O I. From D a line, D C, is drawn parallel to O A, cutting the arc F G in C. Join C O and draw C A parallel to O D, cutting O A at A. Then O A represents the terminal voltage of the secondary

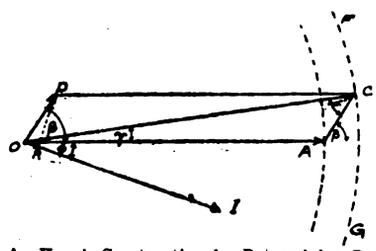


FIG. 4.—Kapp's Construction for Determining Regulation

corresponding to a load current of O I, at a power factor equal to cos ϕ, and at normal primary voltage and frequency. The percentage regulation is, therefore,

$$\frac{O\,C - O\,A}{O\,C} \times 100.$$

The regulation may be calculated from the diagram analytically thus (adopting the notation of Fig. 4):

$$\beta = \left\{\tan^{-1}\frac{L\,p}{R} - \phi\right\} = \left\{\tan^{-1}\frac{\text{equivalent reactance}}{\text{equivalent resistance}} - \phi\right\}$$

$$\sin\gamma = \frac{A\,C}{O\,C}\sin\beta = \sin\beta\left\{\frac{\text{impedance drop}}{\text{no-load voltage}}\right\}.$$

$$\frac{O\,A}{O\,C} = \frac{\sin\alpha}{\sin\beta} = \frac{\sin(\beta-\gamma)}{\sin\beta}.$$

Whence, percentage regulation

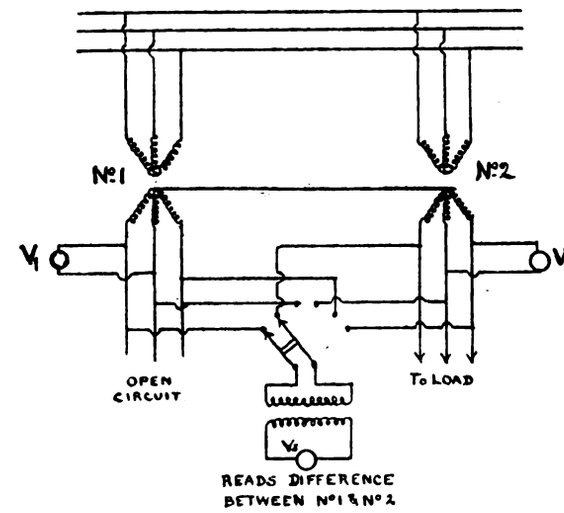
$$= 100 \times \frac{O\,C - O\,A}{O\,C} = 100 \times \frac{\left(O\,C - \frac{\sin(\beta-\gamma)}{\sin\beta}\,.\,O\,C\right)}{O\,C}$$

$$= 100\left\{1 - \frac{\sin(\beta-\gamma)}{\sin\beta}\right\}$$

or $$= 100\left\{1 - \left(\cos\gamma - \frac{\text{impedance drop}}{\text{no-load voltage}}\,.\,\cos\beta\right)\right\}.$$

It will be noted that this construction is applicable to power factors below unity, and that the tests required to furnish the necessary data are relatively simple.—A. E. T.

Answer to No. 1,022 (awarded 5s.).—In order that the 1,000-kw. transformer may run in parallel with the two 500-kw. transformers, it is necessary that the voltage at the terminals (secondary) of the transformers shall be equal at all loads. This means that as the total load supplied by the three transformers varies in amount, the 1,000-kw. transformer shall be supplying 50 per cent. and the 500-kw. transformers 25 per cent. each of the total load, and at the same time any drop of voltage on the secondary side shall be equal on the three transformers. The important point to measure, therefore, is the drop in voltage on the secondary of the 500-kw. transformers from zero load to full load, assuming that the primary voltage is constant. In order to do this the voltage on the primary and secondary should be measured at various loads up to full load. Wattmeter readings should also be taken on the secondary in order that the power factor may be noted and the load regulated (if an artificial load) to the required power factor. As the drop in voltage is what is really required, it will be seen that the voltage on full load is to be subtracted from the voltage on open-circuit secondary in order to obtain the drop. Any error made in determining either the open-circuit voltage or the full-load voltage will be a large error when compared with the difference between these two voltages. As an example, suppose the voltmeter used can be read to an accuracy of 1 per cent. Such a voltmeter is quite useless for the purpose, because the drop on the secondary from no load to full load will be of the order of 2 per cent. We must, therefore, abandon the "method of differences," as the above method is called, and make a direct measurement of the difference. As the two 500-kw. transformers run satisfactorily in parallel at the present time, we will use them both in making the test. The diagram shows the



connections to be made. No. 1 transformer is on open circuit throughout the test, and No. 2 transformer is connected to the load. The two-pole three-way key can be switched over so as to read the amount by which the voltage of No. 2 is less than No. 1, as measured from the neutral point of the two transformers. As both transformers are connected to the same supply, any small alterations in the voltage will not affect the results obtained The two-pole three-way key is connected to the primary of a potential transformer, the secondary coil being connected to the voltmeter V_3. The voltmeters V_1 and V_2 will serve to show that No. 1 and No. 2 are working normally. With regard to the load, the most economical way would be to make the tests with the transformer doing its actual work. Failing this, a water load might be used with a choking coil for regulating the power factor. If a synchronous motor is available, this would form a convenient means of regulating the power factor of the load by altering its exciting current. If the transformers are oil-immersed and water-cooled, the temperature of the oil, as well as the temperature of the water inflow and outflow, should be noted. If the amount of water passing per unit time was also observed, it would be useful for the designer.—B. R. S. L.

[Other replies to Question No. 1,022 will be given in our next issue.—ED. *E. E.*]

* The equivalent resistance, R, of a transformer, referred to its secondary circuit, is

$$r_2 + r_1\left(\frac{S_2}{S_1}\right)^2,$$

where r_1, S_1, and r_2, S_2 are the resistances and number of turns respectively of primary and secondary. Since

$$\frac{S_2}{S_1} = \frac{\text{no-load secondary voltage}}{\text{no-load primary voltage}} = \frac{1}{K},$$

where K is the "ratio" of the transformer, therefore the value of R in $\tan^{-1}\frac{L\,p}{R}$ is:

$$R = r_2 + r_1\left(\frac{1}{K}\right)^2,$$

r_2 and r_1 being determined by suitable means. The term p L is the equivalent reactance, and is obtained from:

$$\text{Equivalent reactance} = \sqrt{(\text{impedance})^2 - (\text{equivalent resistance})^2}$$

$$= \sqrt{(\text{impedance})^2 - \left[r_2 + r_1\left(\frac{1}{K}\right)^2\right]^2}$$

the impedance being determined by the methods described above.

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